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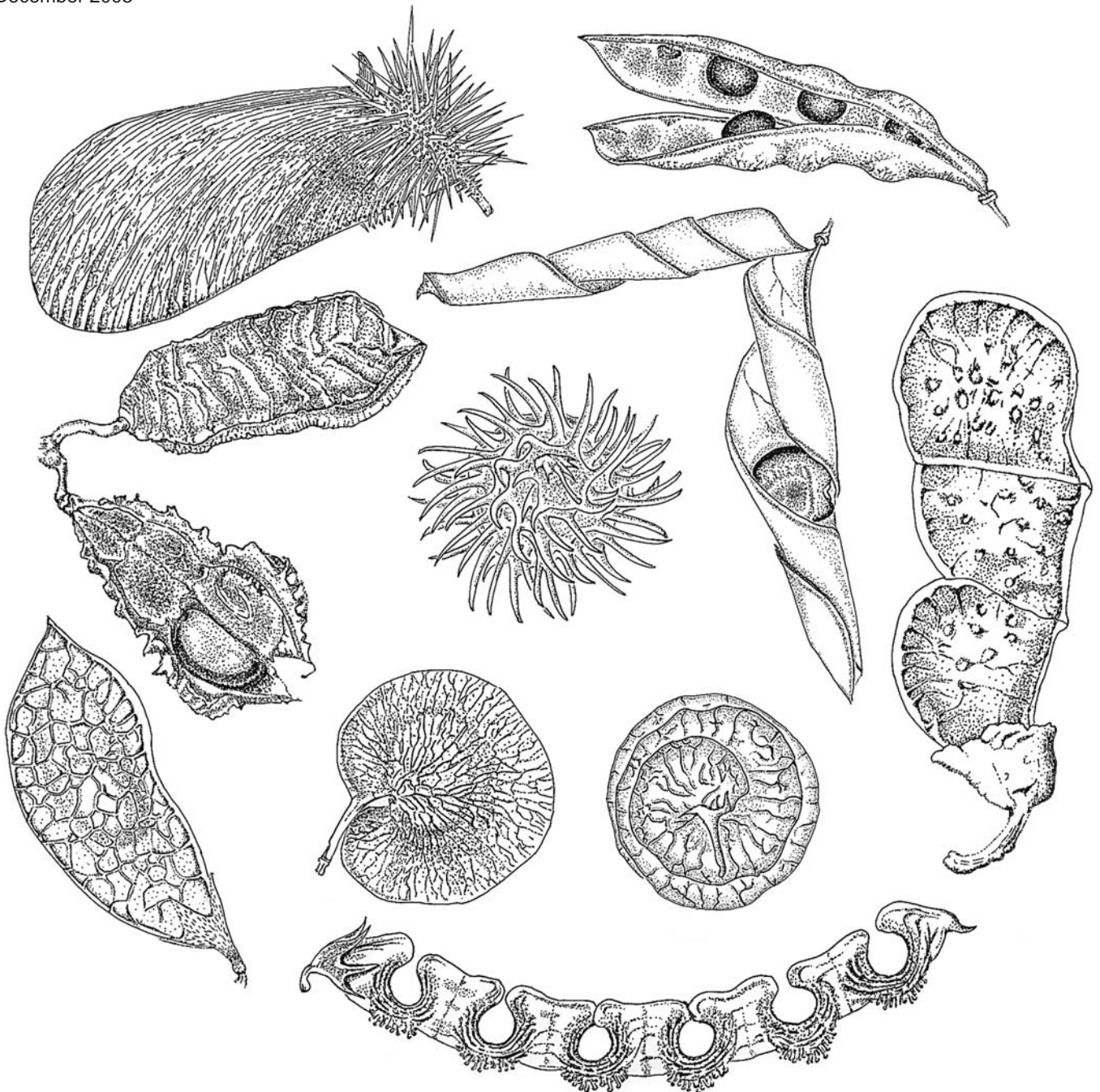
Agricultural
Research
Service

Technical Bulletin
Number 1890

December 2003

Fruits and Seeds of Genera in the Subfamily Faboideae (Fabaceae)

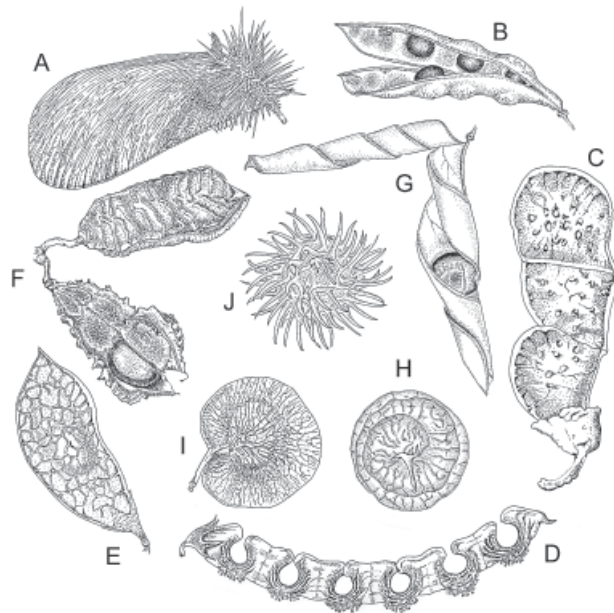
Volume II



Fruits and Seeds of Genera in the Subfamily Faboideae (Fabaceae)

Volume II

Joseph H. Kirkbride, Jr., Charles R. Gunn, and
Anna L. Weitzman



Fruits of A, *Centrolobium paraense* E.L.R. Tulasne. B, *Laburnum anagyroides* F.K. Medikus. C, *Adesmia boronoides* J.D. Hooker. D, *Hippocrepis comosa*, C. Linnaeus. E, *Campylotropis macrocarpa* (A.A. von Bunge) A. Rehder. F, *Mucuna urens* (C. Linnaeus) F.K. Medikus. G, *Phaseolus polystachios* (C. Linnaeus) N.L. Britton, E.E. Stern, & F. Poggenburg. H, *Medicago orbicularis* (C. Linnaeus) B. Bartalini. I, *Riedeliella graciliflora* H.A.T. Harms. J, *Medicago arabica* (C. Linnaeus) W. Hudson.

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Desmodieae (11.01–11.25)

Genus: *Brya* P. Browne

Phylogenetic Number: 11.01.

Tribe: Desmodieae.

Subtribe: Bryinae.

Species Studied—Species in Genus: 4 spp.—4 spp.

Fruit a legume or loment (or loment segment); 0.8–2.5 (upper length is estimated) \times 0.6–0.9 \times 0.07–0.08 cm; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight or curved (or slightly curved); not plicate; not twisted; asymmetrical; moniliform (with more or less elongated isthmuses); when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; widest near middle or D-shaped; not inflated; flattened; without beak; rounded at apex; apex oblique with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain. Fruit substipitate or nonstipitate. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 8–15 mm long; widest across seed area; with all essentially similar in shape; D-shaped or curved. Epicarp dull; monochrome; brown (dark reddish to greenish); pubescent and indurate; with 2 or 3 types of pubescence; puberulent; with pubescence gray (short and plain tipped) or golden (long and gland tipped); with golden hooked and gray plain hairs; with pubescence uniformly distributed; with simple and glandular hairs; pliable; with hair bases plain; glandular; with glandular hairs; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp absent. Endocarp more or less glossy; monochrome; tan; fibrous (to somewhat smooth in seed chamber); septate; with septa thicker than paper, firm; with septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1 or 2; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; up to 1 mm long; of 1 length only; flattened; curved. Aril absent.

Seed 3.5–5 \times 2–3.5 \times 0.5–0.6 mm; not overgrown; not angular; asymmetrical; reniform; flattened; with surface

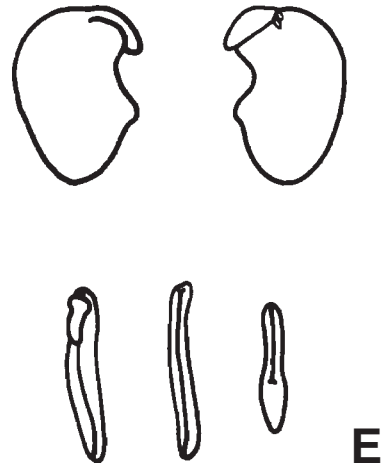
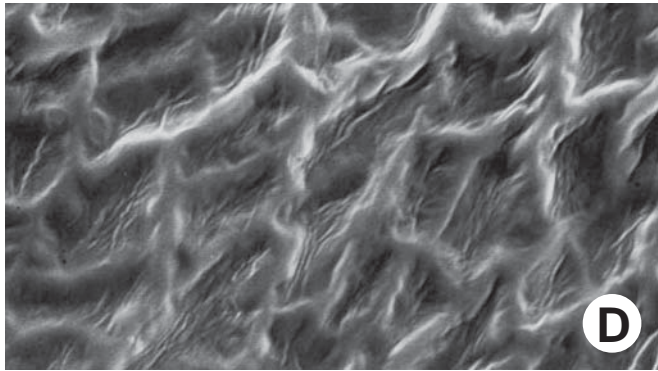
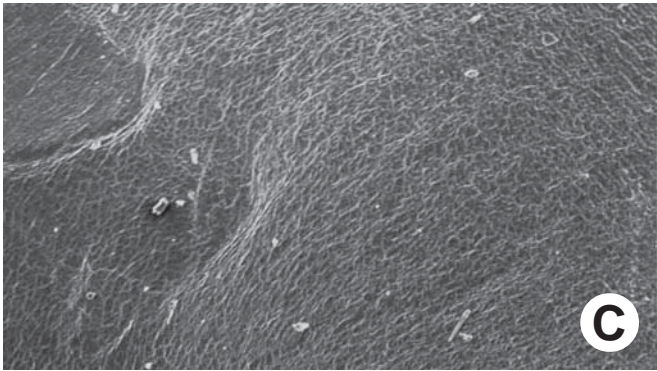
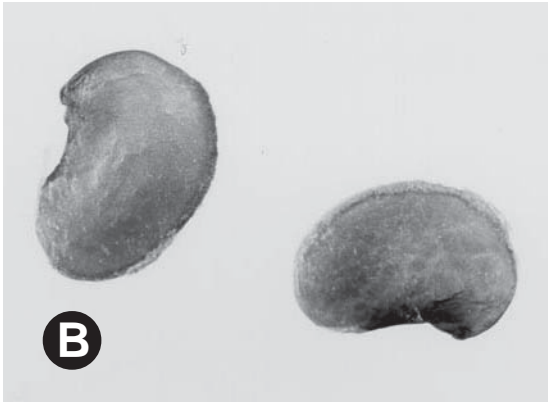
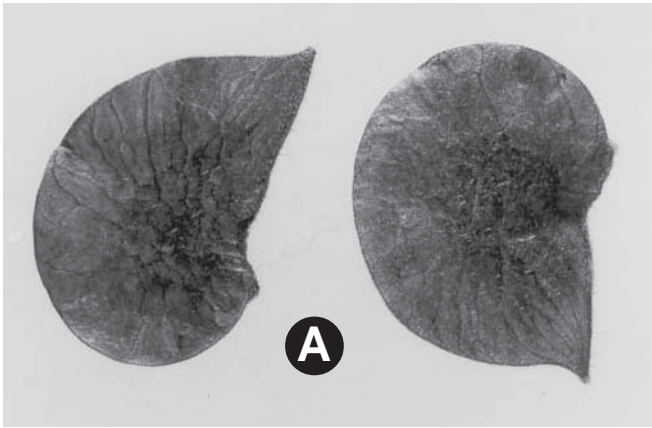
smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; with umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown; glabrous; smooth; chartaceous. Fracture lines absent. Rim absent. Wings absent. Raphe from lens to base of seed and terminating; not bifurcating; darker than testa; dark reddish brown; raised. Hilum fully concealed; concealed by funicular remnant; without faboid split; punctiform or larger than punctiform; 0.2–0.5 mm long; with straight outline; oblong; between cotyledon and radicle lobe; flush; within halo. Hilum halo color darker than testa. Lens not discernible. Endosperm absent. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; notched at radicle; with lobes; with lobes not touching; without basal groin formed by lobes; with the interface division terminating at base of radicle; without margins recessed; reddish tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Cuba (1 sp.) extending to Jamaica and another species to Hispaniola.

Notes: Ohashi et al. (1981) started their treatment of the *Desmodieae* with these thoughts: “A sensible classification of *Desmodieae* is prejudiced by the traditional over-weighting of fruit characters.” [sic] “The fruit normally consists of indehiscent jointed articles, but fruits that open have arisen at least seven times...” They supplemented their text with a fruit-seed plate. They placed *Brya* and *Cranocarpus* (11.02), the only two New World endemic genera, in the new subtribe *Bryinae*, “characterized most notably by glochidiate hairs.” Bailey et al. (1997), using the chloroplast *rpl2* intron and ORF184, suggested that *Brya*, *Cranocarpus*, *Phylacium* (11.22), and *Neocolletia* (11.26) are not members of *Desmodieae* and that they probably belong in *Aeschynomeneae* (14). Lewis (1988) provided a plate showing the fruit and seed of *B. ebenus*.

Brya: *B. ebenus* (C. Linnaeus) A.-P. de Candolle (A–E). A, Fruits (\times 3); B, seeds (\times 5.4); C–D, testa (\times 50, \times 1000); E, embryos (\times 5).

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Genus: *Cranocarpus* G. Bentham

Phylogenetic Number: 11.02.

Tribe: Desmodieae.

Subtribe: Bryinae.

Species Studied—Species in Genus: 2 spp.—3 spp.

Fruit a loment (or loment segment or a 1-seeded loment); 1–2 × 0.5–0.8 cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; irregular or reniform; when asymmetrical with both sutures unequally curved or 1 straight and 1 curved; narrowing in several places, resembling *Desmodium* (11.09) fruit; not inflated; flattened; without beak; rounded at apex; apex right-angled or more with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally visible. Fruit margin constricted or not constricted; constricted only on 1 margin; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 8–13 mm long; widest across seed area; with all essentially similar in shape; D-shaped (to galeiform). Epicarp dull; monochrome; reddish brown; pubescent and indurate; with 1 type of pubescence; villous; with pubescence gray; with pubescence uniformly distributed; with simple and glandular hairs (the simple hairs longer than the glandular ones); stiff and pliable; with hair bases plain; with glandular hairs; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Seeds 1 or 2; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only. Aril absent.

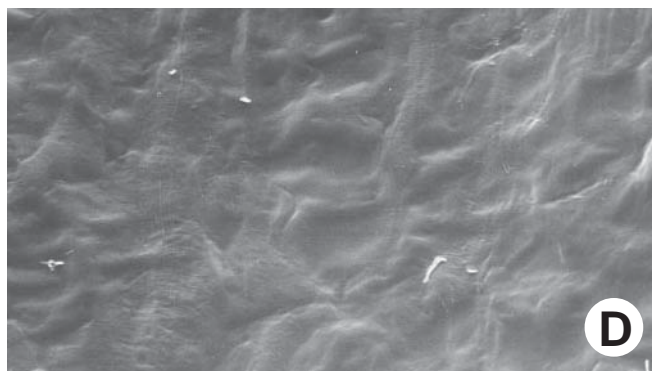
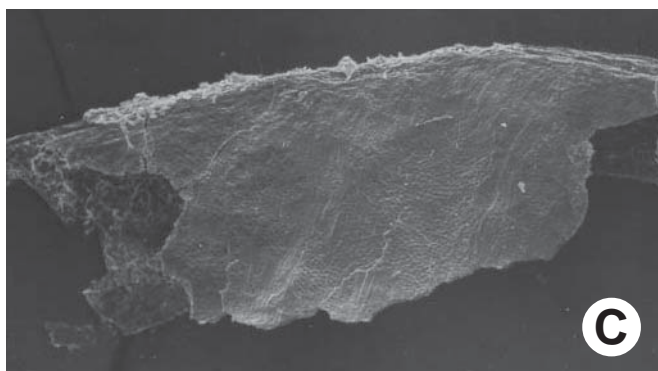
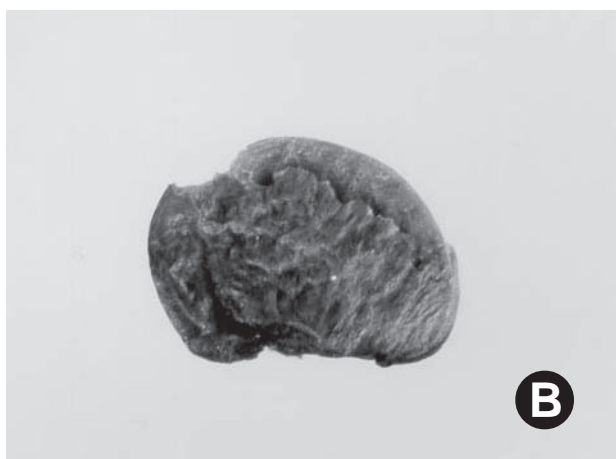
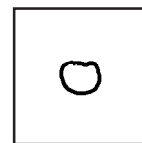
Seed ca. 5.5 mm long; ca. 4 mm wide; ca. 1 mm thick; not overgrown; not angular; asymmetrical; reniform; flattened; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces; without medial ridge on each face. Cuticle not exfoliating; not inflated; not wrinkled. Testa without pieces of adhering epicarp; not adhering to endocarp; free from endocarp; dull; not modified by a

bloom; colored; monochrome; reddish brown; glabrous; smooth; chartaceous. Pseudopleurogram absent. Fracture lines absent. Rim absent. Wing(s) absent. Raphe not visible. Hilum fully concealed; concealed by aril remnant; with faboid split (assumed); larger than punctiform; ca. 0.4 mm long; with straight outline; linear; flush; not within corona, halo, or rim. Lens discernible; ca. 0.3 mm long; with margins straight; linear; not in groove of raphe; adjacent to hilum; ca. 0.2 mm from hilum; flush; dissimilar color from testa; black; not within corona, halo, or rim.

Distribution: Brazil.

Notes: Bailey et al. (1997), using the chloroplast *rpl2* intron and ORF184, suggested that *Cranocarpus* is not a member of Desmodieae and that it belongs in Aeschynomeneae. Harley (1978) monographed *Cranocarpus* (with two species), and Fernandes and Bezerra (1979) named a new species. According to Harley (1978), *C. mezii* P.H.W. Taubert has one- or two-seeded fruits that are loment, and *C. martii* has one-seeded fruits by abortion of the lower ovule. The fruits of *C. martii* are homologous to those of *C. mezii*, and therefore are one-seeded loment. We had only one misshapen seed and one fruit for study.

Cranocarpus: *C. martii* G. Bentham (A–D). A, Fruit (× 3.7); B, seed (× 8.4); C–D, testa (× 50, × 1000).



Genus: *Arthroclianthus* H.E. Baillon

Phylogenetic Number: 11.03.

Tribe: Desmodieae.

Subtribe: Desmodiinae.

Species Studied—Species in Genus: 13 spp.—ca. 10 spp.

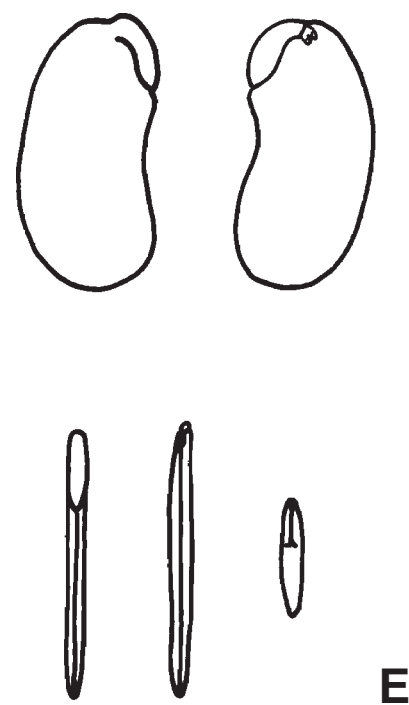
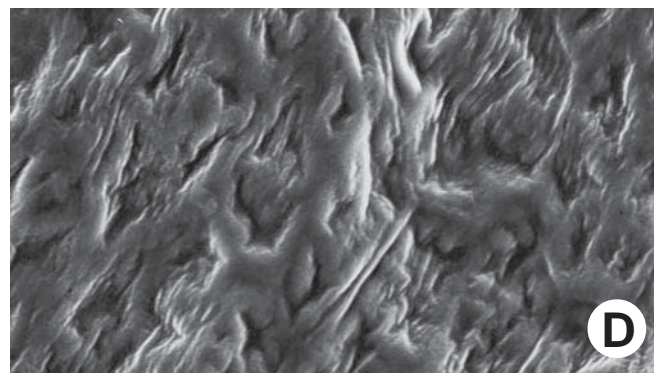
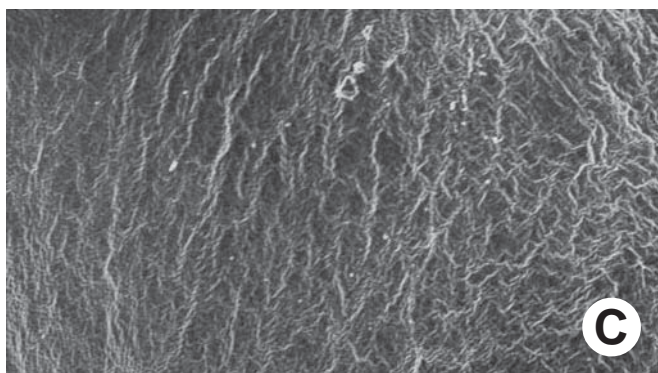
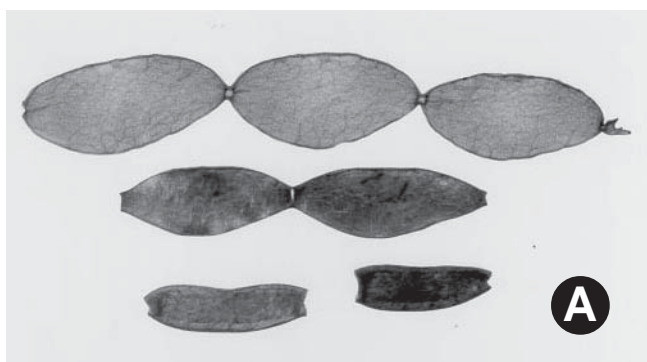
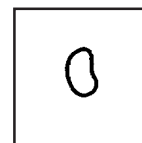
Fruit a loment (or loment segment); 8–14 × 0.5–1.2 × 0.1–1.15 cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; asymmetrical or symmetrical; moniliform (some with elongated isthmuses) or linear; when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; narrowing in several places, resembling *Desmodium* (11.09) fruit; not inflated; flattened; with beak; straight; with solid beak the same color and texture as fruit; rounded at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit stipitate; with the stipe 14–40 mm long. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 14–35 mm long; widest across seed area; with all essentially similar in shape; D-shaped or oblong. Epicarp dull; monochrome; greenish brown to brown; pubescent and indurate or glabrous; with 1 type of pubescence; pilose; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface uniformly veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp glossy; monochrome; greenish tan; smooth; septate; with septa thicker than paper, firm; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 4–9; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; triangular; straight. Aril absent.

Seed 7–9 × 4–4.5 × 0.4–0.5 mm; not overgrown; not angular; asymmetrical; reniform (sub-); flattened; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown; glabrous; smooth; chartaceous. Fracture lines absent. Rim absent. Wings absent. Raphe from hilum to lens (near base of seed); not bifurcating; darker than testa; dark reddish brown; raised. Hilum fully concealed; concealed by funicular remnant; without faboid split; punctiform; marginal according to radicle tip; flush; within rim. Hilum rim color darker than testa. Lens discernible; less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; adjacent to hilum; 2.5 mm from hilum (length of raphe); mounded; similar color as testa; darker than testa; dark reddish brown; not within corona, halo, or rim. Endosperm absent. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

Distribution: New Caledonia.

Notes: Hochreutiner (1907) monographed the genus, and Ohashi et al. (1981) noted that *Arthroclianthus* is scarcely distinct from *Nephrodesmus* (11.04). We are unable to ascertain which of about ten species Ohashi et al. recognized.

Arthroclianthus: *A. pseudo-malaccensis* E. Vieillard ex A.T. Brongnairt & J.A.A. Gris (C–E), *A. spp.* (A–B). A, Fruit segments and articles (× 1); B, seeds (× 6.8); C–D, testa (× 50, × 1000); E, embryos (× 5).



Genus: *Nephrodesmus* A.K. Schindler

Phylogenetic Number: 11.04.

Tribe: Desmodieae.

Subtribe: Desmodiinae.

Species Studied—Species in Genus: 0 spp.—6 spp.

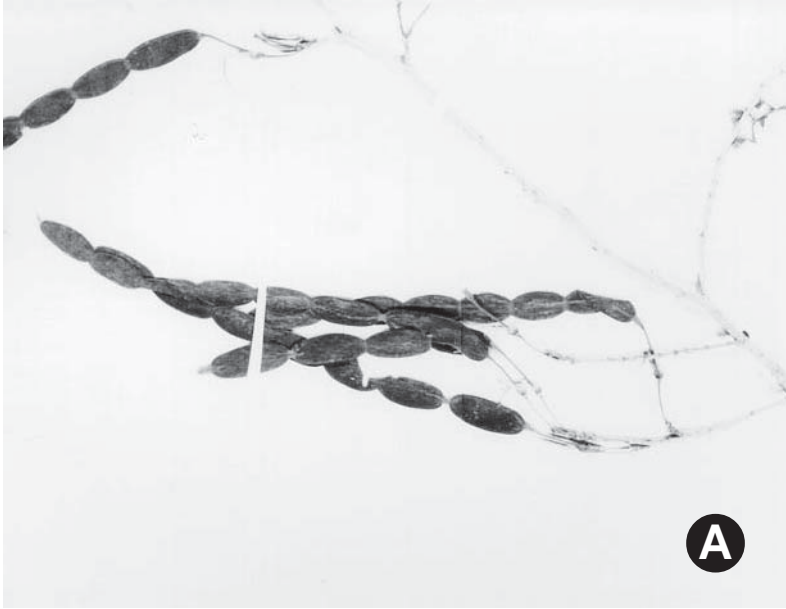
Fruit a loment (or loment segment); up to 15×0.7 – 0.85×0.1 – 0.4 (assumed) cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; asymmetrical or symmetrical; moniliform; when asymmetrical with both sutures parallelly curved; not inflated; flattened; without or with beak; straight; with solid beak the same color and texture as fruit; rounded at apex; apex aligned with longitudinal axis of fruit; rounded at base; base oblique with longitudinal axis of fruit; with the apex and base uniform in texture; membranous or chartaceous (both assumed); seed chambers externally visible. Fruit margin constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit stipitate; with the stipe 10–15 mm long. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 15–20 mm long; widest across seed area; with all essentially similar in shape; oblong. Epicarp dull; monochrome; greenish brown or green; pubescent and indurate; with hairs appressed; with 1 type of pubescence; with pubescence reddish brown; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; longitudinally veined relative to fruit length (assumed); not tuberculate; not exfoliating; without cracks. Mesocarp present or absent (assumed to be like *Desmodium* (11.09)). Endocarp septate; with septa thicker than paper, firm; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 8–9; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only.

Distribution: New Caledonia.

Notes: Ohashi et al. (1981) noted that *Nephrodesmus* is scarcely distinct from *Arthroclianthus* (11.03). Neither seeds nor fruits were available for study. The only materials available for study were a xeroxed herbarium sheet labeled *N. sericeus* (B.P.G. Hochreutiner) A.K. Schindler collected by S.-R. Lenormand (2941), New

Caledonia (Royal Botanic Gardens, Kew) and *N. albus* collected by B. Balansa (2808), New Caledonia (The Natural History Museum (London)). Another sheet of *M. balansa* (Royal Botanic Gardens, Kew) was studied from a colored photograph.

Nephrodesmus: *N. albus* A.K. Schindler (A). A, Fruits from a colored photograph of a specimen collected by M. Balansa 2808 New Caledonia and accessioned at Kew ($\times 0.6$).



Genus: *Trifidacanthus* E.D. Merrill

Phylogenetic Number: 11.05.

Tribe: Desmodieae.

Subtribe: Desmodiinae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a loment (or loment segment); $2.8-6 \times 0.5-0.7 \times 0.055-0.057$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; asymmetrical; moniliform; when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; narrowing in several places, resembling *Desmodium* (9.09) fruit; not inflated; flattened; with beak; straight or declined; with solid beak the same color and texture as fruit; rounded at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted on 1 margin and slightly constricted on the other margin; without sulcus; plain. Fruit wings absent. Fruit stipitate; with the stipe 9–25 mm long. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 2.5–10 mm long; widest across seed area; with all essentially similar in shape; D-shaped, oblong, or quadrangular. Epicarp dull; monochrome; brown or tan; pubescent and indurate; with 1 type of pubescence; puberulent; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; reddish brown; smooth; septate; with septa thicker than paper, firm; with septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 3–8; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; triangular; straight. Aril dry; rim-aril; reddish brown.

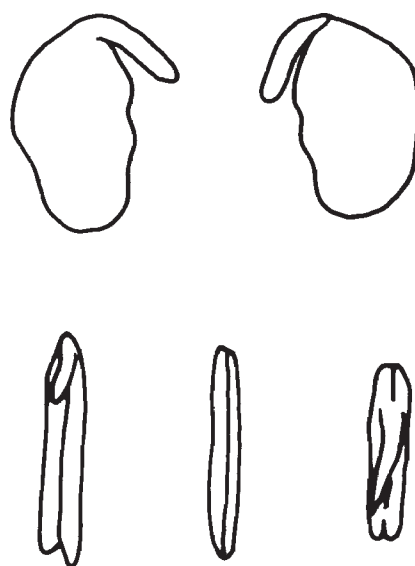
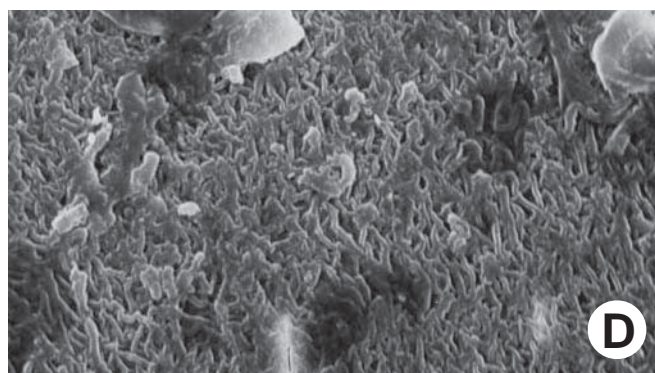
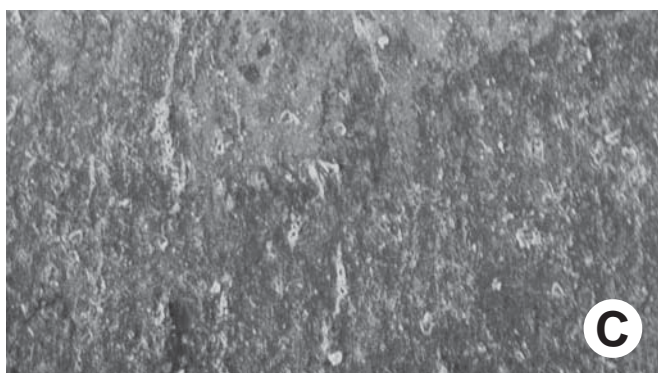
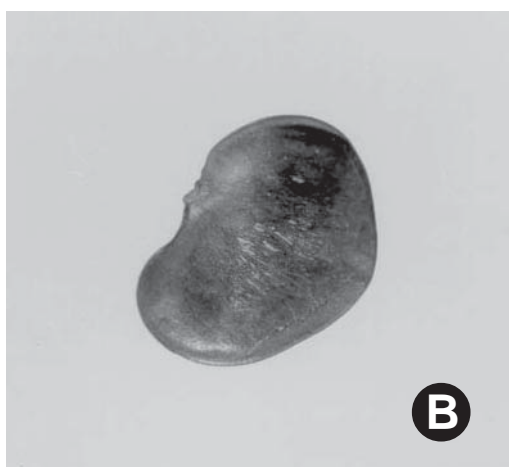
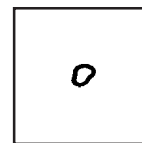
Seed $2-4.5 \times 1-1.4 \times 0.7-0.8$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces.

Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.4 mm long; with curved outline; elliptic; marginal according to radicle tip or between cotyledon and radicle lobe; recessed; not within corona, halo, or rim. Lens discernible; less than 0.5 mm in length or equal to or greater than 0.5 mm in length; 0.5 mm long; with margins straight; linear; not in groove of raphe; confluent with hilum; recessed; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; inner face flat. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip straight; oblique to cotyledons; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary.

Distribution: Vietnam, Hainan, Philippines, and Lesser Sunda Islands.

Notes: Merrill (1917) founded the genus without seeing fruits; 2 years later he described the fruits (Merrill 1919). Ohashi et al. (1996) revised the genus and concluded that it is a distinct, monotypic genus in tribe Desmodieae.

Trifidacanthus: *T. unifoliolatus* E.D. Merrill (A–E). A, Fruit (immature and nearly entire) and article (mature) ($\times 3$); B, seed ($\times 7.6$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 7$).



Genus: *Dendrolobium* (R. Wight & G.A.W. Arnott) G. Bentham

Phylogenetic Number: 11.06.

Tribe: Desmodieae.

Subtribe: Desmodiinae.

Species Studied—Species in Genus: 11 spp.—13 spp.

Fruit a loment (or loment segment) or legume; unilocular; 0.9–4.5 × 0.5–0.85 × 0.12–0.3 cm; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; slightly curved, straight, or curved; not plicate; not twisted; asymmetrical; moniliform, linear, or falcate (sub-); when asymmetrical with both sutures parallelly curved or 1 straight and 1 curved suture; narrowing in several places, resembling *Desmodium* (11.09) fruit; not inflated; compressed or flattened; with or without beak; straight; with solid beak the same color and texture as fruit; short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered or rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; lignous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted along both margins; without sulcus; plain. Fruit substipitate or nonstipitate. Fruit indehiscent. Replum invisible. Loment an intact article; indehiscent. Loment segments (articles) inconspicuous; 7–8 mm long; widest across seed area; with all essentially similar in shape; D-shaped or quadrangular. Epicarp dull; monochrome; reddish brown; pubescent and indurate, glabrous, or glabrate; with hairs appressed or erect; with 1 type of pubescence; tomentose; with pubescence golden; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; not veined or reticulately veined (*D. dispernum* (B. Hayata) A.K. Schindler and *D. rostratum* (A.K. Schindler) A.K. Schindler); not tuberculate; wrinkled; not exfoliating; without cracks. Mesocarp thick; surface not veined; 1- or 2-layered; without balsamic vesicles; without fibers; solid; with honeycomb layer over solid layer; lignous. Endocarp glossy; monochrome; tan (to reddish); smooth; septate; with septa thicker than paper, firm; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–8; length parallel with fruit length; neither overlapping nor

touching; in 1 series. Funiculus measured or less than 0.5 mm long; 0.5 mm long; of 1 length only; thick; straight. Aril absent.

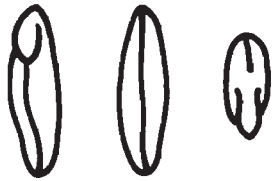
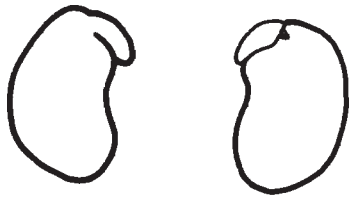
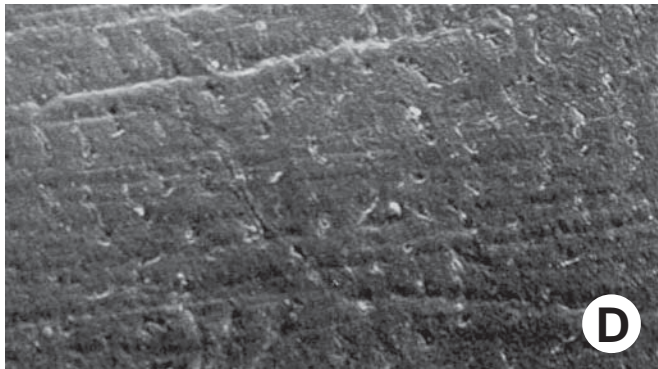
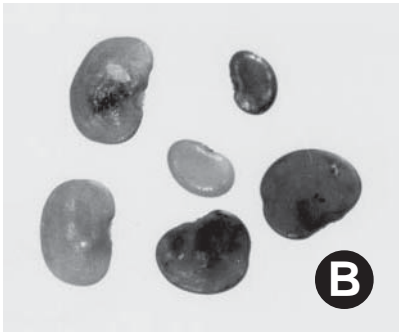
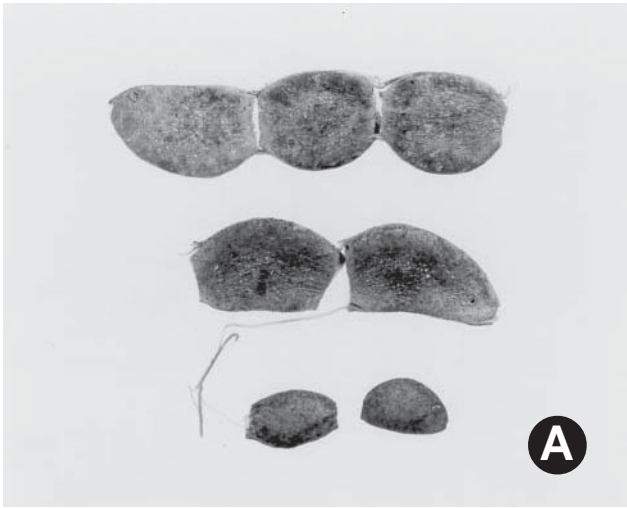
Seed 3–3.6 × 2–2.8 × 1–1.6 mm; not overgrown; not angular; asymmetrical; oblong, ovate, elliptic, or quadrangular; compressed; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without or with umbo on seed faces; with umbo on both faces of seed. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome; reddish brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible or fully concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; marginal according to radicle tip; recessed; within rim. Hilum rim color of testa. Lens discernible; less than 0.5 mm in length or equal to or greater than 0.5 mm in length; 0.5 mm long; with margins straight or curved; triangular or linear; 2 circular mounds separated by groove; not in groove of raphe; confluent with hilum; mounded; dissimilar color from testa; darker than testa; dark reddish brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa or adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear or bulbous; deflexed and parallel to cotyledon length or width; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed or rudimentary; glabrous.

Distribution: Tropical Asia, Australia, and Indian Ocean coastal region.

Notes: Ohashi (1973) monographed the genus and provided illustrations of fruits and seeds. He (Ohashi 1997b,c) also reviewed the species of Malesia, Australia, and Fiji and *D. cumingianum* G. Bentham.

Dendrolobium: *D. lanceolatum* (S.T. Dunn) A.K. Schindler (C–E), *D.* spp. (A–B). A, Fruit segment and articles (× 2.3); B, seeds (× 2.6); C–D, testa (× 50, × 1000); E, embryos (× 5).

3



E

Genus: *Phyllodium* A.N. Desvaux

Phylogenetic Number: 11.07.

Tribe: Desmodieae.

Subtribe: Desmodiinae.

Species Studied—Species in Genus: 6 spp.—6 spp.

Fruit a loment (or loment segment) or legume; unilocular; 0.4–4 × 0.3–0.4 × 0.1–0.15 cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (or slightly curved); not plicate; not twisted; asymmetrical; when asymmetrical with 1 straight and 1 curved suture; widest near middle or D-shaped; not inflated; flattened; with beak; straight or coiled; with solid beak the same color and texture as fruit; rounded at apex; apex aligned or oblique with longitudinal axis of fruit; short tapered or rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted on 1 margin and slightly constricted on the other margin; without sulcus; plain or embellished; with fringe (of hair). Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 3–4 mm long; widest across seed area; with upper and lower 1 different shape than middle ones; D-shaped or quadrangular. Epicarp dull; monochrome; reddish brown; pubescent and indurate; with hairs erect or appressed; with 1 type of pubescence; pilose; with pubescence golden or gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; veined or not veined; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; chartaceous. Endocarp dull; monochrome or mottled and streaked (area below seed somewhat streaked and mottled to lighter colored); reddish brown or tan (reddish); with mottling over seed chambers; with brown (reddish) or tan (reddish) overlay; smooth; septate; with septa thicker than paper, firm; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–9; length transverse to fruit length; neither overlapping nor

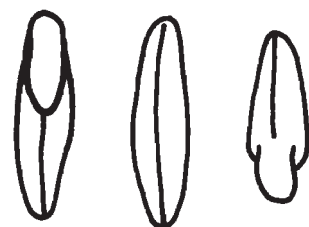
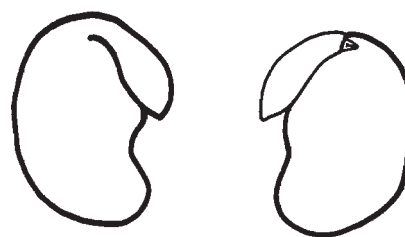
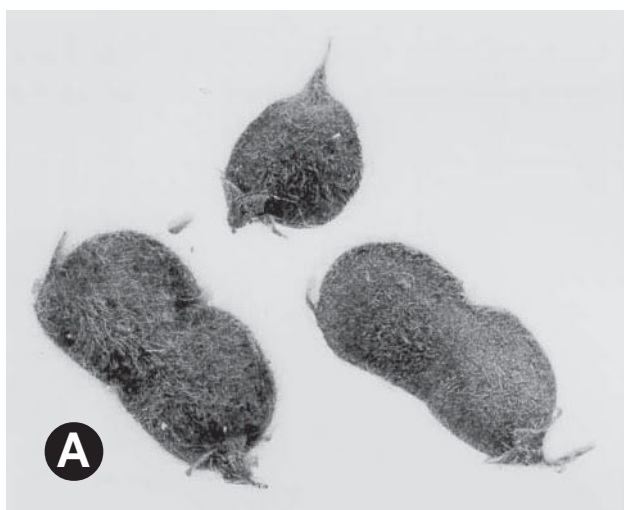
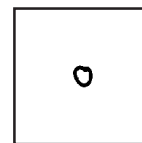
touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; flattened; straight. Aril dry; rim-aril; tan.

Seed 2.2–4 × 1.8–3 × 1 mm; not overgrown; not angular; symmetrical or asymmetrical; reniform; compressed; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome; reddish brown or tan; glabrous; smooth; chartaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform or punctiform; 0.5 mm long; with curved outline; circular; marginal according to radicle tip; recessed; not within corona, halo, or rim. Lens discernible; less than 0.5 mm in length; with margins straight or curved; linear or wedge-shaped; circular; not in groove of raphe; confluent with hilum; mounded; dissimilar color from testa; darker than testa; black or tan (reddish); not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; white or tan (to nearly white); inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

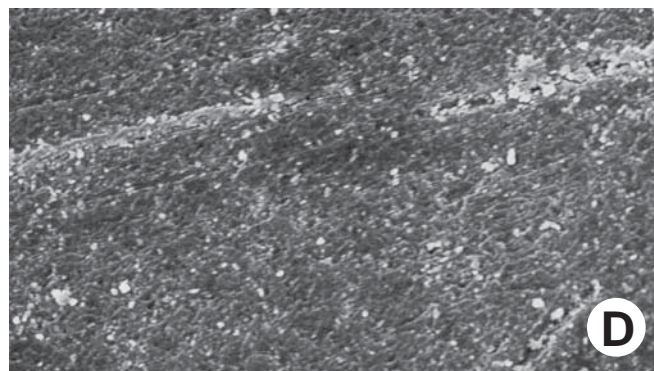
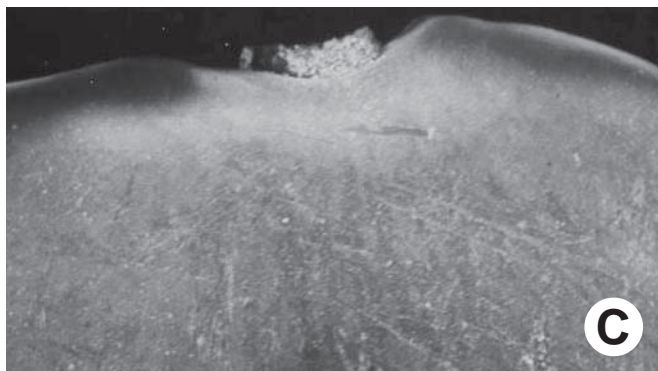
Distribution: Southern Asia and northern Australia.

Notes: Ohashi (1973) monographed the genus and provided a wider range of fruit and seed characters than our plate.

Phyllodium: *P. pulchellum* (C. Linnaeus) A.N. Desvaux (C–E), *P. spp.* (A–B). A, Fruits (1- and 2-seeded) (× 5); B, seeds (× 6.8); C–D, testa (× 50, × 1000); E, embryos (× 10).



E



Genus: *Aphyllodium* (A.-P. de Candolle) F. Gagnepain

Phylogenetic Number: 11.08.

Tribe: Desmodieae.

Subtribe: Desmodiinae.

Species Studied—Species in Genus: 1 sp.—4 spp.

Fruit a loment (or loment segment) or legume; $0.2\text{--}1.7 \times 0.3\text{--}0.35 \times 0.12\text{--}0.15$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical; elliptic or moniliform; not inflated; flattened; with beak; straight; with solid beak the same color and texture as fruit; tapered, rounded, or truncate (if lower of two articles) at apex; apex aligned or oblique with longitudinal axis of fruit; short tapered or truncate (if upper article of two) at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 3.5–4 mm long; widest across seed area; with all essentially similar in shape; elliptic. Epicarp dull; monochrome; reddish brown; pubescent and indurate; with hairs appressed or erect; with 1 type of pubescence; velutinous; with pubescence gray; with pubescence uniformly distributed; with simple hairs; stiff; with hair bases plain; antrorse; straight at apex; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp glossy; monochrome; tan; smooth; septate or nonseptate; with septa thicker than paper, firm; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 2 or 1; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; flattened or triangular; straight. Aril present (easily knocked off); dry; rim-aril; greenish tan or green.

Seed $1.2\text{--}1.5 \times 1\text{--}1.2 \times 1\text{--}1.1$ mm; not overgrown; not angular; asymmetrical; oblong; compressed; with surface smooth; with or without visible radicle and

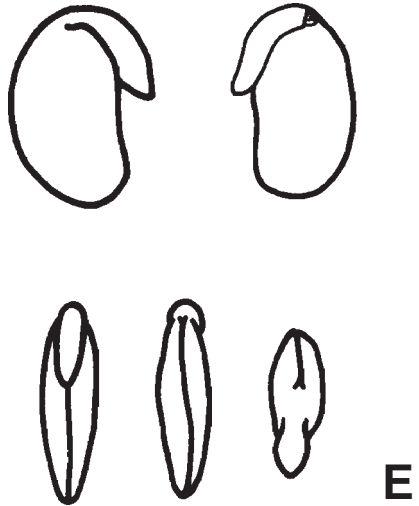
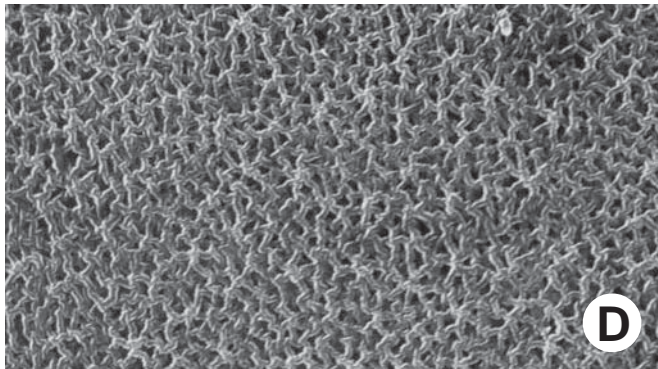
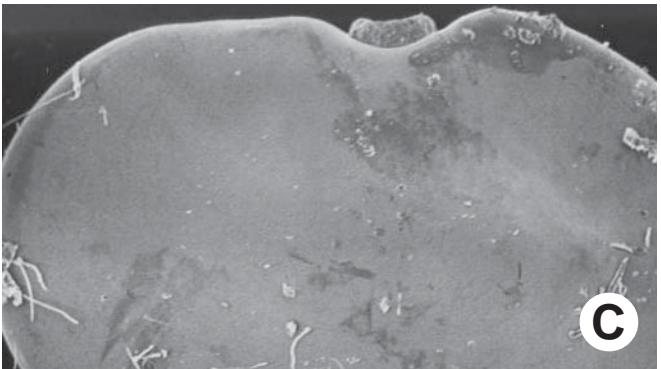
cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; with umbo on both faces of seed. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome or mottled and streaked; greenish tan, green, or purple; with purple overlay (more frequent than background color); glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform (much smaller and much less conspicuous than the darker lens on greenish seeds); between cotyledon and radicle lobe; recessed; not within corona, halo, or rim or within halo. Hilum halo color of testa (but not mottled with purple). Lens discernible (greenish seeds) or not discernible (purplish seeds); less than 0.5 mm in length; with margins straight or curved; square; 2 circular mounds separated by groove; not in groove of raphe; confluent with hilum; mounded; dissimilar color from testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow or green; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Tropical Asia to Australia.

Notes: Ohashi (1997a) corrected the name of this genus from *Dicerma* A.-P. de Candolle to *Aphyllodium* and defined its species more narrowly so that it has four species, the count we used. He (Ohashi 1973) also provided excellent drawings of fruits and seeds of the three species when treated as *Dicerma*.

Aphyllum: *A. biarticulatum* (C. Linnaeus) F. Gagnepain (A–E). A, Fruits (1- and 2-seeded: 1-seeded with calyx and petal) ($\times 6.8$); B, seeds ($\times 10$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).

6



Genus: *Desmodium* A.N. Desvaux

Phylogenetic Number: 11.09.

Tribe: Desmodieae.

Subtribe: Desmodiinae.

Species Studied—Species in Genus: 69 spp.—ca. 300 spp.

Fruit a loment (or loment segment) or legume; unilocular; 0.8–5 × 0.08–2.5 × 0.02–0.09 cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight, curved (or slightly curved), or contorted; not plicate or plicate (*D. styracifolium* (P. Osbeck) E.D. Merrill plicate when young and becoming straight with age); not twisted or twisted; symmetrical or asymmetrical; linear, circular (with notch at funiculus), dolabriform, irregular, or samaroid; when asymmetrical with 1 straight and 1 curved suture, both sutures parallelly curved, or both sutures unequally curved; narrowing in several places; not inflated or inflated; flattened or compressed; without or with beak; with solid beak the same color and texture as fruit; rounded or short tapered at apex; apex aligned or oblique with longitudinal axis of fruit; short tapered, tapered, or long tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous, coriaceous, or chartaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted or not constricted; constricted on 1 margin and slightly constricted on the other margin, slightly constricted only on 1 margin, constricted only on 1 margin, or slightly constricted along both margins; without sulcus; plain or embellished; with prickles (at least stiff, usually hooked hairs). Fruit wing 1; up to 10 mm wide; samaroid; on 1 suture. Fruit substipitate or stipitate; with the stipe 1–20 mm long. Fruit indehiscent or with all layers dehiscent (tardily); splitting along suture. Dehiscence of valves along 1 suture; medial and up and down; passive. Replum invisible (most spp.) or visible (at least 1 sp. in Panama (Schubert 1980)). Loment indehiscent (most spp.) or dehiscent along 1 suture (few spp., especially spp. in subtribe *Sagotia*). Loment segments (articles) inconspicuous; 2–30 mm long; widest across seed area; with all essentially similar in shape; D-shaped, triangular, curved, quadrangular, or circular (with notch at funiculus more or less dolabriform). Epicarp dull; monochrome or multicolored; mottled; brown (various shades and combinations, especially reddish) or tan (to

greenish); with brown (reddish) or purple overlay; glabrate or glabrous; with hairs erect or appressed; with 1 or 2 types of pubescence; pilose, puberulent, or velutinous; with pubescence golden, brown, yellow, or gray-brown; with golden hooked hairs and gray plain hairs; with pubescence uniformly distributed; with simple hairs (plain and hooked hairs mixed, plain hairs, or hooked hairs); pliable or stiff; with hair bases plain; straight, retrorse, or antrorse; hooked or straight at apex; eglandular; without spines; not smooth; with elevated features; veined or not veined; reticulately veined; not tuberculate; wrinkled; not exfoliating; without cracks. Mesocarp present or absent; thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; chartaceous or coriaceous. Endocarp glossy or dull; monochrome; tan; spongy; with hairs in longitudinal rows (*D. auricomum* R. Graham); septate; with septa thicker than paper, firm; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–12; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long or measured; up to 4 mm long; of 1 length only; thick, flattened, or filiform; straight, curved, or S-curved. Aril present or absent; dry; rim-aril or cupshaped (only *D. microphyllum* (C.P. Thunberg) A.-P. de Candolle); entire; covering less than 1/2 of seed.

Seed 0.7–12.5 × 0.5–5 × 0.5–1 mm; not overgrown; not angular; asymmetrical; D-shaped, oblong, quadrangular, rectangular, reniform, or linear; flattened or compressed; with surface grooved (*D. oojeinensis* (W. Roxburgh) H. Ohashi) or smooth; with grooves longitudinal and oblique; without visible radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull or glossy; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; dark to light reddish to brown, tan, green, or olive (green); with brown (dark reddish) overlay; glabrous; smooth or not smooth; with elevated or recessed features; faintly wrinkled; pitted with small separate pits; chartaceous or coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible or fully concealed; concealed by funicular remnant; with or without faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform or larger than punctiform; up to 1 mm long; with curved or straight outline; circular, oblong, or linear; marginal according to radicle tip or between cotyledon and radicle lobe; recessed; within

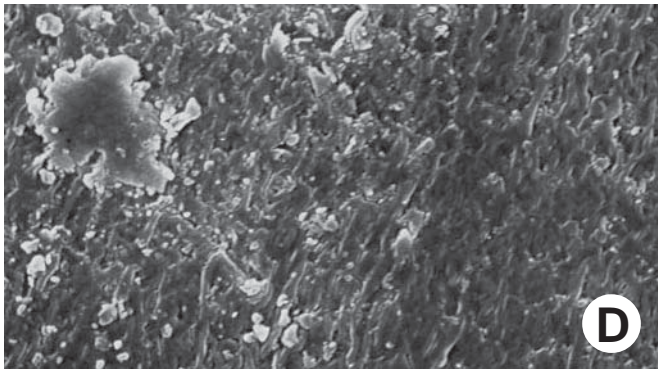
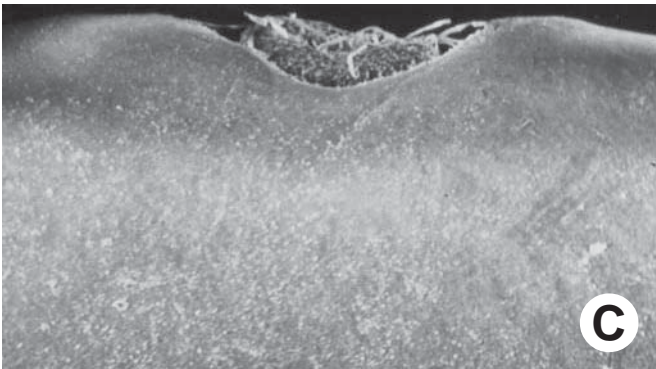
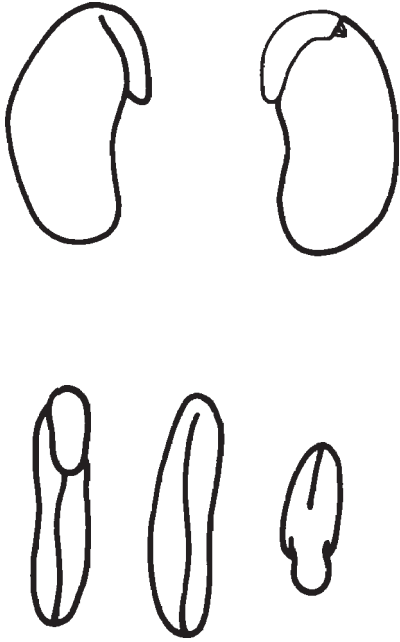
rim or not within corona, halo, or rim. Hilum rim color darker than testa. Lens discernible; less than 0.5 mm in length or equal to or greater than 0.5 mm in length; up to 0.5 mm long; with margins straight or curved; circular, oblong, elliptic, or 2 circular mounds separated by groove; not in groove of raphe; confluent with hilum; flush; dissimilar color from testa; darker than testa; reddish brown, black, or yellow (reddish); not within corona, halo, or rim. Endosperm present or absent; thin; covering entire embryo; adnate to testa or embryo. Cotyledons smooth or not smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow, tan, or green; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed, well developed, or rudimentary; glabrous.

Distribution: Worldwide.

Notes: Several regional or country treatments were reviewed: Schubert (1980), Panama; Oliveira (1983, 1990), Brazil; Verdcourt (1974), Zambia; Schubert (1952, 1954), Congo; Ohashi (1973), Asia; and Ohashi (1988), Hawaii. Verdcourt (1977) synonymized *Papilionopsis* C.G.G.J. van Steenis with *Desmodium*, and Ohashi (1982b) transferred *Murtonia* W.G. Craib to *Desmodium* as a subgenus. Although most species of *Desmodium* have indehiscent lomentaceous fruits, a few species have dehiscent loment, especially in the subgenus *Sagatia* (O.P. Swartz) A.-P. de Candolle, *D. heterophyllum* (C.L. von Willdenow) A.-P. de Candolle and *D. microphyllum* (C.P. Thunberg) A.-P. de Candolle. *Desmodium auricomum* loment has a longitudinal band of dense hairs on the lateral surfaces. All species of *Desmodium* except one, *D. microphyllum*, have small, dry rim-arils (Ohashi 1973); *D. microphyllum* has small, dry, cupshaped arils (Ohashi 1973).

Desmodium: *D. uncinatum* (N. von Jacquin) A.-P. de Candolle (*C-E*), *D. spp.* (*A-B*). *A*, Fruits, partial fruits, and articles ($\times 1.9$); *B*, seeds ($\times 3.4$); *C-D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 10$).

8



Genus: *Codariocalyx* J.C. Hasskarl

Phylogenetic Number: 11.10.

Tribe: Desmodieae.

Subtribe: Desmodiinae.

Species Studied—Species in Genus: 2 spp.—2 spp.

Fruit a legume (resembling a loment); unilocular; $0.7\text{--}5 \times 0.3\text{--}0.7 \times 0.18\text{--}0.2$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; curved (or slightly curved); not plicate; not twisted; asymmetrical; linear (with toothed lower suture); when asymmetrical with 1 straight and 1 curved suture or both sutures nearly straight; narrowing in several places, resembling *Desmodium* (11.09) fruit (false loment); not inflated; flattened; without beak; rounded at apex; apex oblique or aligned with longitudinal axis of fruit; short tapered or rounded at base; base oblique with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers torulose. Fruit margin constricted only on 1 margin; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscent; splitting along suture (lower). Dehiscence of valves along 1 suture (lower margin); passive. Replum invisible. Epicarp dull; monochrome; dark reddish brown; pubescent and indurate; with hairs erect or appressed; with 1 type of pubescence; pilose or tomentose; with pubescence golden (hook tipped) and gray (plain tipped); with pubescence uniformly distributed; with simple hairs (shorter gray plain tipped, longer yellow hooked tipped); with hair bases plain; eglandular; without spines; smooth; not veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull or glossy; monochrome; reddish tan or brown (reddish); smooth; septate; with septa thicker than paper, firm; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–13; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; flattened or triangular; straight. Aril fleshy; cupshaped (with undulate margin); covering less than 1/2 of seed; tan.

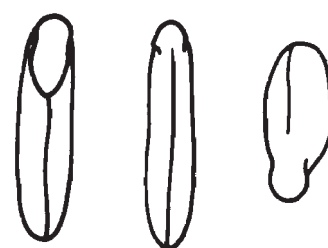
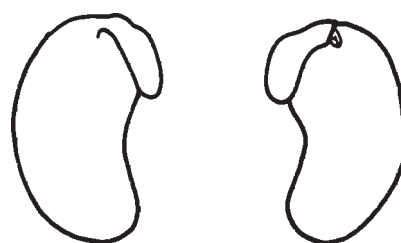
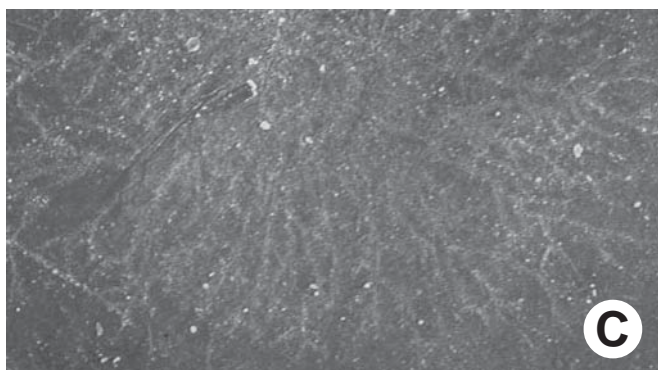
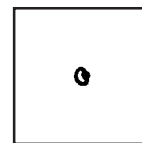
Seed $2.5\text{--}4.5 \times 2.5\text{--}4 \times 1.5\text{--}1.7$ mm; not overgrown; not angular; asymmetrical; elliptic or reniform; com-

pressed; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; with umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; reddish brown; with black overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible or partially concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 1 mm long; with straight outline; oblong; marginal according to radicle tip; recessed; not within corona, halo, or rim. Lens not discernible. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Southeastern Asia and tropical Australia.

Notes: Ohashi (1973) monographed the two species and provided fruit and seed illustrations. The multiseeded legumes of *Codariocalyx* have persistent septa between the seed compartments, so that the fruit appears to be a loment. It dehisces along the lower suture releasing the seeds from the individual seed compartments. The dehiscent fruit is a line of open individual seed compartments which continue to be joined by the upper suture.

Codariocalyx: *C. gyroides* (W. Roxburgh ex J.H.F. Link) J.K. Hasskarl (C–E), *C. spp.* (A–B). A, Fruits ($\times 2$); B, seeds ($\times 7.3$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 8$).



E

Genus: *Pseudarthria* R. Wight & G.A.W. Arnott

Phylogenetic Number: 11.11.

Tribe: Desmodieae.

Subtribe: Desmodiinae.

Species Studied—Species in Genus: 3 spp.—4–6 spp.

Fruit a legume; unilocular; $1.3\text{--}2 \times 0.3\text{--}0.5 \times 0.1\text{--}0.13$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; asymmetrical; oblong; when asymmetrical with both sutures nearly straight; not inflated; flattened; with or without beak; straight; with solid beak the same color and texture as fruit; rounded at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base oblique or aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally invisible or visible (faintly); with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscent; splitting along suture. Dehiscence of valves along 1 suture; apical and down (assumed); active; with valves reflexing. Replum invisible. Epicarp dull; monochrome; dark reddish brown; pubescent and indurate; with 1 type of pubescence; puberulent; with pubescence golden (*P. viscida* (C. Linnaeus) R. Wight & G.A.W. Arnott with hooked-tipped hairs) or gray (*P. hookeri* without hooked-tipped hairs or *P. fagifolia* J.G. Baker with straight- and hooked-tipped hairs); with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; not veined or transversely veined relative to fruit length and reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous (sub-). Endocarp dull; monochrome; reddish brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 5–8; length transverse or oblique to fruit length; touching; in 1 series. Funiculus measured; 10 mm long; of 1 length only; filiform; S-curved or curved. Aril dry; rim-aril; reddish brown.

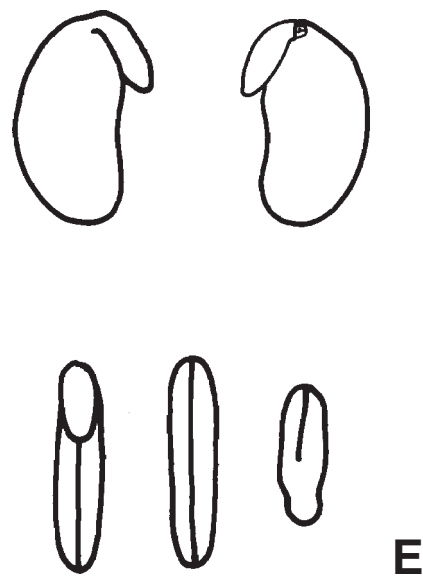
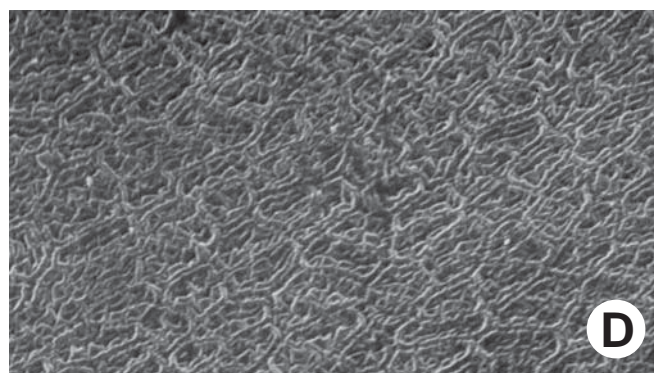
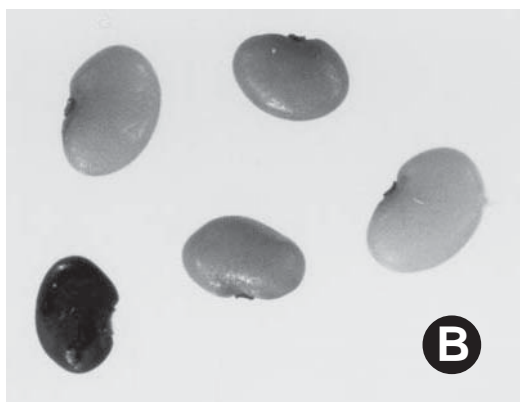
Seed $2.5 \times 1.5 \times 1$ mm; not overgrown; not angular or angular; asymmetrical; reniform, oblong, triangular, or irregular; compressed; with surface smooth; without or

with visible radicle and cotyledon lobes; without or with external groove (faintly) between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; with umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown, tan (to greenish or reddish), black (*P. viscida*), or orange (seeds have been described as orange); glabrous; smooth (*P. hookeri* and *P. fagifolia*) or not smooth (*P. viscida*); with elevated features; shagreen; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; marginal according to radicle tip or between cotyledon and radicle lobe; barely recessed; not within corona, halo, or rim or within halo (faint). Hilum halo color of testa. Lens not discernible or discernible (faintly); less than 0.5 mm in length; with margins straight or curved; somewhat linear or triangular; not in groove of raphe; confluent with hilum; flush; similar color as or dissimilar color from testa; darker than testa; reddish brown or tan (greenish); not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Old World tropics.

Pseudarthria: *P. hookeri* R. Wight & G.A.W. Arnott (C–E), *P.* spp. (A–B). A, Fruits ($\times 4$); B, seeds ($\times 8.8$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).

06



Genus: *Pycnospora* R. Brown ex R. Wight & G.A.W.
Arnott

Phylogenetic Number: 11.12.

Tribe: Desmodieae.

Subtribe: Desmodiinae.

Species Studied—Species in Genus: 1 sp.—1 sp.

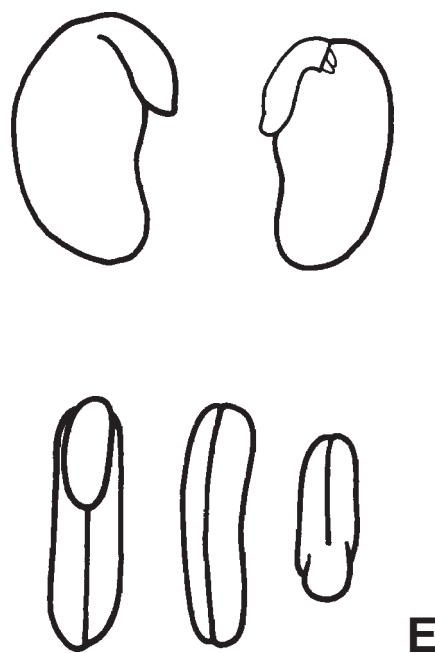
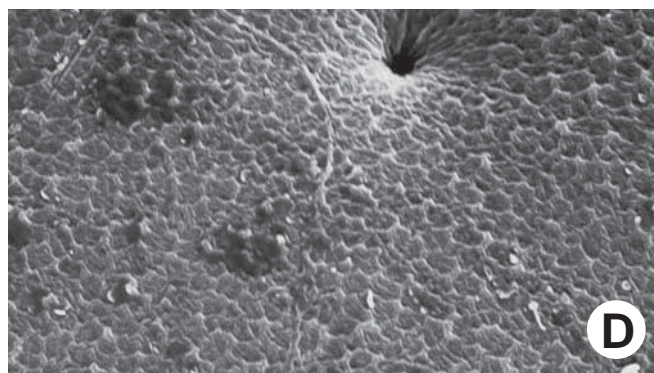
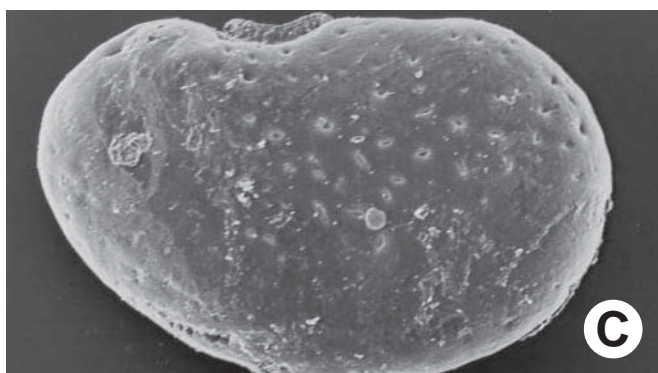
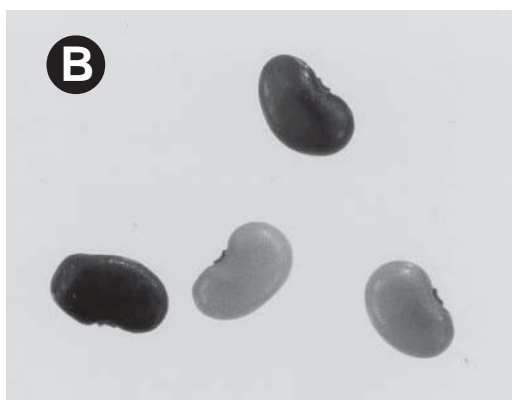
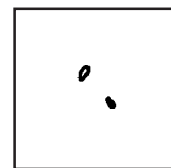
Fruit a legume; unilocular; $1-1.3 \times 0.5-0.6 \times 0.5$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; oblong; when asymmetrical with 1 straight and 1 curved suture or both sutures nearly straight; widest near middle or D-shaped; inflated; terete; without or with beak; straight or hooked; with solid beak the same color and texture as fruit; rounded at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned or oblique with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscent; splitting along suture. Dehiscence of valves along 1 suture; apical and down (assumed); passive. Replum invisible. Epicarp dull; monochrome or multicolored; mottled (large areas); blackish brown, tan (blackish), or black; with black overlay; pubescent and indurate; with 2 types of pubescence; puberulent; with pubescence golden or gray (and some hooked); with erect golden hairs and white hooked or not hooked hairs; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; transversely veined relative to fruit length and reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp very thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; chartaceous. Endocarp glossy; monochrome; blackish brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 10; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; filiform; straight. Aril dry; rim-aril; dark reddish brown.

Seed $1-1.3 \times 0.8-1 \times 0.5$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; without visible radicle and cotyledon lobes;

without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; marginal according to radicle tip; barely recessed; within halo. Hilum halo color lighter than testa. Lens discernible; less than 0.5 mm in length; with margins straight or curved; oblong; not in groove of raphe; adjacent to hilum; 0.1 mm from hilum; flush; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Tropical Africa, India to Philippines, New Guinea, and northern Australia.

Pycnospora: *P. lutescens* (J.L.M. Poir.) A.K. Schindler (A-E). A, Fruits (dehiscent and closed) ($\times 4.6$); B, seeds ($\times 9.3$); C-D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 25$).



Genus: *Tadehagi* H. Ohashi

Phylogenetic Number: 11.13.

Tribe: Desmodieae.

Subtribe: Desmodiinae.

Species Studied—Species in Genus: 1 sp.—4 spp.

Fruit a loment (or loment segment); $2.5-4.7 \times 0.45-0.7 \times 0.07-0.09$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; asymmetrical; moniliform; when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; narrowing in several places, resembling *Desmodium* (11.9) fruit; not inflated; flattened; with beak; straight; with solid beak the same color and texture as fruit; rounded at apex; apex aligned or oblique with longitudinal axis of fruit; short tapered at base; base aligned or oblique with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted on 1 margin and slightly constricted on the other margin; without sulcus; plain. Fruit wings absent. Fruit stipitate, substipitate, or nonstipitate; with the stipe up to 14 mm long. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 2.7–10 mm long; widest across seed area; with upper and lower 1 different shape than middle ones; D-shaped, rectangular, or quadrangular. Epicarp dull; monochrome; brown to reddish or dark reddish brown; pubescent and indurate or glabrous (except for scattered hairs on suture); with 1 or 2 types of pubescence; pilose; with pubescence yellow; with long and short yellow hairs intermixed; with pubescence uniformly distributed; with simple hairs; longer stiff and pliable (shorter); with hair bases plain; antrorse; straight at apex; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; reddish brown; smooth; septate; with septa thicker than paper, firm; with septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 5–7; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 2 mm long; of 1 length only; filiform; curved or straight. Aril dry; rim-aril; tan.

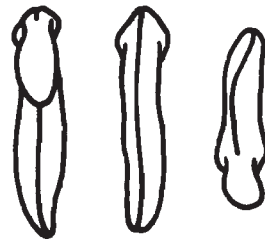
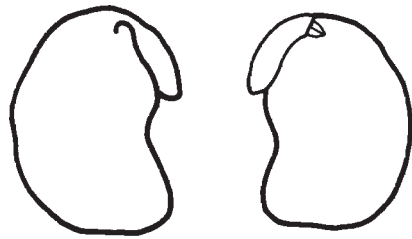
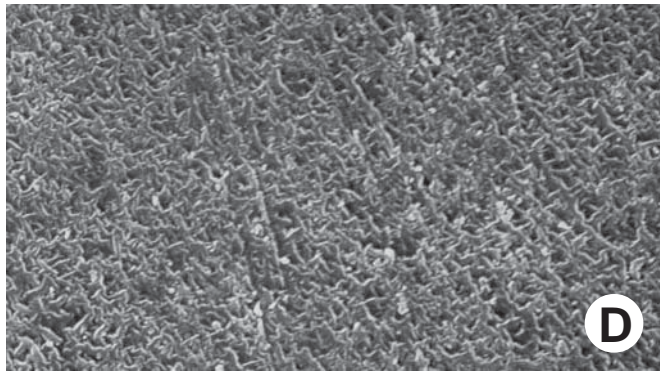
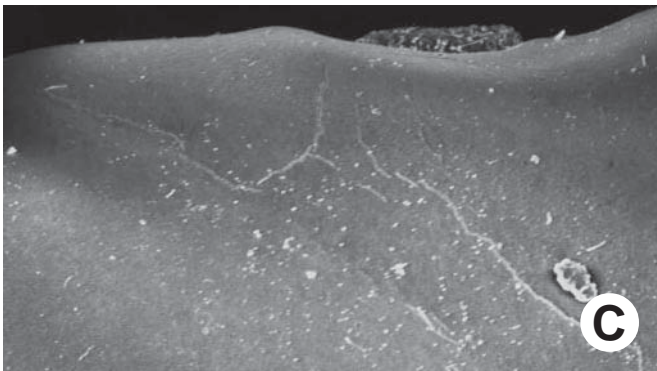
Seed $2.5-3.7 \times 2-2.5 \times 0.7-1.5$ mm; not overgrown; angular or not angular; asymmetrical; reniform or irregular; compressed; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without or with umbo on seed faces; with umbo on 1 face of seed. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown, tan (to reddish or greenish), yellow, green, or orange; glabrous; smooth; coriaceous. Fracture lines present (easier to see on lighter colored seeds) or absent; reticulate. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.5 mm long; with curved outline; circular; marginal according to radicle tip or between cotyledon and radicle lobe; recessed; not within corona, halo, or rim. Lens discernible; less than 0.5 mm in length; with margins curved; 2 oblong mounds separated by groove; not in groove of raphe; confluent with hilum; mounded; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to testa. Cotyledons not smooth; both outer faces convex; both the same thickness; both more or less of equal length; with both folded; sufficiently folded for inner face to touch itself; portions of inner folded face unequal; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without or with lobes; with lobes not touching; without basal groin formed by lobes; with the interface division terminating at base of radicle; without margins recessed; reddish brown or tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; with a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

Distribution: India to southern China to New Caledonia and northern Australia.

Notes: Ohashi et al. (1981) noted that *Tadehagi* integrates with *Droogmansia* (11.14) and provided fruit and seed drawings of *Tadehagi*. Ohashi (1982a) and Maiti and Ghosh (1997) reevaluated *T. triquetrum* subsp. *rodgeri* (A.K. Schindler) H. Ohashi, and raised it to the rank of species, *T. rogeri* (A.K. Schindler) H. Ohashi. Therefore, there are four species in the genus.

Tadehagi: *T. triquetrum* (C. Linnaeus) H. Ohashi (A–E). A,
Fruits (entire but separated and two united articles)
($\times 3.3$); B, seeds ($\times 7.6$); C–D, testa ($\times 50$, $\times 1000$);
E, embryos ($\times 11$).

G



Genus: *Droogmansia* E.A.J. De Wildeman

Phylogenetic Number: 11.14.

Tribe: Desmodieae.

Subtribe: Desmodiinae.

Species Studied—Species in Genus: 2 spp.—ca. 10 spp.

Fruit a loment (or loment segment); 3.3–4 × 0.3–0.7 × 0.7–0.9 cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; slightly curved or straight; not plicate; not twisted; asymmetrical; moniliform; when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; narrowing in several places, resembling *Desmodium* (11.09) fruit; not inflated; flattened; with beak; declined; with solid beak the same color and texture as fruit; rounded at apex; apex aligned or oblique with longitudinal axis of fruit; rounded at base; base aligned or oblique with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted or slightly constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit stipitate or substipitate; with the stipe up to 70 mm long. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 5–13 mm long; widest across seed area; with upper or lower 1 different shape than middle ones; D-shaped or circular. Epicarp dull; monochrome; dark reddish to light brown or tan; pubescent and indurate; with 1 type of pubescence; sericeous; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; veined or not veined; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; reddish brown; smooth; septate; with septa thicker than paper, firm; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–5; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; up to 1 mm long; of 1 length only; flattened; straight. Aril absent.

Seed 2.5–4.5 × 2.5–3 × 1.3–1.5 mm; not overgrown; not angular; asymmetrical; reniform or oblong; flattened; with surface smooth; with or without visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome (but note hilar halo); dark reddish brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.5 mm long; with curved outline; elliptic; marginal according to radicle tip or between cotyledon and radicle lobe; flush; within halo. Hilum halo color darker (and irregular in outline) than testa. Lens discernible; less than 0.5 mm in length or equal to or greater than 0.5 mm in length; 0.3–0.8 mm long; with margins straight or curved; irregular, linear, or wedge-shaped; not in groove of raphe; confluent with hilum; mounded or recessed; dissimilar color from testa; darker than testa; dark reddish brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

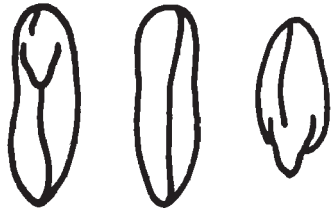
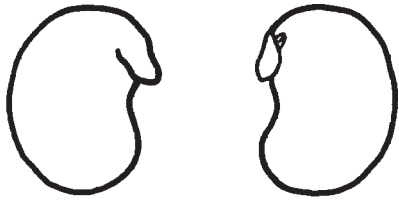
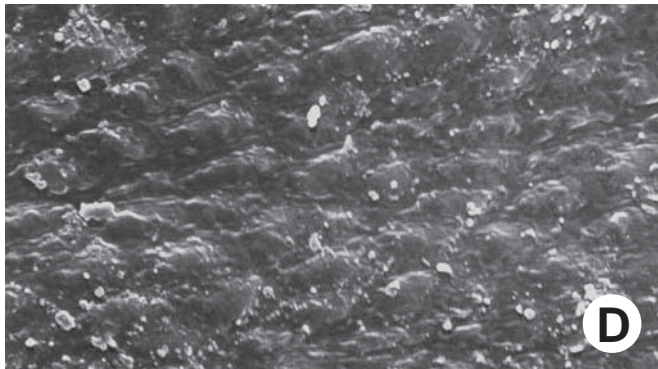
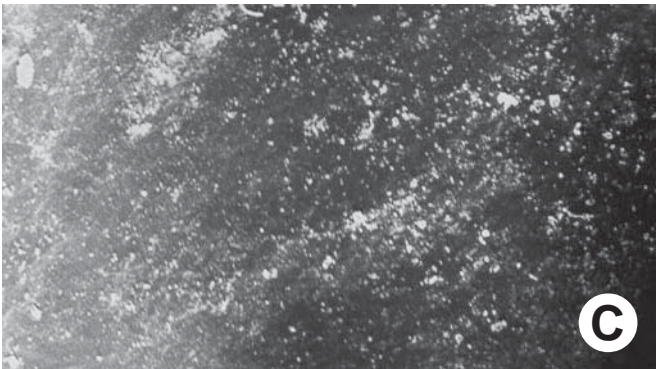
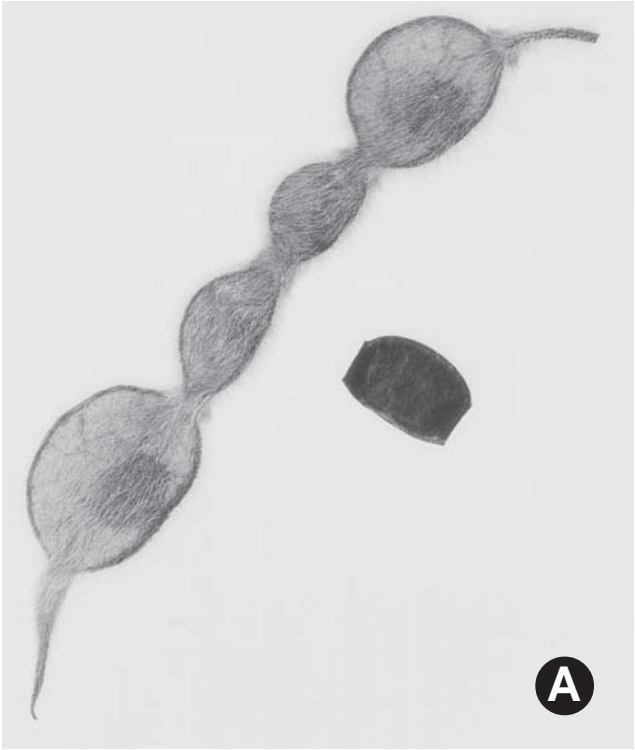
Distribution: South-central and West Africa and 1 sp. in Indochina.

Notes: Ohashi et al. (1981) noted that the number of species is “usually estimated to be about 30 species, but a single species complex in south-central Africa with perhaps a few distinct relatives, then four species in West Africa intergrading with *Tadehagi*” (11.13). We agree with Ohashi et al. (1981) and Verdcourt (1970b, 1974), but not Lock (1989), that there are only a few species in Africa, Lock’s recent list of 23 species in Africa notwithstanding. Schubert (1952) recognized nearly 30 species in Africa and noted that most of her new species were collected in flower. Our count of ca.

10 species is an estimate that may or may not be accurate. Regardless of the species counts, our fruit and seed material was quite limited.

Droogmansia: *D. pteropus* (J.G. Baker) E.A.J. De
Wildemann var. *whytei* (A.K. Schindler) B. Verdcourt
(*C-E*), *D. spp.* (*A-B*). *A*, Fruit and article ($\times 2.8$); *B*,
seeds ($\times 6.5$); *C-D*, testa ($\times 50$, $\times 1000$); *E*, embryos
($\times 6$).

6



E

Genus: *Mecopus* J.J. Bennett

Phylogenetic Number: 11.15.

Tribe: Desmodieae.

Subtribe: Desmodiinae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; unilocular; $0.27 \times 0.2 \times 0.1$ cm; with deciduous or persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; when asymmetrical with 1 straight and 1 curved suture; widest near middle or D-shaped; not inflated; compressed; without beak; short tapered at apex; apex oblique with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit stipitate; with the stipe 50–60 mm long (and reflexed into “bird cage” where fruits are “caught”). Fruit with all layers dehiscing; splitting along suture. Dehiscence of valves along 1 suture; apical and down; passive. Replum invisible. Epicarp dull; monochrome; reddish brown or tan (reddish); pubescent and indurate; with 1 type of pubescence; puberulent; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; reddish brown or tan (reddish); smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1 or 2; length parallel with fruit length; neither overlapping nor touching (if 1-seeded); in 1 series. Funiculus less than 0.5 mm long; of 1 length only; straight. Aril dry; rim-aril; reddish brown.

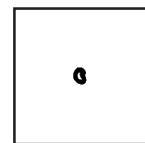
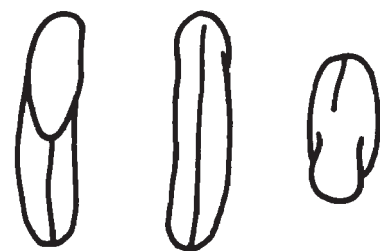
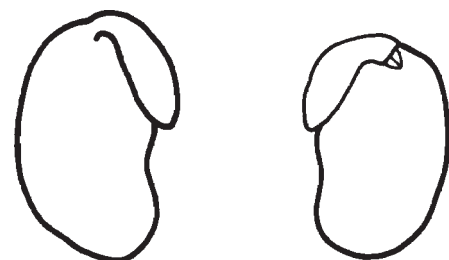
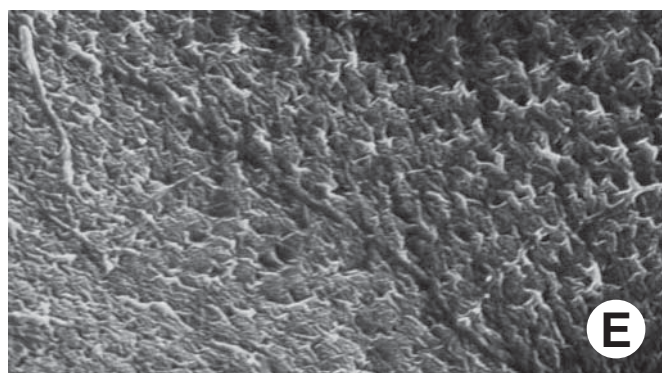
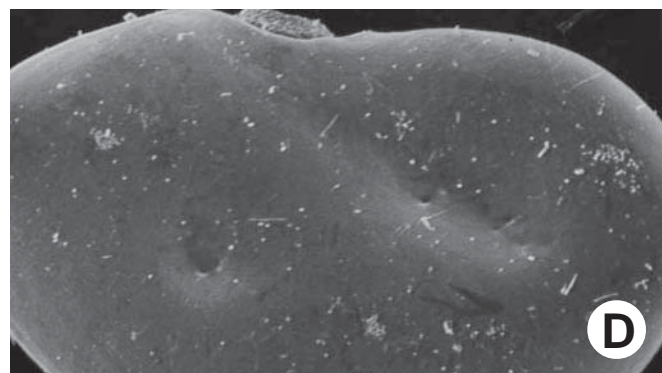
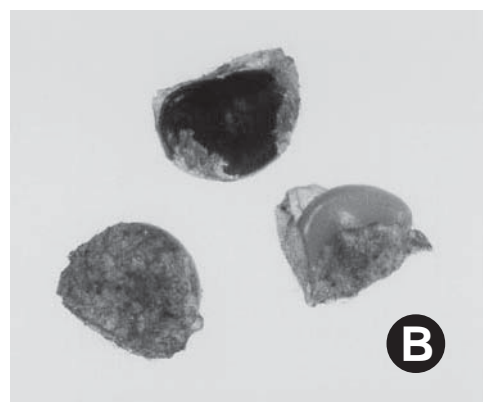
Seed $1.7\text{--}2 \times 1.1\text{--}1.2 \times 0.6\text{--}0.7$ mm; not overgrown; not angular; asymmetrical; reniform (sub-); compressed; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown or tan; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum;

punctiform; marginal according to radicle tip; flush; within halo. Hilum halo color of testa. Lens discernible; less than 0.5 mm in length; with margins straight or curved; oblong; not in groove of raphe; confluent with hilum; mounded; dissimilar color from testa; darker than testa; darker reddish brown; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; white; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

Distribution: India to southern China and Malay Islands.

Notes: The seeds dehisce from the one-seeded fruits while on the plants. Apparently, the “bird-cage” heads fall intact, and the seeds are shed as the heads are transported on animal fur.

Mecopus: *M. nidulans* J.J. Bennett (A–F). A, “bird cage” (see Notes) ($\times 2.9$); B, fruits ($\times 10$); C, seeds ($\times 10$); D–E, testa ($\times 50$, $\times 1000$); F, embryos ($\times 20$).



Genus: *Uraria* A.N. Desvaux

Phylogenetic Number: 11.16.

Tribe: Desmodieae.

Subtribe: Desmodiinae.

Species Studied—Species in Genus: 8 spp.—20 spp.

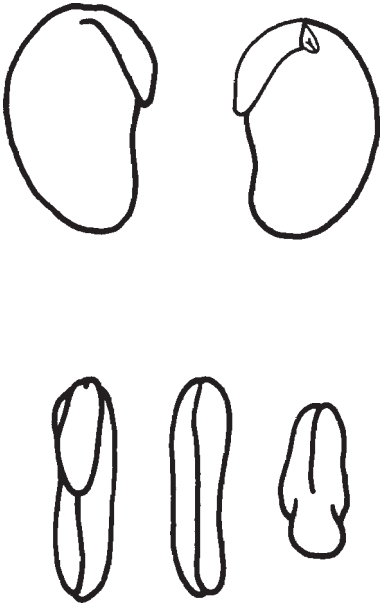
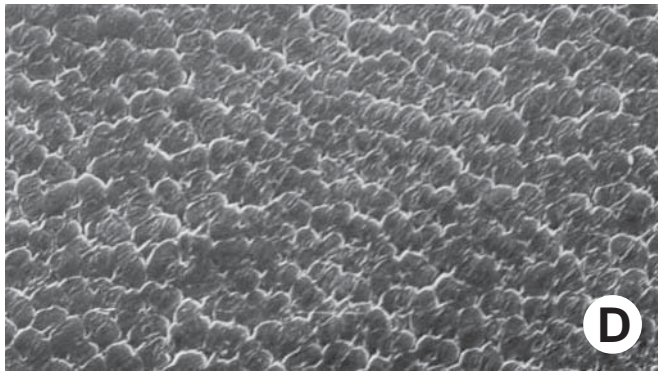
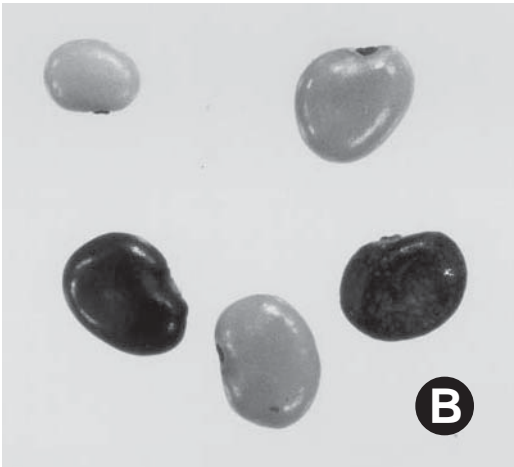
Fruit a loment (or loment segment); $0.3\text{--}0.9 \times 0.2\text{--}0.4 \times 0.1\text{--}0.2$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (or slightly curved); plicate or not plicate; not twisted; asymmetrical; oblong; when asymmetrical with both sutures parallelly curved or 1 straight and 1 curved suture; narrowing in several places, resembling *Desmodium* (11.9) fruit; not inflated; compressed or terete; without beak; rounded at apex; apex oblique with longitudinal axis of fruit; short tapered or rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 2.5–3.5 mm long; widest across seed area; with all essentially similar in shape; ovate. Epicarp dull or glossy; monochrome; brown, tan, black, or gray; glabrous (widely scattered hairs may be on sutures) or pubescent and indurate; with 1 type of pubescence; puberulent; with pubescence golden or gray (with straight-tipped or straight- and hooked-tipped hairs); with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating or exfoliating (*U. picta* leaving a shiny gray mesocarp); without cracks. Mesocarp present or absent; thin to very thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; chartaceous. Endocarp dull or glossy; monochrome; brown (to grayish); smooth; septate; with septa thicker than paper, firm; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; remaining fused to epicarp; entire. Seeds 2–6; length parallel or transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; more or less thick; straight. Aril dry; rim-aril; reddish brown.

Seed $1.8\text{--}2.5 \times 1.5\text{--}2 \times 0.7\text{--}0.8$ mm; not overgrown; not angular or angular; asymmetrical; reniform, elliptic, mitaform, or triangular; compressed; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull or glossy; not modified by a bloom; colored; monochrome; yellowish to reddish brown or tan; glabrous; smooth; coriaceous. Fracture lines present or absent; reticulate. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform or larger than punctiform; to 0.5 mm long; with curved outline; oval; marginal according to radicle tip or between cotyledon and radicle lobe; slightly recessed; within halo (faint). Hilum halo color darker (slightly) than testa. Lens discernible; less than 0.5 mm in length; with margins straight or curved; rectangular or circular; not in groove of raphe; confluent with hilum or adjacent to hilum; 0.1 mm from hilum; mounded; dissimilar color from testa; darker than testa; reddish brown or black; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa or embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan or yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear or bulbous; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Old World tropics.

Notes: *Urariopsis* Schindler (11.16) in Ohashi et al. (1981) is a synonym of *Uraria* (Haas et al. 1980). *Urariopsis cordifolia* (C.F.W. Wallroth) A.K. Schindler is based on *U. cordifolia* C.F.W. Wallroth. Jha and Pandey (1988) studied the seeds of *Uraria* and *Alysicarpus* (11.16 and 11.18).

Uraria: *U. picta* (N. von Jacquin) A.N. Desvaux ex A.-P. de Candolle (C–E), *U. spp.* (A–B). A, Fruits with calyxes and articles ($\times 4.7$); B, seeds ($\times 8.9$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 12$).



Genus: *Christia* C. Moench

Phylogenetic Number: 11.17.

Tribe: Desmodieae.

Subtribe: Desmodiinae.

Species Studied—Species in Genus: 2 spp.—ca. 10 spp.

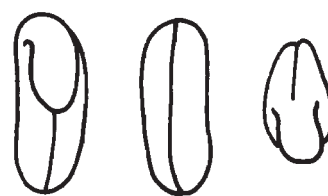
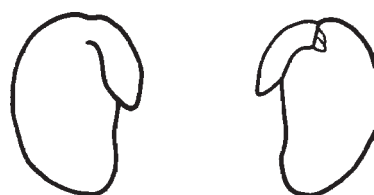
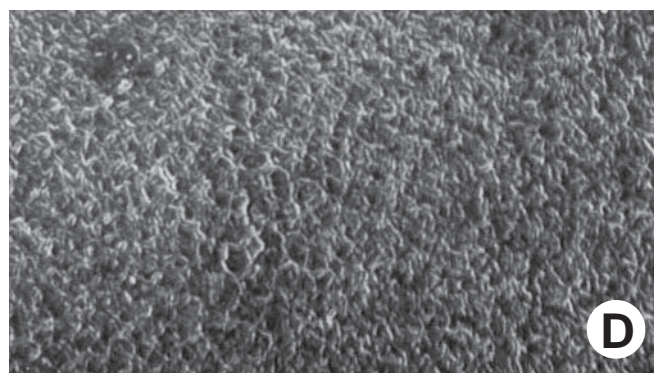
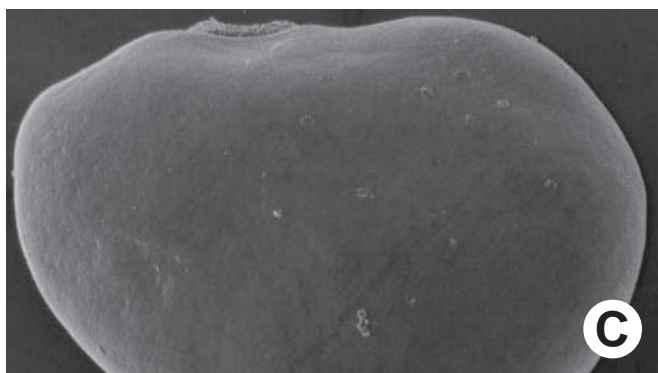
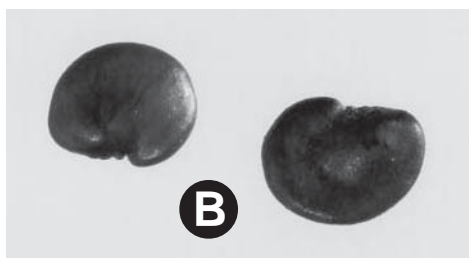
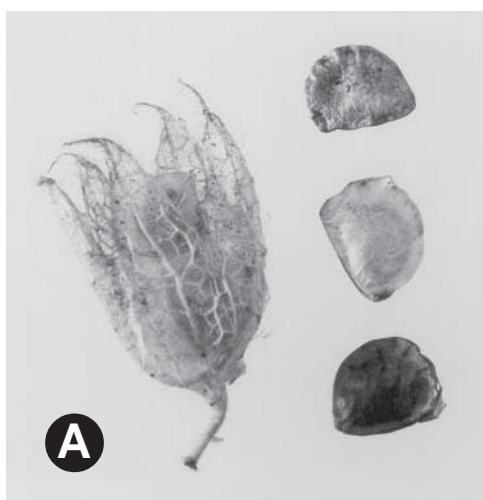
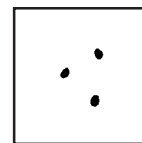
Fruit a loment (or loment segment); $0.6 \times 0.15 \times 0.1$ cm; with persistent calyx; with calyx longer or shorter than fruit; without orifice formed by curving of fruit or fruit segments; S-curved; plicate; not twisted; asymmetrical; irregular; when asymmetrical with 1 straight and 1 curved suture or both sutures unequally curved; narrowing in several places, resembling *Desmodium* (11.09) fruit (though folded); not inflated; flattened; without beak; truncate at apex; apex aligned with longitudinal axis of fruit; truncate at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous (easily eroding); seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted only on 1 margin; without sulcus; plain. Fruit wings absent. Fruit substipitate or nonstipitate. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 2 mm long; widest across seed area; with all essentially similar in shape; D-shaped. Epicarp dull; monochrome; gray, brown, or black; glabrous or pubescent and indurate; with 1 type of pubescence; puberulent; with pubescence gray (with hooked tips); with pubescence uniformly distributed; with simple hairs (with hooked tips); pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; reddish brown or white; smooth; septate; with septa thin (tissue paper-like), flexible; with septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1–3; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent.

Seed $1.6\text{--}2.5 \times 1.2\text{--}1.8 \times 0.6\text{--}0.9$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; with or without visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored;

monochrome; dark to light reddish brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; within rim. Hilum rim color darker than testa. Lens discernible; less than 0.5 mm in length; with margins curved; circular or elliptic; not in groove of raphe; confluent with hilum; slightly mounded; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons not smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Tropical and subtropical Asia and Australasia.

Christia: *C. obcordata* (J.L.M. Poiret) R.C. Bakhuizen van den Brink (*C–E*), *C. spp.* (*A–B*). *A*, Fruit in calyx and articles ($\times 5.5$); *B*, seeds ($\times 10.5$); *C–D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 19$).



E

Genus: *Alysicarpus* A.N. Desvaux

Phylogenetic Number: 11.18.

Tribe: Desmodieae.

Subtribe: Desmodiinae.

Species Studied—Species in Genus: 11 spp.—25–30 spp.

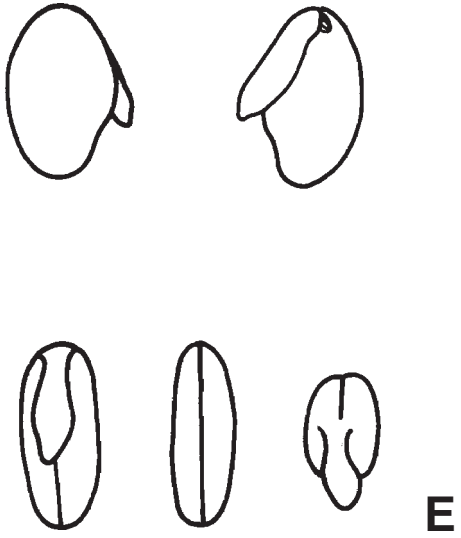
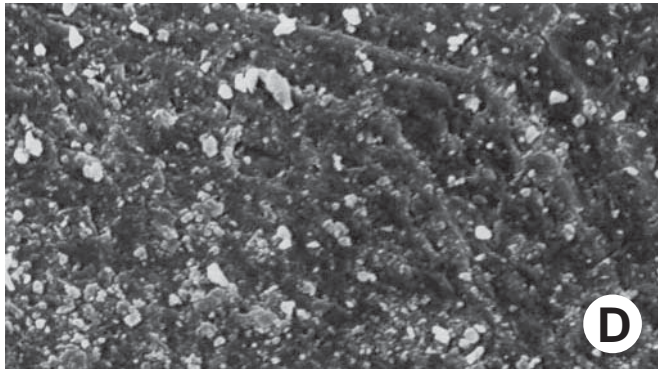
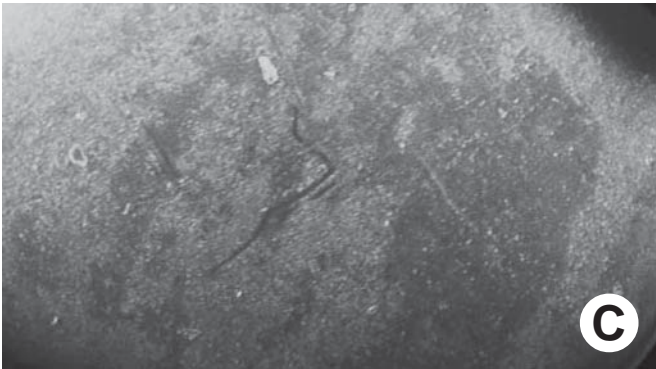
Fruit a loment (or loment segment) or legume; unilocular; 0.5–2.5 × 0.1–0.3 × 0.1–0.2 cm; with persistent or deciduous calyx; with calyx longer than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; asymmetrical or symmetrical; linear, moniliform, or oblong; when asymmetrical with 1 straight and 1 curved suture; widest near middle or D-shaped or narrowing in several places, resembling *Desmodium* (11.09) fruit; not inflated; terete; without or with beak; straight; with solid beak the same color and texture as fruit; rounded at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally visible; with the raised seed chambers torulose or not torulose. Fruit margin constricted or not constricted; constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Loment indehiscent or dehiscent along 1 suture (somewhat). Loment segments (articles) conspicuous; 1–4 mm long; widest across seed area; with all essentially similar in shape; rectangular or quadrangular. Epicarp dull; monochrome or multicolored; bichrome; brown (to dirty-, greenish-, dark-, or reddish-brown), tan, or black; with brown (reddish) overlay; pubescent and indurate or glabrous; with hairs erect or appressed; puberulent; with pubescence gray; with simple hairs (with hooked tips that are easily broken off); pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined or transversely veined relative to fruit length; not tuberculate; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; brown; smooth; septate; with septa thicker than paper, firm; with septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1–8; length parallel or transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; filiform; straight. Aril absent.

Seed 1.5–2.5 × 1.2–1.8 × 0.8–1.2 mm; not overgrown; not angular; symmetrical; elliptic (and oblong), oblong, rhombic (rounded), quadrangular, or circular (to sub-); slightly compressed; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome or mottled (faint to conspicuous); with frequent mottles; reddish brown, tan (and greenish- to reddish-tan), yellow, or black; with brown (reddish) or purple overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum fully concealed or visible; concealed by funiculus; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; marginal according to radicle tip; flush; within rim or within halo. Hilum halo color of testa (essentially). Hilum rim color of testa. Lens discernible; equal to or greater than 0.5 mm in length; 0.3 mm long; with margins straight or curved; linear; more or less circular; not in groove of raphe; confluent with hilum; flush; dissimilar color from testa; darker than testa; dark reddish brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa or embryo. Cotyledons not smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing or not concealing radicle; entire over radicle; without or with lobes; with lobes not touching; without basal groin formed by lobes; with the interface division terminating at base of radicle; without margins recessed; yellow or white; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length or width; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Old World tropics with *A. vaginalis* (C. Linnaeus) A.-P. de Candolle a worldwide crop.

Notes: Jha and Pandey (1988) studied seeds of *Alysicarpus* and *Uraria* (11.16).

Alysicarpus: *A. rugosus* (C.L. von Willdenow) A.-P. de Candolle (C–E), *A. spp.* (A–B). A, Fruits (with and without calyx) and articles (× 3.4); B, seeds (× 8.3); C–D, testa (× 50, × 1000); E, embryos (× 8).



Genus: *Desmodiastrum* (D. Prain) A. Pramanik & K. Thothathri

Phylogenetic Number: 11.18A.

Tribe: Desmodieae.

Subtribe: Desmodiinae.

Species Studied—Species in Genus: 1 sp.—2 spp.

Fruit a loment (or loment segment); 0.8–1.5 × 0.35–0.5 cm; with persistent calyx; with calyx shorter or longer than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; moniliform; when asymmetrical with both sutures parallelly curved (nearly so) or 1 straight and 1 curved suture; narrowing in several places, resembling *Desmodium* (11.09) fruit; not inflated; flattened; with beak; nearly straight; with solid beak the same color and texture as fruit; short tapered or rounded at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted only on 1 margin; without sulcus; plain. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; widest across seed area; with all essentially similar in shape; D-shaped. Epicarp dull; monochrome; brown (assumed); pubescent and indurate; with hairs appressed; with 1 type of pubescence; with pubescence uniformly distributed; with simple hairs (mixture of hooked and plain tipped hairs); pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp present or absent (assumed to be like *Desmodium* (11.09)). Endocarp septate; with septa thicker than paper, firm; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 3–6; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only. Aril absent.

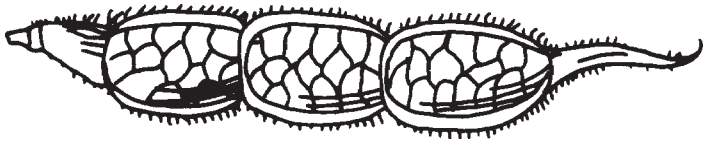
Seed 1.2–2 × 1.2–2 mm; not overgrown; not angular; asymmetrical; reniform or ovate; compressed; with surface smooth; with visible radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by

a bloom; colored; monochrome; dark brown or gray (dark); glabrous; smooth; coriaceous (assumed). Fracture lines absent. Rim present. Wings absent.

Distribution: India, Indochina, Indonesia.

Notes: Pramanik and Thothathri (1986) raised *Alysicarpus* subgenus *Desmodiastrum* to the genus level. We were unable to obtain fruits and seeds and instead used Pramanik and Thothathri's text and the plate from Wight (1838) for our figure.

Desmodiastrum: *D. belgaumense* (W. Wight) A. Pramanik & K. Thothathri (A–B). A, Fruit (× 4.5); B, seed (× 10), both from Wight (1838).



A



B

Genus: *Melliniella* H.A.T. Harms

Phylogenetic Number: 11.19.

Tribe: Desmodieae.

Subtribe: Desmodiinae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; unilocular; $1-1.3 \times 0.2 \times 0.5-0.7$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; slightly curved or straight; not plicate; not twisted; asymmetrical; C-shaped or linear; when asymmetrical with both sutures parallelly curved or nearly straight; not inflated; compressed; with beak; with solid beak the same color and texture as fruit; short tapered or tapered at apex; apex oblique or aligned with longitudinal axis of fruit; tapered at base; base oblique or aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate or nonstipitate. Fruit with all layers dehiscent; splitting along suture. Dehiscence of valves along 1 suture; apical and down; passive. Replum invisible. Epicarp dull; monochrome; brown or tan; pubescent and indurate; with 1 type of pubescence; puberulent; with pubescence gray; with pubescence uniformly distributed; with simple hairs (with hooked tips); pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; transversely veined relative to fruit length and reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; chartaceous. Endocarp dull or glossy; monochrome; brown; smooth; septate or nonseptate; with septa thicker than paper, firm; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 5–8; length transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; filiform; straight. Aril present (but difficult to see) or absent; dry; rim-aril; reddish brown or tan.

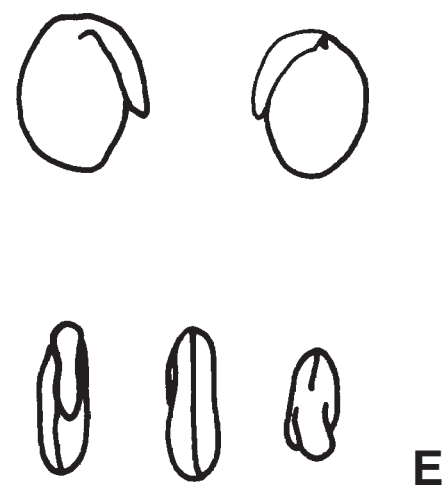
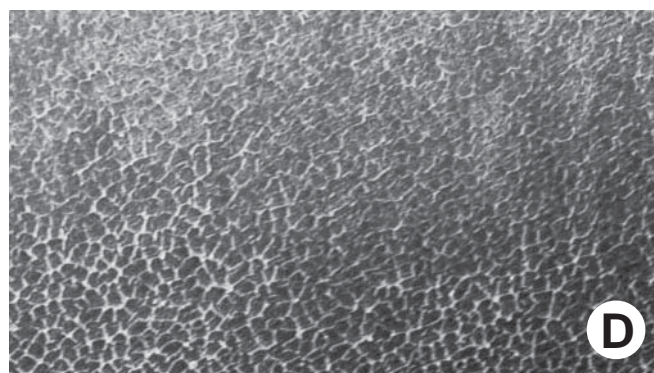
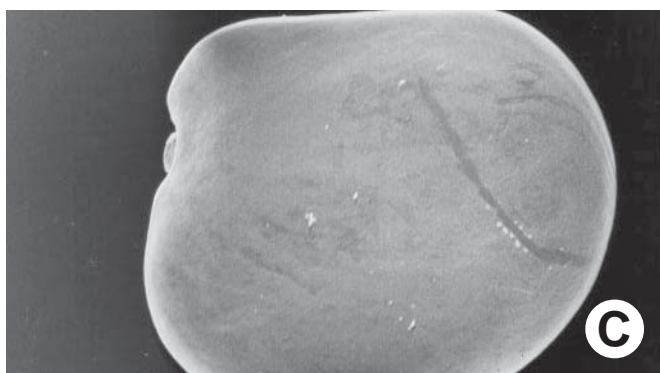
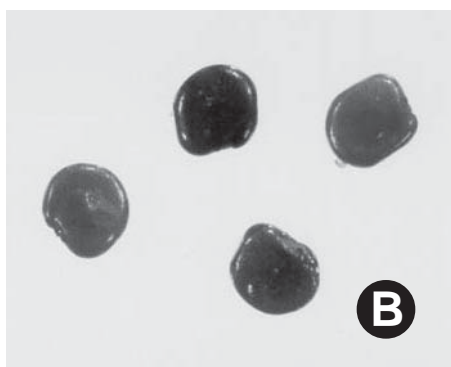
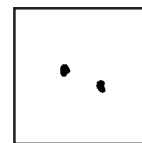
Seed $1.2-1.3 \times 1.1-1.2 \times 0.6-0.7$ mm; not overgrown; not angular; asymmetrical; mitaform or oblong; compressed; with surface smooth; with visible radicle and

cotyledon lobes; with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome; reddish brown or tan; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible (but difficult to see because of size and color); with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; within rim. Hilum rim color of testa. Lens discernible or not discernible; less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; confluent with hilum; mounded; dissimilar color from or similar color as testa; darker than testa; black or brown (darker reddish); not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; white; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; $1/2$ to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Western tropical Africa.

Notes: Harms (1914) founded the genus and provided fruit and seed drawings. Ohashi et al. (1981) noted that *Melliniella* is “a minor segregate of *Alysicarpus*” (11.18).

Melliniella: *M. micrantha* H.A.T. Harms (A–E). A, Fruits with and without calyx ($\times 6.4$); B, seeds ($\times 13.3$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 15$).



Genus: *Leptodesmia* G. Bentham

Phylogenetic Number: 11.20.

Tribe: Desmodieae.

Subtribe: Desmodiinae.

Species Studied—Species in Genus: 4 spp.—6 spp.

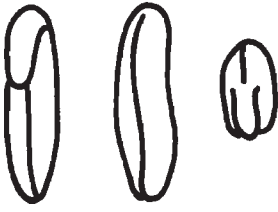
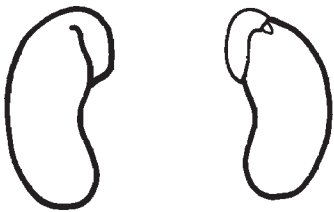
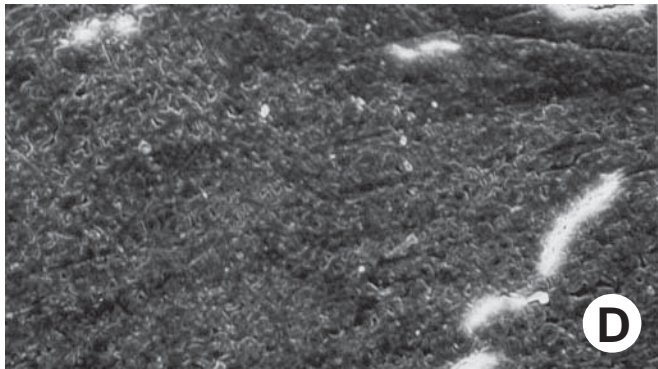
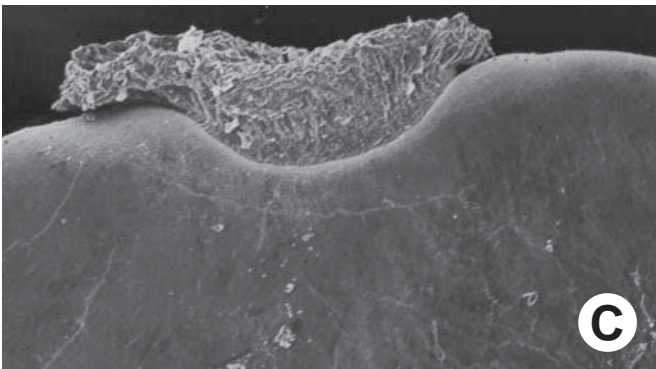
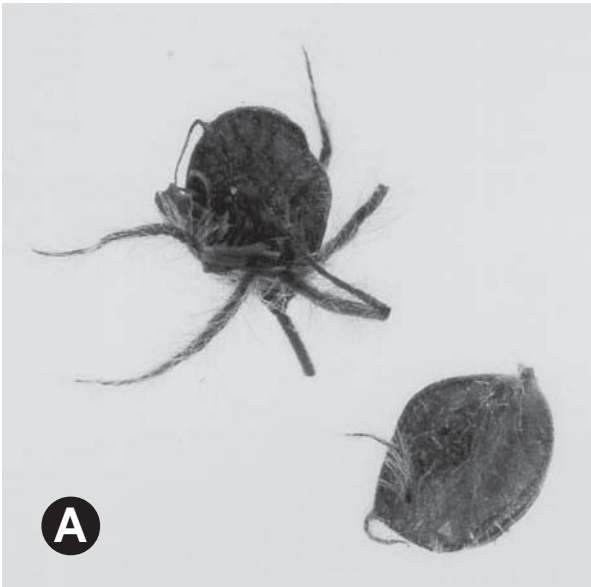
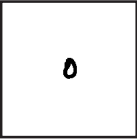
Fruit a legume; unilocular; $0.4\text{--}0.5 \times 0.25 \times 0.05$ cm; with persistent calyx; with calyx longer than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; oblong; when asymmetrical with both sutures parallelly curved; not inflated; flattened; without beak; rounded at apex; apex oblique to right-angled with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscent; splitting along suture. Dehiscence of valves along 1 suture; medial and up and down; active; with valves reflexing. Replum invisible. Epicarp dull; monochrome; reddish brown; pubescent and indurate; with 1 type of pubescence; puberulent; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; golden brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seed 1; length parallel with fruit length. Funiculus less than 0.5 mm long; flattened; straight. Aril fleshy; cupshaped; covering less than 1/2 of seed; reddish brown or cream.

Seed $2\text{--}2.5 \times 1\text{--}1.5 \times 0.5\text{--}0.8$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; mottled and streaked or monochrome; with frequent mottles; with frequent streaks; dark to lighter reddish brown, green, or olive; with black overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum fully concealed; concealed by aril;

with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.5 mm long; with curved outline; elliptic; marginal according to radicle tip; flush; within rim. Hilum rim color of testa. Lens discernible (under aril); less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; confluent with hilum; mounded; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons or 1/2 to nearly length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Madagascar (5 spp.) and India (*L. congesta*).

Leptodesmia: *L. congesta* G. Bentham ex J.G. Baker (*C–E*), *L. spp.* (*A–B*). *A*, Fruits with and without calyx ($\times 8$); *B*, seeds ($\times 10.9$); *C–D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 10$).



E

Genus: *Eleiotis* A.-P. de Candolle

Phylogenetic Number: 11.21.

Tribe: Desmodieae.

Subtribe: Desmodiinae.

Species Studied—Species in Genus: 1 sp.—2 spp.

Fruit a legume; unilocular; $0.6\text{--}0.65 \times 0.2\text{--}2.5 \times 0.1\text{--}0.15$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; C-shaped; when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; widest near middle or D-shaped; not inflated; compressed; with or without beak; straight; with solid beak the same color and texture as fruit; short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin not constricted; with sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome or multicolored; mottled and streaked; reddish brown or purple; with green overlay; glabrous (at first glance glabrous but with careful examination puberulent) or pubescent and indurate; with 1 type of pubescence; puberulent (tiny hairs); with pubescence gray; with pubescence uniformly distributed; pliable; with hair bases plain; glandular or eglandular; with glandular dots (absent to numerous); without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp present or absent; trace or thin (very); surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; chartaceous. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; remaining fused to epicarp; entire. Seed 1; length parallel with fruit length. Funiculus less than 0.5 mm long; flattened; straight. Aril present (inconspicuous) or absent; dry; rim-aril and tongue-aril; reddish brown.

Seed $4 \times 2.7 \times 1\text{--}1.1$ mm; not overgrown; not angular; asymmetrical; reniform (sub-) or oblong; compressed; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without umbo on

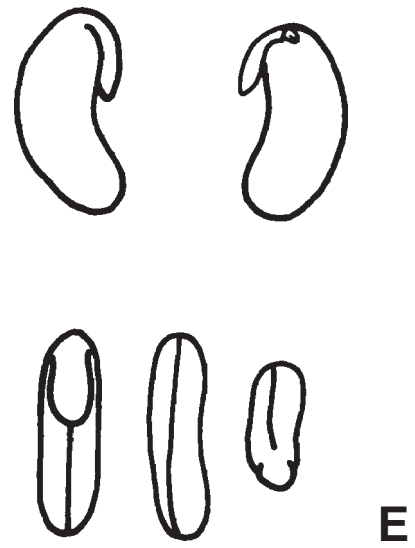
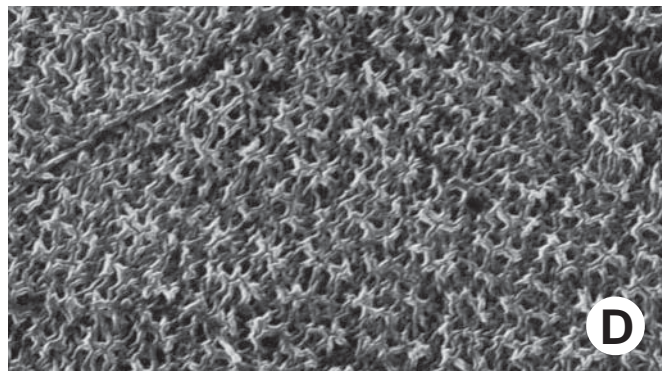
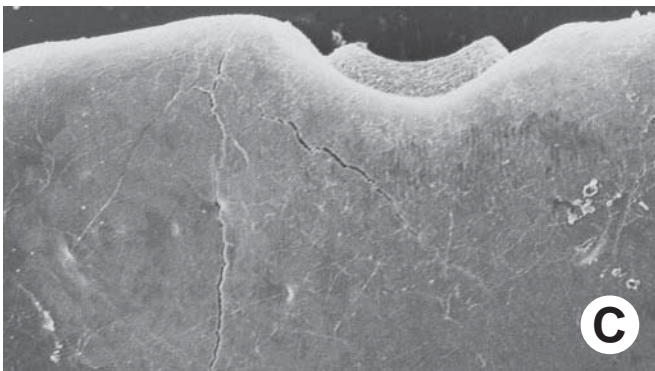
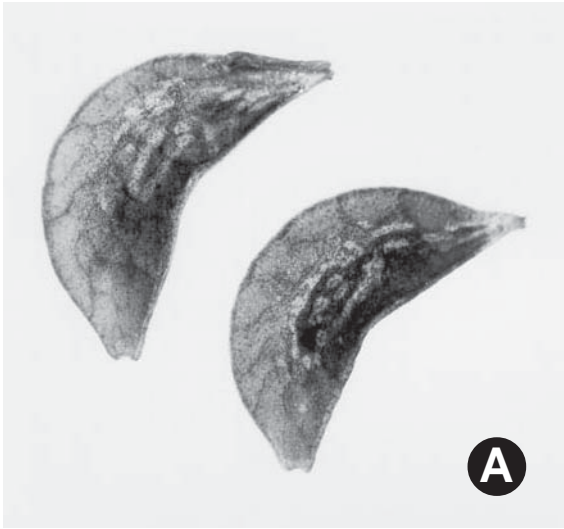
seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; very dark reddish brown, black, tan (greenish), or green; with purple overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split lighter colored than the rest of the hilum and therefore conspicuous; larger than punctiform; 0.5 mm long; with straight outline; oblong; marginal according to radicle tip; flush; within halo. Hilum halo color darker than testa. Lens discernible; less than 0.5 mm in length or equal to or greater than 0.5 mm in length; 0.5 mm long; with margins curved; circular; not in groove of raphe; confluent with hilum; mounded; dissimilar color from or same color as testa; darker than testa; very dark reddish brown, blackish, or tan (greenish); not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; completely concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; reddish brown; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

Distribution: India.

Notes: Based on its fruit characters (presence or absence of hairs and glandular dots), *Eleiotis monophylla* may be a mixed species.

Eleiotis: E. monophylla (N.L. Burman) A.-P. de Candolle (A–E). A, Fruits ($\times 7.8$); B, seeds ($\times 10.3$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).

6



Genus: *Phylacium* J.J. Bennett

Phylogenetic Number: 11.22.

Tribe: Desmodieae.

Subtribe: Lespedezinae.

Species Studied—Species in Genus: 2 spp.—2 spp.

Fruit a legume; unilocular; $0.7\text{--}1.2 \times 0.4\text{--}0.6 \times 0.15\text{--}0.2$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; when asymmetrical with 1 straight and 1 curved (more or less) suture; widest near middle or D-shaped (more or less); not inflated; flattened; with beak; declined (especially, tip of *P. bracteosum* J.J. Bennett) or coiled (especially tip of *P. majus*); with solid beak the same color and texture as fruit; short tapered at apex; apex aligned or oblique with longitudinal axis of fruit (especially tip); short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally visible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome; reddish brown to brown; pubescent and indurate; with hairs erect or appressed; with 1 type of pubescence; puberulent; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; reddish brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seed 1; length parallel with fruit length. Funiculus less than 0.5 mm long; filiform or thick and triangular; straight. Aril dry; rim-aril; reddish brown to brown.

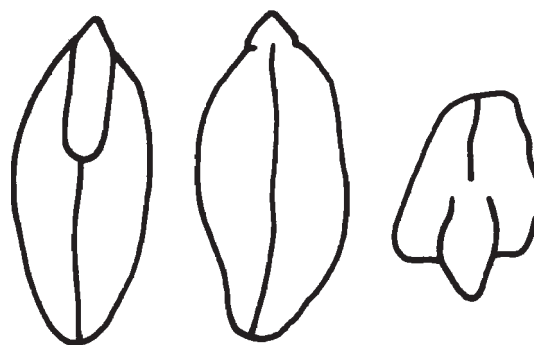
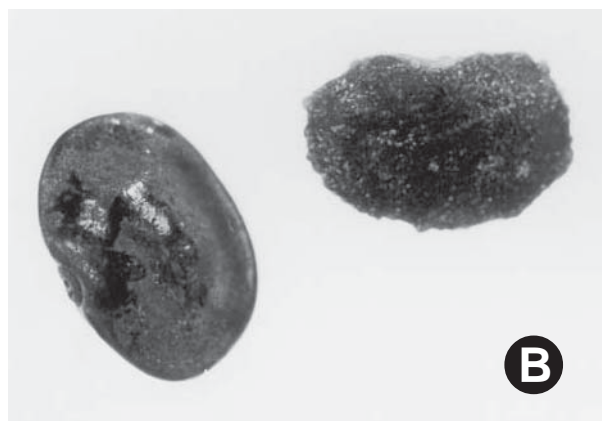
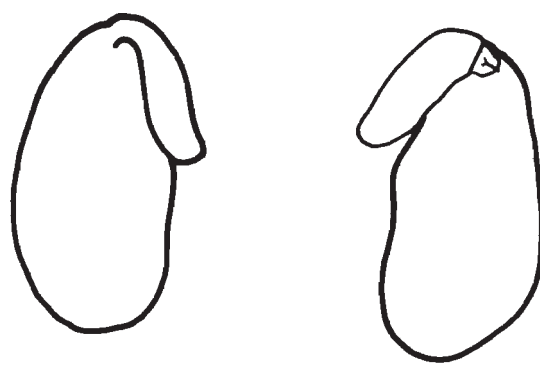
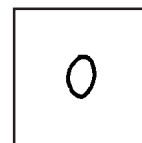
Seed $4\text{--}5 \times 1.5\text{--}3 \times 2\text{--}2.2$ mm; not overgrown; not angular; symmetrical; reniform, circular, or ovate; compressed; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering or partially adhering to endocarp (very thin layer *P. majus*); dull; not modified by a bloom; colored; monochrome (but with very thin reddish-brown

endocarp layer *P. majus*); black, purple, pale pink, or yellow; glabrous; smooth (shagreen) or not smooth; with elevated features; shagreen and warty (small); coriaceous. Fracture lines absent. Rim absent. Wings present. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split lighter colored than the rest of the hilum and therefore conspicuous; larger than punctiform; 1 mm long; with curved outline; elliptic; marginal according to radicle tip or between cotyledon and radicle lobe; slightly recessed; not within corona, halo, or rim or within halo. Hilum halo color lighter than testa. Lens discernible; less than 0.5 mm in length or equal to or greater than 0.5 mm in length; 0.5 mm long; with margins straight or curved; more or less triangular; elliptic; not in groove of raphe; confluent with hilum; mounded; same color as testa; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; reddish brown or red; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

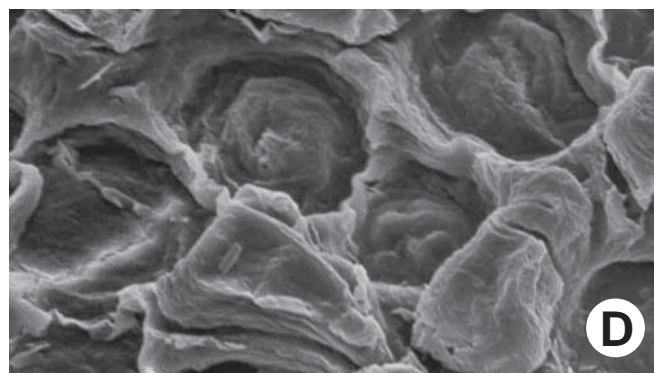
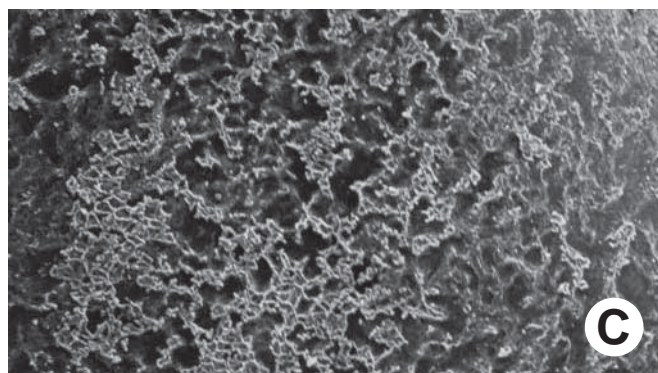
Distribution: China, Indochina, and Philippines to Australia (northern Queensland).

Notes: Bresser (1978) monographed the genus and carefully described the “most striking” feature of the inflorescences: “Large pale green bracts, which cover the fruits and the old flowers.” Figure A was lighted from the back to show the two fruits inside the bracts. There may be one to three fruits in each set of bracts, and this unit may function as a “winged fruit.” Bailey et al. (1997), using the chloroplast *rpl2* intron, suggested that *Phylacium* is not a member of Desmodieae, but did not indicate where it should be placed.

Phylacium: *P. majus* H. Collett & W.B. Hemsley (C–E), *P.* spp. (A–B). A, Fruits within large bracts and a freed fruit (see Notes) ($\times 1.7$); B, seeds ($\times 9$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



E



Genus: *Campylotropis* A.A. von Bunge

Phylogenetic Number: 11.23.

Tribe: Desmodieae.

Subtribe: Lespedezinae.

Species Studied—Species in Genus: 15 spp.—ca. 65 spp.

Fruit a legume; unilocular; $0.8\text{--}1.5 \times 0.4\text{--}0.5 \times 0.05\text{--}0.07$ cm; with deciduous or persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; asymmetrical or symmetrical; oblong; when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; widest near middle or D-shaped; not inflated; flattened; without or with beak; straight; with solid beak the same color and texture as fruit; rounded or short tapered at apex; apex aligned with longitudinal axis of fruit; tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally visible. Fruit margin not constricted; without sulcus; plain. Fruit wings present. Fruit substipitate. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome; brown; pubescent and indurate or glabrous (except for stiff hairs along sutures); with hairs erect or appressed; with 1 type of pubescence; pilose; with pubescence brown (to reddish) or golden; with pubescence uniformly distributed; with simple hairs; pliable or stiff (golden hairs along sutures); with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp absent. Endocarp glossy; monochrome; reddish brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seed 1; length parallel with fruit length. Funiculus less than 0.5 mm long; thick; straight. Aril absent.

Seed $3.7\text{--}4.5 \times 2\text{--}2.5 \times 1.3\text{--}1.5$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome; reddish brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than

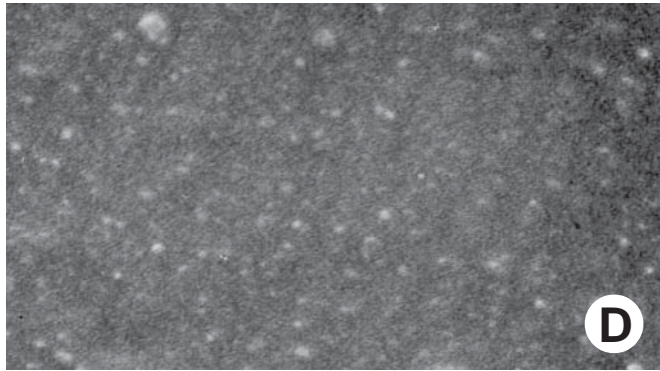
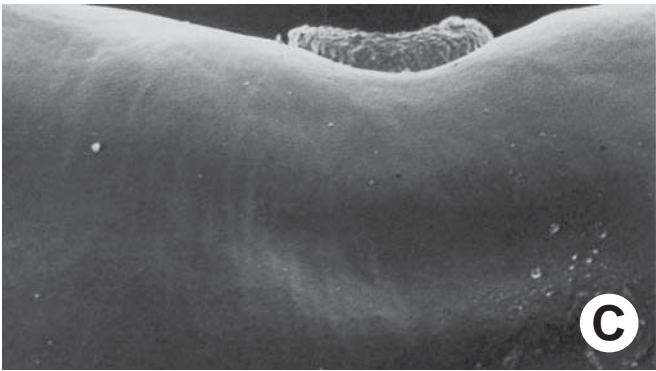
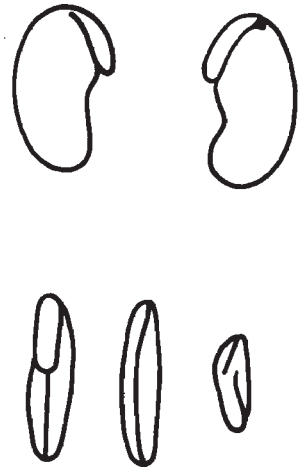
punctiform; 0.4 mm long; with curved outline; circular; marginal according to radicle tip; flush; within rim, or within halo (halo absent or faintly present). Hilum halo color darker than testa. Hilum rim color of testa. Lens discernible; less than 0.5 mm in length; with margins curved; elliptic; not in groove of raphe; confluent with hilum (or nearly so); flush; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm absent. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; reddish to greenish brown; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Asia.

Notes: Ohashi (1974a,b,c) published a trio of papers on *Campylotropis*, and Fu (1987) recognized 29 species in the People's Republic of China. Akiyama and Ohba (1985) and Nemoto and Ohashi (1988) maintained *Campylotropis*, *Kummerowia* (11.25), and *Lespedeza* (11.24) as distinct genera.

Campylotropis: *C. macrocarpa* (A.A. von Bunge) A. Rehder (C–E), *C. spp.* (A–B). A, Fruits (with and without calyx) ($\times 4.3$); B, seeds ($\times 6.3$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 5$).

6



Genus: *Lespedeza* A. Michaux

Phylogenetic Number: 11.24.

Tribe: Desmodieae.

Subtribe: Lespedezinae.

Species Studied—Species in Genus: 30 spp.—ca. 40 spp.

Fruit a legume; unilocular; $0.25 \times 0.2-0.4 \times 0.1-0.2$ cm; with persistent or deciduous calyx; with calyx shorter than or equal in length to fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; elliptic, oblong, ovate, circular, linear (somewhat), or C-shaped (slightly); when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; widest near middle or D-shaped; not inflated; compressed; with or without beak; hooked or straight; with solid beak the same color and texture as fruit; short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally visible. Fruit margin not constricted; without sulcus; plain or embellished; with fringe (of hairs). Fruit wings absent. Fruit substipitate. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome; reddish brown, tan (to greenish), green, or gray (because of hairs); pubescent and indurate, pubescent but soon deciduous, or glabrous; with hairs appressed (often missing from center of each valve) or erect; with 1 type of pubescence; puberulent; with pubescence gray or with pubescence golden; with apical pubescence different from basal pubescence; with apical $1/3-1/2$ pubescent and basal $1/2-2/3$ glabrous; with simple hairs (either straight or somewhat hooked at apex); pliable or stiff; with hair bases plain; antrorse; straight or curved at apex; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp present or absent; trace or thin (usually very); surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; chartaceous. Endocarp dull; monochrome; reddish brown or tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; remaining fused to epicarp; entire. Seed 1; length parallel with fruit length. Funiculus less than 0.5 mm long or measured; up to 1 mm long; flattened, thick, or partially filiform and partially thick; curved or straight. Aril dry; rim-aril; tan.

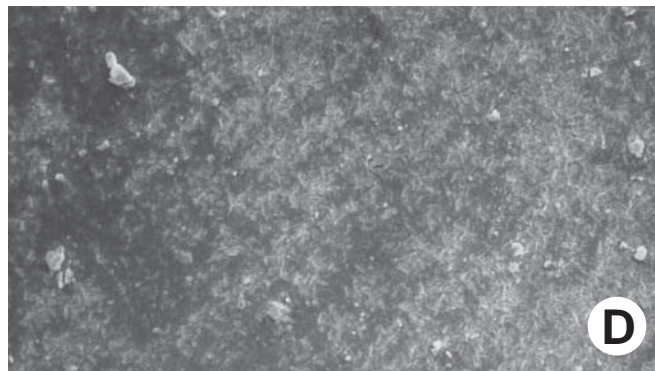
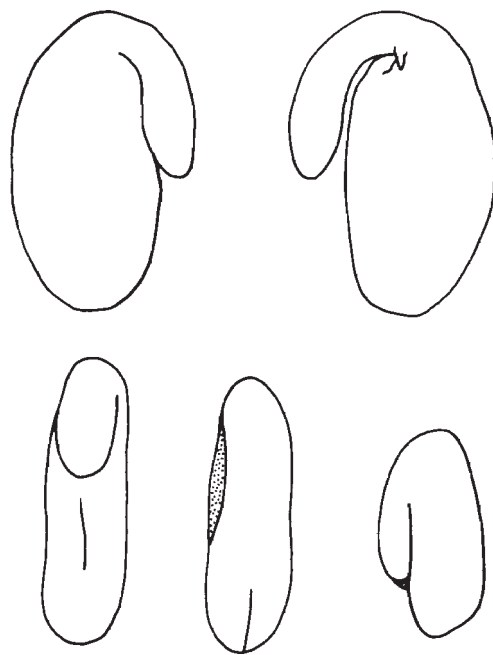
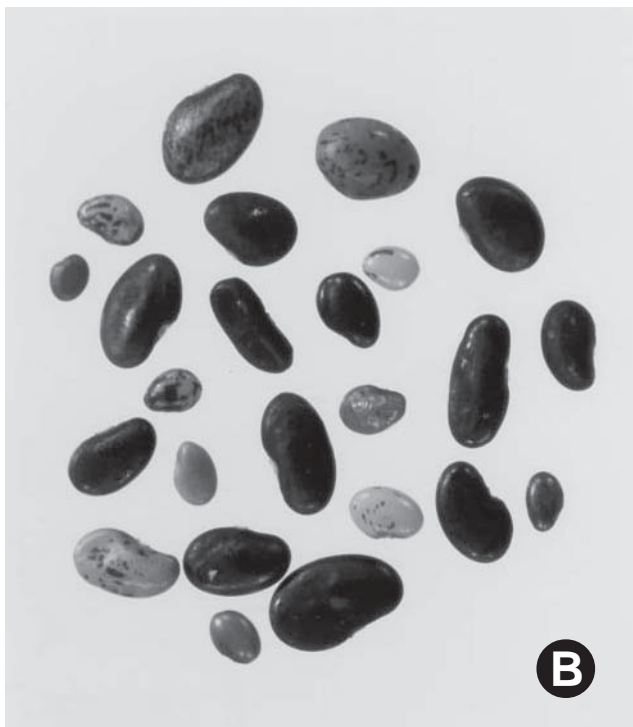
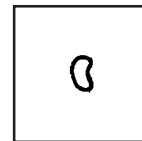
Seed $1.5-5 \times 1.3-3 \times 0.7-1.5$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; without or with visible radicle and cotyledon lobes; without or with external groove between radicle and cotyledon lobes; same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; light to dark reddish brown, tan, purple, yellow (greenish), green, or black; with purple overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform or larger than punctiform; 0.3–0.6 mm long; with straight outline; oblong; marginal according to radicle tip; recessed; within halo. Hilum halo color lighter or darker than testa. Lens discernible; less than 0.5 mm in length; with margins straight or curved; oblong, wedge-shaped, or linear (somewhat and with or without medial groove); circular or oblong; not in groove of raphe; confluent with or adjacent to hilum; up to 0.2 mm from hilum; flush; dissimilar color from testa; darker or lighter than testa; black or tan; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa or embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; white, yellow, green, or tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than $1/2$ length of cotyledons. Plumule moderately developed or rudimentary; glabrous.

Distribution: Temperate North America, eastern and tropical Asia, and Australia.

Notes: Akiyama (1988) monographed section *Macrolespedeza*, and Akiyama and Ohba (1988) revised *Lespedeza formosa* (J.R.T. Vogel) B.A.E. Koehne. Clewell (1966) monographed the native species of *Lespedeza* in North America. Although cleistogamous and chasmogamous flowers may produce slightly different fruits, these differences do not affect the genus circumscription of the fruits and seeds. Nemoto and Ohashi (1993) studied *Lespedeza*

seedling morphology and presented excellent SEM illustrations of the embryo and plumule. They found that the first pair of plumule leaves are either opposite or alternate and that their relative position is positively correlated with the subgeneric classification. *Lespedeza stipulacea* C.J. Maximowicz and *L. striata* C.P. Thunberg are now in the segregate genus *Kummerowia* (11.25). Akiyama and Ohba (1985) and Nemoto and Ohashi (1988) maintained *Campylotropis* (11.23), *Kummerowia* (11.25), and *Lespedeza* as distinct genera. Nemoto et al. (1995), using morphological and molecular evidence, concluded that “*Lespedeza* is closer to *Kummerowia* than to *Campylotropis*.”

Lespedeza: *L. virginica* (C. Linnaeus) N.L. Britton (*C-E*),
L. spp. (*A-B*). *A*, Fruits (with and without calyx) (\times
2.8); *B*, seeds (\times 4.7); *C-D*, testa (\times 50, \times 1000); *E*,
embryos (\times 13).



Genus: *Kummerowia* A.K. Schindler

Phylogenetic Number: 11.25.

Tribe: Desmodieae.

Subtribe: Lespedezinae.

Species Studied—Species in Genus: 2 spp.—2 spp.

Fruit a legume; unilocular; $0.28\text{--}0.45 \times 0.15\text{--}0.23 \times 0.1\text{--}0.13$ cm; with persistent or deciduous calyx; with calyx shorter than or equal (nearly) in length to fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical; oblong; not inflated; compressed; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous; seed chambers externally visible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome; brown or tan; pubescent but soon deciduous, pubescent and indurate, or glabrate; with hairs appressed or erect; with 1 type of pubescence; velutinous; with pubescence gray; with pubescence uniformly distributed or with apical pubescence different from basal pubescence; with apical $1/3\text{--}1/2$ pubescent and basal $1/2\text{--}2/3$ glabrous; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; tuberculate; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seed 1; length parallel with fruit length. Funiculus less than 0.5 mm long; more or less filiform; curved. Aril present (barely visible) or absent; dry; rim-aril; reddish tan or brown (reddish).

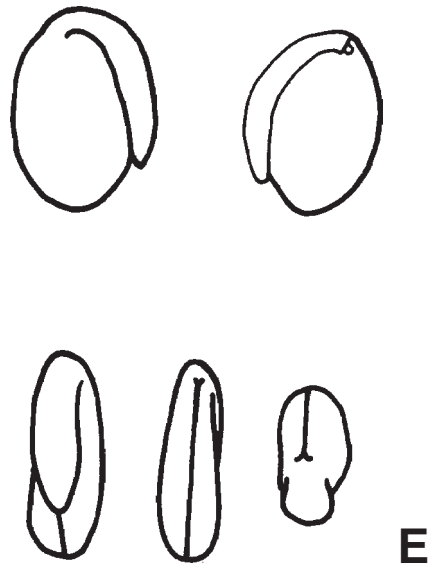
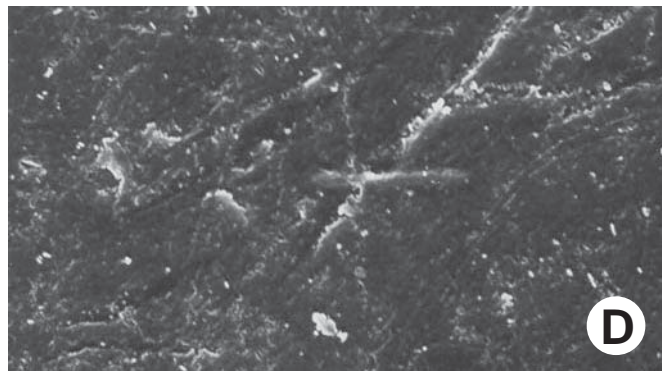
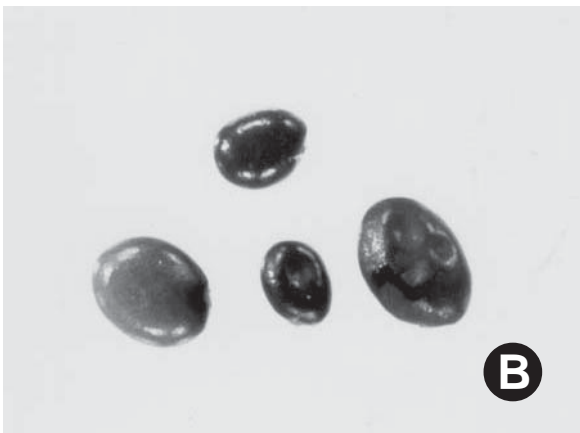
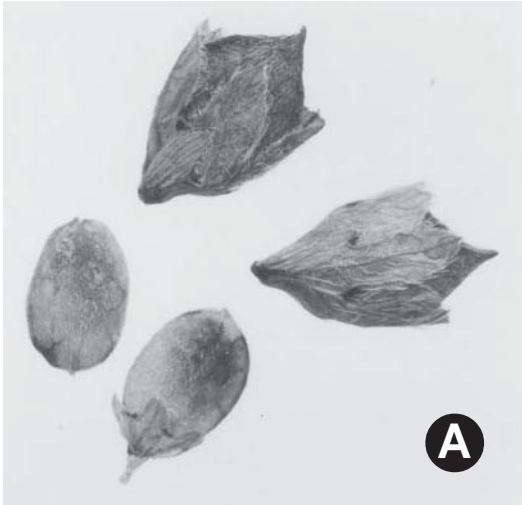
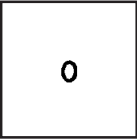
Seed $1.5\text{--}2.3 \times 1.5\text{--}1.8 \times 0.8\text{--}1$ mm; not overgrown; not angular; symmetrical (except hilum); oblong, ovate, or elliptic; compressed; with surface smooth; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; dark reddish brown or tan (reddish); with purple overlay; glabrous; smooth; coriaceous. Fracture

lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split lighter colored than the rest of the hilum and therefore conspicuous; punctiform or larger than punctiform; 0.3 mm long; with curved outline; circular; between cotyledon and radicle lobe or subapical to radicle tip; flush; within halo. Hilum halo color lighter than testa. Lens discernible; less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; confluent with hilum; recessed; dissimilar color from testa; darker or lighter than testa; reddish brown, tan (greenish), or green; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon width; centered between cotyledons; $1/2$ to nearly length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Asia and naturalized in temperate North America.

Notes: Isely (1948) discussed the two species of annual *Lespedeza* naturalized in the United States, which now are placed in the genus *Kummerowia*. Akiyama and Ohba (1985) and Nemoto and Ohashi (1988) maintained *Campylotropis* (11.23), *Kummerowia*, and *Lespedeza* (11.24) as distinct genera.

Kummerowia: *K. stipulacea* (C.J. Maximowicz) T. Makino (C–E), *K. spp.* (A–B). A, Fruits with and without calyx ($\times 8.7$); B, seeds ($\times 9.3$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



Psoraleeae (12.01–12.09)

Genus: *Cullen* F.C. Medikus

Phylogenetic Number: 12.01.

Tribe: Psoraleeae.

Species Studied—Species in Genus: 10 spp.—32 spp.

Fruit a legume; unilocular; $0.25\text{--}0.7 \times 0.15\text{--}0.35 \times 0.1\text{--}0.5$ cm; with persistent calyx; with calyx longer than fruit; without orifice formed by curving of fruit or fruit segments; straight to curved; not plicate; not twisted; asymmetrical or symmetrical; oblong or reniform; when asymmetrical with both sutures parallelly or unequally curved; partially inflated or not inflated; compressed; without beak; short tapered to rounded at apex; apex aligned to oblique to right-angled (nearly) with longitudinal axis of fruit; rounded at base; base aligned to oblique with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally visible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome; black or red (brownish often concealed by deciduous white hairs); glabrous, pubescent and indurate, or pubescent but soon deciduous; with 1 type of pubescence; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; glandular or eglandular; without spines; not smooth; with elevated or recessed features; veined or not veined; transversely veined relative to fruit length; not tuberculate; scaly or wrinkled; glandularly punctate; exfoliating in part or not exfoliating; without cracks. Mesocarp absent. Endocarp absent. Seed 1; length parallel with fruit length. Funiculus less than 0.5 mm long; filiform; straight. Aril present or absent; dry; rim-aril; white.

Seed $2.5\text{--}5 \times 1.5\text{--}3.5 \times 1\text{--}2.5$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with or without visible radicle and cotyledon lobes; without umbo on seed faces. Testa with pieces of adhering epicarp; partially adhering to endocarp; somewhat glossy; not modified by a bloom; colored; monochrome or mottled; with frequent mottles; reddish brown or green (brownish); with brownish black overlay; glabrous; smooth (when partially adhering endocarp not considered); coriaceous. Fracture lines absent. Rim absent. Raphe not visible. Hilum fully concealed; concealed by funiculus or funicular remnant; without

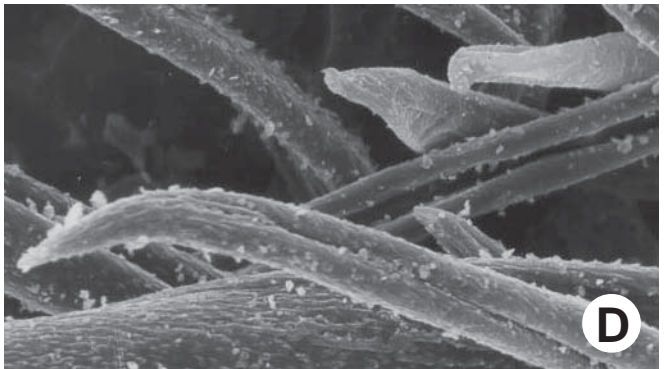
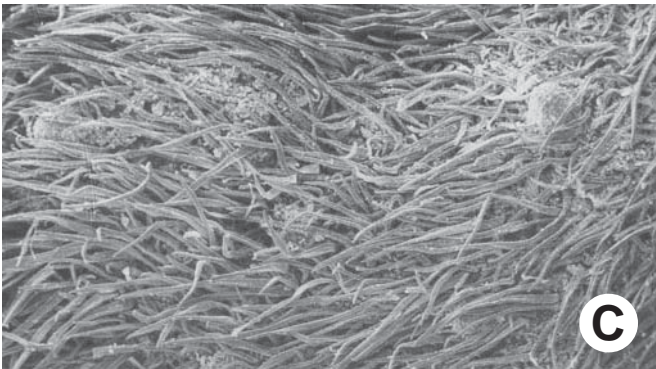
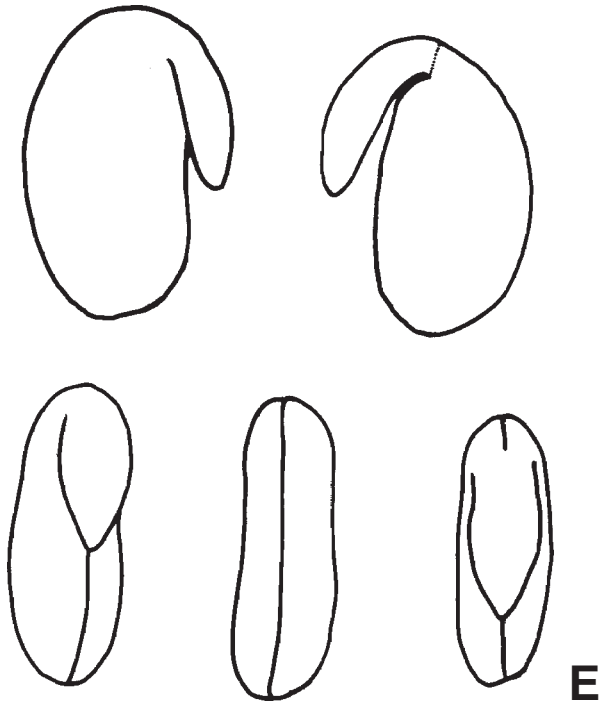
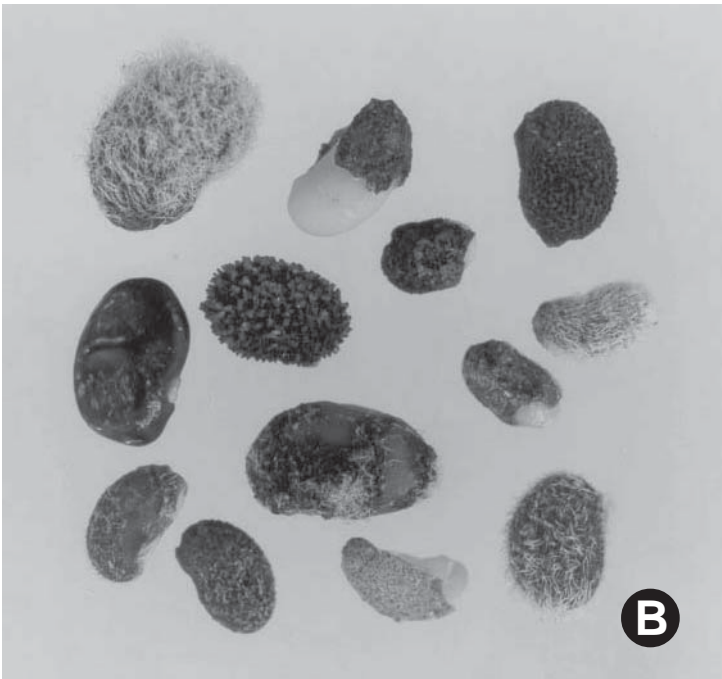
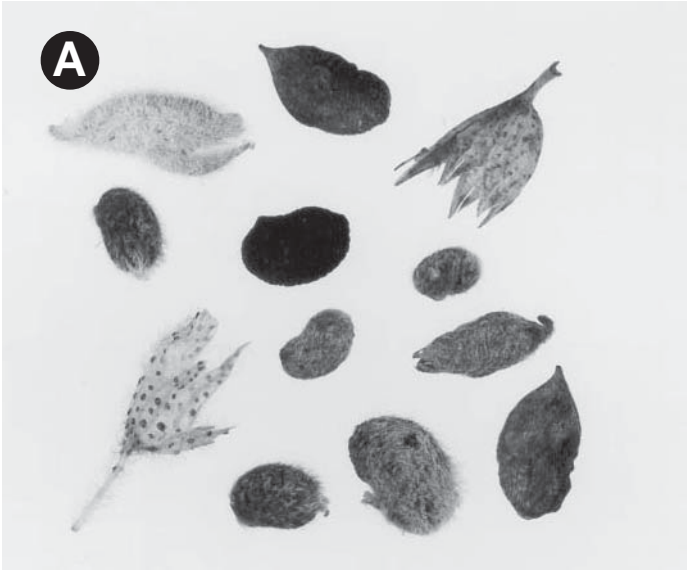
faboid split; punctiform; marginal according to radicle tip; recessed; within corona. Hilum corona color lighter than testa (reddish to yellow). Lens not discernible. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating in radicle tissue; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; parallel to length of seed. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Africa through India and Sri Lanka to Burma, Philippines, Papua New Guinea, and Australia.

Notes: Stirton (1981) illustrated seeds and fruits of Amorpheae and Psoraleeae. Since Isely (1962) monographed the tribe for north-central United States the spelling of the tribe name has changed as well as the genera recognized in the tribe. *Amorpha* (6.04), *Dalea* (6.08), and *Petalostemon* A. Michaux (now part of *Dalea*) are now in the Amphoreae, and species in the remaining genus, *Psoralea* (12.09), have been assigned to several genera treated here. Grimes (1990) noted that this tribe “has been described as having indehiscent fruits. However, in many North American species the fruit is secondarily dehiscent (that is, not along sutures) by transverse rupture of the pod.” This technically is not dehiscence. Stirton (1981) transferred six African species of *Psoralea* (12.09) to *Cullen*. The unit of dispersal may include the soon-deciduous to apparently permanent-papery-to-leathery 5-lobed calyx. The calyx bears reddish glands and may be glabrous to pubescent with silvery to golden hairs. Grimes (1997) revised *Cullen*, and his species count is used. He accepted it as monophyletic because all of its species have a small invagination of the epicarp just above the fruit stalk on the ventral side. The invagination only partially penetrates the epicarp. The fruit of *C. glandulosa* (C. Linnaeus) J.W. Grimes abscises below the calyx and travels with it, while in *C. americanum* the fruit falls free of the calyx. The fruit of *C. glandulosa* is unusual among the studied species because the upper half is more or less inflated and the lower half is adnate to the testa.

Cullen: C. americanum (C. Linnaeus) P.A. Rydberg (*C-E*),
C. spp. (*A-B*). *A*, Fruits with and without calyx ($\times 3.4$);
B, embryos with and without epicarp ($\times 5$); *C-D*,
exocarp ($\times 50$, $\times 1000$); *E*, embryos ($\times 10$).

0



Genus: *Bituminaria* L. Heister ex P.C. Fabricius

Phylogenetic Number: 12.02.

Tribe: Psoraleeae.

Species Studied—Species in Genus: 1 sp.—2 spp.

Fruit a legume; unilocular; 0.4–0.6 (exclusive of fragile beak up to 1 cm long) \times 0.3–0.4 \times 0.2–0.3 cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; when asymmetrical with 1 straight and 1 curved suture; widest near middle or D-shaped; not inflated; compressed; with beak; declined; with papery fragile beak up to 1 cm long; truncate at apex (exclusive of beak); apex aligned with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous or fragile, thinner than chartaceous like *Trifolium* (23.07); seed chambers externally visible. Fruit margin not constricted; without sulcus; embellished; with prickles. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent or with all layers dehiscing (secondarily: see Notes). Replum invisible. Epicarp dull; multicolored; mottled; brown or gray; with red overlay (if spines knocked off); with surface texture uniform or not uniform, with patches of different texture not restricted to the base and apex; pubescent but soon deciduous and glabrous (except apex); with 1 type of pubescence; villous; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; glandular; with glandular dots (reddish brown); with spines (black on seed chamber); with spines persistent or broken off and their bases evident; with spines same color as or a different color (or their basal remnant) from the rest of the fruit; not smooth; with elevated or recessed features; not veined; not tuberculate; faintly wrinkled; glandularly punctate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 2-layered; without balsamic vesicles; without fibers; with spongy layer over solid layer; coriaceous. Endocarp dull; monochrome; grayish black; smooth; nonseptate; coriaceous; not exfoliating; remaining fused to mesocarp and epicarp. Seed 1; length parallel with fruit length. Funiculus less than 0.5 mm long; straight. Aril absent.

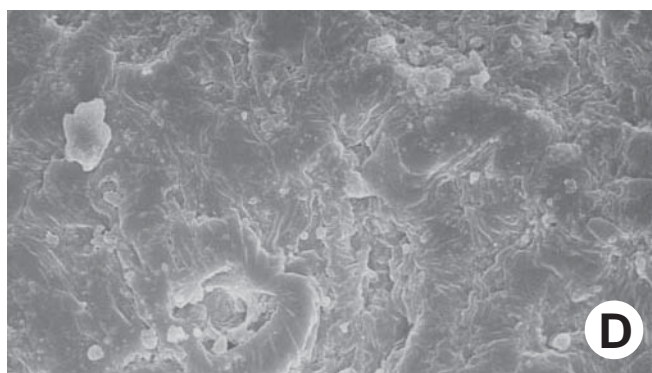
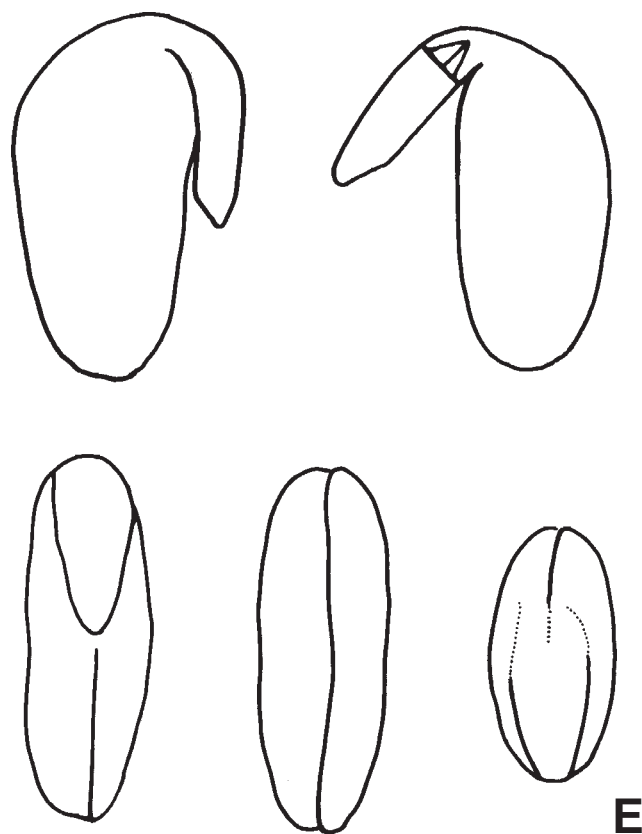
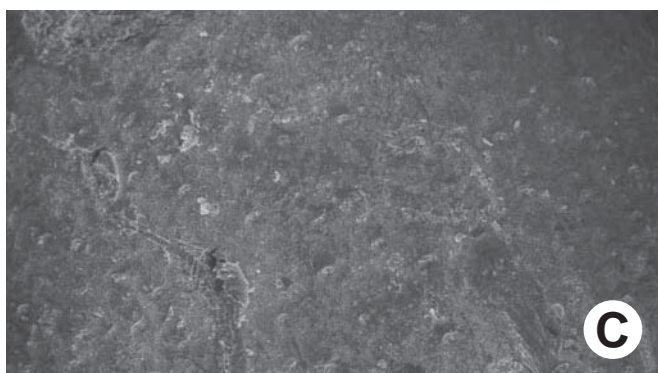
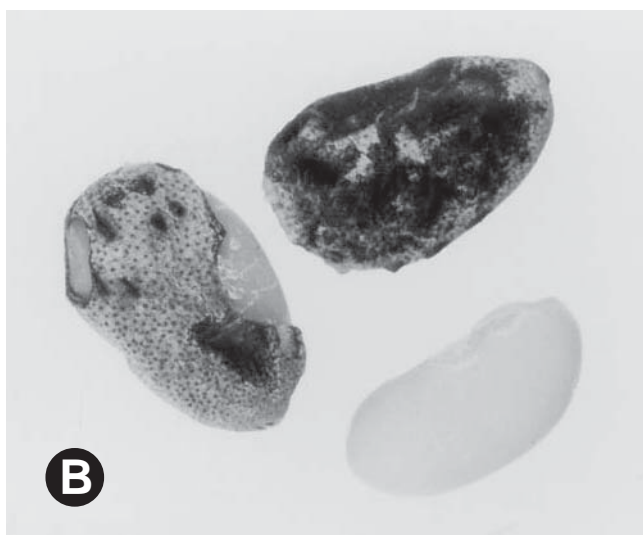
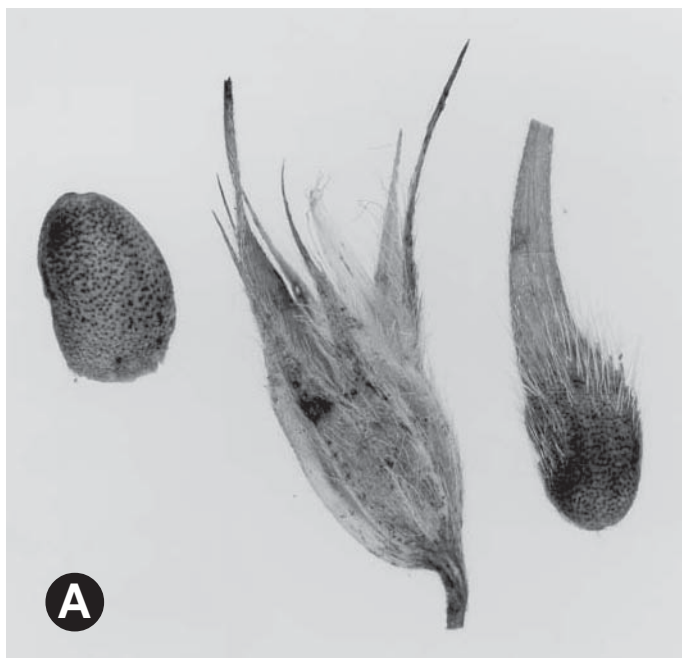
Seed 3.5–4.5 \times 2.5–3.5 \times 1.5–2.5 mm; not overgrown; not angular; asymmetrical; D-shaped; quadrangular; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa absent. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating in radicle tissue; without margins recessed; dark tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; parallel to length of seed. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Mediterranean Europe, North Africa, and southwestern Asia.

Notes: Intact seeds of *B. bituminosa* do not exist free of the fruit because the testa is fused to the endocarp. Therefore, the testa, raphe, hilum, and lens characters could not be scored. The fruits have an aroma reminiscent of fenugreek (*Trigonella foenum-graecum*, 21.04).

Bituminaria: *B. bituminosa* (C. Linnaeus) C.H. Stirton (A–E). A, Fruits (without beak and hairs, within calyx, and with beak and hairs) (\times 4.9); B, embryo and two fruits functioning as seeds (\times 8); C–D, exocarp (\times 50, \times 1000); E, embryos (\times 8).

0



Genus: *Pediomelum* P.A. Rydberg

Phylogenetic Number: 12.03.

Tribe: Psoraleeae.

Species Studied—Species in Genus: 4 spp.—21 spp.

Fruit a legume; unilocular; 0.8–1.6 (including beak) × 0.4–0.5 × 0.2–0.25 cm; with persistent calyx; with calyx shorter than fruit (but not beak); without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical (except beak); oblong; when asymmetrical with both sutures parallelly curved; not inflated; compressed; with beak; straight; with solid beak the same color and texture as fruit; long tapered or rounded at apex; apex aligned to oblique with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform or differing in texture; upper 3/4 barely inflated, reticulate, and pubescent and lower 1/4 not inflated, reticulate, or pubescent; chartaceous or fragile, thinner than chartaceous like *Trifolium* (21.06); seed chambers externally visible. Fruit margin not constricted; without sulcus; plain or embellished; with thickened sutural areas (thickened margins). Fruit wings absent. Fruit substipitate to nonstipitate. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome; red or tan; pubescent and indurate; with 1 type of pubescence; villous; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; glandular or eglandular; with glandular dots; limited to a portion of fruit; upper 3/4 glandular and lower 1/4 eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seed 1; length parallel with fruit length. Funiculus measured; less than 1 mm long; straight. Aril absent.

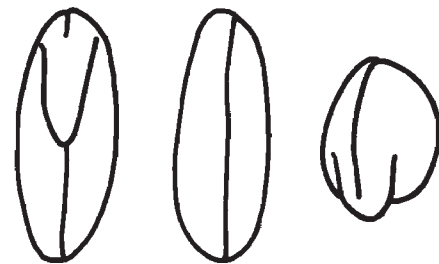
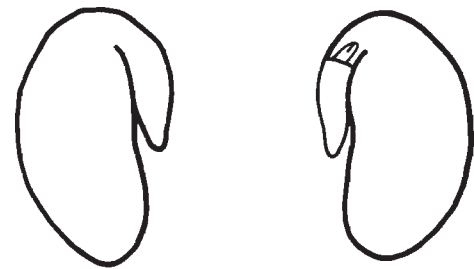
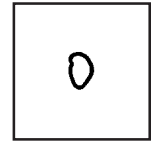
Seed 4.5–6 × 2.8–4 × 1.5–2.5 mm; not overgrown, 1 seed filling entire fruit cavity; not angular; symmetrical or asymmetrical; oblong; compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa partially adhering to endocarp (may have); glossy; not modified by a bloom; colored; monochrome or streaked; with frequent streaks; green (ish), red (brownish), tan, or yellow; with black (faintly) or brown overlay; glabrous; smooth (*P. cyphocalyx* (A.

Gray) P.A. Rydberg) or not smooth; with elevated or recessed features; wrinkled (*P. castoreum* (S. Watson) P.A. Rydberg); pitted with small separate pits (faintly and widely scattered); coriaceous. Fracture lines absent. Rim absent. Raphe not visible. Hilum fully concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; up to 0.6 mm long; with curved outline; circular or elliptic; marginal according to radicle tip; recessed; within corona or not within corona, halo, or rim. Hilum corona color lighter than testa. Lens discernible; equal to or greater than 0.5 mm in length; up to 0.5 mm long; with margins straight or curved; linear, circular, or oblong; not in groove of raphe; adjacent to hilum; up to 0.2 mm from hilum; mounded; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thin (thinnest of all genera in tribe); covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating in radicle tissue; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; parallel to length of seed. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

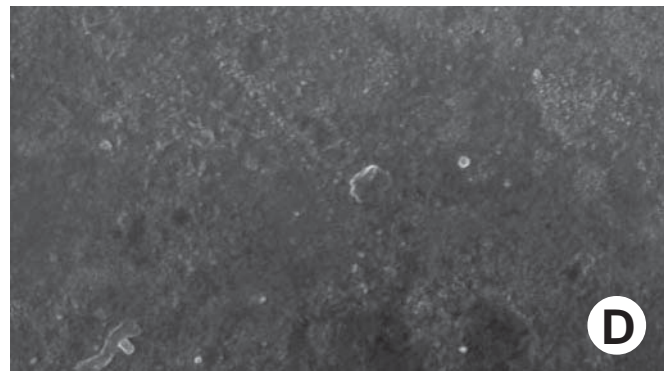
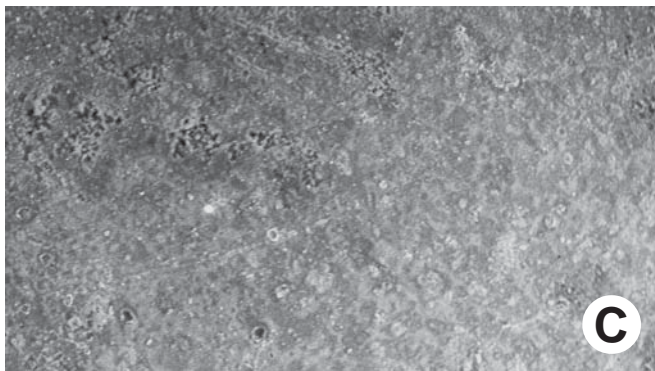
Distribution: North America, Mexico, and central and southern Africa.

Notes: Grimes (1990) recognized 21 species, and we are following his count. *Pediomelum argophyllum* (F.T. Pursh) J.W. Grimes and *P. castoreum* have beaks like *Bitumaria* (12.02), but their fruits are too fragile and were too few in number in our sample for our analysis to be considered complete.

Pediomelum: *P. esculentum* (F.T. Pursh) P.A. Rydberg (C–E), *P. spp.* (A–B). A, Fruits with and without calyx (× 3.2); B, seeds (× 6); C–D, testa (× 50, × 1000); E, embryos (× 6).



E



Genus: *Psoralidium* P.A. Rydberg

Phylogenetic Number: 12.04.

Tribe: Psoraleae.

Species Studied—Species in Genus: 2 spp.—13 spp.

Fruit a legume; unilocular; 0.4–0.95 (including beak up to 3 mm long in *P. tenuifolium*) \times 0.35–0.5 \times 0.25–0.4 cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical; circular, elliptic, or oblong; not inflated; compressed to terete; without or with beak; straight; with solid beak the same color and texture as fruit (*P. tenuifolium* (F.T. Pursh) P.A. Rydberg); rounded at apex; apex aligned to oblique with longitudinal axis of fruit; short tapered to rounded at base; base aligned to oblique with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome (but with well developed reddish-brown glands); tan; pubescent and indurate; with 1 type of pubescence; tomentose; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; glandular; with glandular dots; without spines; not smooth; with elevated or recessed features; not veined; tuberculate; glandularly punctate; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp. Seed 1; length parallel with fruit length. Funiculus measured; up to 1 mm long; thick; straight. Aril absent.

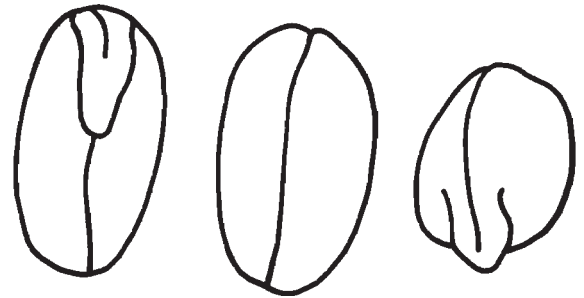
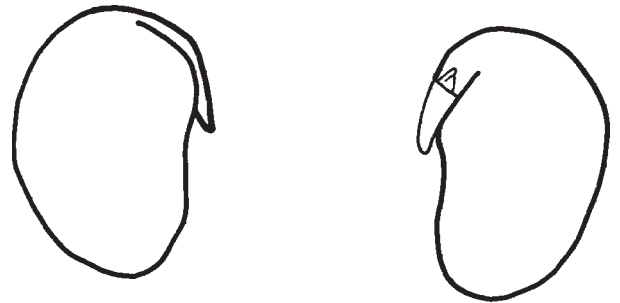
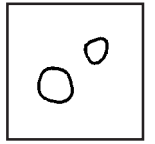
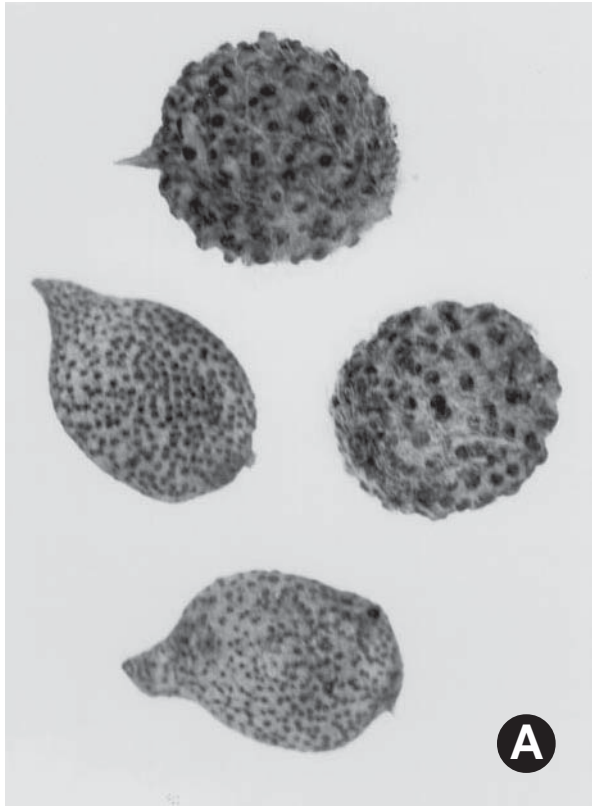
Seed 3.4–5.5 \times 3–3.5 \times 2–3 mm; not overgrown; angular to not angular; symmetrical or asymmetrical; circular, irregular (many seeds have large, irregularly placed dimples), or oblong; terete to compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or streaked; with frequent streaks; brownish green or red (brownish); with purple overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.4 mm long; with curved or straight outline; elliptic or oblong; marginal according to radicle tip; flush; not within corona, halo, or rim. Lens discern-

ible; equal to or greater than 0.5 mm in length; up to 0.6 mm long; with margins straight or curved; linear, elliptic, oblong, or key-hole shaped (*P. lanceolatum*); not in groove of raphe; confluent with hilum; recessed; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons outer face of 1 cotyledon flat and other cotyledon concave; 1 thicker than the other; both more or less of equal length; with both or only 1 folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating in radicle tissue; without margins recessed; yellow or green; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; parallel to length of seed. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

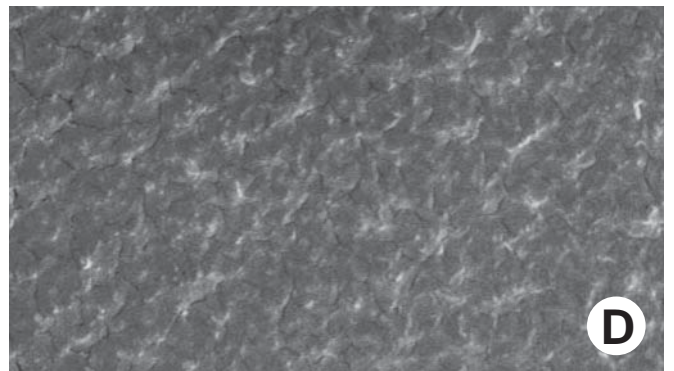
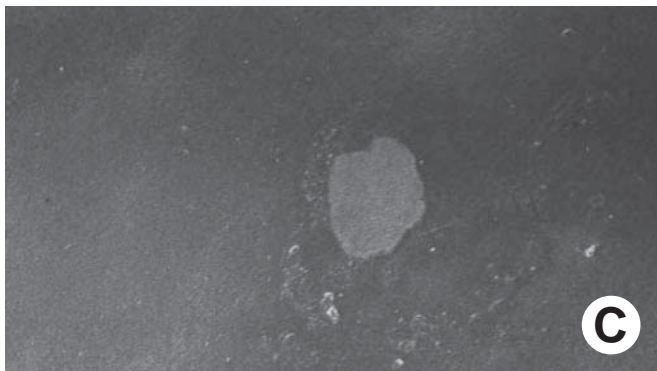
Distribution: Western Canada and western United States.

Notes: Our species count is based on Grimes (1990). The micropyle of *P. tenuiflorum* is bright reddish and therefore more conspicuous than the black lens.

Psoralidium: *P. lanceolatum* (F.T. Pursh) P.A. Rydberg (C–E), *P. spp.* (A–B). A, Fruits (\times 6.7); B, seeds (\times 7.8); C–D, testa (\times 50, \times 1000); E, embryos (\times 6).



E



Genus: *Rupertia* J.W. Grimes

Phylogenetic Number: 12.05.

Tribe: Psoraleeae.

Species Studied—Species in Genus: 2 spp.—3 spp.

Fruit a legume; unilocular; $0.4\text{--}0.7 \times 0.3\text{--}0.5 \times 0.27$ cm; with persistent calyx; with calyx equal in length to fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical; elliptic; not inflated; compressed; without (*R. physodes*) or with beak; with solid beak the same color and texture as fruit (beak 1–3 mm long in *R. hallii* (P.A. Rydberg) J.W. Grimes and *R. rigida* (S.B. Parish) J.W. Grimes); short tapered or rounded at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform; chartaceous; seed chambers externally visible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome; tan; pubescent and indurate; with 1 type of pubescence; puberulent; with pubescence gray or brown; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; glandular or eglandular; with glandular dots (golden and fading with age); without spines; not smooth; with elevated features; veined or not obliquely veined relative to fruit length (at least lower one-half); not tuberculate; wrinkled; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; spongy; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp. Seed 1; length parallel with fruit length. Funiculus measured; less than 1 mm long; thick; straight. Aril absent.

Seed $4.5\text{--}7 \times 2.7\text{--}4 \times 1.7$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; brownish red; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.8 mm long; with curved outline; circular; marginal according to radicle tip; recessed; within corona. Hilum corona color darker than testa. Lens discernible; equal to or greater than 0.5 mm or less than 0.5 mm in length;

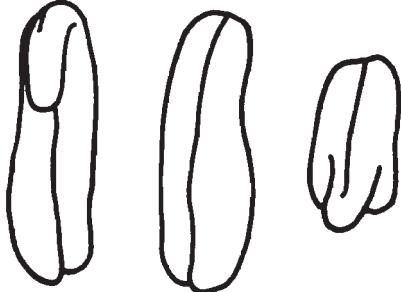
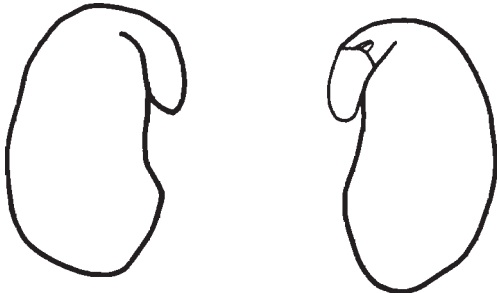
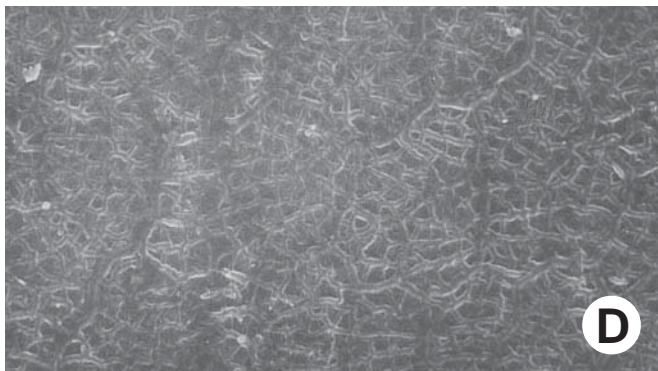
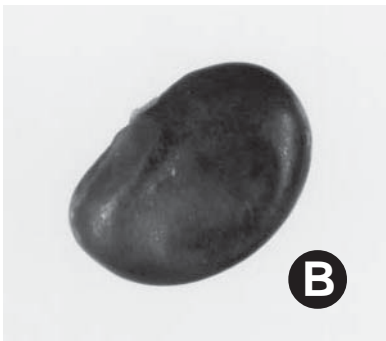
0.5 mm long; with margins straight; wedge-shaped; not in groove of raphe; confluent with hilum; flush; dissimilar color from testa; darker than testa; black; within corona. Lens corona color darker than testa. Endosperm absent. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating in radicle tissue; green; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; parallel to length of seed. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Western Canada and United States to Mexico (Baja California).

Notes: Grimes (1990) founded the genus.

Rupertia: *R. physodes* (D. Douglas ex W.J. Hooker) J.W. Grimes (A–E). A, Fruits with and without calyx ($\times 6$); B, seed ($\times 8.5$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).

3



E

Genus: *Hoita* P.A. Rydberg

Phylogenetic Number: 12.06.

Tribe: Psoraleeae.

Species Studied—Species in Genus: 3 spp.—3 spp.

Fruit a legume; unilocular; $0.6-1 \times 0.3-0.5 \times 0.2-0.25$ cm; with persistent or deciduous calyx; with calyx longer or shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; when asymmetrical with 1 straight and 1 curved suture; widest near middle or D-shaped; barely inflated or not inflated; compressed; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; rounded at base; base oblique with longitudinal axis of fruit; with the apex and base differing in texture; upper 3/4 barely inflated, reticulate, and pubescent and lower 1/4 not inflated, reticulate, or pubescent; chartaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome; brown; pubescent and indurate; with 1 type of pubescence; pilose; with pubescence golden; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; glandular; with glandular dots; limited to a portion of fruit; upper 3/4 glandular and lower 1/4 eglandular; without spines; not smooth; with elevated features; veined or not veined; transversely veined relative to fruit length; not tuberculate; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seed 1; length parallel with fruit length. Funiculus measured; less than 1 mm long; thick; straight. Aril absent.

Seed $5.5-6.7 \times 3.5-3.7 \times 2-2.5$ mm; not overgrown; not angular; symmetrical (except for hilum); elliptic; compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome or streaked; with frequent streaks; dark reddish brown; with brown (in dark, broad bands) overlay; glabrous; smooth or not smooth; with recessed features; pitted with small separate pits (some seeds with numerous pits and other seeds with few to no pits *H. strobilina* (J.W. Hooker & G.A. Arnott) G.A.W. Rydberg); coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible

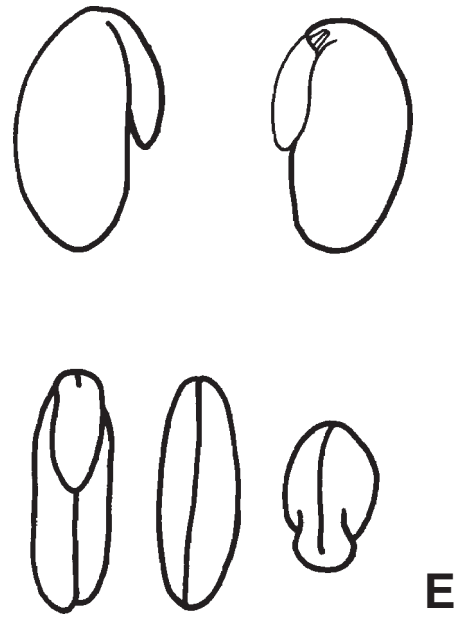
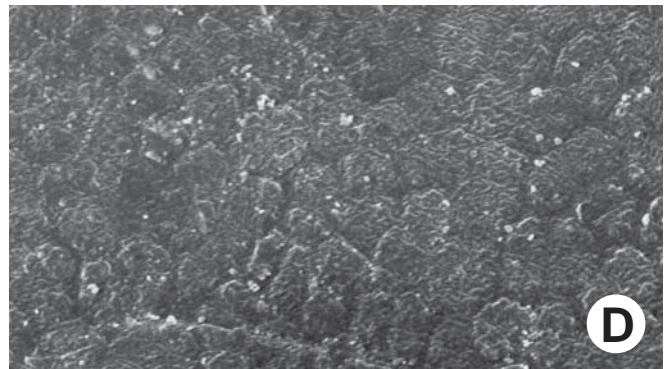
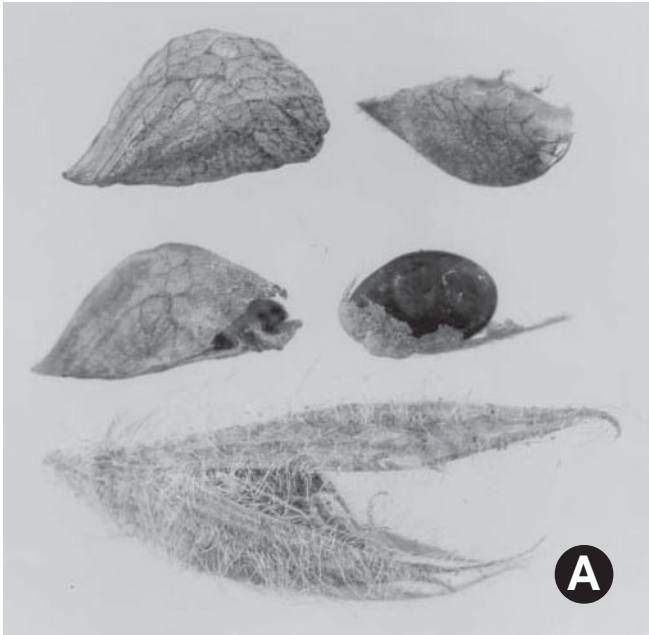
(with conspicuous light tan rim); with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; marginal according to radicle tip; recessed; within rim. Hilum rim color lighter than testa. Lens not discernible. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating in radicle tissue; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; parallel to length of seed. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Canada, western United States, and Mexico (Baja California).

Notes: Our species count is based on Grimes (1990).

Hoita: H. macrostachys (A.-P. de Candolle) P.A. Rydberg (C-E), *H. spp.* (A-B). A, Fruits and fruit in calyx ($\times 4.5$); B, seeds ($\times 8$); C-D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 6$).

0



Genus: *Orbexilum* C.S. Rafinesque-Schmaltz

Phylogenetic Number: 12.07.

Tribe: Psoraleeae.

Species Studied—Species in Genus: 6 spp.—8 spp.

Fruit a legume; unilocular; $0.3\text{--}1.2 \times 0.3\text{--}0.65 \times 0.3$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; circular or obovate; when asymmetrical with 1 straight and 1 curved suture; widest near middle or D-shaped; not inflated; compressed; without or with beak; straight; with solid beak the same color and texture as fruit; short tapered to rounded at apex; apex aligned (with 3–4 mm long beak) or right-angled with longitudinal axis of fruit; short tapered to rounded at base; base aligned to oblique with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome; brownish black, brown, or green; glabrous to glabrate to pubescent and indurate; with 1 type of pubescence; puberulent; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; glandular or eglandular; with glandular dots; without spines; not smooth; with elevated features; obliquely veined relative to fruit length or reticulately veined; not tuberculate; papillose or rugose; not exfoliating; without cracks. Mesocarp thin; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seed 1; length parallel with fruit length. Funiculus measured; less than 1 mm long; thick; straight. Aril absent.

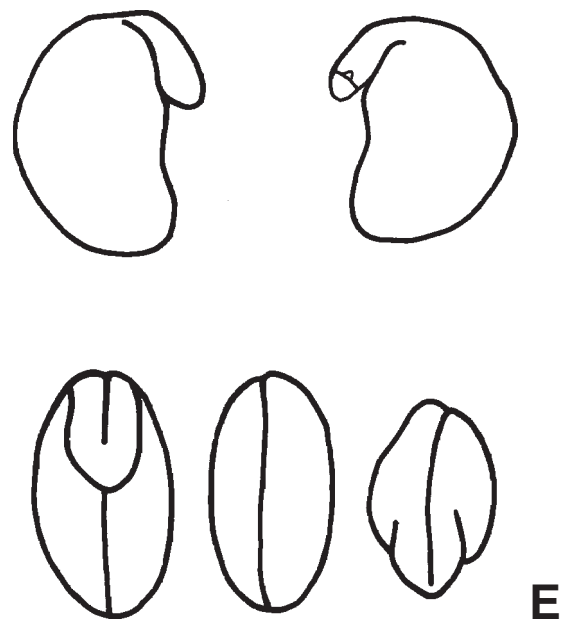
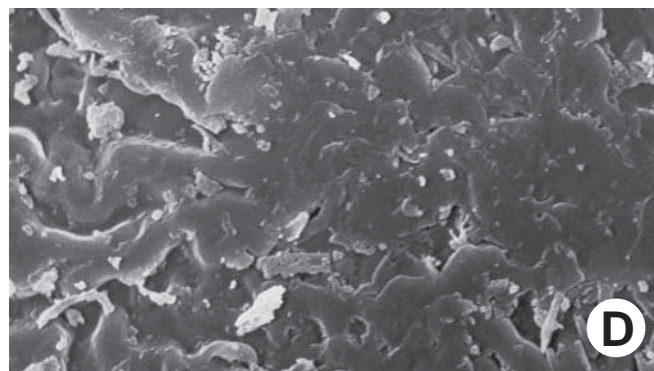
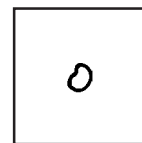
Seed $2\text{--}7 \times 2\text{--}4 \times 2.5$ mm; not overgrown; not angular; asymmetrical; ovate or reniform; compressed to terete (nearly); without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; black or brown (reddish); glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of

the hilum; larger than punctiform; 0.6 mm long; with curved outline; circular; marginal according to radicle tip; flush; not within corona, halo, or rim. Lens not discernible. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire or split over radicle; without or with lobes; with the interface division terminating in radicle tissue; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; parallel to length of seed. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: North America and Mexico.

Notes: Stirton (1981) noted that “*Orbexilum* is all that remains of *Psoralea* s.l.” when other segregate genera including *Psoralea* s.s. (12.09) are removed. “Furthermore, *Orbexilum* is clearly an unsatisfactory assemblage of plants.” The species count and distribution are based on Grimes (1990), who noted “*Orbexilum* is easily distinguished from all other Psoraleeae by its rugose fruits.” Also, he classified fruits as rugose-ribbed, but in *O. onobrychis* (T. Nuttall) P.A. Rydberg fruits are papillate.

Orbexilum: *O. pedunculatum* (P. Miller) A.M. Vail (C–E), *O.* spp. (A–B). A, Fruits with and without calyx ($\times 3.8$); B, seeds ($\times 7.6$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



Genus: *Otholobium* C.H. Stirton

Phylogenetic Number: 12.08.

Tribe: Psoraleae.

Species Studied—Species in Genus: 15 spp.—ca. 45 spp.

Fruit a legume; unilocular; 0.45–1.6 (including beak) × 0.25–0.5 × 0.25–0.3 cm; with persistent or deciduous calyx; with calyx longer than to equal in length to shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; circular, oblong, or obovate; when asymmetrical with both sutures parallelly curved; not inflated; compressed; with beak; straight; with solid beak (flat, 2 mm long) the same color and texture as fruit; short tapered to rounded at apex; apex right-angled with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform or differing in texture; upper 1/2 inflated and reticulate over seed cavity and lower 1/2 adnate and wrinkled to scurfy over seed cavity (*O. glandulosa* (C. Linnaeus) J.W. Grimes); chartaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome; tan; pubescent and indurate; with 1 type (gray) or 2 types of pubescence; pilose or puberulent; with pubescence gray and brown or brown (dark); with appressed dark brown hairs and scattered erect gray hairs intermixed; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; transversely veined relative to fruit length; not tuberculate; not exfoliating; with cracks; cracking transverse to fruit length. Mesocarp absent. Endocarp dull; monochrome; tan; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seed 1; length parallel with fruit length. Funiculus measured; less than 1 mm long; straight. Aril absent.

Seed 3–6 × 2–3 × 2 mm; not overgrown; not angular; asymmetrical; oblong; terete (to subterete); without visible radicle and cotyledon lobes; without umbo on seed faces. Testa partially adhering to endocarp (*O. pubescens* (J.L.M. Poiret) J.W. Grimes); nearly glossy; not modified by a bloom; colored; monochrome or mottled; with frequent mottles; tannish olive or brown (reddish); with black overlay; glabrous; smooth or not

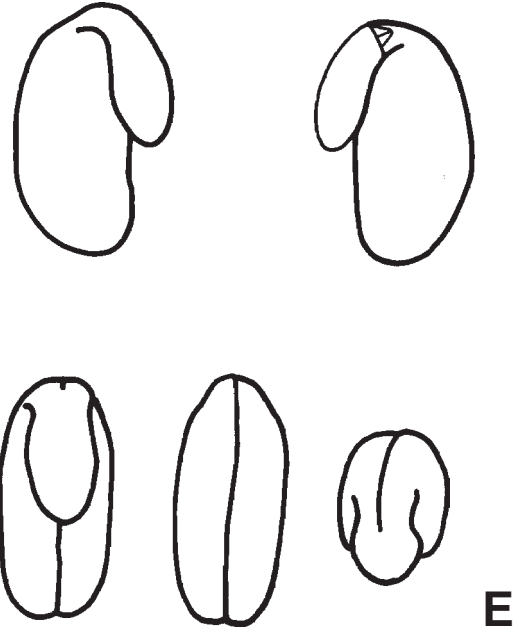
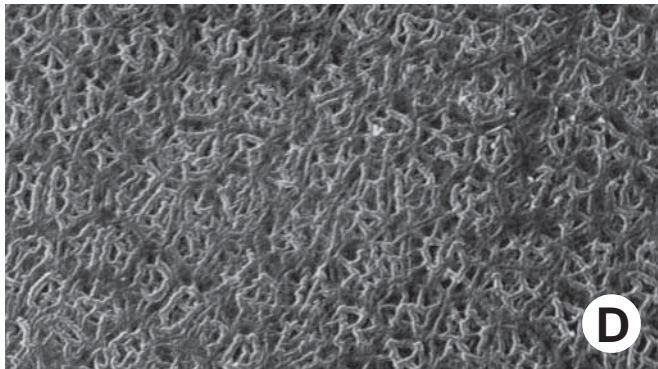
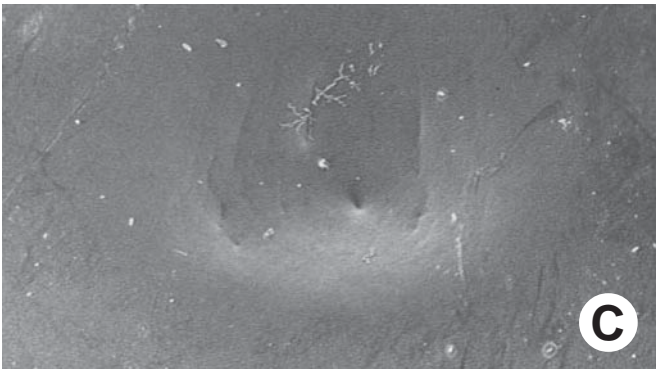
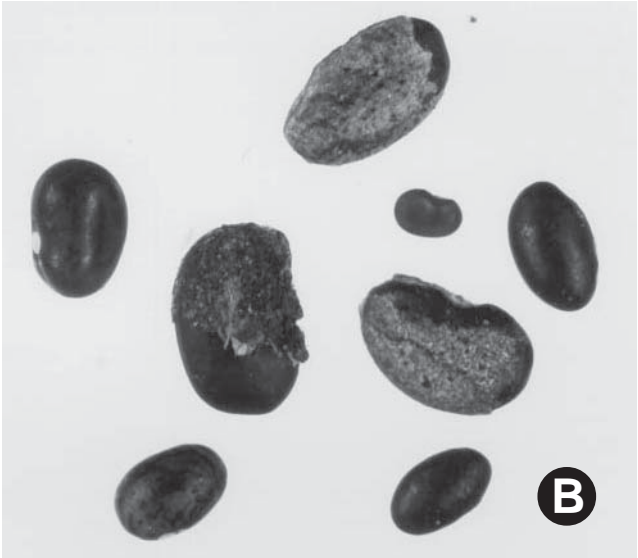
smooth; with elevated features; heavily wrinkled; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum fully concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.5 mm long; with curved outline; circular; marginal according to radicle tip; flush; not within corona, halo, or rim. Lens not discernible. Endosperm thin; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating in radicle tissue; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; parallel to length of seed. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Southeastern and eastern Africa into South Africa (zone of Mediterranean vegetation) and South America (8 spp.).

Notes: The species count and distribution are based on Grimes (1990), who noted 8 species in South America and about 35 species in the Old World. Stirton (1986a) reviewed *Otholobium* and named two new species from southeastern Africa (Stirton 1990). The Old World species need to be revised. Stirton noted that the “morphology of the fruiting calyx and fruit of *O. sericeum* (J.L.M. Poiret) C.H. Stirton are quite different from that of the type species” (*O. caffrum* (C.F. Ecklon & C.L.P. Zeyher) C.H. Stirton).

Otholobium: *O. hirtum* (C. Linnaeus) C.H. Stirton (C–E), *O.* spp. (A–B). A, Fruits with and without calyx (× 3.3); B, seeds some with adhering epicarp (× 6); C–D, testa (× 50, × 1000); E, embryos (× 10).

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Genus: *Psoralea* C. Linnaeus

Phylogenetic Number: 12.09.

Tribe: Psoraleeae.

Species Studied—Species in Genus: 7 spp.—ca. 20 spp.

Fruit a legume; unilocular; 0.3–0.6 (including beak) × 0.2–0.4 × 0.15–0.2 cm; with persistent calyx; with calyx longer than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical; elliptic; not inflated; terete; with beak (0.7–0.8 mm long); straight, or declined; with solid beak the same color and texture as fruit; rounded at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous or fragile, thinner than chartaceous like *Trifolium* (21.06); seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome; gray or brown; with surface texture uniform; glabrous or pubescent but soon deciduous; with 1 type of pubescence; eglandular; without spines; not smooth; with elevated features; irregularly veined (not aligned); not tuberculate; wrinkled; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; gray; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seed 1; length parallel with fruit length. Funiculus less than 0.5 mm long; straight. Aril dry; rim-aril; tan.

Seed 3–3.5 × 1.7–2 × 1.5 mm; not overgrown; not angular; symmetrical (except hilum); oblong; terete; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled; with frequent mottles; brown; with black overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Raphe not visible. Hilum fully concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.6 mm long; with curved outline; elliptic; marginal according to radicle tip; flush; within corona or not within corona, halo, or rim. Hilum corona color lighter than testa. Lens discernible; equal to or greater than 0.5 mm in length; 0.5 mm long; with margins straight; linear; not in groove of raphe; confluent with hilum; recessed; dissimilar color from

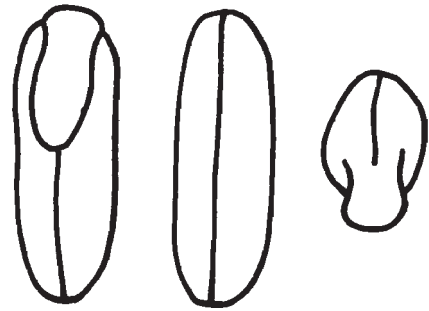
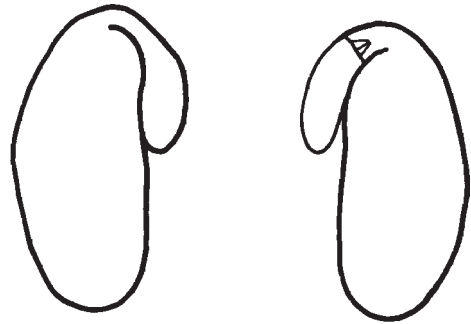
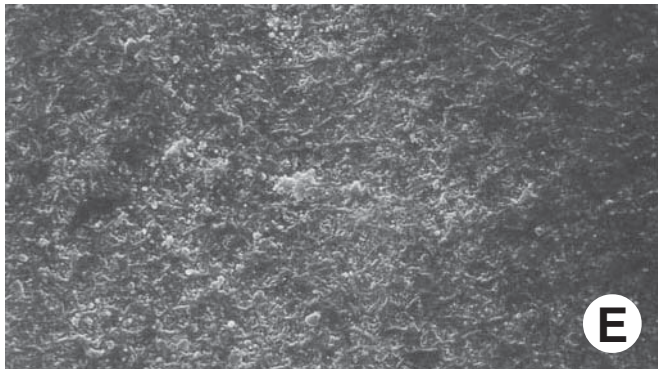
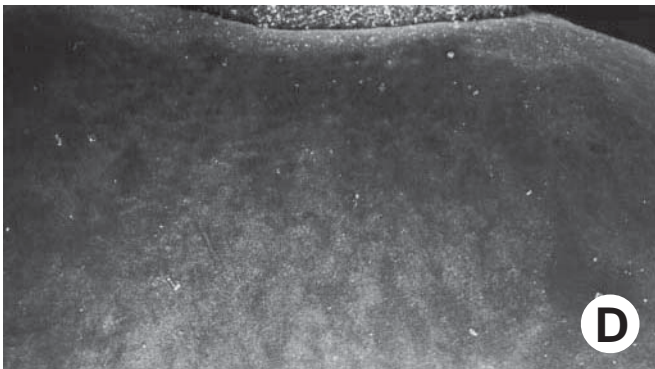
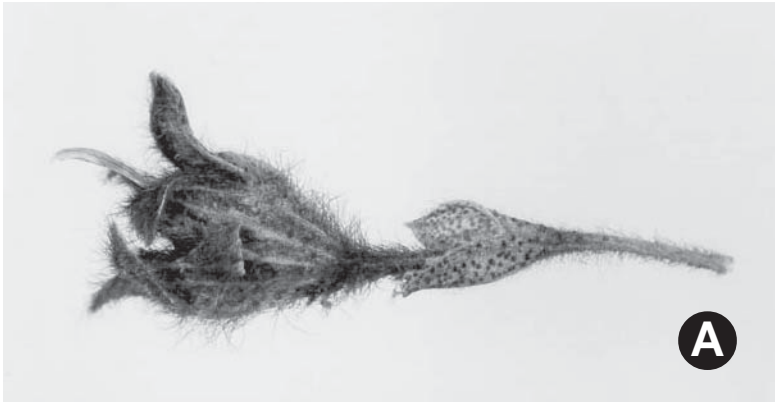
testa; darker than testa; black; within corona. Lens corona color lighter than testa. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating in radicle tissue; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis straight; parallel to length of seed. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: South Africa.

Notes: Stirton (1981) considered *Psoralea* to be an artificial assemblage and redefined it to include approximately 20 species, all endemic to South Africa. He accepted the genus *Hallia* (12.09) with nine species but later (Tucker and Stirton 1991, Polhill 1994b, Crow et al. 1997) expressed the opinion that it is a subgenus of *Psoralea*, *P.* subgenus *Hallia* (C.P. Thunberg) T.M. Salter. Grimes (1990) concurred with Stirton and transferred all New World *Psoralea* species to various genera.

Psoralea: *P. aphylla* C. Linnaeus (*D–E*), *P. pinnata* C. Linnaeus (*A–C, F*). *A*, Calyx with a fruit inside and a cupulum (× 4.6); *B*, fruit without calyx (× 8.8); *C*, seeds (× 8); *D–E*, testa (× 50, × 1000); *F*, embryos (× 10).

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F

Loteae (13.01–13.17)

Genus: *Cytisopsis* H.F. Jaubert & É. Spach

Phylogenetic Number: 13.01.

Tribe: Loteae.

Species Studied—Species in Genus: 1 sp.—ca. 2 spp.

Fruit a legume; unilocular; $1\text{--}2.2 \times 0.4\text{--}0.5 \times 0.4\text{--}0.5$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical; oblong; not inflated; terete; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; ligneous; seed chambers externally visible or invisible; with the raised seed chambers not torulose. Fruit margin not constricted or constricted; constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscing (to tardily so); splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive or active; with valves twisting. Replum invisible. Epicarp dull; monochrome; reddish brown; pubescent and indurate; with hairs appressed; with 1 type of pubescence; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; somewhat reticulately veined; not tuberculate; wrinkled; not exfoliating; without cracks. Mesocarp thick; 1-layered; without balsamic vesicles; without fibers; solid; ligneous. Endocarp dull; monochrome or mottled; tan; with mottling above and below seed chambers; with brown (reddish) overlay; smooth; subseptate; with septa thin (tissue paper-like), flexible; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 2–6; length transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent.

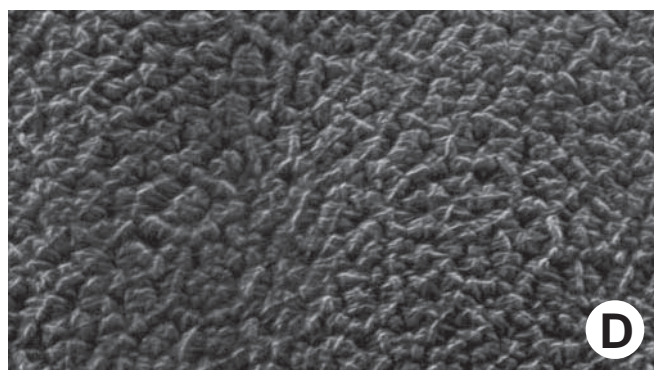
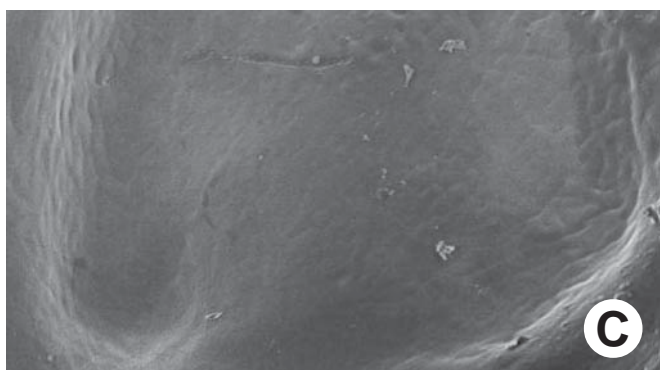
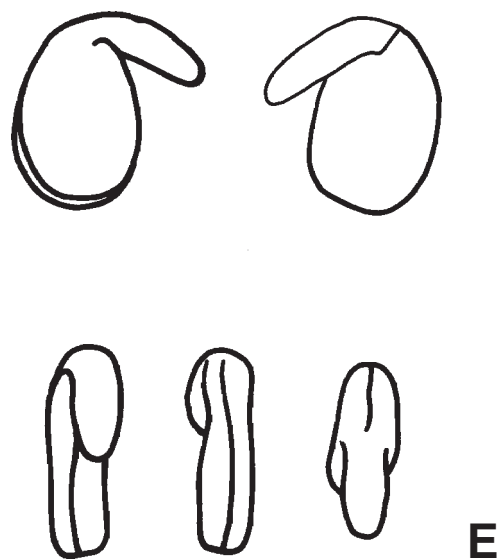
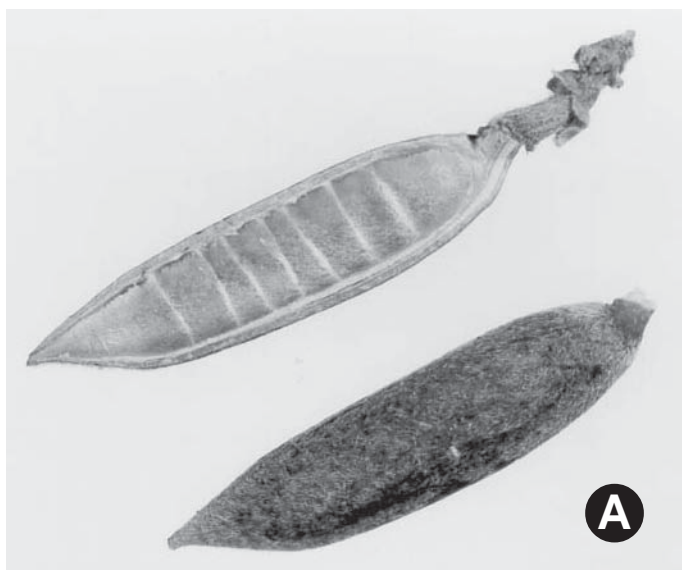
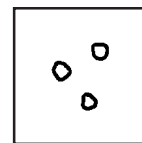
Seed $2.2\text{--}2.8 \times 2 \times 2$ mm; not overgrown; not angular or angular; asymmetrical; circular, oblong, or irregular; terete; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; clear; monochrome; dark reddish

brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum fully concealed; concealed by funicular remnant; with faboid split; the same color as the rest of the hilum; punctiform; apical at apex of radicle tip; flush; not within corona, halo, or rim. Lens discernible or not discernible; equal to or greater than or less than 0.5 mm in length; 0.5 mm long; with margins curved; elliptic; not in groove of raphe; adjacent to hilum; 0.3 mm from hilum; mounded; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thin; not pluglike and resembling tip of radicle; covering entire embryo; adnate to embryo and testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan or green; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; with a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; $1/2$ to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Eastern Mediterranean (1 sp.) and perhaps in north Africa (1 sp.).

Notes: In 1981, Polhill (1981*k*) accepted much broader generic circumscriptions in tribe Loteae and only accepted four genera in the tribe: *Cytisopsis*, *Anthyllis* (13.02), *Hymenocarpus* (13.04), and *Lotus* (13.07). In his most recent classification of Fabaceae (Polhill 1994*a,b*), he combined the tribes Loteae and Coronilleae and accepted six segregate genera in Loteae, s.s.: *Tripodion* (13.03), *Dorycnopsis* (13.05), *Dorycnium* (13.06), *Podolotus* J.F. Royle (13.08), *Pseudolotus* K.H. Rechinger (13.09), and *Vermifruux* (13.10). Polhill (1981*k*) noted that the status of the North African species of *Cytisopsis*, which also has been placed in the segregate genus *Lyauteya* R.C.J.E. Maire, is not certain and that perhaps both species of *Cytisopsis* are better placed in *Anthyllis* (13.02). We studied only the eastern Mediterranean species *C. pseudocytisus*.

Cytisopsis: *C. pseudocytisus* (P.E. Boissier) Fertig (A–E). A, Fruit and valve ($\times 4$); B, seeds ($\times 7$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



Genus: *Anthyllis* C. Linnaeus

Phylogenetic Number: 13.02.

Tribe: Loteae.

Species Studied—Species in Genus: 19 spp.—20–25 spp.

Fruit a legume; unilocular; $0.4\text{--}1.3 \times 0.2\text{--}0.5 \times 0.1\text{--}0.2$ cm; with deciduous or persistent calyx; with calyx longer than fruit; without or with orifice formed by curving of fruit or fruit segments; straight or 1-coiled; not plicate; not twisted; symmetrical or asymmetrical; linear or coiled; when asymmetrical with both sutures parallelly curved or 1 straight and 1 curved suture; widest near middle or D-shaped; inflated; compressed or terete; without or with beak; with solid beak the same color and texture as fruit; short tapered or rounded at apex; apex oblique with longitudinal axis of fruit; tapered or rounded at base; base right angled with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous or fragile, thinner than chartaceous like *Trifolium* (21.06) (area of “dehiscences”); seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin not constricted or constricted; slightly constricted along both margins; without sulcus; plain or embellished. Fruit wing absent or present; 1; 0.5 mm wide; sutural; on 1 suture. Fruit nonstipitate or stipitate. Fruit indehiscent or with all layers dehiscent (tardily); opening by deterioration of delicate strip of tissue along inner suture or both sutures. Dehiscence of valves along 1 suture; medial and up and down; passive. Replum invisible. Epicarp dull or semiglossy; monochrome; brown or tan; with surface texture uniform or not uniform, with patches of different texture not restricted to the base and apex; glabrous; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; tan; smooth; nonseptate or septate; with septa thin (tissue paper-like), flexible; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–3; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; filiform; straight. Aril absent.

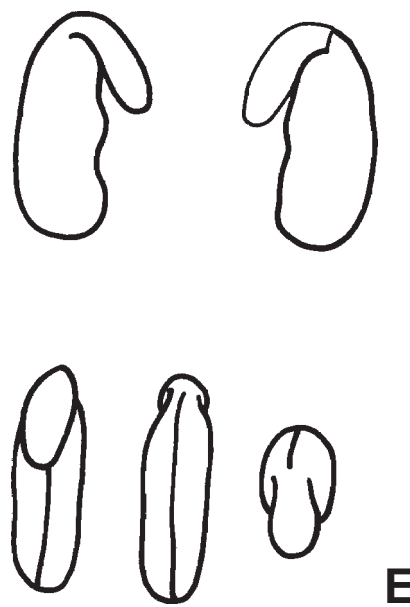
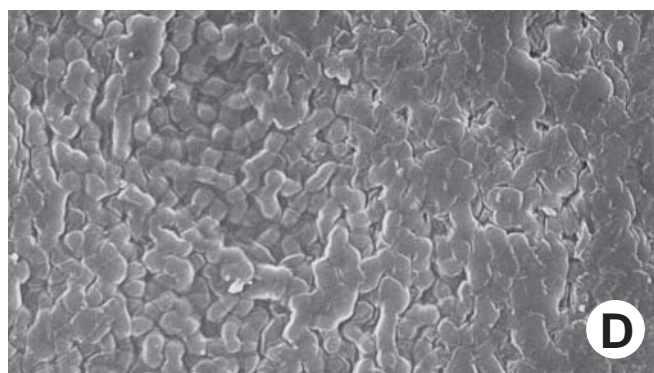
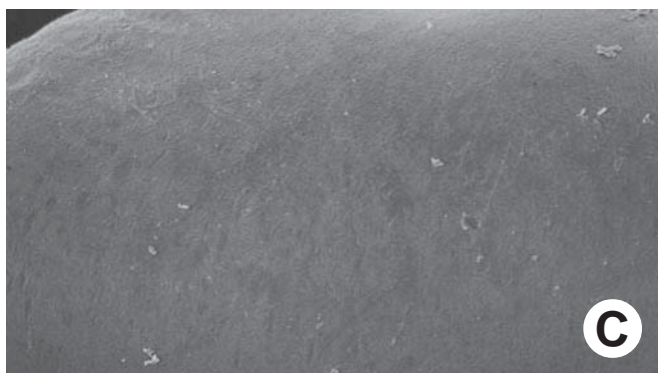
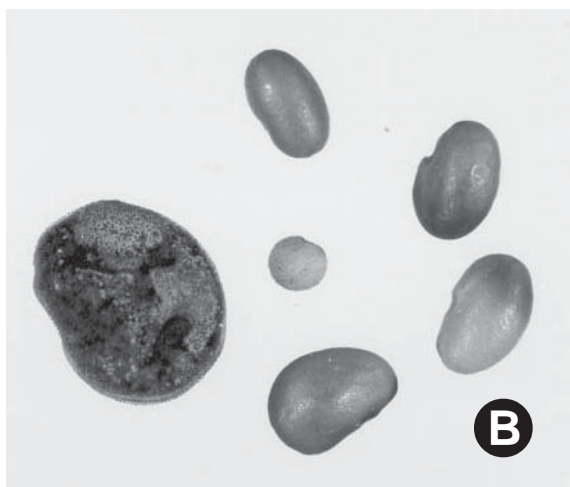
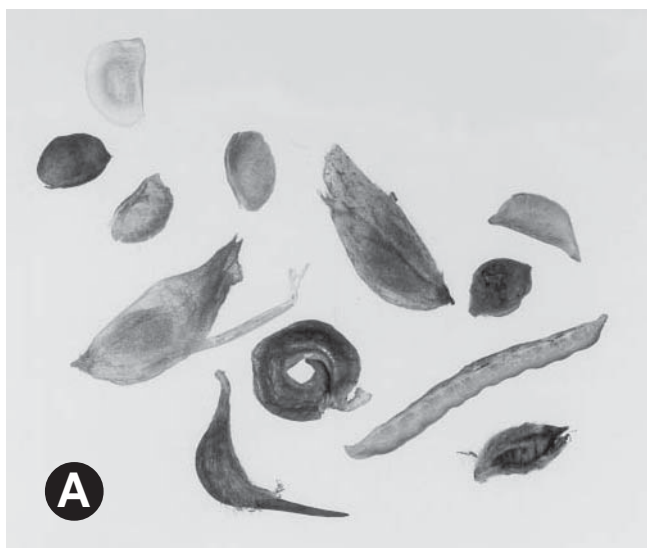
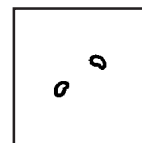
Seed $1.7\text{--}3.5 \times 1\text{--}3 \times 1\text{--}2$ mm; not overgrown; not angular or angular; asymmetrical or symmetrical (except

hilum); oblong, mitaform, or triangular; compressed or terete; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; brown, tan, or green; with purple overlay; glabrous; smooth or not smooth; with elevated features; shagreen, wrinkled, or tuberculate; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; within rim. Hilum rim color slightly darker than testa. Lens discernible; less than 0.5 mm in length; with margins straight or curved; wedge-shaped; elliptic, or hourglass or dumbbell-shaped; not in groove of raphe; confluent with hilum; mounded; dissimilar color from testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length or 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Mediterranean region, extending into Europe, Atlantic islands, and North Africa.

Notes: Polhill (1981k) noted that *Anthyllis* and *Lotus* (13.07) seem to be closely related to *Hammatolobium* (13.17). Polhill also noted that *Cytisopsis* (13.01) may be combined with *Anthyllis*. *Tripodion* (13.03), previously *A. tetraphylla* C. Linnaeus, was not discussed by Polhill. *Anthyllis vulneraria* C. Linnaeus is a variable species with many subspecies and some economic value. Some species, but not *A. vulneraria*, possess fruits with unusual dehiscences. Either the lower or both sutural areas have much thinner fruit tissue, and this tissue easily ruptures gradually exposing the seeds in situ. Eventually the seeds fall free from one or both valves.

Anthyllis: *A. hermanniae* C. Linnaeus (*C-E*), *A. spp.* (*A-B*).
A, Fruits ($\times 3$); B, seeds ($\times 7$); C-D, testa ($\times 50$,
 $\times 1000$); E, embryos ($\times 10$).



Genus: *Tripodion* F.C. Medikus

Phylogenetic Number: 13.03.

Tribe: Loteae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; unilocular; $0.9-1 \times 0.3-0.4 \times 0.2$ cm; with persistent calyx; with calyx longer than fruit (and inflated); without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; oblong; when asymmetrical with both sutures unequally or parallelly curved; not inflated (but calyx inflated); terete; with beak (1 mm long); with solid beak the same color and texture as fruit; short tapered at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous or fragile, thinner than chartaceous like *Trifolium* (21.06); seed chambers externally visible; with the raised seed chambers torulose. Fruit margin constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit indehiscent (but fragile enough to open easily). Replum invisible. Epicarp dull; multicolored; streaked (because streaked endocarp is seen through epicarp); tan; with brown (reddish) overlay; with mottling over seed chambers; pubescent and indurate; with 1 type of pubescence; puberulent; with pubescence golden or gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; straight; eglandular; without spines; smooth or not smooth; veined or not veined; reticulately veined (some best seen from endocarp view); not tuberculate; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; streaked; tan; with streaking above and below seed chambers; with brown (reddish) overlay; smooth; septate; with septa thin (tissue paper-like), flexible; with septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds (1–)2; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; filiform; straight. Aril absent.

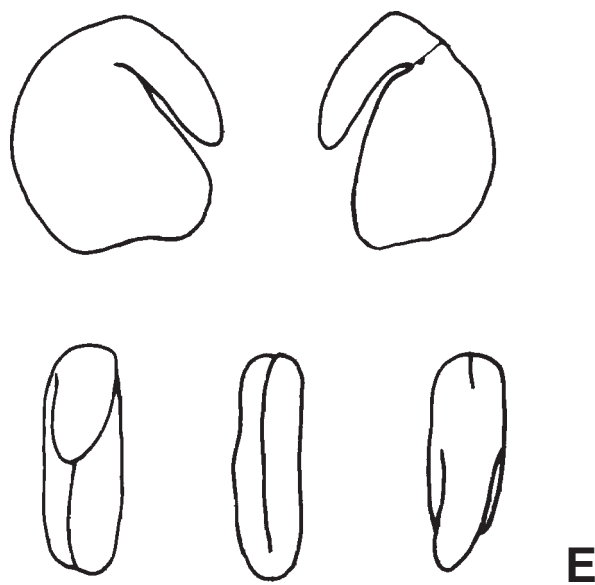
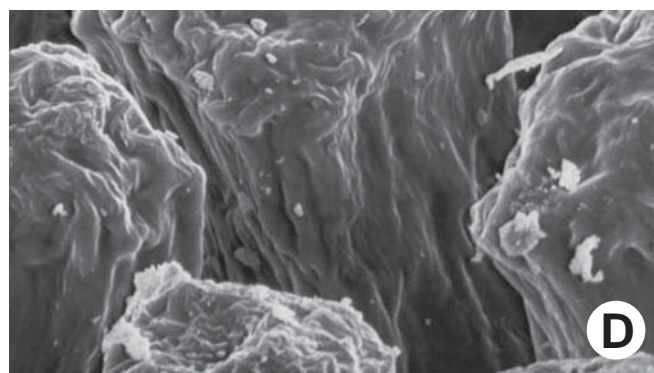
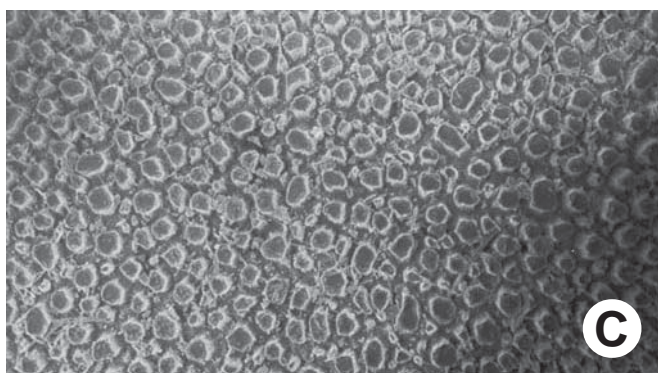
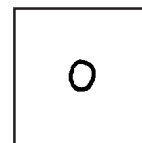
Seed $3-3.5 \times 2.8-3.2 \times 1.5-2.5$ mm; not overgrown; not angular or angular (to somewhat); asymmetrical; oblong or reniform; compressed; with surface smooth; without hilar sinus; without umbo on seed faces. Testa without or with pieces of adhering epicarp (occasionally); not adhering to endocarp; dull; not modified by a

bloom; colored; monochrome or streaked and mottled; with frequent mottles; with frequent streaks; reddish brown or tan; with black overlay; glabrous; not smooth (and distinctly grooved between cotyledons especially opposite from hilum); with elevated features; tuberculate; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; marginal according to radicle tip or between cotyledon and radicle lobe; recessed; not within corona, halo, or rim. Lens obviously or faintly discernible or not discernible; less than 0.5 mm in length; with margins curved; circular or elliptic; not in groove of raphe; adjacent to hilum; 0.5 mm from hilum; mounded; same color as, similar color as, or dissimilar color from testa; lighter than or darker than testa; reddish brown, tan (reddish), or black; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Mediterranean region, southern Portugal.

Notes: This genus was part of *Anthyllis* (13.02) in the report of Polhill (1981k), but *Tripodion* is now recognized as a separate genus (Polhill 1994a,b). Previously, *Tripodion* was also known as *Physanthyllis* P.E. Boissier. The testa fragments during imbibition as does that of *Cyamopsis* (9.06).

Tripodion: *T. teraphyllum* (C. Linnaeus) J.P. Fourreau (A–E). A, Fruits and fruiting calyx ($\times 1.25$); B, seeds ($\times 4$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 15$).



Genus: *Hymenocarpus* C.G. Savi

Phylogenetic Number: 13.04.

Tribe: Loteae.

Species Studied—Species in Genus: 1 sp.—1 sp.

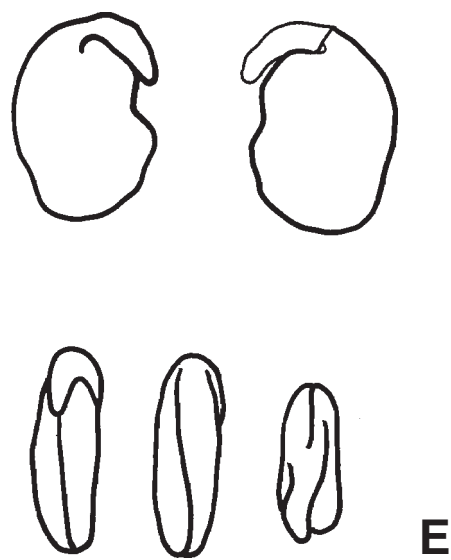
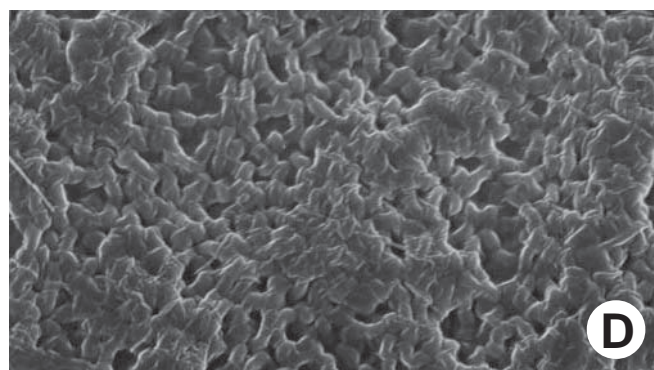
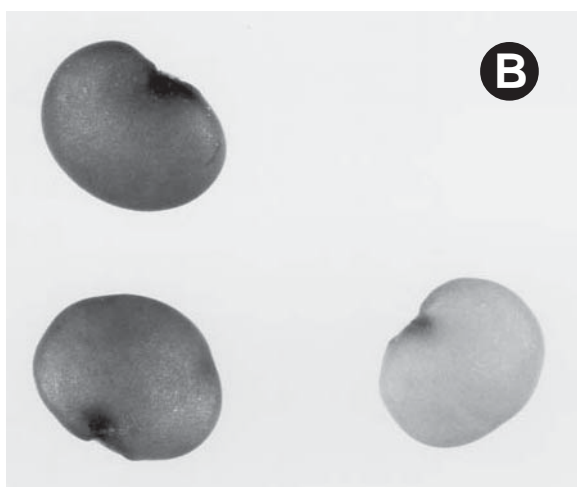
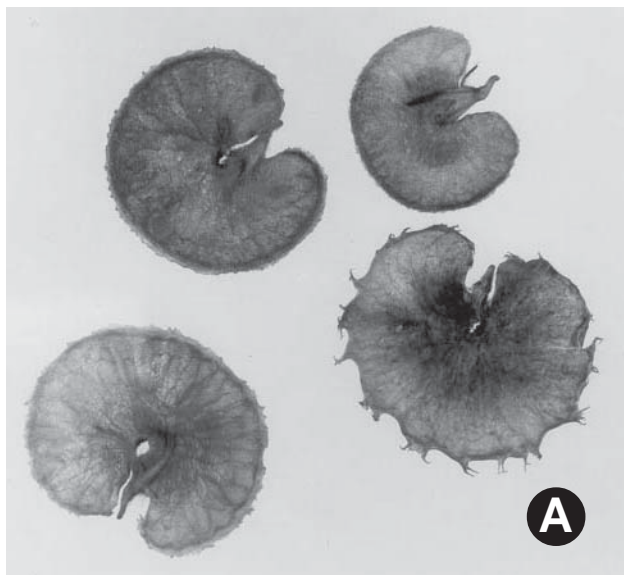
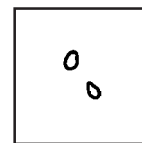
Fruit a legume; unilocular; $2-2.5 \times 0.6-0.8 \times 0.25$ cm; with persistent calyx; with calyx shorter than fruit; with orifice formed by curving of fruit or fruit segments; 1-coiled; not plicate; not twisted; asymmetrical; coiled; when asymmetrical with both sutures parallelly curved; not inflated; flattened; without beak; truncate at apex; apex right-angled with longitudinal axis of fruit; truncate at base; base right angled with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; embellished; with wing (margins either entire, dentate, or aculeate). Fruit wing 1; 3 mm wide; sutural; on 1 suture. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome (to irregularly brown tinged with purple); brown, tan, or gray and purple; glabrous, pubescent and indurate, or pubescent but soon deciduous; with hairs appressed; with 1 type of pubescence; with pubescence golden; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp present (restricted only to seed chamber); thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp glossy; monochrome; tan; smooth; septate; with septa thicker than paper, firm; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 2; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; filiform; straight. Aril absent.

Seed $1-3 \times 2-2.5 \times 1$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown, tan, cream, or yellow; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum fully concealed; concealed by funicular remnant; without faboid split; punctiform; between cotyledon

and radicle lobe; somewhat recessed; not within corona, halo, or rim (if testa light colored) or within halo (if testa dark colored). Hilum halo color darker than testa. Lens discernible; less than 0.5 mm in length; with margins curved; elliptic; not in groove of raphe; confluent with hilum; mounded; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm absent. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; light tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; with a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Mediterranean region and western Asia.

Hymenocarpus: *H. circinnatus* (C. Linnaeus) C.G. Savi (A-E). A, Fruits ($\times 2$); B, seeds ($\times 6$); C-D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



Genus: *Dorycnopsis* P.E. Boissier

Phylogenetic Number: 13.05.

Tribe: Loteae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; unilocular; $0.2\text{--}0.23 \times 0.15 \times 0.1$ cm; with deciduous calyx (if fruits in a head then longer than calyx); without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; elliptic; when asymmetrical with both sutures parallelly curved; not inflated; terete; without beak; rounded at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; embellished. Fruit wing 1; 0.3 mm wide; sutural; on 1 suture. Fruit nonstipitate. Fruit indehiscent (difficult to remove seed from fruit even though fruit coat thin). Replum invisible. Epicarp dull; monochrome; brown; glabrous; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp glossy; monochrome; reddish brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1(–2) (though 2-seeded fruits not seen); length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; filiform; straight. Aril absent.

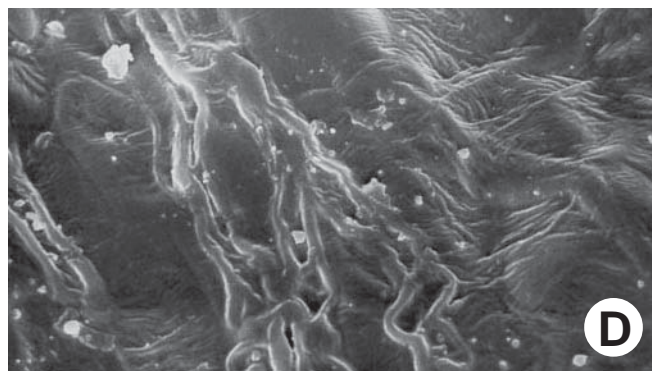
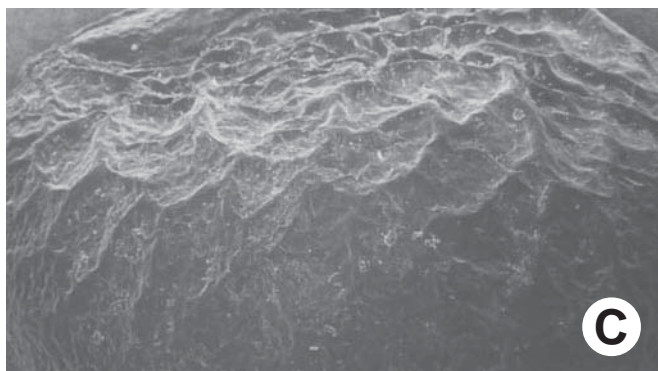
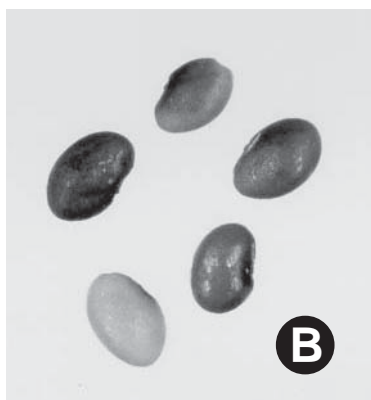
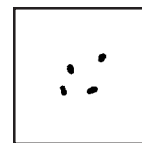
Seed $1.5 \times 1 \times 0.8$ mm; not overgrown; not angular; symmetrical (except hilum); elliptic; terete; with surface smooth; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum fully concealed; concealed by funicular remnant; with faboid split; the same color as the rest of the hilum; punctiform; marginal according to radicle tip; flush; within rim. Hilum rim color darker than testa. Lens discernible; less than 0.5 mm in length; with margins straight or curved; oblong; not in groove of raphe; adjacent to hilum; 0.1 mm from hilum; mounded; dissimilar color from testa; darker than testa;

reddish brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Spain and southwestern Europe.

Notes: This genus was part of *Anthyllis* (13.02) in the report of Polhill (1981*k*), but *Dorycnopsis* is now recognized as a separate genus (Polhill 1994*a,b*). Tikhomirov and Sokoloff (1997) examined the taxonomic status of *Vermifru* (13.10) *abyssinica* (A. Richard) J.B. Gillett and concluded that *Vermifru* and *Dorycnopsis* are synonymous. Therefore they made the new combination *D. abyssinica* (A. Richard) V.N. Tikhomirov & D.D. Sokoloff for the only species of *Vermifru*. Pending further evaluation, we are accepting *Vermifru*.

Dorycnopsis: *D. gerardii* (C. Linnaeus) P.E. Boissier (A–E). A, Fruits ($\times 1.25$); B, seeds ($\times 4$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 15$).



Genus: *Dorycnium* P. Miller

Phylogenetic Number: 13.06.

Tribe: Loteae.

Species Studied—Species in Genus: 7 spp.—ca. 12 spp.

Fruit a legume; unilocular; $0.3\text{--}2 \times 0.2\text{--}1 \times 0.2\text{--}0.32$ cm; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; oblong, obovate, ovate, or circular; when asymmetrical with both sutures nearly straight or parallelly curved; not inflated; terete; without or with beak; straight; with solid beak the same color and texture as fruit; rounded or short tapered at apex; apex aligned or oblique with longitudinal axis of fruit; rounded at base; base aligned or oblique with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous or ligneous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active or passive; with valves twisting or enrolling. Replum invisible. Epicarp dull; monochrome; light to dark reddish brown; glabrous or pubescent and indurate; pilose; with simple hairs; eglandular; without spines; not smooth; with elevated features; not veined; not tuberculate; wrinkled; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; subligneous. Endocarp glossy; monochrome or mottled; reddish brown or tan (greenish); with mottling (dark); with brown (reddish) overlay; smooth; septate or nonseptate; with septa thin (tissue paper-like), flexible; with septa eglandular; chartaceous; exfoliating in part to exfoliating; separating from mesocarp; entire. Seeds 1–8; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; filiform; straight. Aril absent.

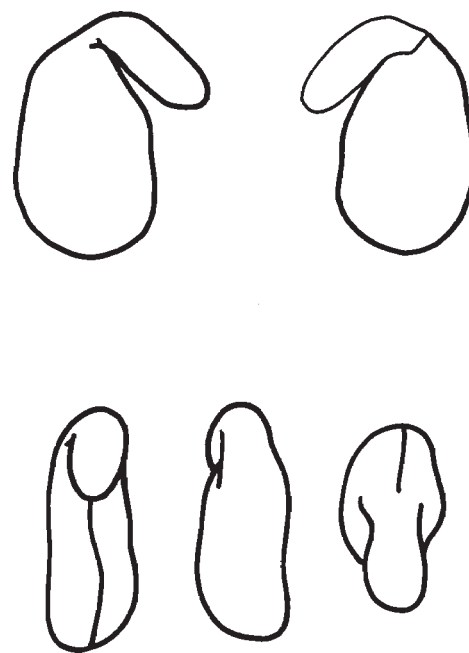
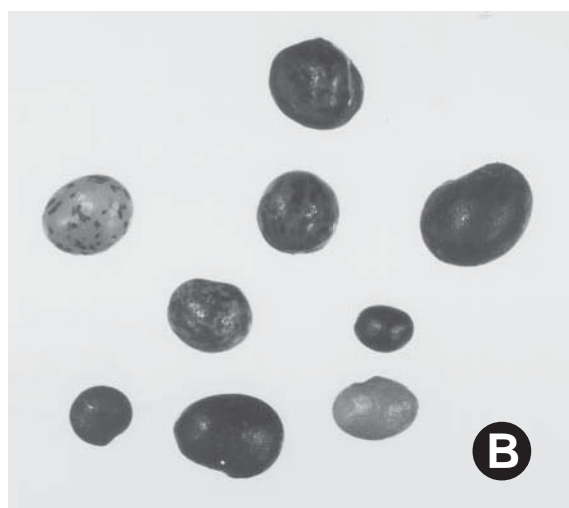
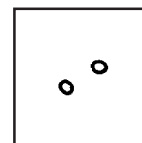
Seed $1.3\text{--}2 \times 1\text{--}1.6 \times 1\text{--}1.4$ mm; not overgrown; not angular; symmetrical or asymmetrical; elliptic, mitaform, or circular; terete; with surface smooth; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled; with frequent mottles; brown to yellowish or reddish brown or green (to tannish); with black overlay;

glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Raphe not visible. Hilum visible or fully concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; marginal according to radicle tip or between cotyledon and radicle lobe; flush; not within corona, halo, or rim or within halo. Hilum halo color darker than or lighter than testa. Lens discernible or not discernible; equal to or greater than or less than 0.5 mm in length; 0.5 mm long; with margins curved; key-hole shaped; not in groove of raphe; adjacent to hilum; 0.1 mm from hilum; mounded; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan or white; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; with a joint evident between the radicle and the cotyledons. Radicle linear or bulbous (somewhat); deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Central and southern Europe and Mediterranean region.

Notes: This genus was part of *Lotus* (13.07) in the report of Polhill (1981k), but *Dorycnium* has often been recognized as a separate genus with two sections: *Bonjeania* (H.G.L.R. Reichenbach) P.E. Boissier with 2–8-seeded legumes and *Dorycnium* with 1-seeded legumes.

Dorycnium: *D. hirsutum* (C. Linnaeus) N.C. Seringe (*C–E*), *D.* spp. (*A–B*). *A*, Fruits (dehiscent and closed) ($\times 1.25$); *B*, seeds ($\times 4$); *C–D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 15$).



Genus: *Lotus* C. Linnaeus

Phylogenetic Number: 13.07.

Tribe: Loteae.

Species Studied—Species in Genus: 62 spp.—ca. 100 spp.

Fruit a legume; unilocular; $2.5\text{--}9 \times 0.2\text{--}0.8 \times 0.2\text{--}0.3$ cm; with deciduous or persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (or slightly curved); not plicate; not twisted; symmetrical or asymmetrical; linear, oblong, or falcate; when asymmetrical with both sutures parallelly curved or nearly straight; not inflated; terete or compressed; without beak; short tapered or rounded at apex; apex aligned with longitudinal axis of fruit; short tapered or rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible or invisible; with the raised seed chambers not torulose or torulose. Fruit margin not constricted or constricted; slightly constricted along both margins; without sulcus; plain or embellished. Fruit wings absent or present (section *Tetragonolobus*); 2 or 4 (with 2 wings on long upper suture and none below or 2 wings along both sutures); 1–2 mm wide; sutural; on both sutures or 1 suture. Fruit nonstipitate. Fruit with all layers dehiscent or indehiscent (rarely); splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive or active; with valves twisting or enrolling. Replum invisible. Epicarp dull; monochrome; reddish brown; glabrous or pubescent and indurate; with hairs appressed; with 1 type of pubescence; with pubescence golden; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth or smooth; with elevated features; veined or not veined; reticulately veined; not tuberculate; not exfoliating or checking (of cuticle); without or with cracks (of cuticle); cracking oblique to fruit length. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; tan; smooth; septate; with septa thin (tissue paper-like), flexible; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–18; length parallel with fruit length; neither overlapping nor touching; in 1 or 2 or more series (section *Tetragonolobus*). Funiculus less than 0.5 mm long; of 1 length only; triangular or thick; straight. Aril absent.

Seed $0.8\text{--}5 \times 0.7\text{--}5 \times 0.3\text{--}5$ mm; not overgrown; not angular or angular; symmetrical or asymmetrical; circular, mitaform, irregular, quadrangular, or triangular; terete, compressed, or quadrangular; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; dark brown, tan (to reddish), green, yellow, or purple; with black or purple overlay; glabrous; smooth or not smooth; with elevated features; tuberculate; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially or fully concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; marginal according to radicle tip or between cotyledon and radicle lobe; flush; within rim or halo. Hilum halo color darker than testa. Hilum rim color darker than testa. Lens discernible; less than 0.5 mm in length; with margins straight or curved; linear; circular or elliptic; not in groove of raphe; adjacent to or confluent with hilum; 0.2–0.4 mm from hilum; mounded; dissimilar color from or similar color as testa; darker than testa; black; not within corona, halo, or rim. Endosperm thin or thick; covering entire embryo; adnate to embryo or testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; green, tan, or yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: North America and extratropical South America, Europe, Russia, extending into Africa and Australia.

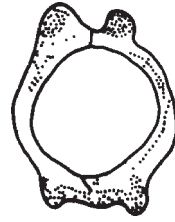
Notes: Polhill (1981k) noted that *Lotus* and *Anthyllis* (13.02) seem to be closely related to *Hammatolobium* (13.17). In our treatment, *Tetragonolobus* G.A. Scopoli is included in *Lotus* even though the species of section *Tetragonolobus* have winged fruits and generally larger seeds than species in other sections of *Lotus*. Lassen (1986) transferred *L. roudairei* E. Bonnet of North

Africa to *Acmispon* (13.07A) because of its glandular stipules and 5–6 leaflets per leaf. Kramina and Sokoloff (1997) reexamined *L. roudairei* and concluded that it is not related to New World taxa and should remain in *Lotus*. They recognized its unique features among Old World *Lotus* by placing it in the new section *Lotus* sect. *Pseudosimpeteria* T.E. Kramina & D.D. Sokoloff. We left it in *Lotus* pending further study.

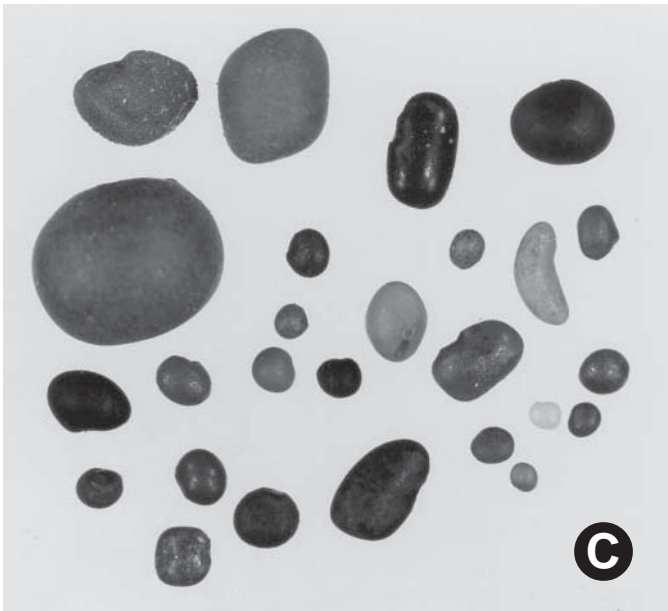
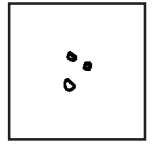
Lotus: *L. corniculatus* C. Linnaeus (*D–F*), *L. maritimus* C. Linnaeus (*B*), *L. spp.* (*A, C*). *A*, Fruits ($\times 1.25$); *B*, fruit cross section with four wings ($\times 10$); *C*, seeds ($\times 4$); *D–E*, testa ($\times 50, \times 1000$); *F*, embryos ($\times 15$).



A



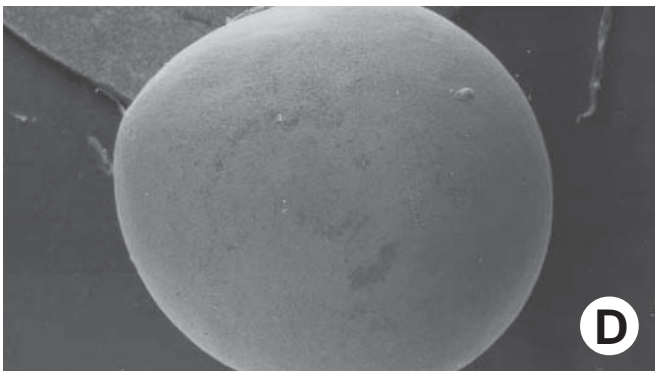
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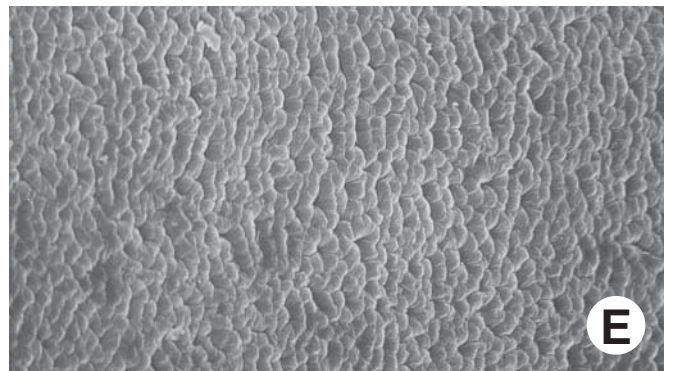
C



F



D



E

Genus: *Acmispon* C.S. Rafinesque-Schmaltz

Phylogenetic Number: 13.07A.

Tribe: Loteae.

Species Studied—Species in Genus: 5 spp.—ca. 10 spp.

Fruit a legume; unilocular; $0.8\text{--}3 \times 0.1\text{--}0.3 \times 0.1$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (or slightly curved); not plicate; not twisted; symmetrical; linear; not inflated; compressed or terete; without or with beak; hooked; tapered at apex; apex oblique with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible. Epicarp dull or semiglossy; monochrome; reddish brown; glabrous or pubescent and indurate; with 1 type of pubescence; pilose or villous; with pubescence gray or golden; with pubescence uniformly distributed; pliable; with hair bases plain; eglandular or glandular; with glandular dots (in herringbone pattern on valve); without spines; not smooth; with elevated features; reticulately veined; not tuberculate; dotted or wrinkled; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; tan; smooth (below and around seed and cobweb between “seed chambers” or smooth throughout); septate; with septa thin (tissue paper-like), flexible (each seed in individual “seed chamber” with 2 septa between seeds or with 1 thin septum between each seed); with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 5–10; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; filiform; curved. Aril absent.

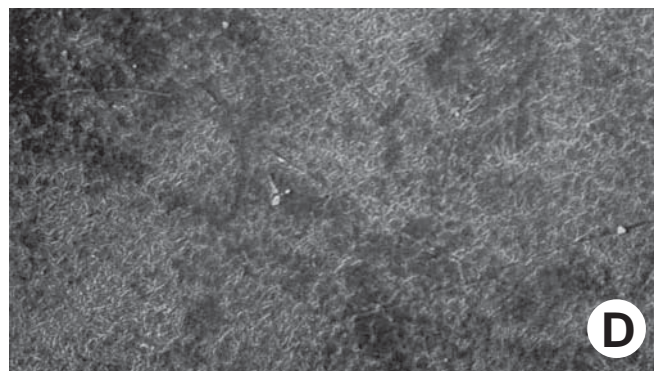
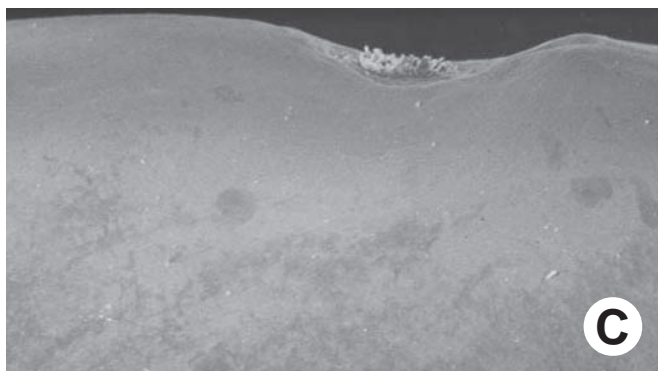
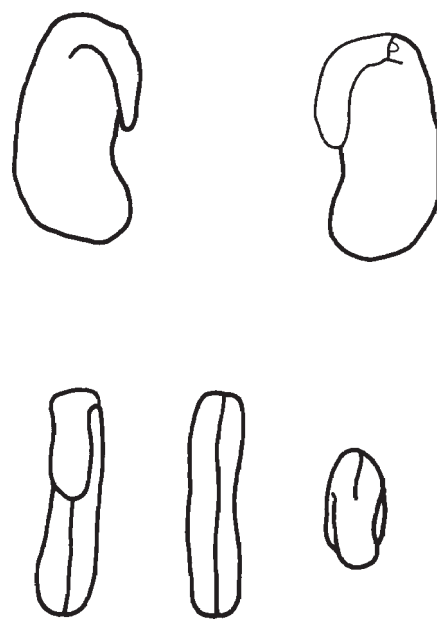
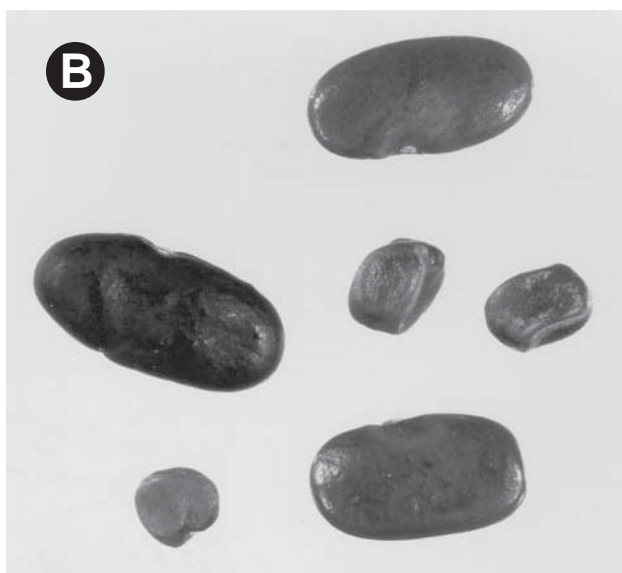
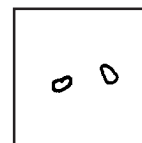
Seed $1\text{--}2.7 \times 1\text{--}1.5 \times 0.6\text{--}0.8$ mm; not overgrown; not angular or angular; asymmetrical; circular, oblong, or mitaform; compressed; with surface smooth; with or without visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa

not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled and streaked (both faintly); with frequent mottles; with frequent streaks; reddish brown or tan (greenish); with brown (darker reddish) overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; barely recessed; within halo. Hilum halo color darker than testa. Lens discernible; equal to or greater than or less than 0.5 mm in length; 0.5 mm long; with margins curved; elliptic or 2 circular mounds separated by groove; not in groove of raphe; adjacent to hilum; 0.2 mm from hilum; mounded; dissimilar color from testa; darker than testa; dark reddish brown; not within corona, halo, or rim. Endosperm thin or thick; covering entire embryo; adnate to embryo or testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan, yellow, or green; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon length; centered or not centered between cotyledons (radicle outside 1 cotyledon and inside other, therefore junctions for each cotyledon different); less than 1/2 length or 1/2 to nearly length of cotyledon. Plumule rudimentary; glabrous.

Distribution: North America, Mexico, South America.

Notes: Lassen (1986) transferred *Lotus roudairei* E. Bonnet of North Africa to *Acmispon* because of its glandular stipules and 5–6 leaflets per leaf. Kramina and Sokoloff (1997) reexamined *L. roudairei* and concluded that it is not related to New World taxa and should remain in *Lotus*.

Acmispon: *A. americanus* (T. Nuttall) P.A. Rydberg (*C–E*); *A. spp.* (*A–B*). *A*, Fruits (dehiscent and closed) ($\times 1.5$); *B*, seeds ($\times 4$); *C–D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 15$).



Genus: *Vermifrux* J.B. Gillett

Phylogenetic Number: 13.10.

Tribe: Loteae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; unilocular; $0.4\text{--}0.6 \times 0.15\text{--}0.17 \times 0.15\text{--}0.2$ cm; with deciduous or persistent calyx (rarely); with calyx shorter than fruit; with or without orifice formed by curving of fruit or fruit segments; 1-coiled, 0.5-coiled, or curved; not plicate; not twisted; asymmetrical; coiled or C-shaped; when asymmetrical with both sutures parallelly curved; not inflated; terete; without beak; short tapered at apex; apex oblique with longitudinal axis of fruit; short tapered at base; base oblique with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible or visible (faintly). Fruit margin not constricted; without sulcus; embellished. Fruit wing (very narrow) 1; 0.3 mm wide; sutural; on 1 suture. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Epicarp glossy; monochrome; reddish brown or tan; glabrous; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp glossy; monochrome; reddish brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 2; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; filiform; straight. Aril absent.

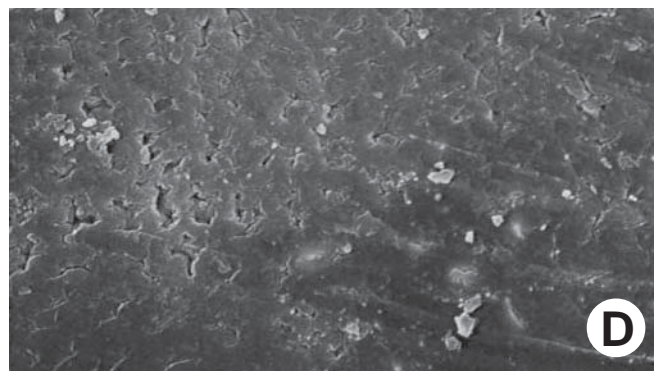
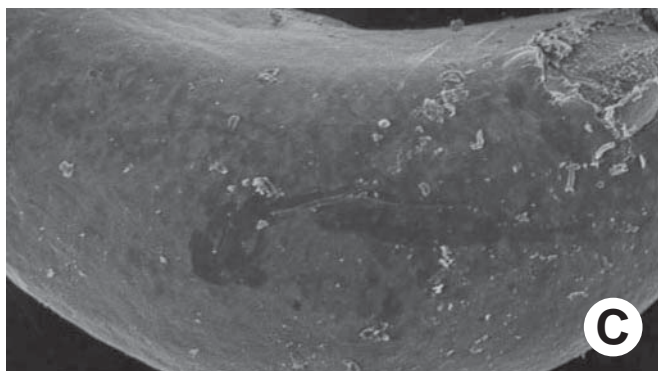
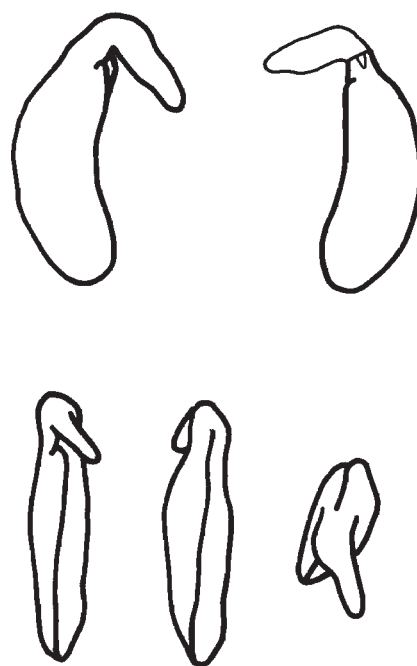
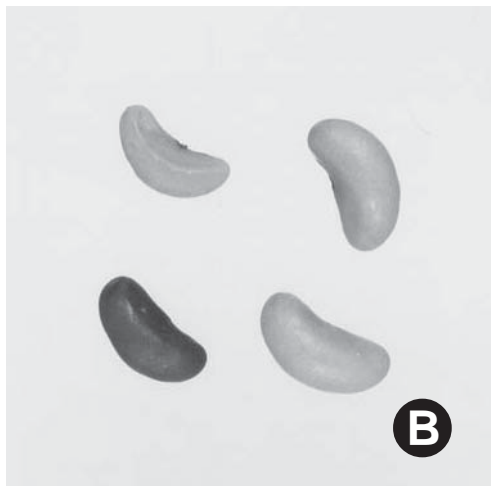
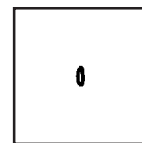
Seed $1.8\text{--}2 \times 0.9\text{--}1 \times 0.7\text{--}0.8$ mm; not overgrown; not angular; asymmetrical; C-shaped; terete; with surface smooth; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; dark reddish brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum fully concealed; concealed by funicular remnant; without faboid split; punctiform; marginal according to radicle tip; flush; within rim. Hilum rim color slightly darker than testa. Lens discernible; less than 0.5 mm in length; with margins curved; elliptic; not in groove of raphe; adjacent to hilum; 0.1 mm from hilum; mounded; dissimilar color from testa; darker than testa; black; not

within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; brown; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; with a joint evident between the radicle and the cotyledons. Radicle somewhat bulbous or linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Africa (Yemen, Sudan, Eritrea, Ethiopia).

Notes: This genus was part of *Lotus* (13.07) in the report of Polhill (1981k), but *Vermifrux* often has been recognized as a separate genus. Tikhomirov and Sokoloff (1997) examined the taxonomic status of *Vermifrux abyssinica* and concluded that *Vermifrux* and *Dorycnopsis* (13.05) are synonymous. Therefore they made the new combination *D. abyssinica* (A. Richard) V.N. Tikhomirov & D.D. Sokoloff for the only species of *Vermifrux*. Pending further evaluation, we are accepting *Vermifrux*.

Vermifrux: *V. abyssinicum* (A. Richard) J.B. Gillett (A–E). A, Fruits ($\times 1.25$); B, seeds ($\times 4$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 15$).



Genus: *Coronilla* C. Linnaeus

Phylogenetic Number: 13.11.

Tribe: Loteae.

Species Studied—Species in Genus: 7 spp.—9 spp.

Fruit a loment (or a loment segment); $1-5 \times 0.1-0.3 \times 0.1-0.25$ cm; with deciduous corolla; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight to curved; not plicate; not twisted; symmetrical; linear or moniliform; not inflated; compressed or terete; with beak; straight; with solid beak the same color and texture as fruit; short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform or differing in texture; upper $3/4$ barely inflated, reticulate, and pubescent and lower $1/4$ not inflated, reticulate, or pubescent; coriaceous; seed chambers externally visible or invisible; with the raised seed chambers not torulose. Fruit margin constricted or not constricted; constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 4.5–5.5 mm long; widest across each end or widest across seed area; with upper or lower 1 different shape than middle ones; oblong or quadrangular. Epicarp dull or glaucous; monochrome; brown or tan; glabrous; glandular or eglandular; with glandular dots; limited to a portion of fruit; upper $3/4$ glandular and lower $1/4$ eglandular; without spines; not smooth; with elevated features; longitudinally veined relative to fruit length; not tuberculate; not exfoliating; without cracks. Mesocarp absent. Endocarp glossy; monochrome or bichrome (with central reddish-brown band); tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1–7; length parallel with fruit length; neither overlapping nor touching; in 2 or more series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent.

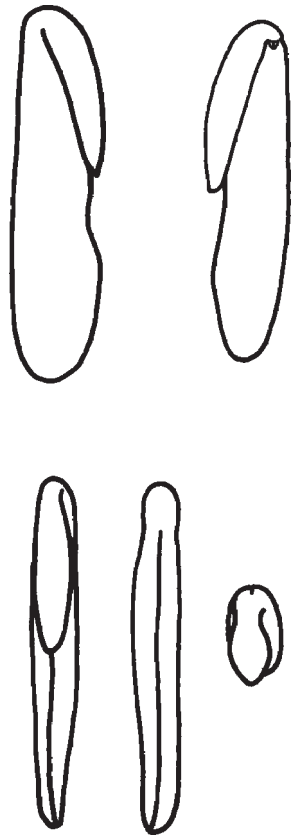
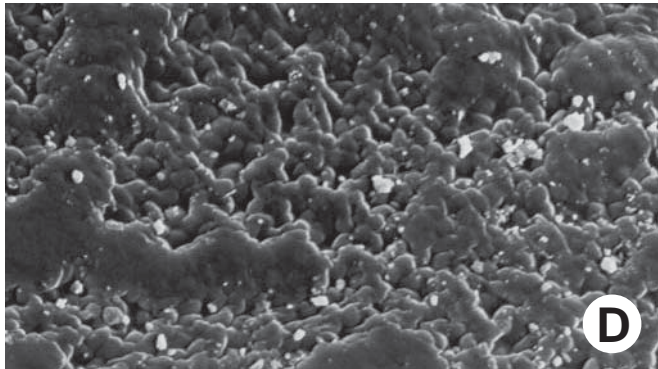
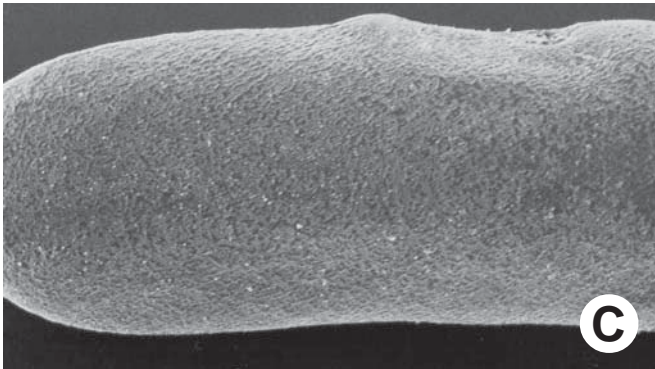
Seed $3-5 \times 1-2 \times 1-1.5$ mm; not overgrown; not angular; symmetrical or asymmetrical; rhombic; compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; dark reddish brown or tan; glabrous; smooth (except for 1 longitudinal ridge on each face) or not smooth; with

or without (Schmidt 1979a) elevated features; with 1 longitudinal ridge on each face; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible or fully concealed; concealed by funicular remnant; with or without faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; marginal according to radicle tip; flush or recessed (within depression or not); not within corona, halo, or rim. Lens discernible (or barely discolored or darker than testa); less than 0.5 mm in length; with margins straight; wedge-shaped; not in groove of raphe; adjacent to hilum; mounded; dissimilar color from testa; darker than testa; black or brown; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to testa or embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; parallel to length of seed. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than $1/2$ or $1/2$ to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Europe, Mediterranean region, Atlantic islands, West Asia, northeastern Africa.

Notes: Schmidt (1979b) monographed *Coronilla* and documented (Schmidt 1979a) the reduction of *Securigera*. We accept *Securigera* (13.12) as a separate genus based on Lassen (1989) and use it as the basis of our species count. Schmidt (1979a) illustrated the seeds of 31 species, showing which ones bear a longitudinal line on each face.

Coronilla: *C. scorpioides* (C. Linnaeus) W.D.J. Koch (C–E), *C. spp.* (A–B). A, Fruits and articles ($\times 2.3$); B, seeds ($\times 6.6$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



Genus: *Securigera* A.P. de Candolle

Phylogenetic Number: 13.12.

Tribe: Loteae.

Species Studied—Species in Genus: 5 spp.—12 spp.

Fruit a legume or loment (or a loment segment); unilocular; 8.5–9.5 × 0.15–0.6 × 0.1–1.6 cm; with deciduous corolla; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight to curved (slightly); not plicate; not twisted; symmetrical; linear; not inflated; flattened or terete; with beak; declined or hooked; with solid beak the same color and texture as fruit; long tapered at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin not constricted; with sulcus; plain or embellished; with thickened sutural areas. Fruit wings absent. Fruit substipitate or nonstipitate. Fruit indehiscent (the chartaceous valve surface between thickened sutures open transversely and irregularly in *S. securidaca*). Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 5–10 mm long; widest across seed area; with upper 1 different shape than middle ones; linear. Epicarp dull; monochrome or multicolored; bichrome (sutures thickened and a lighter or darker shade); brown (including dirty-brown), tan (and greenish-tan), or green; glabrous or pubescent and indurate; with 1 type of pubescence; pilose (but not on thickened sutures); with pubescence golden; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated or recessed features; veined or not veined; longitudinally veined relative to fruit length (1 medial on each valve) or reticulately veined (faint); not tuberculate; wrinkled (faintly); grooved (faintly); not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; smooth; septate or subseptate; with septa thicker than paper, firm; with the septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 7–9; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; filiform; straight. Aril absent.

Seed 3.5–4 × 1.5–4 × 1–1.5 mm; not overgrown; angular or not angular (some are square in outline); symmetri-

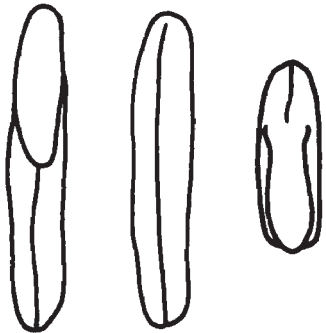
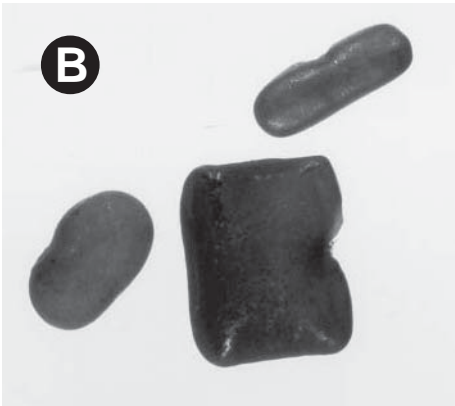
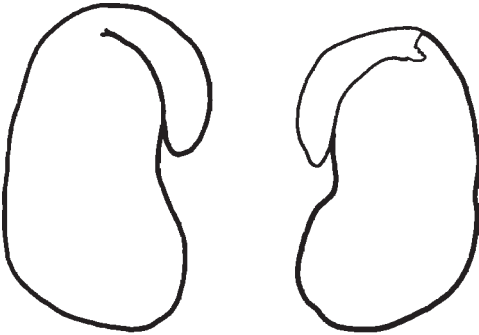
cal; linear, rectangular, or quadrangular; compressed or flattened; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome; light to dark reddish brown or tan (reddish near hilum); glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum fully concealed; concealed by funicular remnant; without faboid split; punctiform; marginal according to radicle tip; flush; not within corona, halo, or rim or within halo. Hilum halo color darker than testa. Lens discernible or not discernible; less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; adjacent to hilum; 0.3 mm from hilum; mounded; same color as testa; within halo. Lens halo color darker than testa. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow or tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle bulbous or linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 or 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Southern Europe.

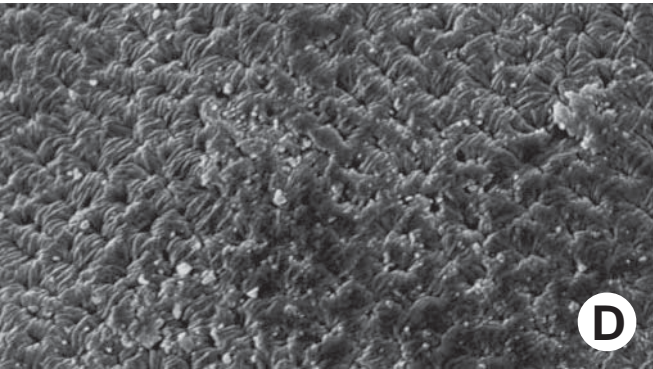
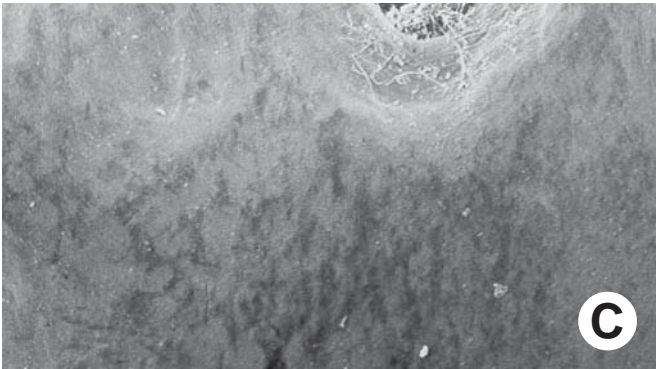
Notes: *Securigera* has been maintained separate from *Coronilla* (13.11) because of its fruits being heavy, flattened, and apparently not divided and thus not breaking into articles at maturity. It was united with *Coronilla* (13.11) for diverse reasons by Schmidt (1979a). Lassen (1989) realigned *Coronilla* (13.11), *Hippocrepis* (13.13), and *Securigera* and in so doing recognized 12 species of *Securigera*, the species count that we are using. When doing this, Lassen devaluated the loment versus legume character.

Securigera: *S. securidaca* (C. Linnaeus) A. von Degen & I. Doerfler (C–E), *S. spp.* (A–B). A, Fruits and articles (× 1.2); B, seeds (× 6.5); C–D, testa (× 50, × 1000); E, embryos (× 11.4).

B



E



Genus: *Hippocrepis* C. Linnaeus

Phylogenetic Number: 13.13.

Tribe: Loteae.

Species Studied—Species in Genus: 10 spp.—30 spp.

Fruit a loment (or a loment segment); $1.2-4 \times 0.1-0.6 \times 0.07-0.16$ cm; with deciduous corolla; with persistent calyx; with calyx shorter than fruit; with orifice formed by curving of fruit or fruit segments (more than 1 per fruit) or without orifice formed by curving of fruit or fruit segments (*H. emerus*); straight to curved (to slightly curved) or 0.5-coiled to 1-coiled to 1.5-coiled; not plicate; not twisted; asymmetrical or symmetrical; linear or quadrangular; when asymmetrical with both sutures parallelly or unequally curved; not inflated; flattened or compressed; without beak; long tapered to tapered at apex; apex aligned to oblique with longitudinal axis of fruit; long tapered at base; base aligned to oblique with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted or not constricted; constricted along both margins; without sulcus; plain or embellished; with wing. Fruit wing present or absent; 1; 2 mm wide; sutural; on both sutures. Fruit substipitate. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 5–25 mm long; widest across seed area; with all essentially similar in shape; hippocrepiform. Epicarp semiglossy; monochrome; reddish brown; pubescent and indurate; with 1 type of pubescence; puberulent; with pubescence gray; with pubescence uniformly distributed; with glandular hairs (restricted to top of arch between winged margins); stiff; with hair bases plain; glandular; with glandular hairs; without spines; smooth or not smooth; with elevated features; longitudinally veined relative to fruit length; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp glossy; monochrome; tan; smooth; septate; with septa thicker than paper, firm; with the septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 3–12; length transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent.

Seed $2-4.5 \times 0.7-0.8 \times 0.7-0.8$ mm; not overgrown; not angular; asymmetrical; hippocrepiform or linear; terete;

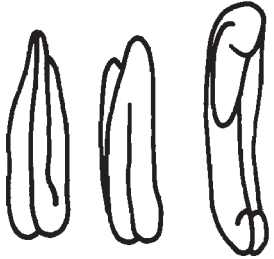
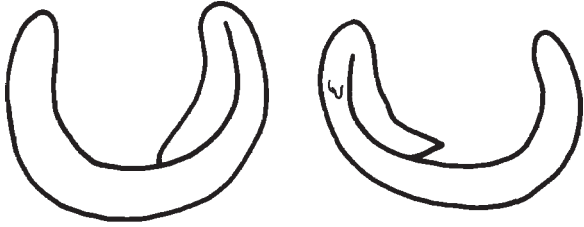
without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome; brown (brown to reddish), green (yellowish), tan, or blue (reddish); glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; without faboid split; punctiform; between cotyledon and radicle lobe; slightly recessed; within corona (*H. ciliata* C.L. von Willdenow) or not within corona, halo, or rim. Hilum corona color darker than testa (black). Lens discernible; less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; adjacent to hilum; mounded or flush; same color as testa or dissimilar color from testa; darker than testa; red; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; parallel to length of seed. Radicle linear; with 180-degree turn; not centered between cotyledons (radicle outside 1 cotyledon and inside other, therefore junctions for each cotyledon different); less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Mediterranean region into Europe and western Asia.

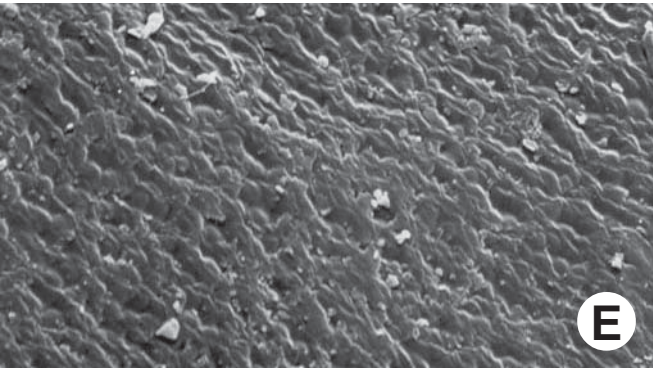
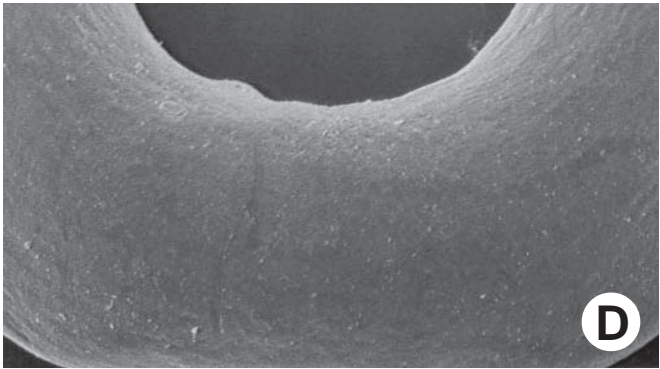
Notes: Domínguez (1976) monographed the annual species of *Hippocrepis* and illustrated their fruits. Our species count is based on Lassen (1989), who gave the genus a traditional treatment except for the transfer of *Coronilla emerus* C. Linnaeus into *Hippocrepis*. This transfer is particularly disturbing to us because the fruit characters and to some degree the seed characters are unlike those of the other species in *Hippocrepis* (compare figs. A and B).

Hippocrepis: *H. emerus* (C. Linnaeus) P. Lassen (B), *H. unisiliquosa* C. Linnaeus (D–F), *H. spp.* (A, C). A–B, Fruits and fruit segments ($\times 2$, $\times 2.3$); C, seeds ($\times 6$); D–E, testa ($\times 50$, $\times 1000$); F, embryos ($\times 10$).

C



F



Genus: *Scorpiurus* C. Linnaeus

Phylogenetic Number: 13.14.

Tribe: Loteae.

Species Studied—Species in Genus: 2 spp.—2 spp.

Fruit a loment (or a loment segment); $8 \times 0.3 \times 0.3$ cm; with deciduous corolla; with deciduous calyx; with or without orifice formed by curving of fruit or fruit segments; 4-coiled; not plicate to plicate (at most loosely plicate); loosely to tightly twisted or not twisted; asymmetrical or symmetrical; linear; when asymmetrical with both sutures nearly straight; not inflated; terete; without beak; long tapered or short tapered at apex; apex exceeding (crossing) longitudinal axis of fruit; long to short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin constricted or not constricted; slightly constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 5–10 mm long; with all essentially similar in shape; curved. Epicarp dull; monochrome or multicolored; bichrome (spines may be darker colored than surface and ribs below spines may be darker colored); brown or tan; glabrous; eglandular; with spines (aligned in longitudinal ribs) or without spines (longitudinal ribs present); with spines persistent; with spines same color or spines (or their basal remnant) a different color from the rest of the fruit; not smooth; with elevated features; not veined; tuberculate or not tuberculate; tuberculate (blunt spines in longitudinal rows); not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; smooth; subseptate; with septa thicker than paper, firm; with the septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seed length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; filiform; straight. Aril absent.

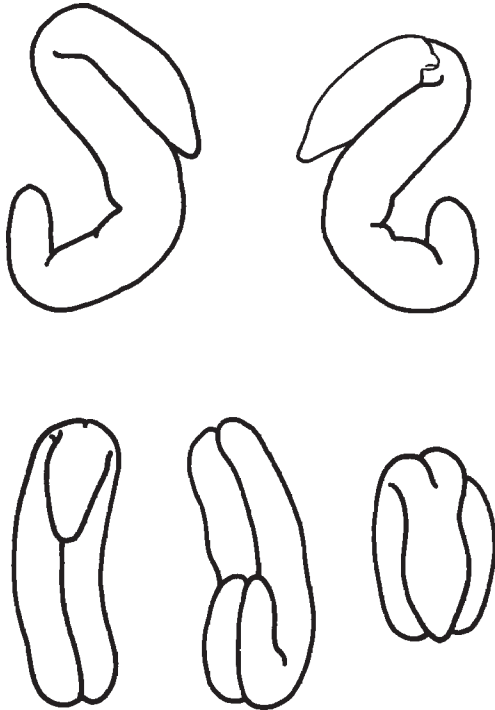
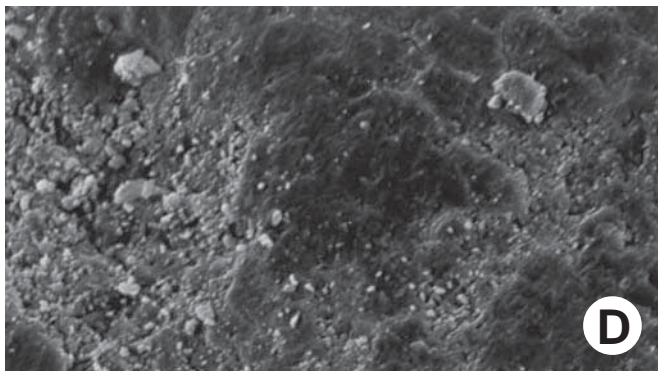
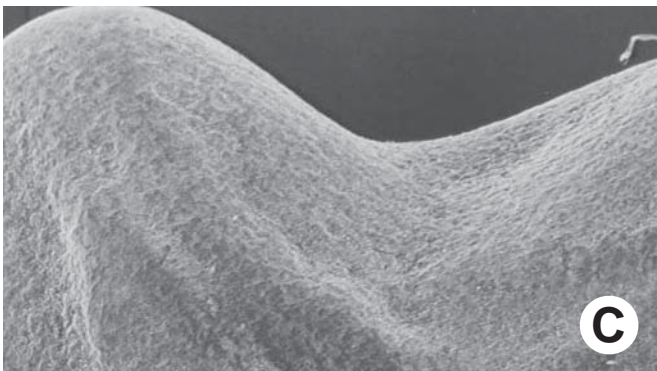
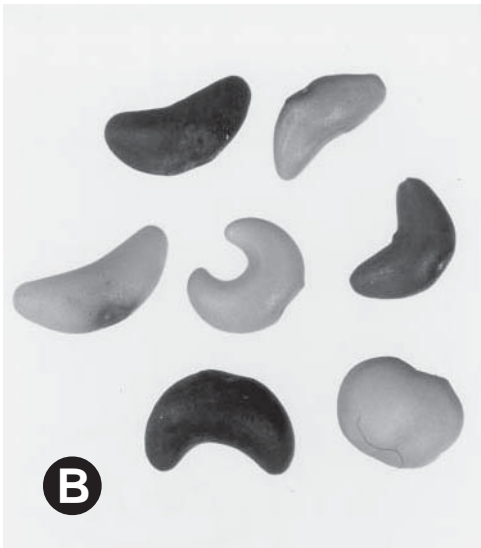
Seed $2.3\text{--}5 \times 1.5\text{--}3 \times 1.5\text{--}3$ mm; not overgrown; not angular; asymmetrical; C-shaped, circular (subcircular), or reniform; terete; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; orangish red to orange; gla-

brous; smooth or not smooth; with elevated and recessed (present or absent) features; shagreen; striate (faintly and when present caused by ribs on fruit); coriaceous. Fracture lines absent. Rim absent. Raphe not visible. Hilum fully concealed; concealed by funicular remnant; without faboid split; punctiform; marginal according to radicle tip (but on side opposite lobes); flush; not within corona, halo, or rim or within halo. Hilum halo color darker than testa (blackish-brown). Lens discernible; less than 0.5 mm in length; with margins curved; elliptic; not in groove of raphe; adjacent to hilum; 0.4 mm from hilum; mounded; dissimilar color from testa; darker than testa; dark brown; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth or not smooth; both outer faces convex; both the same thickness; both more or less of equal length; with both folded; not sufficiently folded for inner face to touch itself; portions of inner folded face unequal; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; white; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle bulbous; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Europe, Mediterranean region, western Asia, northeastern Africa.

Notes: Domínguez and Galiano (1974) monographed the genus and recognized four species; however, Heyn and Raviv (1966) recognized only two of the four species: *S. vermiculatus* C. Linnaeus and *S. muricatus*. Heyn and Raviv reorganized the *S. muricatus* complex with two varieties: var. *muricatus* (*S. muricatus*, s.s., and *S. sulcatus*, p.p.) and var. *subvillosus* (C. Linnaeus) J.B.A.P.M. de Lamarck (*S. subvillosus* and *S. sulcatus* C. Linnaeus, p.p.). Kaniewski and Miszkiel (1980) studied the histogenesis of the pericarp of *Scorpiurus* and noted that *S. muricatus* var. *muricatus* had “pods with smooth or tubercled ribs, usually coiled in one plane,” while *S. muricatus* var. *subvillosus* had “pods spiny, usually twisted.” Heyn and Raviv noted that the two seed shapes (straight with truncate margin and reniform with apiculate margin) faithfully reflect the degree of coiling of the loment segment, or article in which it developed. Upon soaking the seeds, the endosperm greatly expands (up to twice the diameter of the seed) and ruptures the testa, as it does in *Antopetita* (13.16).

Scorpiurus: *S. muricatus* C. Linnaeus (*C–E*), *S. spp.* (*A–B*).
A, Fruits and one article ($\times 2.2$); *B*, seeds ($\times 4.8$);
C–D, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 10$).



E

Genus: *Ornithopus* C. Linnaeus

Phylogenetic Number: 13.15.

Tribe: Loteae.

Species Studied—Species in Genus: 6 spp.—6 spp.

Fruit a loment (or a loment segment); $1.5-5 \times 0.1-0.23 \times 0.08-0.13$ cm; with deciduous corolla; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; curved to 0.5-coiled; not plicate; not twisted; asymmetrical or symmetrical; linear or falcate; when asymmetrical with both sutures parallelly curved; not inflated; compressed; with beak; hooked; with solid beak the same color and texture as fruit; long tapered at apex; apex oblique with longitudinal axis of fruit; tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted or not constricted; slightly constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous or conspicuous; 4–11 mm long; widest across seed area; with upper or lower 1 different shape than middle ones; circular, oblong, or rectangular. Epicarp dull; monochrome; brown or tan; glabrous or pubescent and indurate; with 1 type of pubescence; puberulent; with pubescence brown; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; smooth or not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp glossy; monochrome; tan; smooth; septate; with septa thicker than paper, firm; with the septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 4–12; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent.

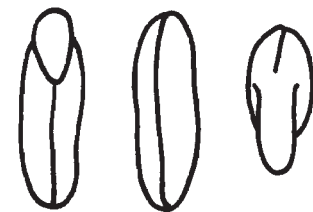
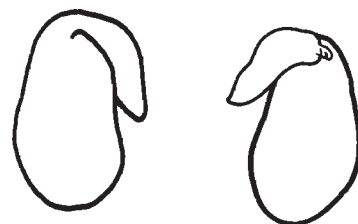
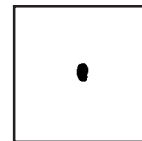
Seed $1.5-3 \times 1-2 \times 0.7-1.1$ mm; not overgrown; not angular (except hilum); symmetrical (except hilum); circular, oblong, ovate, or reniform; compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa dull; not modified by a

bloom; colored; monochrome; orange (reddish), red (dish), or yellow (pale); glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; marginal according to radicle tip; flush; within halo. Hilum halo color darker than testa. Lens discernible or not discernible; less than 0.5 mm in length; with margins curved; circular (sub); not in groove of raphe; adjacent to hilum; mounded; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thick or thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; parallel to length of seed. Radicle bulbous; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 or 1/2 to nearly length of cotyledons. Plumule rudimentary or moderately developed; glabrous.

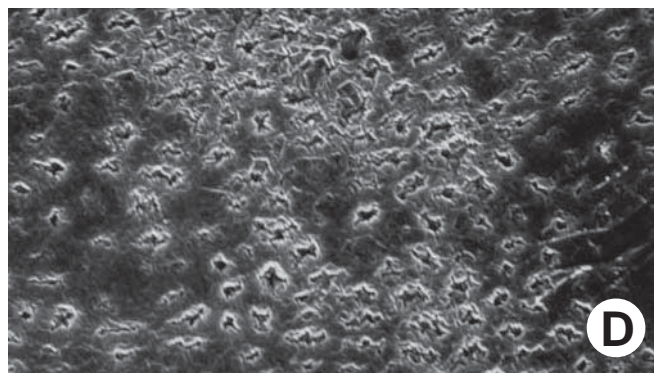
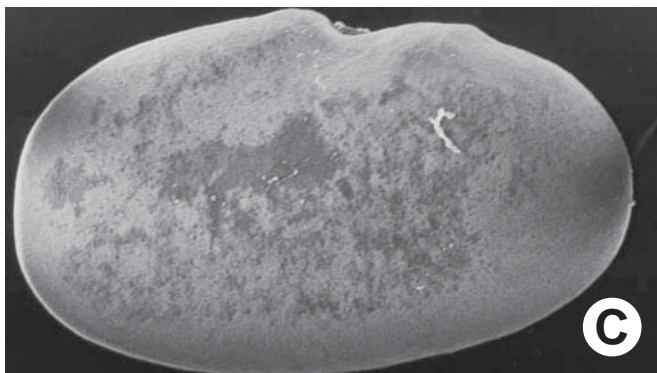
Distribution: Five species in Europe, Mediterranean region, western Asia, and Atlantic islands; *O. micranthus* (G. Benth) J. Arechaveleta y Bolpardo in southern South America.

Notes: Alsina (1988) described the morphology and anatomy of seeds of four species and illustrated their testa with micrographs at $\times 320$. The monotypic genus *Antopetitia* (13.16) differs by having dehiscent fruit segments and a persistent dorsal suture (Verdcourt 1974).

Ornithopus: *O. sativus* F.d'A. Brotero (C–E), *O. spp.* (A–B). A, Fruits and articles ($\times 2.2$); B, seeds ($\times 5.6$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



E



Genus: *Antopetitia* A. Richard

Phylogenetic Number: 13.16.

Tribe: Loteae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume or a loment (not a true loment); unilocular; 0.7–1.2 × 0.2–0.25 × 0.23 cm; with deciduous corolla; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; slightly curved to curved; not plicate; not twisted; asymmetrical; falcate or moniliform; when asymmetrical with both sutures parallelly curved; not inflated; terete; with beak (small); straight; with solid beak the same color and texture as fruit; rounded at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base oblique with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit substipitate (may be longer than 2–3 mm if lowest locule aborted). Fruit with all layers dehiscing; fenestrating, opening by a coiling strip of tissue. Dehiscence of valves along 1 suture; passive. Replum invisible. Loment dehiscing along 1 suture. Loment segments (articles) inconspicuous; 2–2.5 mm long; widest across seed area; with upper or lower 1 different shape than middle ones; circular. Epicarp glossy; monochrome; light brown to tan; glabrous; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without fibers; solid; coriaceous. Endocarp glossy; monochrome; tan or white; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 2–4; length parallel with fruit length; neither overlapping nor touching; in 2 or more series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent.

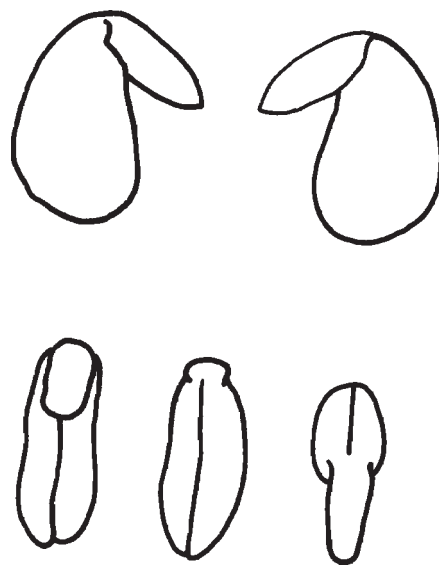
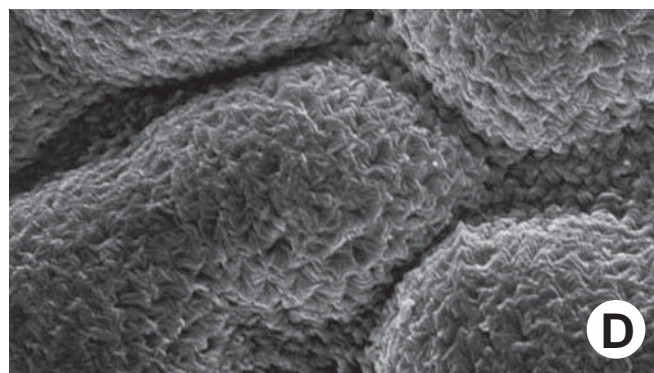
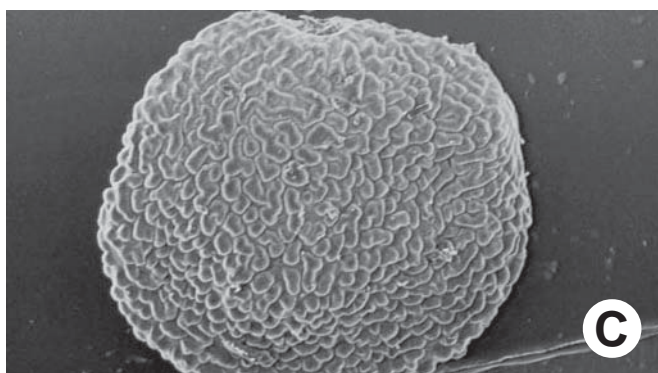
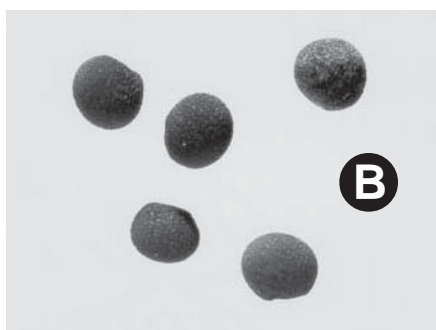
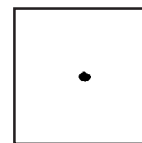
Seed 1.5–2 × 1.2–1.7 × 0.5–1.3 mm; not overgrown; angular to not angular; asymmetrical; circular to irregular; compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; dark to reddish brown to tan (reddish); glabrous; not smooth; with elevated features; rugose or tuberculate; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum

visible; without faboid split (hilum too small); punctiform; between cotyledon and radicle lobe; flush; not within corona, halo, or rim. Lens not discernible. Endosperm thick; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle bulbous; oblique to cotyledons; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Tropical Africa.

Notes: Polhill (1981) noted that this genus is closely related to *Ornithopus* (13.15) and that the genera of the Coronilleae only differ from those of the Loteae (13) by the presence of jointed fruits in the former. Verdcourt (1974) noted that *Antopetitia* is “a monotypic genus closely allied to *Ornithopus* L., but differing in the pod segments being dehiscent and in the persistent dorsal suture.” Both authors alluded to an anomaly in fruit of *Antopetitia*. These fruits are unique in the Fabaceae. At first glance they appear to be loment-like, but they are not. At most they are loment-like or lomentaceous because the fruits dehisce, albeit by a unique mechanism. In addition, Léonard (1954, fig. 10) clearly illustrated that the fruit dehisces on the plant, the seeds falling free of the fruiting cluster. By definition a loment separates at maturity into 1-seeded indehiscent articles. The unique dehiscence mechanism is the opening of the valves by the rolling up of the vertical suture. During the process, the individual fruit segments become fenestrated and then the seed may fall out or one valve may fall off (Léonard 1954, fig. 10). Upon soaking the testa fractures as the endosperm rapidly expands (as in *Scorpiurus* (13.14)). Both the seed and fruit dehiscences are related to edaphic factors in the habitat of the species.

Antopetitia: *A. abyssinica* A. Richard (A–E). A, Fruits and fruit segments (× 4.5); B, seeds (× 6.3); C–D, testa (× 50, × 1000); E, embryos (× 20).



Genus: *Hammatolobium* E. Fenzl

Phylogenetic Number: 13.17.

Tribe: Loteae.

Species Studied—Species in Genus: 2 spp.—2 spp.

Fruit a loment (or a loment segment); $2-6 \times 0.15-0.4 \times 0.2$ cm; with deciduous corolla; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical; linear and moniliform; not inflated; compressed; with beak; straight; with solid beak the same color and texture as fruit; short tapered at apex; apex oblique with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 3–6 mm long; widest across seed area; with upper or lower 1 different shape than middle ones; oblong. Epicarp dull; monochrome; dark brown; pubescent and indurate; with 1 type of pubescence; pilose or villous; with pubescence golden; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; smooth or not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp glossy; monochrome; white; smooth; septate; with septa thicker than paper, firm; with the septa eglandular; coriaceous; not exfoliating; remaining fused to epicarp; entire. Seeds up to 11; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent.

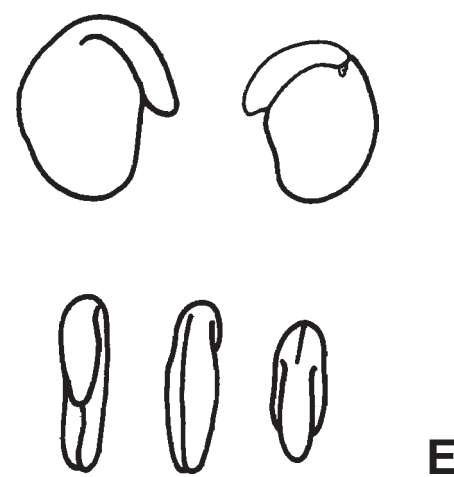
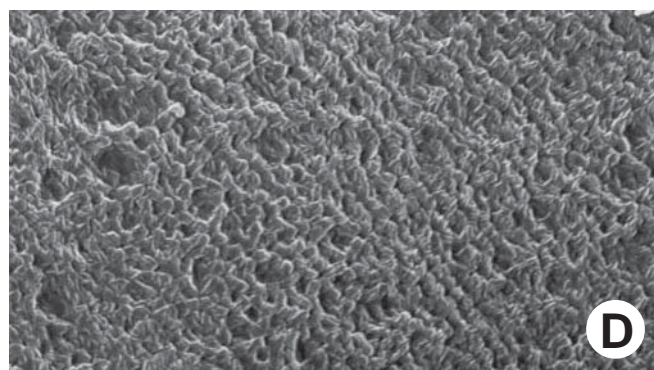
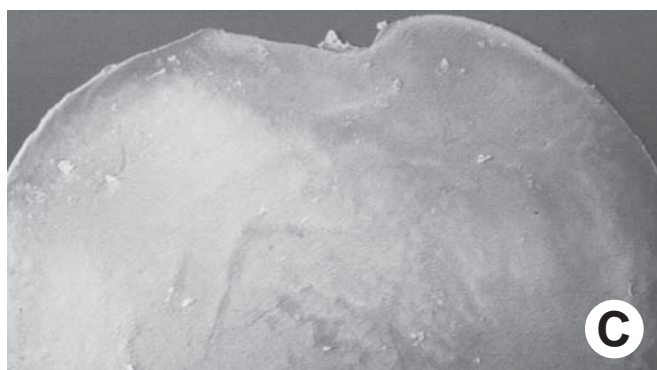
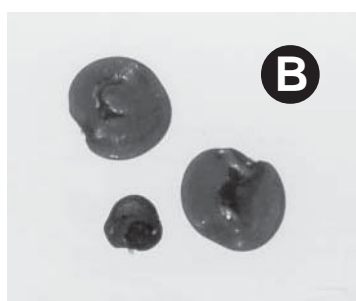
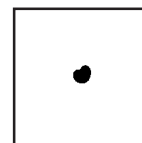
Seed $2.5 \times 2.3 \times 1$ mm; not overgrown; not angular; asymmetrical; nearly circular; compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum fully concealed; concealed by funicular remnant; without faboid split; punctiform; between cotyledon

and radicle lobe; recessed; not within corona, halo, or rim. Lens discernible; less than 0.5 mm in length; with margins curved; elliptic; not in groove of raphe; adjacent to hilum; mounded; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear; oblique to cotyledons; centered between cotyledons; $1/2$ to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: One species at either end of the Mediterranean region.

Notes: Polhill (1981) noted that this genus seems to be more closely related to *Anthyllis* (13.02) and *Lotus* (13.07) in the Loteae than to *Coronilla* (13.11).

Hammatolobium: *H. kremerianum* (E.St.-C. Cosson) C.H. Muller (C–E), *H. spp.* (A–B). A, Fruits with calyx and 1 article ($\times 1.8$); B, seeds ($\times 7$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



Aeschynomeneae (14.01–14.26)

Genus: *Ormocarpum* A.M.F.J. Palisot de Beauvois

Phylogenetic Number: 14.01.

Tribe: Aeschynomeneae.

Subtribe: Ormocarpinae.

Species Studied—Species in Genus: 12 spp.—ca. 20 spp.

Fruit a legume or loment; unilocular; $3.5\text{--}6 \times 0.5\text{--}0.8 \times 0.2\text{--}0.3$ cm; with persistent (*O. kirkii* S. le M. Moore) or deciduous corolla; with persistent (*O. kirkii*) or deciduous calyx; with calyx shorter than fruit; with or without orifice formed by curving of fruit or fruit segments (*O. kirkii*); straight to curved to 1-coiled (*O. kirkii*); not plicate; not twisted; asymmetrical or symmetrical; moniliform, C-shaped, or coiled; when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; widest near middle or D-shaped; not inflated; flattened; without or with beak; straight; with solid beak the same color and texture as fruit; long tapered, short tapered, or rounded at apex; apex aligned to oblique with longitudinal axis of fruit; long or short tapered at base; base aligned to oblique with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit stipitate to substipitate; with the stipe 3–8 mm long. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 6–20 mm long; widest across seed area; with upper 1 or lower 1 different shape than middle ones; oblong or D-shaped. Epicarp dull; monochrome; dark green; glabrous or pubescent and indurate; with 1 type of pubescence; puberulent; with pubescence yellow; with pubescence uniformly distributed; with simple hairs (often with swollen bases); stiff; with hair bases swollen; retrorse; straight at apex; glandular; with glandular hairs (minutely tubercule bases); with spines; not smooth; with elevated features; longitudinally veined relative to fruit length or reticulately veined; tuberculate or not tuberculate; with solid tubercles on each valve; tuberculate; not exfoliating; without cracks. Mesocarp thick; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp nearly glossy; monochrome; brown; smooth; septate or nonseptate; with septa thicker than paper, firm; with the septa eglandular;

chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1–6; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight or curved. Aril absent.

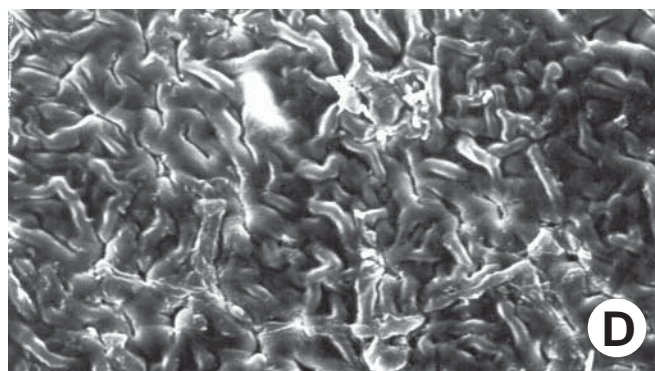
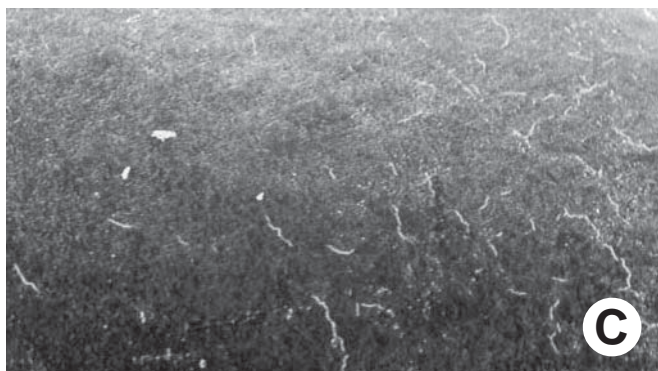
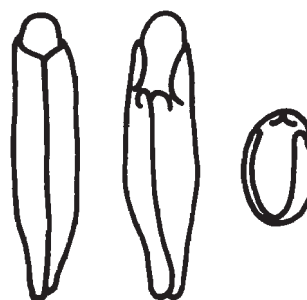
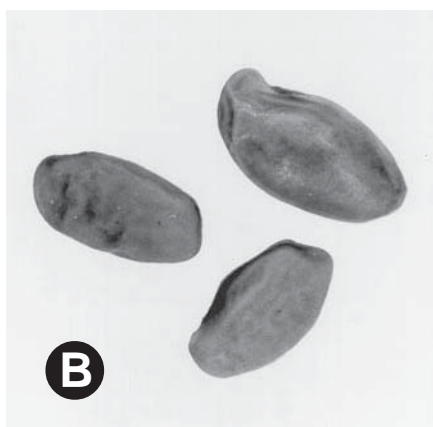
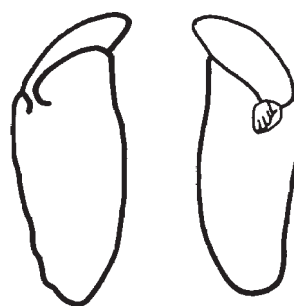
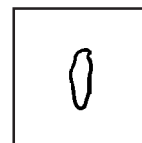
Seed $2\text{--}9 \times 1.5\text{--}4 \times 1.2\text{--}2$ mm; not overgrown; not angular; asymmetrical; circular to elliptic to oblong; compressed to flattened; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes; same color as testa; without umbo on seed faces. Testa not adhering to endocarp; dull; colored; monochrome; pinkish to reddish brown or tan; glabrous; smooth; chartaceous. Fracture lines absent. Rim absent. Wings absent. Raphe from hilum to near base of seed and terminating (from hilum to nearly base of seed); not bifurcating; darker than testa; brown; flush. Hilum fully concealed; concealed by funicular remnant; without faboid split; larger than punctiform; 1–1.3 mm long; with curved outline; elliptic; between cotyledon and radicle lobe; flush; within halo. Hilum halo color of or darker than testa. Lens not discernible. Endosperm trace; $1/2$ covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; split over radicle; with lobes; with lobes not touching; with the interface division terminating at base of radicle; without margins recessed; reddish tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear; oblique to cotyledons; centered between cotyledons; less than $1/2$ length of cotyledons. Plumule well developed; glabrous.

Distribution: Tropical and South Africa, Madagascar, southern Asia to Philippines, and Fiji.

Notes: Rudd (1981a) recognized four subtribes of Aeschynomeneae: Ormocarpinae Rudd (genera 14.01–14.08), Aeschynomeninae (genera 14.09–14.16), Discolobiinae (Burkart) Rudd (genus 14.17: *Discolobium*), Poirertiinae (Burkart) Rudd (genera 14.18–14.21), and Stylosanthinae (Bentham) Rudd (genera 14.22–14.26). Tribal and subtribal placement of *Diphysa* is based on Lavin (1987) and Polhill (1994a, 1994b) and not on Polhill and Sousa (1981), who placed *Diphysa* in Robinieae. Because Lavin did not relate *Diphysa* to a genus in subtribe Ormocarpinae, we have assigned the genus the phylogenetic number 14.03. Bailey et al. (1997), using the chloroplast *rpl2*

intron and ORF184, suggested that *Brya* (11.01), *Cranocarpus* (11.02), *Phylacium* (11.22), and *Neocollettia* (11.26) are not members of Desmodieae (11) and that they probably belong in Aeschynomeneae. Gillett (1966b) described the 17 species of *Ormocarpum* from southwestern Asia and Africa (excluding Madagascar) and presented some fruit and seed data and some fruit illustrations.

Ormocarpum: *O. orientale* (C.P.J. Sprengel) E.D. Merrill
(*C-E*), *O. spp.* (*A-B*). *A*, Article and partial fruit,
without or with calyx ($\times 1.8$); *B*, seeds ($\times 4$); *C-D*,
testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 5$).



Genus: *Ormocarpopsis* R. Viguier

Phylogenetic Number: 14.02.

Tribe: Aeschynomeneae.

Subtribe: Ormocarpinae.

Species Studied—Species in Genus: 1 sp.—5 spp.

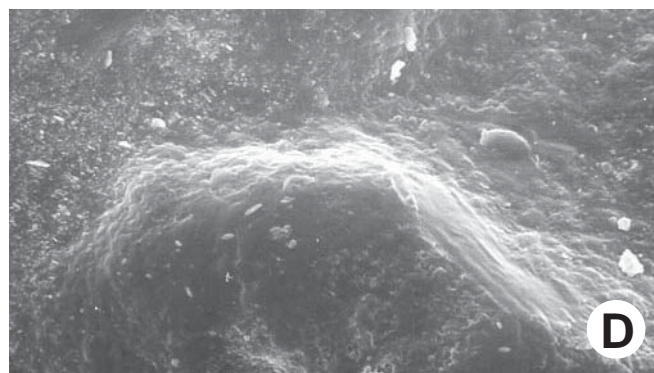
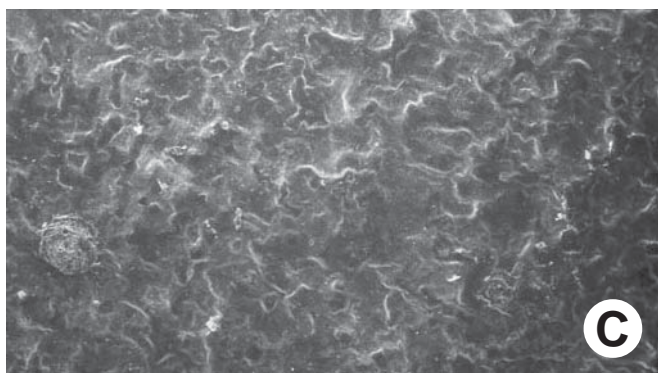
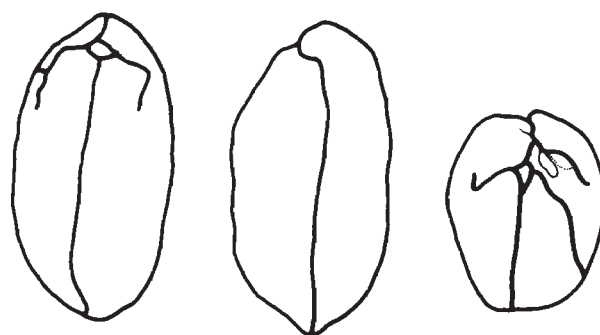
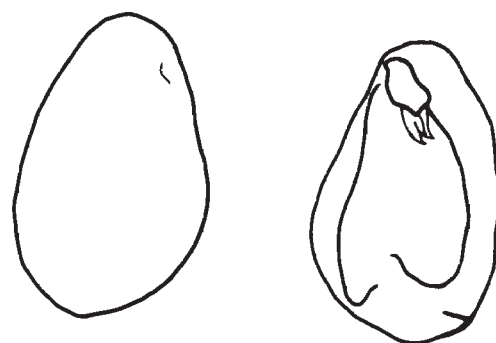
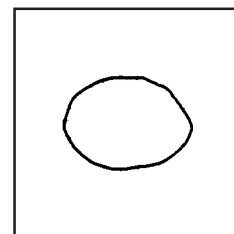
Fruit a legume; unilocular; $2.3-3 \times 1.3-2 \times 1.3-2$ cm; with deciduous corolla; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; oblong; when asymmetrical with both sutures parallelly curved; not inflated; terete; with beak; straight; with the apex and base uniform in texture; seed chambers externally invisible. Fruit margin not constricted; without sulcus; embellished. Fruit wings absent. Fruit stipitate or substipitate; with the stipe up to 8 mm long. Fruit indehiscent. Replum invisible. Fruit a nutlet; entire. Epicarp dull; monochrome; greenish brown; glabrous; glandular; with spines (glandular) or without spines; not smooth; with elevated features; not veined; tuberculate or not tuberculate; with solid tubercles on each valve (minute); warty (bases of spines); not exfoliating; without cracks. Mesocarp present (and streaked with purple); thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; exfoliating; separating from mesocarp. Seed 1; length parallel with fruit length. Funiculus less than 0.5 mm long; thick; straight. Aril absent.

Seed $18 \times 13 \times 10$ mm; overgrown, 1 seed filling entire fruit cavity; not angular; asymmetrical; ovate; terete; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown; glabrous; not smooth; with elevated features; shagreen; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; without faboid split; larger than punctiform; 1.5 mm long; with straight outline; linear; marginal according to radicle tip; flush; not within corona, halo, or rim. Lens discernible; equal to or greater than 0.5 mm in length; 2.5 mm long; with margins straight or curved; oblong; not in groove of raphe; confluent with hilum; mounded; similar color as testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm absent. Cotyledons not smooth or smooth; wrinkled or

wrinkled and 1–3 grooves on each face; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin not entire 180 degrees from base of radicle; notched or notched and bearing flaps; similar at apex; completely concealing radicle; split over radicle; with lobes; with lobes touching (auriculate) or not touching; with basal groin formed by lobes; with the interface division terminating at base of radicle; without margins recessed; brown; inner face concave (in center with varying width rim around the depression); glabrous around base of radicle. Embryonic axis straight; parallel to oblique to length of seed; with a joint evident between the radicle and the cotyledons. Radicle differentiated from cotyledon; triangular; lobe tip straight; straight with embryonic axis; centered between cotyledons; less than 1/2 length of cotyledons. Plumule well developed; pubescent at the base and glabrous at the apex.

Distribution: Madagascar.

Ormocarpopsis: *O. aspera* R. Viguier (A–E). A, Fruit ($\times 2.1$); B, seed ($\times 2.3$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 2.5$).



Genus: *Diphysa* N. von Jacquin

Phylogenetic Number: 14.03.

Tribe: Aeschynomeneae.

Subtribe: Ormocarpinae.

Species Studied—Species in Genus: 8 spp.—15 spp. or 20 spp.

Fruit a legume; unilocular; $3\text{--}6.5 \times 0.7\text{--}3 \times 0.7\text{--}3$ (estimated) cm; with deciduous corolla; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical; linear or oblong; inflated; terete; without beak; short tapered to rounded at apex; apex aligned with longitudinal axis of fruit; long tapered or rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain or embellished; with wing. Fruit wing present or absent; 1; sutural (subwinged or keeled); on 1 suture. Fruit stipitate to substipitate; with the stipe up to 15 mm long. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome; brown or tan; glabrous; without spines; not smooth; with elevated features; longitudinally veined relative to fruit length (with faint cross veining) or reticulately veined; not tuberculate; not exfoliating; with to without cracks; cracking irregular. Mesocarp absent. Endocarp dull; monochrome; tan; scurfy; nonseptate; coriaceous; not exfoliating; remaining fused to epicarp; entire. Seeds few, probably less than 5; length oblique to fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; filiform; straight. Aril absent.

Seed $4\text{--}7 \times 2.7\text{--}4.5 \times 1.5\text{--}3.3$ mm; not overgrown; not angular; asymmetrical; oblong; terete to compressed; with or without visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes; same color as testa; without umbo on seed faces. Testa not adhering to endocarp; dull; modified by a bloom; colored; monochrome; dark reddish brown to tan; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Raphe from hilum to near base of seed and terminating; not bifurcating; color of testa; raised to recessed. Hilum visible to partially concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the

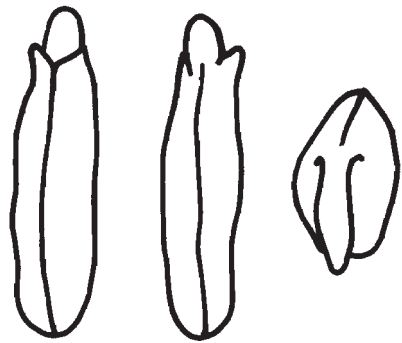
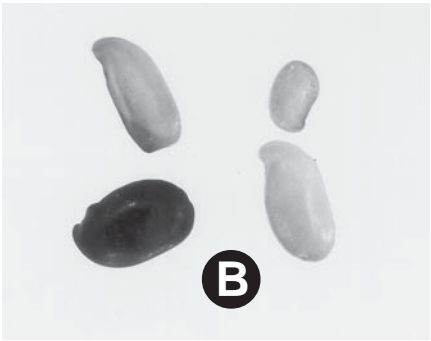
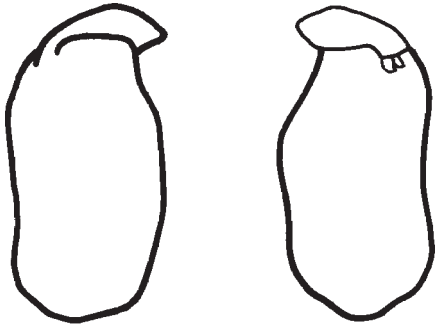
hilum; punctiform to larger than punctiform; up to 0.5 mm long; with curved outline; circular; subapical to radicle tip or between cotyledon and radicle lobe; recessed; within rim or not within corona, halo, or rim. Hilum rim color of testa. Lens not discernible. Endosperm thick to thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; split over radicle; with lobes; with lobes not touching; with the interface division terminating at base of radicle; without margins recessed; yellow or green (ish); inner face flat; glabrous around base of radicle. Embryonic axis right angled; perpendicular to length of seed. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon width; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed to well developed; glabrous.

Distribution: Mexico, Central America, northern South America.

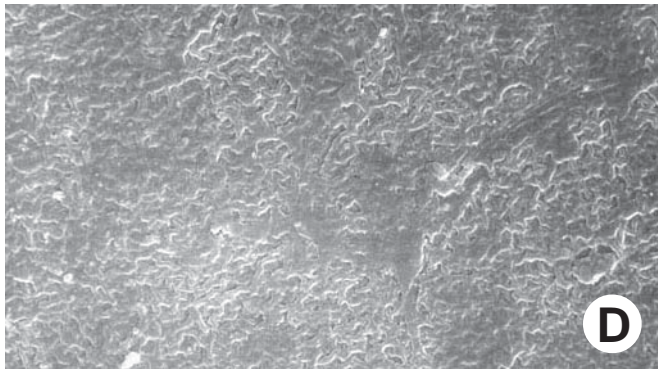
Notes: Tribal and subtribal placement of *Diphysa* is based on Lavin (1987, Polhill 1994a,b), and not on Polhill and Sousa (1981), who placed *Diphysa* in Robinieae.

Diphysa: *D. minutifolia* J.N. Rose (*E*), *D. robinoides* G. Bentham (*C–D*), *D.* spp. (*A–B*). *A*, Fruits ($\times 0.9$); *B*, seeds ($\times 2.4$); *C–D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 6$).

0



E



Genus: *Belairia* A. Richard

Phylogenetic Number: 14.04.

Tribe: Aeschynomeneae.

Subtribe: Ormocarpinae.

Species Studied—Species in Genus: 1 sp.—5–6 spp.

Fruit a legume; unilocular; $1.5\text{--}2 \times 0.4\text{--}0.5 \times 0.03$ cm; with deciduous corolla; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical; linear or oblong; not inflated; flattened; without or with beak; with solid beak the same color and texture as fruit; short tapered to rounded at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome; brown; glabrous; eglandular; without spines; not smooth; with elevated features; longitudinally veined relative to fruit length or reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; spongy; coriaceous. Endocarp dull; monochrome; brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 2; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent.

Seed $3.5\text{--}3.7 \times 2.5\text{--}2.7 \times 0.6$ mm; not overgrown; not angular; asymmetrical; circular (with radicle lobe); flattened; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; tan; smooth; chartaceous. Fracture lines absent. Rim absent. Raphe not visible. Hilum fully concealed; concealed by funicular remnant; without faboid split; punctiform; marginal according to radicle tip; flush (and dark brown). Lens not discernible. Endosperm absent. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with lobes not touching; with the interface division terminat-

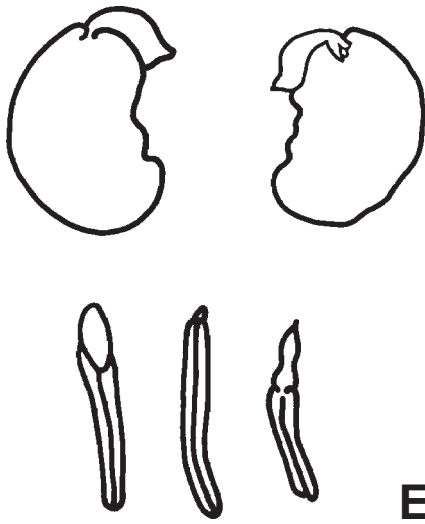
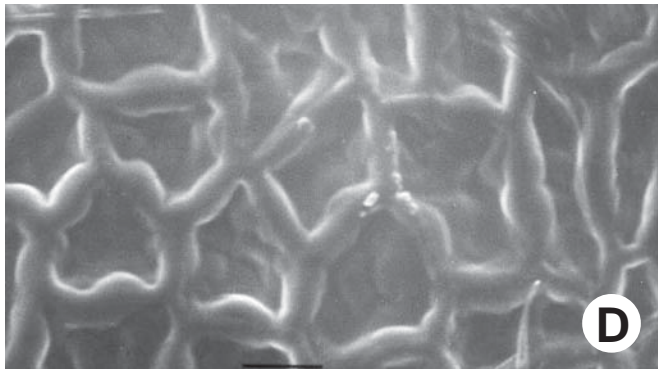
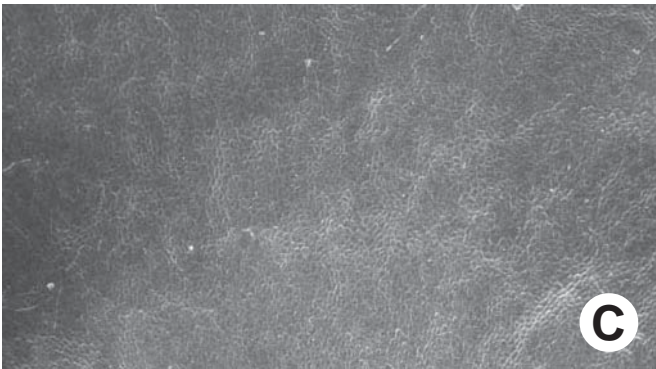
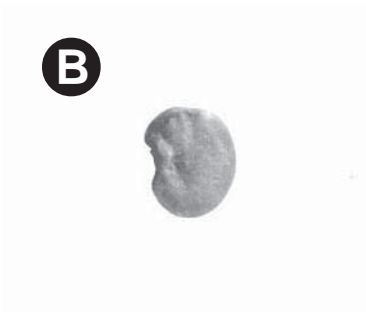
ing at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length or width; centered between cotyledons; less than 1/2 length of cotyledons. Plumule well developed; glabrous.

Distribution: Cuba.

Notes: Data from the meager (at the U.S. National Seed Herbarium [BARC]) samples were supplemented by fruit notes and illustrations in Lewis (1988). The number of species in the genus is based on Lewis, not on Rudd (1981a).

Belairia: *B. mucronata* A.H.R. Grisebach (A–E). A, Fruits ($\times 3.2$); B, seed ($\times 4.5$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).

0



Genus: *Pictetia* A.-P. de Candolle

Phylogenetic Number: 14.05.

Tribe: Aeschynomeneae.

Subtribe: Ormocarpinae.

Species Studied—Species in Genus: 4 spp.—ca. 6 spp.

Fruit a legume or loment; unilocular; $2.5-4 \times 0.5-1 \times 0.09-0.2$ cm; with deciduous corolla; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight to curved (to slightly curved); not plicate; not twisted; asymmetrical or symmetrical; broadly linear to oblong; when asymmetrical with both sutures parallelly curved; not inflated; flattened to compressed; without beak; short tapered to rounded at apex; apex aligned with longitudinal axis of fruit; short tapered to rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible or invisible; with the raised seed chambers not torulose. Fruit margin constricted or not constricted; constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit substipitate to nonstipitate. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 7–10 mm long; widest across seed area; with all essentially similar in shape; oblong. Epicarp dull to glossy; monochrome; brown; pubescent and indurate; with 1 type of pubescence; puberulent; with pubescence gray; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; tuberculate or not tuberculate; with solid tubercles on each valve; tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; mealy; chartaceous. Endocarp dull; monochrome; tan; smooth; septate or nonseptate; with septa thicker than paper, firm; with the septa eglandular; coriaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1–5; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; contorted. Aril dry; rim-aril; tan.

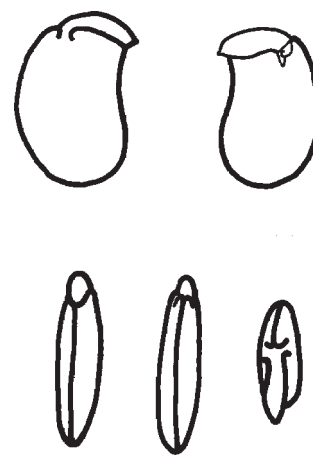
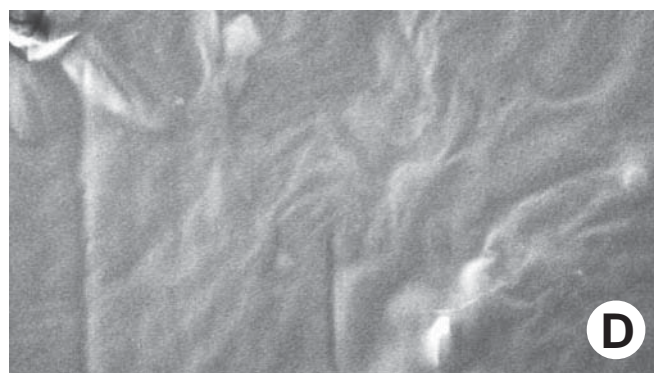
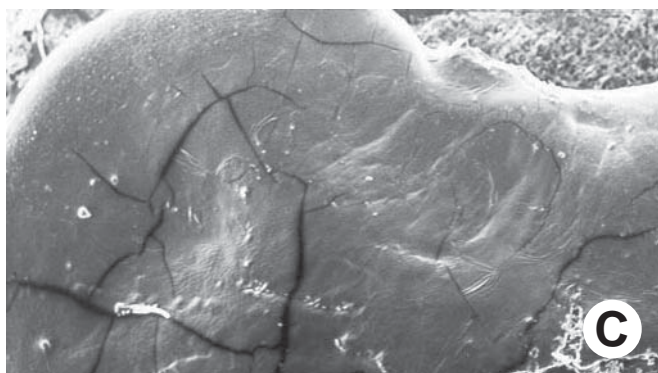
Seed $5-5.3 \times 3-3.2 \times 0.3-0.4$ mm; not overgrown; not angular; asymmetrical; C-shaped; flattened; with visible radicle and cotyledon lobes (barely); without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome; tan;

glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Raphe not visible. Hilum fully concealed; concealed by aril; without faboid split (visible); punctiform; between cotyledon and radicle lobe; flush; not within corona, halo, or rim. Lens discernible; less than 0.5 mm in length; with margins straight or curved; oblong; not in groove of raphe; 180 degrees from hilum; flush; dissimilar color from testa; darker than testa; black (ish); not within corona, halo, or rim. Endosperm thin; 1/2 covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; split over radicle; with lobes; with lobes not touching; with the interface division terminating at base of radicle; without margins recessed; white; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon width; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

Distribution: West Indies.

Pictetia: *P. spinifolia* (A.N. Desvaux) I. Urban (*B-E*), *P.* spp. (*A*). *A*, Fruit and partial fruit ($\times 2.6$); *B*, seeds ($\times 5.3$); *C-D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 5$).

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Genus: *Fiebrigiella* H.A.T. Harms

Phylogenetic Number: 14.06.

Tribe: Aeschynomeneae.

Subtribe: Ormocarpinae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a loment; $3-3.1 \times 0.3-0.4 \times 0.08-0.1$ cm; with deciduous corolla; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight to curved (slightly); not plicate; not twisted; asymmetrical; when asymmetrical with 1 straight and 1 curved suture; narrowing in several places, resembling *Desmodium* fruit; not inflated; flattened; without beak; short tapered at apex; apex aligned to oblique with longitudinal axis of fruit; tapered to short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted only on 1 margin; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 5–6 mm long; widest across seed area; with all essentially similar in shape; D-shaped. Epicarp dull; monochrome; dirty brown; pubescent but soon deciduous; with 1 type of pubescence; puberulent; with pubescence golden; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined (with 1 major vein and 1 minor longitudinal vein); not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp glossy; monochrome; tan; spongy; septate; with septa thicker than paper, firm; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 2–4; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril dry; rim-aril; reddish brown.

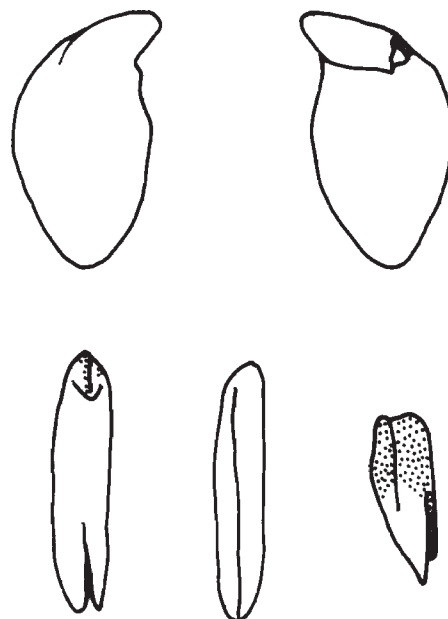
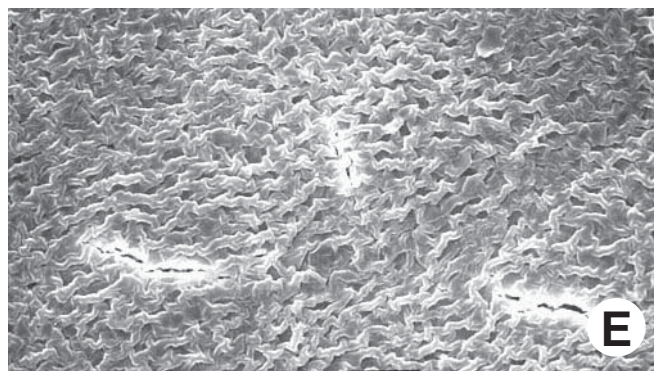
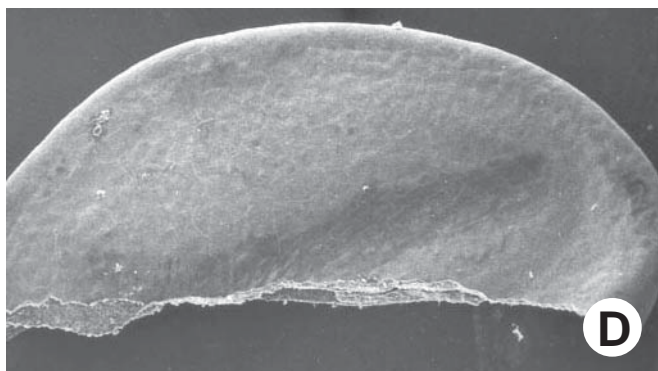
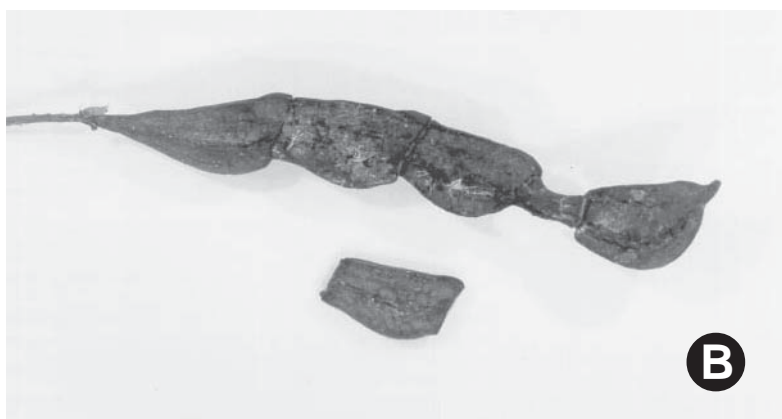
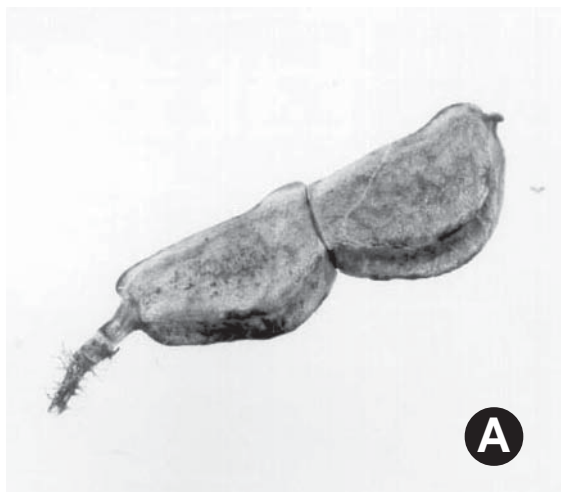
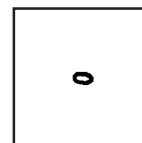
Seed $4.2-5 \times 2.5-3 \times 0.7-1$ mm; not overgrown; not angular; asymmetrical; D-shaped; flattened; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish

brown; glabrous; smooth or not smooth; with elevated features; wrinkled (1 longitudinal wrinkle); chartaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by aril (rim); without faboid split; punctiform; marginal according to radicle tip; flush; not within corona, halo, or rim. Lens discernible; less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; adjacent to hilum; 1 mm from hilum; mounded; dissimilar color from testa; darker than testa; black (ish); not within corona, halo, or rim. Endosperm absent. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with lobes not touching; without basal groin formed by lobes; with the interface division terminating at base of radicle; without margins recessed; brown; inner face flat; glabrous around base of radicle. Embryonic axis straight; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle differentiated from cotyledon; bulbous; lobe tip straight; oblique to cotyledons; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Bolivia.

Notes: Burkart and Vilchez (1971) monographed the genus, and their figure 2 was consulted in preparing our plate. Scant seeds and fruits were available for our study.

Fiebrigiella: *F. gracilis* H.A.T. Harms (A–F). A, Fruit ($\times 5.9$); B, fruit and article ($\times 3$); C, seed ($\times 8$); D–E, testa ($\times 50$, $\times 1000$); F, embryos ($\times 8$).



Genus: *Chaetocalyx* A.-P. de Candolle

Phylogenetic Number: 14.07.

Tribe: Aeschynomeneae.

Subtribe: Ormocarpinae.

Species Studied—Species in Genus: 10 spp.—12 spp.

Fruit a loment; $7-16 \times 0.2-2.2 \times 0.07-0.2$ cm; with deciduous corolla; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight, curved (or slightly curved), or S-curved; not plicate; not twisted; asymmetrical or symmetrical; linear; when asymmetrical with both sutures parallelly curved; not inflated; flattened or compressed; without beak; tapered or short tapered at apex; apex aligned or oblique with longitudinal axis of fruit; short tapered or rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain or embellished; with wing. Fruit wing 1; 8–10 mm wide; continuous wing around fruit. Fruit stipitate, substipitate, or nonstipitate; with the stipe 5–15 mm long. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 4–17 mm long; widest across seed area; with upper 1 different shape than middle ones; oblong or quadrangular. Epicarp dull; monochrome or multicolored; bichrome (flattened fruit have a darker center (over seed chambers) that fades to lighter margins); brown or tan; glabrous, glabrate, or pubescent and indurate; with 1 type of pubescence; velutinous; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; glandular; with glandular setae (few); without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thick; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; ligneous (sub). Endocarp dull; monochrome; gray; cobwebby; septate; with septa thicker than paper, firm; with the septa eglandular; coriaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 6–16; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; straight. Aril absent.

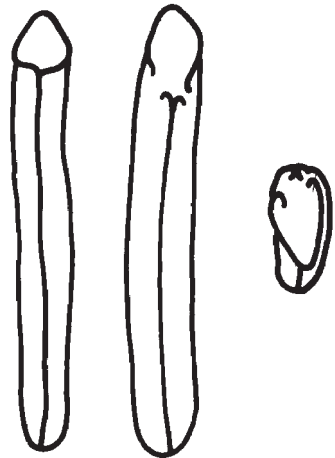
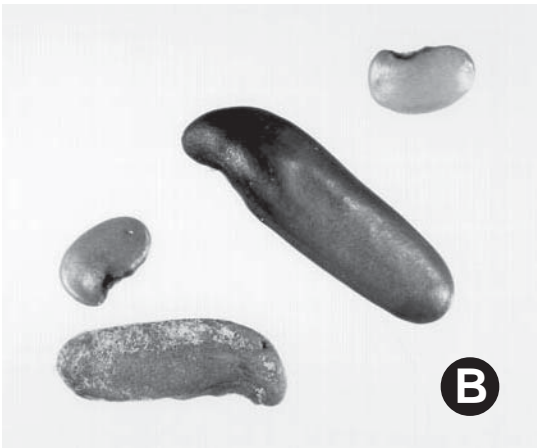
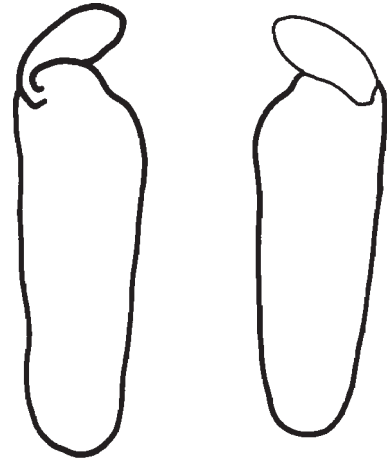
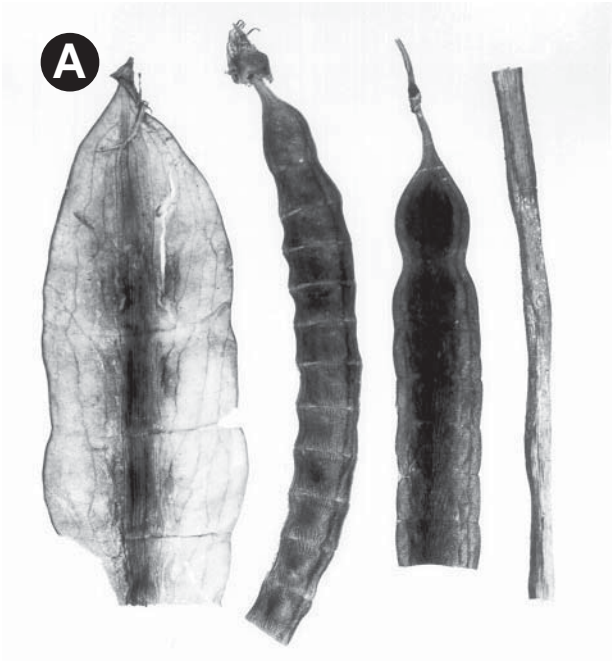
Seed $2.5-7 \times 2-2.5 \times 2-2.5$ mm; not overgrown; not angular; asymmetrical; linear or reniform; terete; with

visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to partially adhering to endocarp; glossy; not modified by a bloom; colored; monochrome; reddish brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform or larger than punctiform; 0.3 mm long; with curved outline; circular; between cotyledon and radicle lobe; flush; within rim. Hilum rim color darker than testa (slightly). Lens discernible; less than 0.5 mm in length (ca. 0.3 mm); with margins curved; circular; not in groove of raphe; adjacent to hilum; 0.1 mm from hilum; mounded; similar color as testa; darker than testa; brown; not within corona, halo, or rim. Endosperm thick; 1/2 covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle bulbous; lobe tip curved; deflexed and parallel to cotyledon width; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

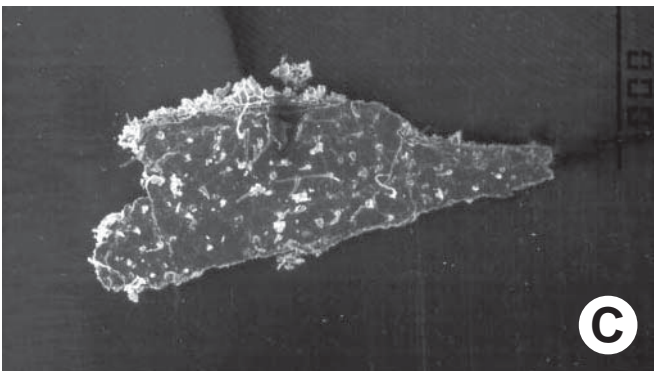
Distribution: Tropical America.

Notes: Rudd (1958) monographed the genus and Diatloff and Diatloff (1977) noted that *Chaetocalyx* is a non-nodulating faboid legume genus.

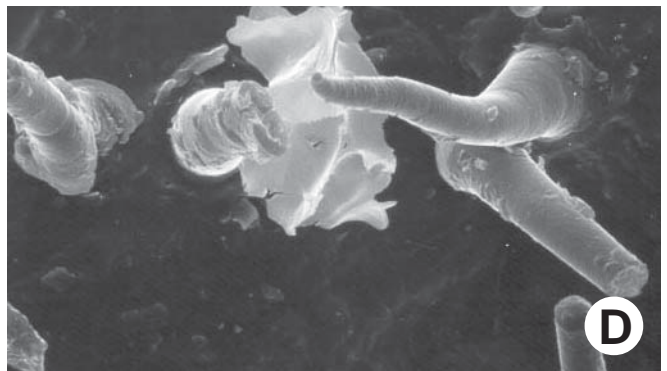
Chaetocalyx: *C. brasiliensis* (J.R.T. Vogel) G. Bentham (*E*), *C. latisiliqua* (J.L.M. Poiret) G. Bentham ex W.B. Hemsley (*C-D*), *C. spp.* (*A-B*). *A*, Fruits (none entire) ($\times 1.4$); *B*, seeds ($\times 6$); *C-D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 10$).



E



C



D

Genus: *Nissolia* N. von Jacquin

Phylogenetic Number: 14.08.

Tribe: Aeschynomeneae.

Subtribe: Ormocarpinae.

Species Studied—Species in Genus: 11 spp.—13 spp.

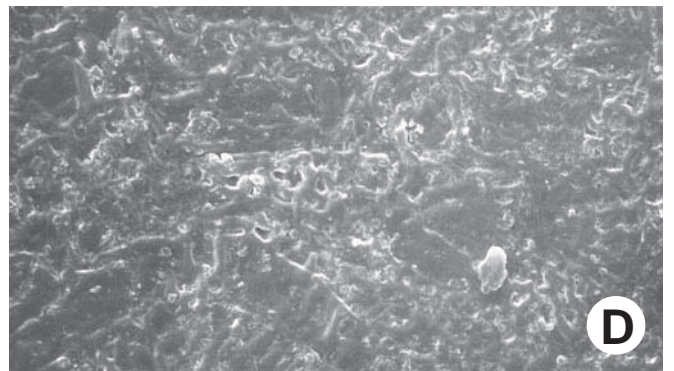
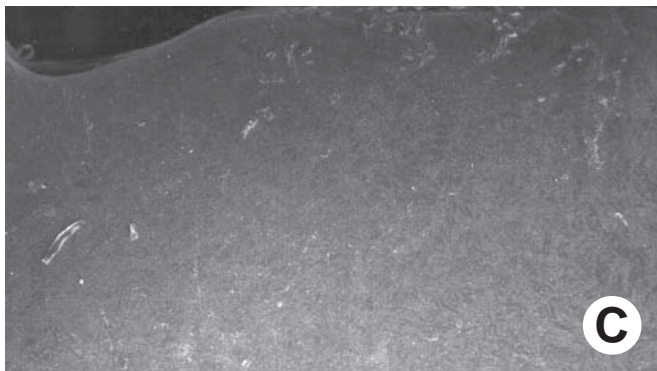
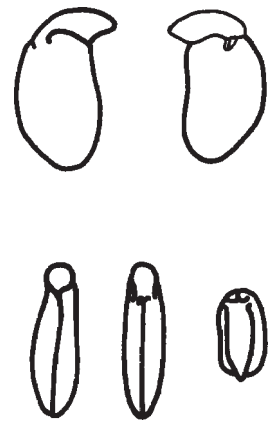
Fruit a loment; $1.5\text{--}4.3 \times 0.5\text{--}1.5 \times 0.09\text{--}0.3$ cm; with persistent or deciduous androecial sheath; with deciduous corolla; with persistent or deciduous calyx (rarely); with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved; not plicate; not twisted; asymmetrical or symmetrical; oblong or falcate; when asymmetrical with both sutures parallelly curved; not inflated; compressed; without beak; tapered to rounded at apex; apex aligned to oblique with longitudinal axis of fruit; short tapered to rounded at base; base aligned to oblique with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin slightly constricted along both margins; without sulcus; plain or embellished; with wing (restricted to apical article). Fruit wing present or absent; 1; 5–15 mm wide; samaroid; apical. Fruit stipitate to substipitate to nonstipitate; with the stipe up to 6 mm long. Fruit indehiscent (if 1-seeded). Replum invisible. Loment indehiscent. Loment segments (articles) conspicuous; 3–10 mm long (sterile (winged) 10–25 mm); widest across seed area; with upper 1 different shape than middle ones; oblong (with apical article with terminal wing) or rectangular. Epicarp dull; monochrome; reddish brown or tan; glabrous or pubescent and indurate; with 1 type of pubescence; crinkled pilose; with pubescence gray; with pubescence uniformly distributed; with simple or glandular hairs; pliable; with hair bases plain; glandular or eglandular; with glandular setae; without spines; not smooth; with elevated features; longitudinally veined relative to fruit length (with 3 to many well developed veins) or reticulately veined; not tuberculate; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; tan; cobwebby; septate; with septa thicker than paper, firm; coriaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1–6; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; straight. Aril dry; rim-aril; tan.

Seed $2\text{--}5 \times 1.5\text{--}3.5 \times 1.7$ mm; not overgrown; not angular; asymmetrical; oblong, quadrangular (nearly), or reniform; compressed; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without umbo on seed faces. Testa partially adhering to endocarp (hairs); more or less glossy; not modified by a bloom; colored; monochrome; reddish brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe from hilum to lens; not bifurcating; darker than testa; black; flush. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform to larger than punctiform; up to 0.3 mm long; with curved outline; circular; between cotyledon and radicle lobe; flush; not within corona, halo, or rim or within halo. Hilum halo color lighter than testa. Lens not discernible. Endosperm thick; $1/2$ covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing or not concealing radicle; split over radicle; with lobes; with lobes not touching; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle bulbous (nearly); lobe tip straight; deflexed and parallel to cotyledon width; centered between cotyledons; less than $1/2$ length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Mexico, West Indies, Central America, South America.

Notes: Rudd (1956) monographed the genus and noted that the “fruits are samaralike, 2–5-articulate loment with terminal joint sterile, flat, and winglike.”

Nissolia: *N. leiogyne* N.Y. Sandwith (*E*), *N. schottii* (J. Torrey) A. Gray (*C–D*), *N. spp.* (*A–B*). *A*, Fruits and 1 article ($\times 1.9$); *B*, seeds ($\times 5.3$); *C–D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 5$).



Genus: *Aeschynomene* C. Linnaeus

Phylogenetic Number: 14.09.

Tribe: Aeschynomeneae.

Subtribe: Aeschynomeneinae.

Species Studied—Species in Genus: 21 spp.—ca. 150 spp.

Fruit a loment; $0.8-2 \times 0.4-0.5 \times 0.1-0.3$ cm; with deciduous corolla; with persistent or deciduous calyx; with calyx shorter than fruit (in loments that do not articulate); with or without orifice formed by curving of fruit or fruit segments; straight, curved (or slightly curved), S-curved, or 0.5-, 1-, 1.5-, 4-, or 2-coiled; not plicate; not twisted; asymmetrical or symmetrical; circular, linear, moniliform, or falcate; when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; narrowing in several places, resembling *Desmodium* (11.09) fruit; not inflated; compressed or quadrangular; without beak; tapered at apex; apex aligned with longitudinal axis of fruit; tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous or fragile, thinner than chartaceous like *Trifolium* (21.06); seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted or not constricted; constricted along both margins or only on 1 margin; without sulcus; plain. Fruit wings absent. Fruit stipitate to substipitate; with the stipe 1–25 mm long. Fruit indehiscent. Replum occasionally visible. Fruit a segment; an intact article; loment segment. Loment indehiscent. Loment segments (articles) inconspicuous; 3–7 mm long; widest across seed area; with all essentially similar in shape; D-shaped or rectangular. Epicarp dull; monochrome; black, brown, green (ish-black), or tan; with surface texture uniform or not uniform, with patches of different texture not restricted to the base and apex; glabrous or pubescent and indurate; with 1 type of pubescence; appressed puberulent or tomentose; with pubescence gray; with pubescence uniformly distributed; with simple or glandular hairs; pliable; with hair bases plain; glandular (sections *Aeschynomene* and *Ochopodium*); with glandular hairs; without spines; smooth or not smooth; with elevated features; veined or not veined; obliquely veined relative to fruit length; not tuberculate; verrucose-rugose, muricate, or faveolate; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; smooth; septate; with

septa thicker than paper, firm; with the septa eglandular; ligneous (sub); not exfoliating; remaining fused to epicarp; entire. Seeds 1–18; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent.

Seed $1-6 \times 0.7-5 \times 2-2.5$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; glossy; colored; monochrome; black (and greenish) or brown (light); smooth; coriaceous. Fracture lines absent. Rim absent. Raphe not visible. Hilum fully concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color or lighter colored than the rest of the hilum and therefore conspicuous; larger than punctiform; 1.5 mm long; with curved outline; elliptic; marginal according to radicle tip or between cotyledon and radicle lobe; flush; within halo. Hilum halo color lighter than testa. Lens not discernible. Endosperm thin; 1/2 covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with lobes not touching; with the interface division terminating at base of radicle; without margins recessed; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; perpendicular to length of seed. Radicle bulbous; lobe tip straight or curved; deflexed and parallel to cotyledon width; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule rudimentary or well developed; glabrous.

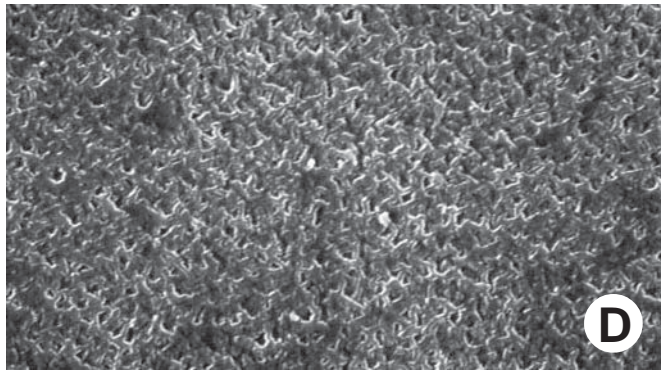
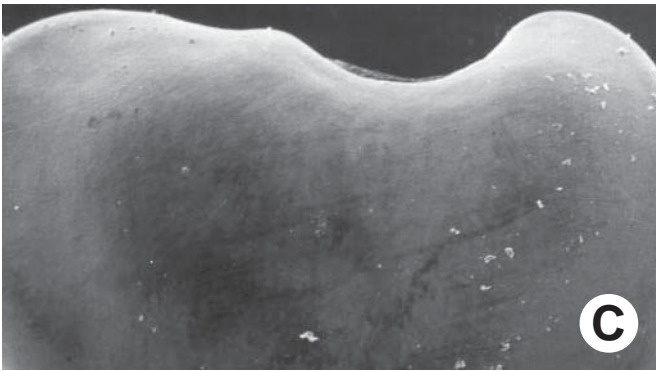
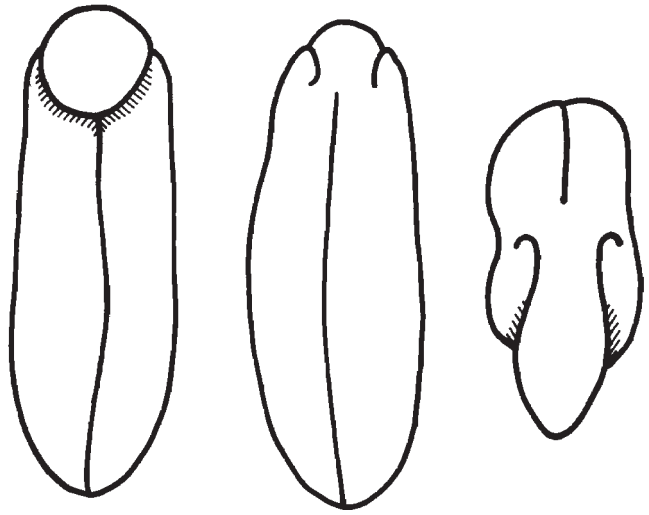
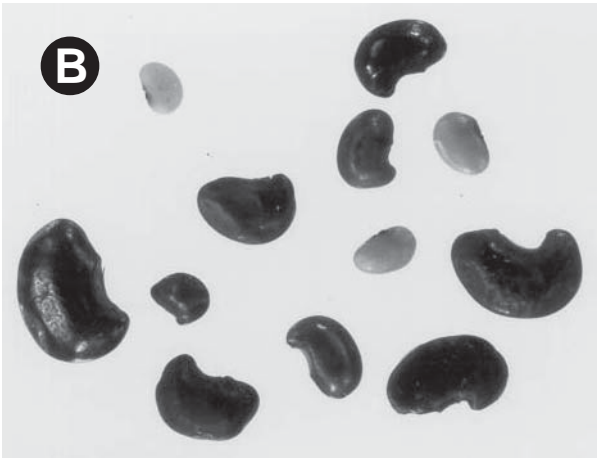
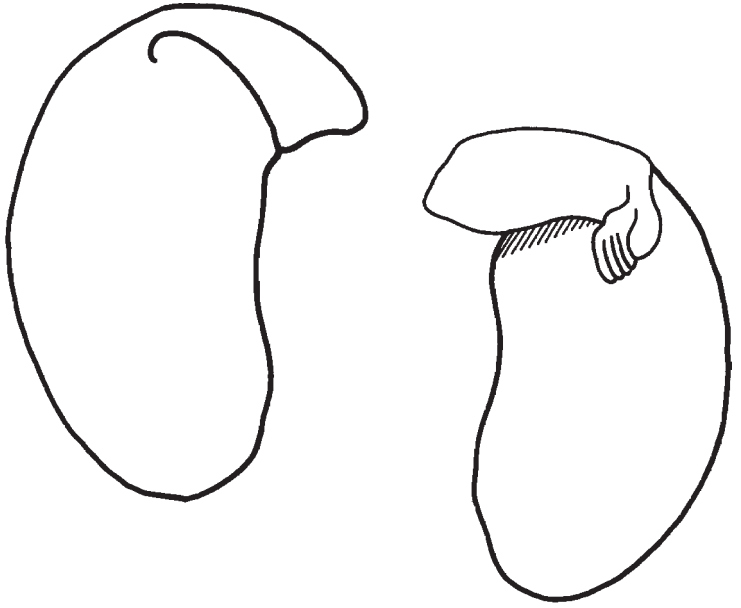
Distribution: Tropics to warm temperate America, Africa, and Asia.

Notes: Rudd (1955) monographed the American species and, according to her subgeneric categories, the U.S. National Seed Herbarium (BARC) has representatives of both subgenera and seven of eight series. The missing series included two species: *A. fluminensis* J. Velloso de Miranda and *A. parviflora* M. Micheli. Of the studied species, only three are restricted to the Old World. Rudd also provided seed and fruit data for each American taxon. Verdcourt (1974) monographed *Aeschynomene* for the Flora of Zambia and included seed and fruit data. Pandey and Jha (1989) reported on the seed structure of *A. aspera* C. Linnaeus (type for genus) and *A. indica* C. Linnaeus. Rudd (1955) re-

corded the variable epicarp surfaces of articles using these descriptors: (Hairs) appressed-pubescent, ciliate, crisp-pubescent, glabrate, glabrous, glandular-hispidulous, hispid, hispidulous, pubescent, sericeous, subappressed hairs, subglabrous, villous-hispid, white-pubescent; (surface) faveolate, muricate, muricate in center of article, reticulate-veiny, rugose, smooth, tuberculate, tuberculate bases of hairs..., veiny, ventricose, verrucose, and verrucose at center of article. All species of *Aeschynomene* are noxious weeds in rice (*Oryza sativa* C. Linnaeus) in Arkansas.

Aeschynomene: *A. virginica* (C. Linnaeus) N.L. Britton,
E.E. Sterns & J.F. Poggenberg (*C–E*), *A. spp.* (*A–B*).
A, Articles and broken and entire fruits ($\times 1.9$); *B*,
seeds ($\times 3.6$); *C–D*, testa ($\times 50$, $\times 1000$); *E*, embryos
($\times 10$).

3



Genus: *Soemmeringia* C.F.P. von Martius

Phylogenetic Number: 14.10.

Tribe: Aeschynomeneae.

Subtribe: Aeschynomeninae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a loment; $0.4\text{--}0.5 \times 0.18\text{--}0.2 \times 0.05\text{--}0.06$ cm; with persistent or deciduous androecial sheath; with persistent or deciduous corolla; with various petals; with persistent calyx; with calyx longer than fruit; without orifice formed by curving of fruit or fruit segments; somewhat contorted; somewhat plicate to not plicate; not twisted; asymmetrical; moniliform; when asymmetrical with both sutures parallelly curved; not inflated; compressed; without beak; rounded at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 1.5–2 mm long; widest across seed area; with all essentially similar in shape; circular. Epicarp dull; monochrome; brown; glabrous; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; smooth; septate; with septa thicker than paper, firm; with the septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 2–4; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; flattened; straight. Aril dry; rim-aril; reddish brown.

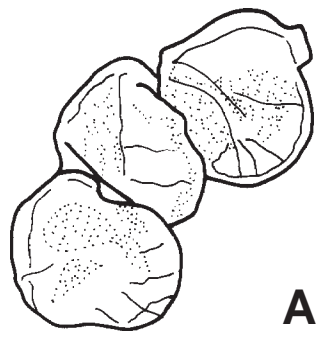
Seed $1 \times 1 \times 0.3$ mm; not overgrown; not angular; asymmetrical; mitaform; compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome; brown (dark brown) or green; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible or fully concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; recessed; not

within corona, halo, or rim. Lens discernible; less than 0.5 mm in length; with margins straight or curved; irregular; irregular; not in groove of raphe; adjacent to hilum; 0.2 mm from hilum; mounded; dissimilar color from testa; darker than testa; black (on dark brown testa) or brown (on green testa); not within corona, halo, or rim. Endosperm thick; 1/2 covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin not entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; split over radicle; with lobes; with lobes not touching; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle nearly bulbous; lobe tip straight; deflexed and parallel to cotyledon width; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

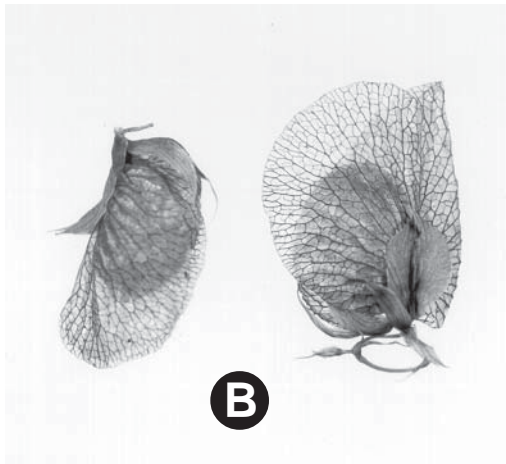
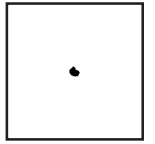
Distribution: Venezuela, Brazil, and Bolivia.

Notes: Apparently the marcescent corolla acts as a wing in fruit dispersal and therefore aids in seed dissemination.

Soemmeringia: *S. semperflorens* C.F.P. von Martius (A–F). A, Partial fruit ($\times 14$); B, fruit (left) and fruits in marcescent corollas (right) ($\times 3.7$); C, seeds ($\times 9$); D–E, testa ($\times 50$, $\times 1000$); F, embryos ($\times 15$).



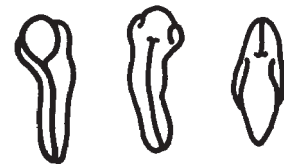
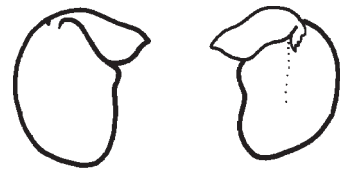
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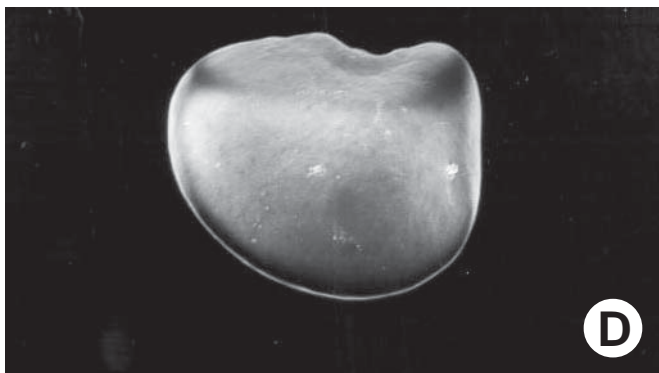
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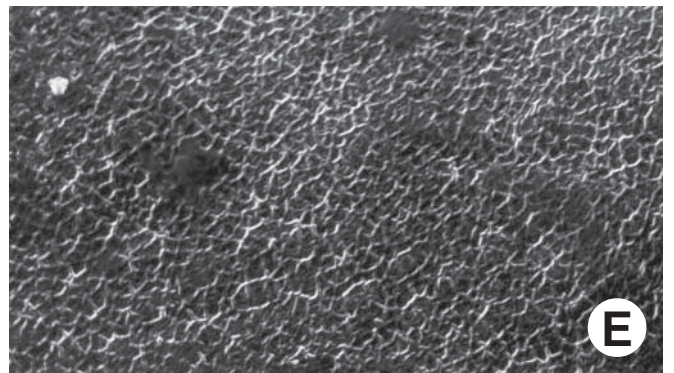
C



F



D



E

Genus: *Kotschya* S.F.L. Endlicher

Phylogenetic Number: 14.11.

Tribe: Aeschynomeneae.

Subtribe: Aeschynomeninae.

Species Studied—Species in Genus: 7 spp.—ca. 30 spp.

Fruit a loment; 0.2–3.9 (see Notes) \times 0.2–0.4 \times 0.15 cm; with persistent corolla; with standard; with persistent calyx; with calyx longer than fruit; without orifice formed by curving of fruit or fruit segments; straight; plicate (see Notes); not twisted; asymmetrical; when asymmetrical with 1 straight and 1 curved suture; narrowing in several places, resembling *Desmodium* fruit; not inflated; compressed; without beak; rounded at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted only on 1 margin; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 2–6 mm long; widest across seed area; with all essentially similar in shape; D-shaped. Epicarp dull; monochrome; brown (including reddish) or tan; glabrous or pubescent and indurate; with 2 types of pubescence; pilose; with pubescence gray and yellow; with golden hooked hairs and gray plain hairs; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases swollen or plain; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; tuberculate (bases of hairs); not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; smooth; septate; with septa thin (tissue paper-like), flexible; with the septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1–9; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; filiform; straight. Aril dry; rim-aril; yellow.

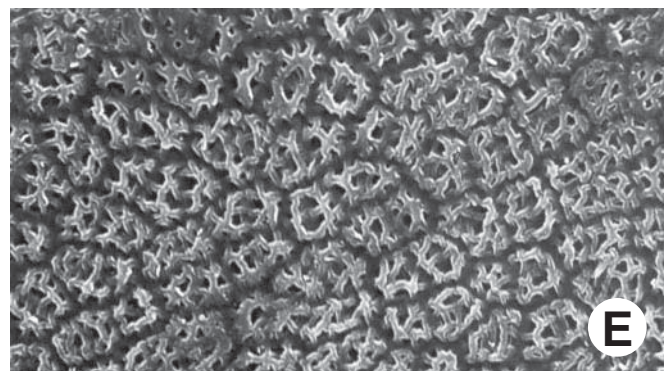
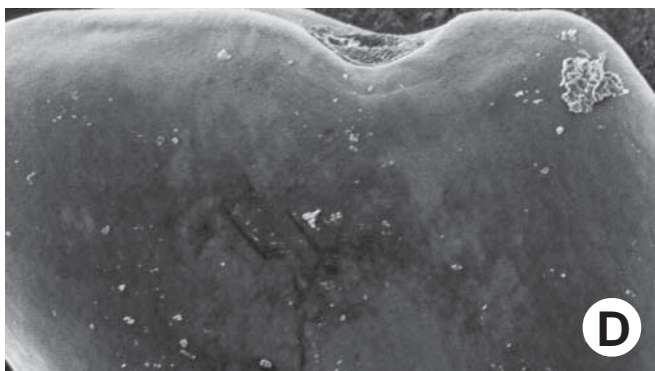
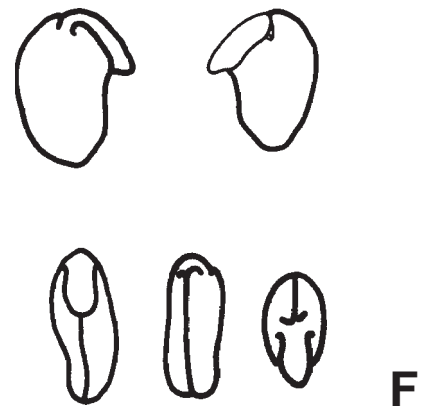
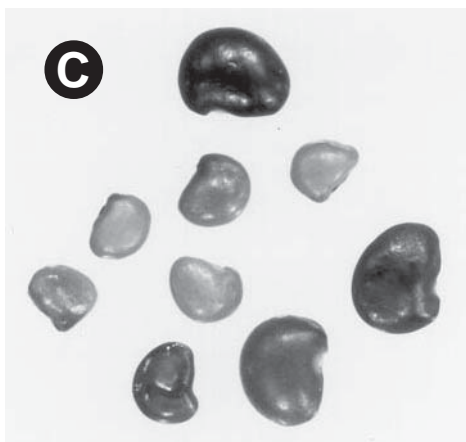
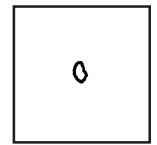
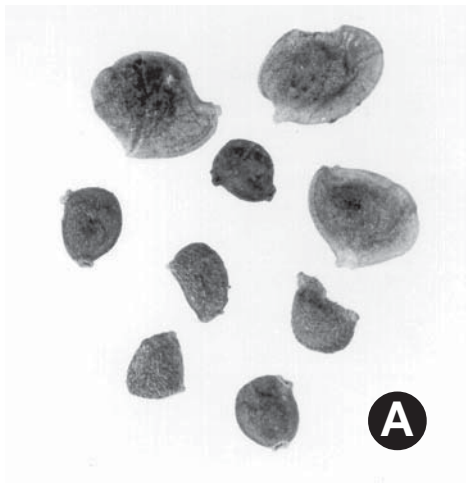
Seed 2–4.7 \times 1.2–3 \times 0.5–1.7 mm; not overgrown; not angular; asymmetrical; elliptic, circular (sub), reniform (to ellipsoid-reniform), or triangular; compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome; reddish

black, brown (reddish or gray), green, or yellow; glabrous; smooth; osseous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; not within corona, halo, or rim. Lens discernible; equal to or greater than 0.5 mm in length or less than 0.5 mm in length; 0.5 mm long; with margins straight; linear; not in groove of raphe; adjacent to hilum; less than 0.5 mm from hilum; recessed; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm absent. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially or not concealing radicle; split over radicle; with lobes; with lobes not touching; with the interface division terminating at base of radicle; without margins recessed; red; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear; lobe tip straight or curved; oblique to cotyledons; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary.

Distribution: Tropical Africa and Madagascar.

Notes: Verdcourt (1974) described 19 species from Zambia and noted that if the fruit is composed of several articles, then the fruit is “folded like a concertina.” Upon opening the calyx, the fruit disarticulates, making length measurements difficult. Our fruit length range is based on maximum and minimum number of articles multiplied by the maximum and minimum article lengths.

Kotschya: *K. africana* S.F.L. Endlicher var. *bequaertii* (E.A.J. De Wildeman) B. Verdcourt (*D–F*), *K.* spp. (*A–C*). *A*, Articles, fruits in calyx and corolla (\times 4.3); *B*, fruit in flower (\times 3); *C*, seeds (\times 5.8); *D–E*, testa (\times 50, \times 1000); *F*, embryos (\times 8).



Genus: *Smithia* W. Aiton

Phylogenetic Number: 14.12.

Tribe: Aeschynomeneae.

Subtribe: Aeschynomeninae.

Species Studied—Species in Genus: 12 spp.—ca. 30 spp.

Fruit a loment; 1–1.5 (estimated) × 0.15–0.3 × 0.2–0.22 cm; with deciduous corolla; with persistent calyx; with calyx longer than fruit; without orifice formed by curving of fruit or fruit segments; contorted; plicate; not twisted; asymmetrical; moniliform; when asymmetrical with both sutures parallelly curved; not inflated; compressed; without beak; rounded at apex; apex aligned with longitudinal axis of fruit (probably); rounded at base; base aligned with longitudinal axis of fruit (probably); with the apex and base uniform in texture; chartaceous; seed chambers externally visible. Fruit margin constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 2–3 mm long; widest across seed area; with all essentially similar in shape; circular. Epicarp dull; monochrome; glabrous; without spines; smooth or not smooth; with elevated features; veined or not reticulately veined; tuberculate or not tuberculate; with solid tubercles on each valve; tuberculate; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; septate; with septa thicker than paper, firm; with the septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 4–7; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only. Aril absent.

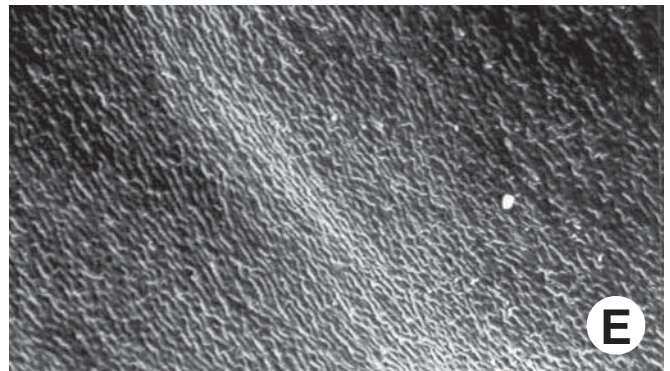
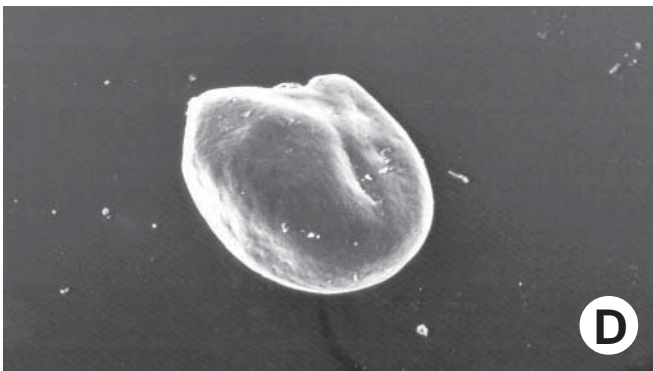
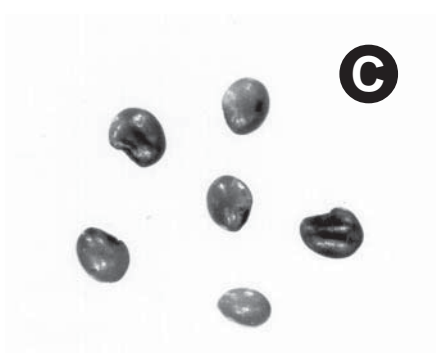
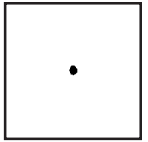
Seed 1.5–1.8 × 1.3 × 0.5 mm; not overgrown; not angular; asymmetrical; reniform; compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; not within corona, halo, or rim or within halo. Hilum halo color darker than testa. Lens discernible; less than 0.5 mm in length; with margins curved; elliptic; not in groove of

raphe; adjacent to hilum; mounded; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thin; 1/2 covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; differing at apex (1 concealed by overarching radicle and other auriculate and concealing radicle); partially concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon length or width; not centered between cotyledons (radicle outside 1 cotyledon and inside other, therefore junctions for each cotyledon different); 1/2 to nearly length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Old World tropics, mainly Asia, Madagascar, and Africa.

Notes: Dewit and Duvigneaud (1954) evaluated the species of *Smithia* in the Congo. The testa is thin, and the cotyledons are soft, making it difficult to remove the embryo. This is unlike most faboid legume seeds, whose embryos are easy to remove from the testa.

Smithia: *S. elliotti* E.G. Baker var. *elliotti* (B), *S. purpurea* W.J. Hooker (D–F), *S. spp.* (A, C). A, Fruits and fruits within calyx and bracts (× 5); B, young fruit (× 10, modified from Gillett et al. 1971); C, seeds (× 8); D–E, testa (× 50, × 1000); F, embryos (× 15).



Genus: *Geissaspis* R. Wight & G.A.W. Arnott

Phylogenetic Number: 14.13.

Tribe: Aeschynomeneae.

Subtribe: Aeschynomeninae.

Species Studied—Species in Genus: 2 spp.—3 spp.

Fruit a legume or loment; unilocular; $0.35\text{--}0.8 \times 0.25\text{--}0.35 \times 0.1\text{--}0.15$ cm; with persistent androecial sheath; with deciduous corolla; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; when asymmetrical with 1 straight and 1 curved suture; widest near middle or D-shaped; not inflated; compressed; without or with beak; straight or declined; with solid beak the same color and texture as fruit (if present, quite small); rounded at apex; apex oblique with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit (more or less); with the apex and base uniform in texture; chartaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted along both margins; without sulcus; plain or embellished; with wing. Fruit wing 1 (article); $0.5\text{--}0.6$ mm wide; continuous wing around fruit; on 1 suture. Fruit substipitate. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; $5\text{--}6$ mm long; widest across seed area; with all essentially similar in shape; D-shaped. Epicarp dull; monochrome or multicolored; streaked; brown or tan; with red overlay; with mottling over seed chambers; pubescent and indurate; with 1 type of pubescence; with pubescence brown; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; with cracks (if cracked because fruit is fragile) or without cracks; cracking irregular. Mesocarp absent. Endocarp dull; monochrome; brown or tan; smooth; septate; with septa thicker than paper, firm; with the septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1 or 2; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent.

Seed $2.2\text{--}2.8 \times 1.8\text{--}2.2 \times 0.9\text{--}1.1$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with

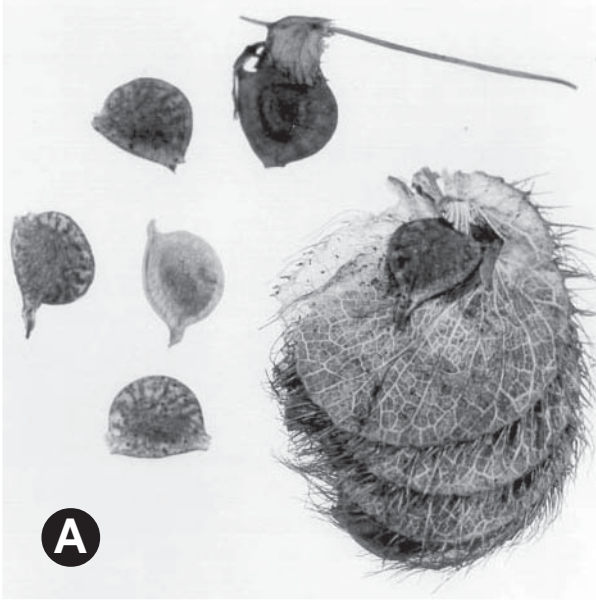
visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown; glabrous; smooth; osseous. Fracture lines absent. Rim absent. Wings absent. Raphe visible or not visible; from hilum to lens; not bifurcating; color of testa or darker than testa; black (ish); recessed. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; marginal according to radicle tip or between cotyledon and radicle lobe; recessed; within rim or not within corona, halo, or rim. Hilum rim color of testa. Lens discernible; equal to or greater than 0.5 mm in length; $1\text{--}2$ mm long; with margins curved; more or less circular; not in groove of raphe; adjacent to hilum; 2 mm from hilum; mounded; dissimilar color from testa; darker than testa; black (ish); not within corona, halo, or rim. Endosperm thin; $1/2$ covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing to not concealing radicle; split over radicle; with lobes; with lobes touching (auriculate); with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle more or less bulbous; lobe tip straight; oblique to cotyledons; centered between cotyledons; less than $1/2$ length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Tropical and subtropical Asia.

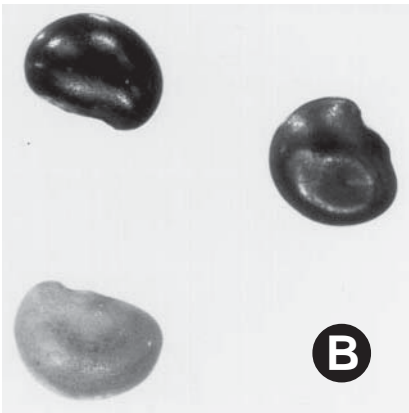
Notes: Duvigneaud (1954b) evaluated the genus.

Geissaspis: *G. cristata* R. Wight & G.A.W. Arnott (C–E), *G. spp.* (A–B). A, Articles and fruits concealed in bracts ($\times 4.5$); B, seeds ($\times 8.6$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 8$).

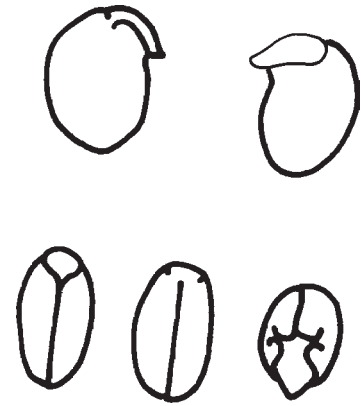
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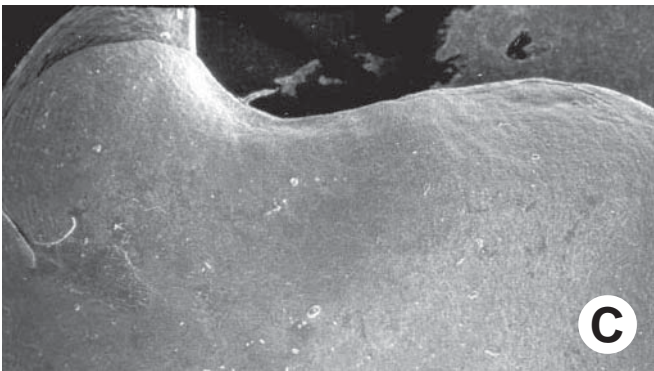
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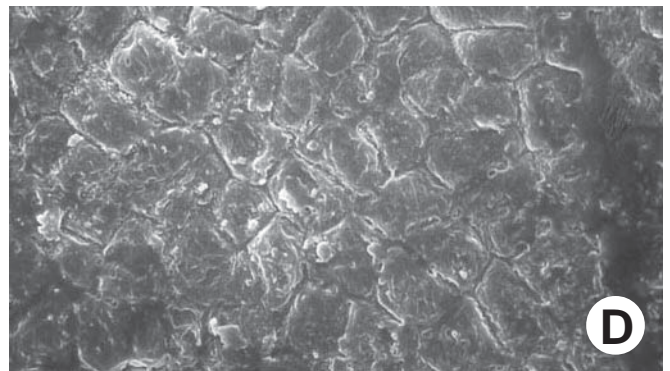
B



E



C



D

Genus: *Bryaspis* P. Duvigneaud

Phylogenetic Number: 14.14.

Tribe: Aeschynomeneae.

Subtribe: Aeschynomeninae.

Species Studied—Species in Genus: 1 sp.—2 spp.

Fruit a loment; 0.8–1.3 × 0.2 × 0.14–0.15 cm; with deciduous corolla; with deciduous calyx (within large bract); without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; when asymmetrical with 1 straight and 1 curved suture; narrowing in several places, resembling *Desmodium* fruit; not inflated; compressed; without beak; rounded at apex; apex oblique with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted only on 1 margin; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Fruit a segment; an intact article; entire. Loment indehiscent. Loment segments (articles) inconspicuous; 2–3 mm long; widest across seed area; with all essentially similar in shape; D-shaped. Epicarp dull; monochrome; reddish brown; glabrous; eglandular; without spines; not smooth; with elevated features; irregularly veined; not tuberculate; subvesicular; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; reddish brown; smooth; septate; with septa thicker than paper, firm; with the septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1 or 2; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent.

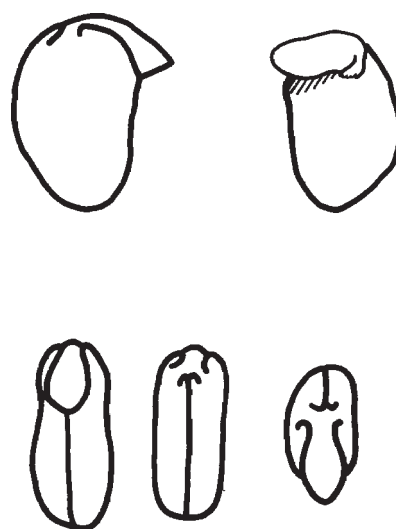
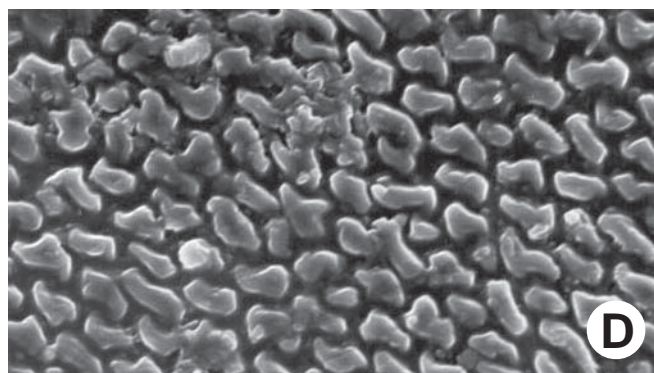
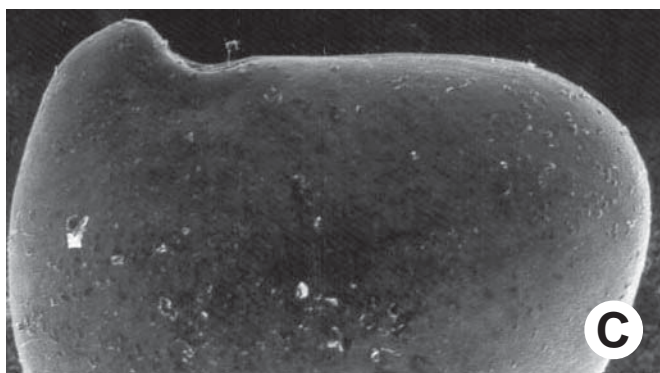
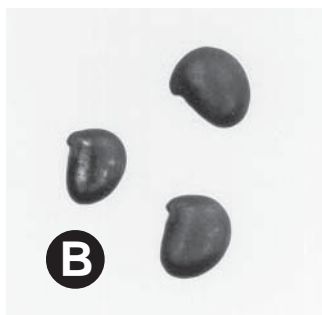
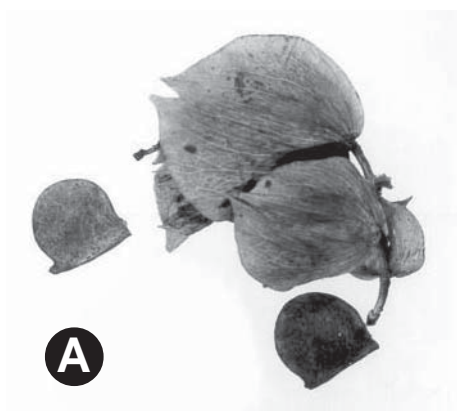
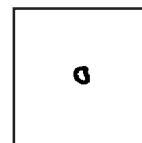
Seed 2–2.5 × 1.6–2 × 1.2–1.5 mm; not overgrown; not angular; asymmetrical; D-shaped (with radicle lobe); terete; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; tan; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform or punctiform; 0.3 mm long; with curved outline; circular; between cotyledon and radicle lobe; flush; not within corona, halo, or rim. Lens discernible;

equal to or greater than 0.5 mm in length; 0.5 mm long; with margins straight; linear (centered within a discolored area); not in groove of raphe; confluent with hilum; recessed; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm absent. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; split over radicle; with lobes; with lobes not touching; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon width; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Western tropical Africa.

Notes: Duvigneaud (1954b) separated *Geissaspis* (14.13) from *Bryaspis* by stipule, bract, standard, keel, and fruit characters. His fruit key characters were: Fruit membranaceous and article densely reticulate for *Geissaspis* and fruit firmer and article faintly reticulate for *Bryaspis*.

Bryaspis: *B. lupulina* (L.D. Planchon ex G. Benth) P. Duvigneaud (A–E). A, Articles and fruit within bracts (× 1.9); B, seeds (× 5); C–D, testa (× 50, × 1000); E, embryos (× 10).



Genus: *Humularia* P. Duvigneaud

Phylogenetic Number: 14.15.

Tribe: Aeschynomeneae.

Subtribe: Aeschynomeneinae.

Species Studied—Species in Genus: 18 spp.—ca. 40 spp.

Fruit a legume or loment; unilocular; $0.5\text{--}1.5 \times 0.4\text{--}0.55 \times 0.3$ cm; with persistent or deciduous androecial sheath; with persistent or deciduous corolla; with various petals; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; when asymmetrical with 1 straight and 1 curved suture; narrowing in several places, resembling *Desmodium* (11.09) fruit; not inflated; flattened; without or with beak; with solid beak the same color and texture as fruit; rounded at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted on 1 margin and slightly constricted on the other margin; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 6.5 mm long; widest across seed area; with all essentially similar in shape; D-shaped. Epicarp dull; monochrome; brown; glabrous or pubescent but soon deciduous; with 1 type of pubescence; puberulent; with pubescence gray; with pubescence uniformly distributed; with simple or glandular hairs; pliable; with hair bases plain; glandular or eglandular; with glandular hairs; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; warty (scattered to numerous); not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; smooth; septate, subseptate, or nonseptate; with septa thicker than paper, firm; with the septa eglandular; coriaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1 or 2; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril dry; rim-aril; covering less than 1/2 of seed; dark reddish brown.

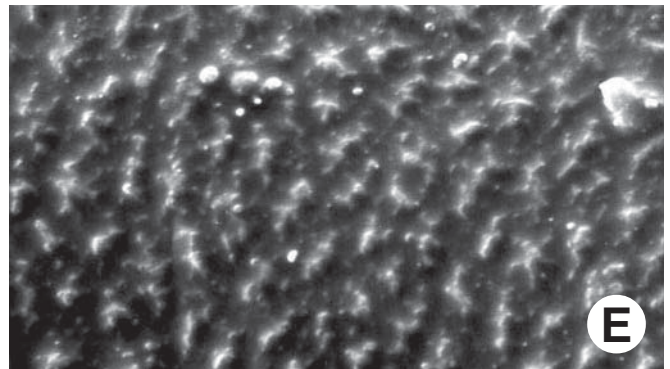
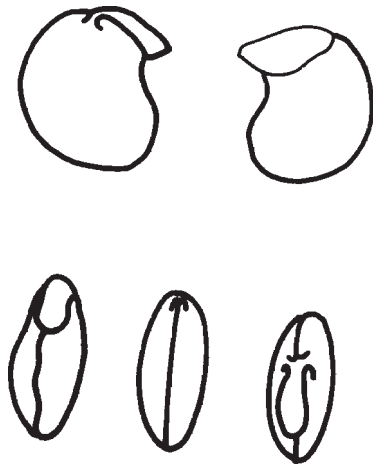
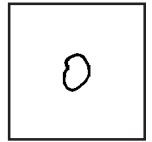
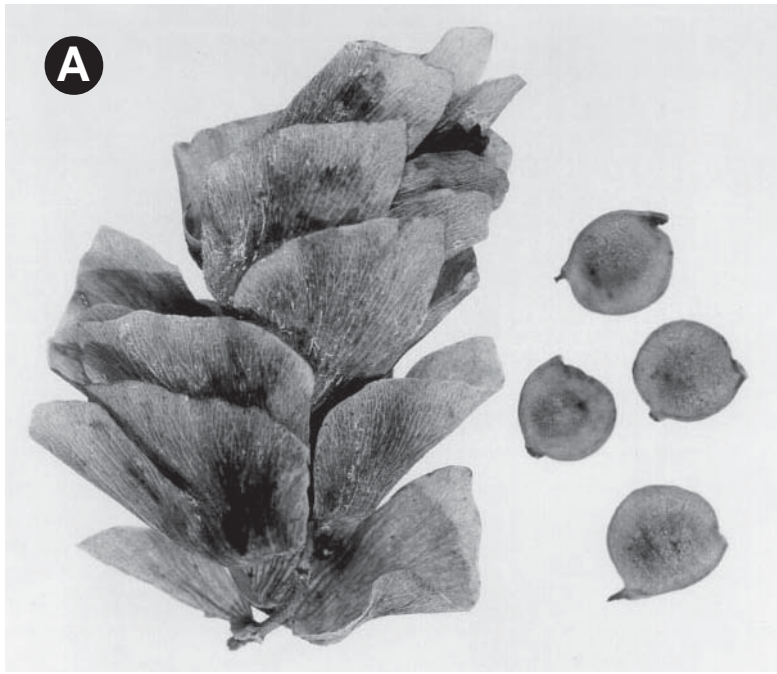
Seed $2.4\text{--}4 \times 2.2\text{--}3.5 \times 1\text{--}2$ mm; not overgrown; not angular; asymmetrical; nearly circular, D-shaped, quadrangular (nearly), or reniform; compressed; with

visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; purplish black or brown (reddish); smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by funicular remnant; without faboid split; larger than punctiform; 0.3–0.4 mm long; with curved outline; circular; between cotyledon and radicle lobe; flush; not within corona, halo, or rim. Lens discernible or not discernible; less than 0.5 mm in length (0.1–0.2 mm); with margins straight or curved; irregular, linear, or wedge-shaped; irregular; not in or in groove of raphe; adjacent to hilum; flush or recessed; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thin; 1/2 covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; split over radicle; with lobes; with lobes not touching; with the interface division terminating at base of radicle; without margins recessed; red; inner face flat; glabrous around base of radicle. Embryonic axis oblique; oblique to length of seed. Radicle bulbous; lobe tip straight; oblique to cotyledons; centered between cotyledons; less than 1/2 or 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Africa.

Notes: Duvigneaud (1954a) analyzed the tropical African species and Verdcourt (1974) described the species for Flora of Zambia.

Humularia: *H. chevalieri* (E.A.J. De Wildeman) P.A. Duvigneaud (*D–F*), *H. drepanocephalus* (E.G. Baker) P.A. Duvigneaud (*B*), *H. spp.* (*A, C*). *A*, Articles and fruits concealed in bracts ($\times 2.8$); *B*, fruit ($\times 2.8$, modified from Gillett et al. 1971); *C*, seeds ($\times 5.7$); *D–E*, testa ($\times 50$, $\times 1000$); *F*, embryos ($\times 5$).



Genus: *Cyclocarpa* A. Afzelius ex J.G. Baker

Phylogenetic Number: 14.16.

Tribe: Aeschynomeneae.

Subtribe: Aeschynomeninae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a loment; 1.5–2.2 (diameter of coiled fruit 0.4–0.6 cm) \times 0.15–0.27 \times 0.03–0.04 cm; with deciduous corolla; with deciduous calyx; with orifice formed by curving of fruit or fruit segments; 1.5-coiled; not plicate; not twisted; symmetrical; circular; not inflated; flattened; without beak; rounded at apex; apex oblique with longitudinal axis of fruit (slightly); rounded at base; base oblique with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscing; separating from sutures and along loment segment margins. Dehiscence of valves along both sutures (fig. B); passive. Replum visible (when articles separate). Loment dehiscing along 1 suture. Loment segments (articles) inconspicuous; 1.5–2 mm long; widest across seed area; with upper or lower 1 different shape than middle ones; trapezoid. Epicarp dull; monochrome; dark brown; glabrous; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp absent. Endocarp glossy; monochrome; dark brown; spongy; septate; with septa thicker than paper, firm; with the septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 8–11; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; filiform; straight. Aril absent.

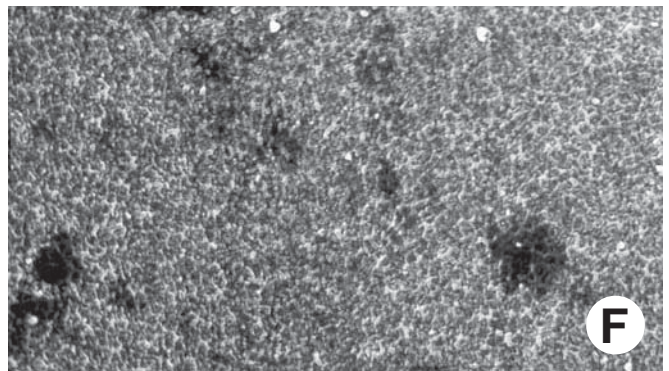
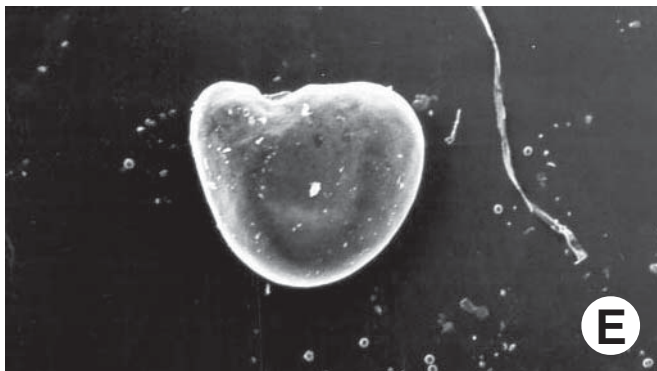
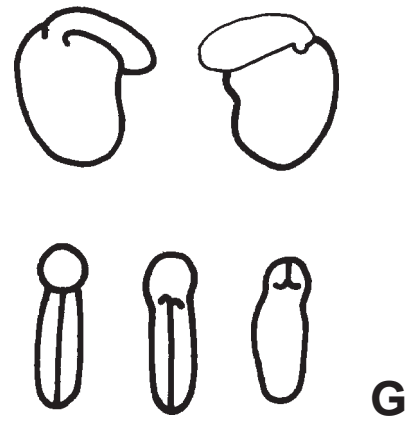
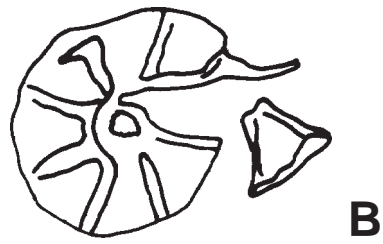
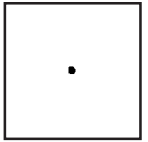
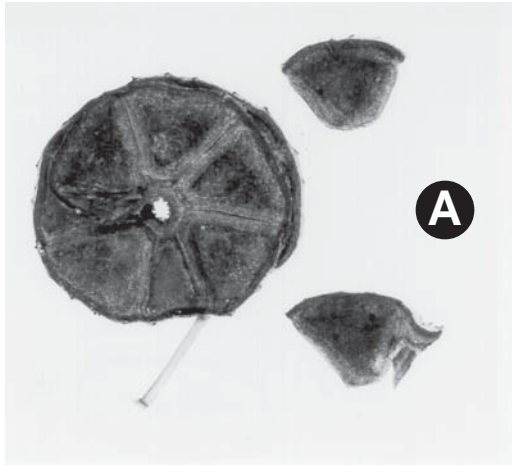
Seed 0.7–1.2 \times 0.5–1 \times 0.25–0.5 mm; not overgrown; not angular; asymmetrical; mitaform; compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; nearly glossy; colored; monochrome; dark brown, green, or tan; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; not within corona, halo, or rim. Lens discernible; less than 0.5 mm in length; with margins curved; more or less circular; not

in groove of raphe; adjacent to hilum; 0.5 mm from hilum; flush; dissimilar color from testa; darker than testa; black (ish); not within corona, halo, or rim. Endosperm thick; 1/2 covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; completely concealing radicle; split over radicle; with lobes; with lobes not touching; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis right angled; perpendicular to length of seed. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon width; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Tropical Africa, Indochina, Indonesia (Java), and Australia (Queensland).

Notes: Gillett et al. (1971) have an excellent fruit illustration. Verdcourt (1974) noted that the species is “very local.” Because the fruits are coiled 1.5 times, their lengths, though determined, are of little diagnostic value. Their diameters are noted. This unique dehiscence in the Fabaceae is illustrated in figure B. The fruit breaks into articles that in turn dehisce along their margins.

Cyclocarpa: *C. stellaris* A. Afzelius ex J.G. Baker (A–G). A, Articles and fruit (\times 7.1); B, article with marginal dehiscence (\times 10 and see Notes); C, segment with seed dispersing (\times 13); D, seeds (\times 11); E–F, testa (\times 50, \times 1000); G, embryos (\times 20).



Genus: *Discolobium* G. Bentham

Phylogenetic Number: 14.17.

Tribe: Aeschynomeneae.

Subtribe: Discolobiinae.

Species Studied—Species in Genus: 3 spp.—8 spp.

Fruit a legume; unilocular; $2.7\text{--}3.7 \times 0.8\text{--}1.2 \times 0.07\text{--}0.09$ cm; with persistent or deciduous androecial sheath; with deciduous corolla; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments (because of the upper and lower coils arising from a twisted suture); 1- to 3-coiled (when single coiled, with one major central coil with upper and lower much smaller, sterile coils); not plicate; twisted (top and bottom coils twisted when compared to center coil); symmetrical; circular; not inflated; flattened; without beak; rounded at apex (with persistent long, thick style); apex oblique with longitudinal axis of fruit; rounded at base; right angled with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; embellished; with wing. Fruit wing 1 (per coil); 3–4 mm wide; continuous wing around fruit; on 1 suture. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Epicarp glossy (nearly); monochrome; brown, red (dish), or tan; glabrous or pubescent but soon deciduous; with 1 type of pubescence; puberulent; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; with spines (short and widely spaced on valves of *D. pulchellum* G. Bentham); not smooth; with elevated features; reticulately veined; tuberculate or not tuberculate; with solid tubercles on each valve; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; spongy; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seed 1; length parallel with fruit length. Funiculus less than 0.5 mm long; thick; straight. Aril absent.

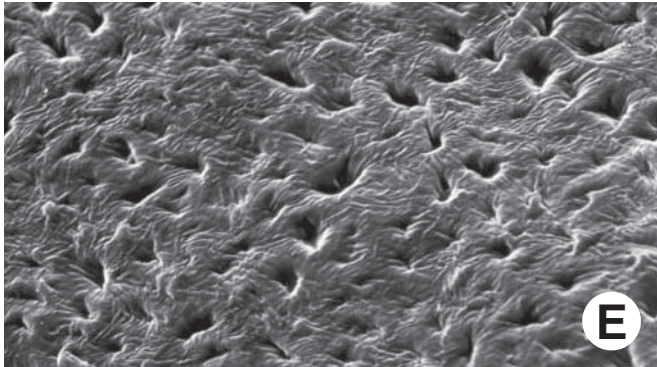
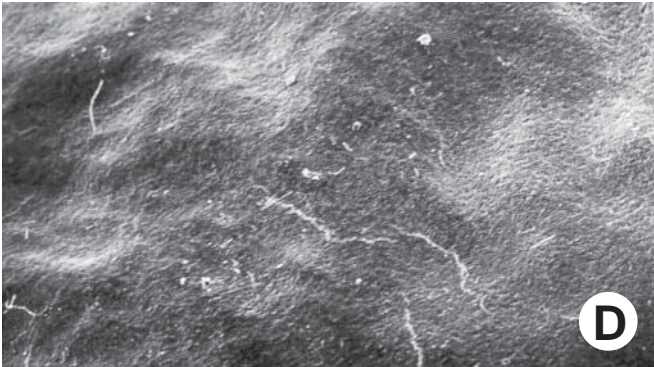
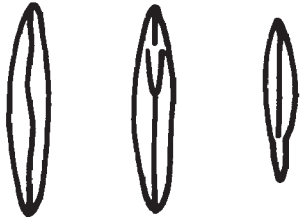
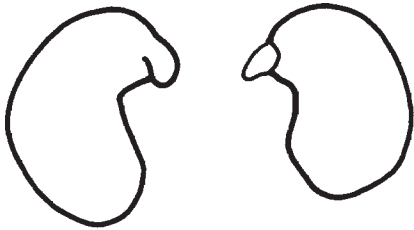
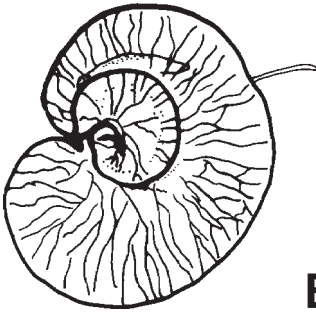
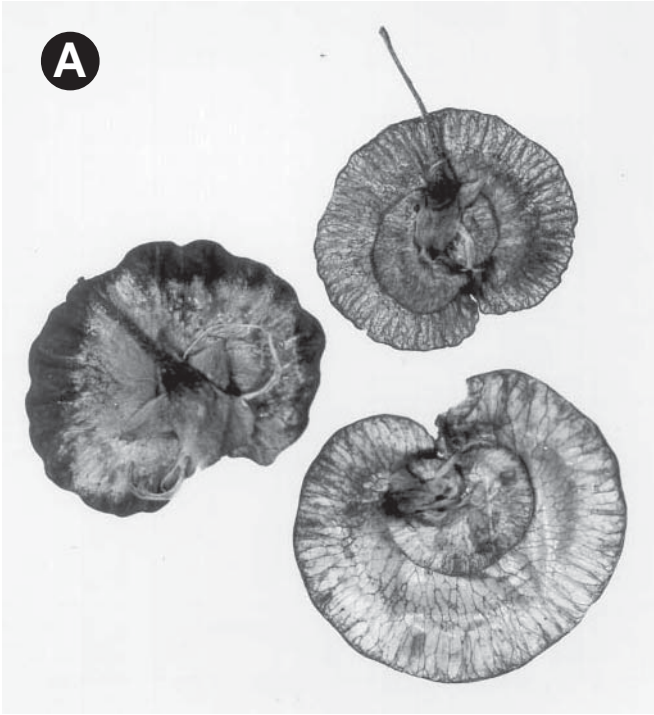
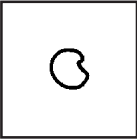
Seed $8 \times 5 \times 0.4$ mm; not overgrown; not angular; asymmetrical; reniform (to lunate); flattened; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown; not smooth; with elevated features; wrinkled;

chartaceous. Fracture lines absent. Rim absent. Raphe not visible. Hilum fully concealed; concealed by funiculus; without faboid split; larger than punctiform; 1 mm long; with curved outline; elliptic; marginal according to radicle tip or between cotyledon and radicle lobe; flush; not within corona, halo, or rim. Lens not discernible. Endosperm absent. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle or notched at radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; red; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle bulbous; lobe tip curved; oblique to cotyledons; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Brazil, Paraguay, and Argentina.

Notes: Burkart (1939) monographed the four species in Argentina and provided excellent seed and fruit illustrations of *Discolobium psoraleifolium*. The curiously formed fruit of *Discolobium* are unusual, though not as unique as *Eligmocarpus cynometroides* R. Capuron (Caesalpinioideae: Cassieae) (Gunn 1991). The *Discolobium* fruit is composed of three whorls. The upper and lower whorls are smaller in diameter and sterile, and the middle whorl is larger in diameter and one-seeded (fig. F). This arrangement indicates wind dispersal of the seeds in the indehiscent fruits.

Discolobium: *D. psoraleifolium* G. Bentham (B–F), *D. spp.* (A). A, Fruits ($\times 2.2$); B, fruit diagram showing coiling ($\times 2$); C, seed ($\times 7.3$); D–E, testa ($\times 50$, $\times 1000$); F, embryos ($\times 5$).



Genus: *Amicia* K.S. Kunth

Phylogenetic Number: 14.19.

Tribe: Aeschynomeneae.

Subtribe: Poiretiinae.

Species Studied—Species in Genus: 4 spp.—7 spp.

Fruit a loment; $1-1.5 \times 0.2-0.3 \times 0.05-0.09$ cm; with deciduous corolla; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; when asymmetrical with 1 straight and 1 curved suture; narrowing in several places, resembling *Desmodium* fruit; not inflated; compressed; without beak; rounded at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; ligneous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted along both margins; with sulcus (margins so thickened to create appearance of a sulcus) or without sulcus; plain or embellished; with prickles or with wings. Fruit wings present or absent; 2; 1 mm wide; valvular; on both valves (and compressed to valves). Fruit nonstipitate. Fruit indehiscent. Replum invisible. Fruit a segment; an intact article; loment segment. Loment indehiscent. Loment segments (articles) inconspicuous; 3–4 mm long; widest across seed area; with all essentially similar in shape; D-shaped. Epicarp dull; monochrome or multicolored; mottled; brown or gray; with black or brown overlay; with mottling over seed chambers; glabrous; eglandular; without spines; not smooth; with elevated features; veined or not veined; reticulately veined; not tuberculate or tuberculate (faintly); not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; smooth; septate; with septa thicker than paper, firm; with the septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1–5; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril dry; rim-aril; tan.

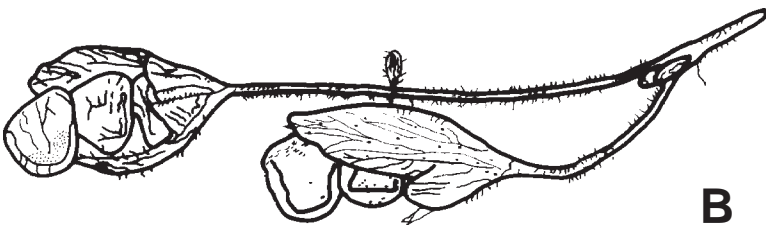
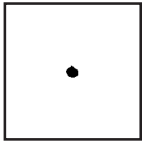
Seed $1.8-3 \times 1.8-3 \times 0.8$ mm; not overgrown; not angular; asymmetrical; mitaform; compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown;

glabrous; smooth; chartaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; without faboid split (perhaps too small to see split); punctiform; between cotyledon and radicle lobe; recessed; not within corona, halo, or rim. Lens not discernible. Endosperm absent. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with lobes not touching; with the interface division terminating at base of radicle; without margins recessed; red (dish); inner face flat; glabrous around base of radicle. Embryonic axis deflexed; parallel to length of seed. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; $1/2$ to nearly length of cotyledons. Plumule rudimentary; glabrous.

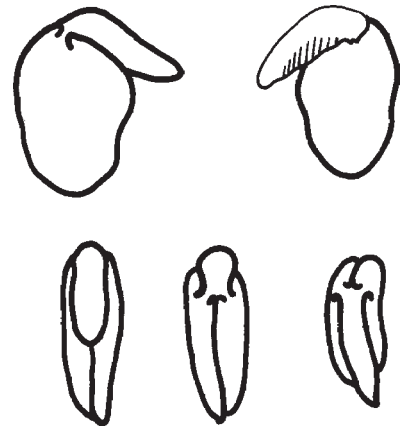
Distribution: Mexico, Ecuador, Peru, Bolivia, and Argentina.

Notes: Burkart (1939) provided a key to the seven species of *Amicia* and described the seeds and fruits of the three species found in Argentina. Our fruit data were somewhat limited and readers should not infer from our plate that the calyx falls with the mature fruit. The relation of the calyx to the mature fruit has not been recorded in the field. The fruits of *A. zygoteris* A.-P. de Candolle are unlike those of other species in the genus. Compare the extreme left article in figure A with the other articles.

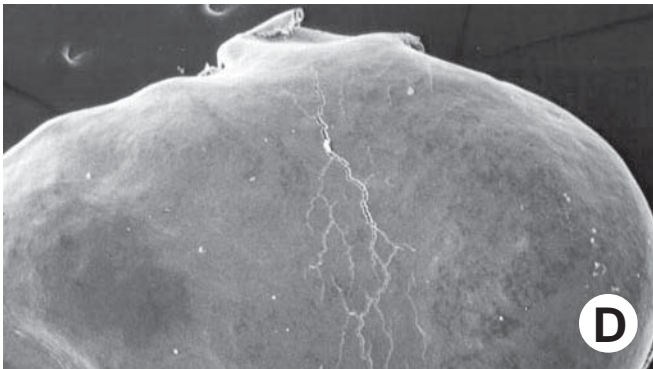
Amicia: *A. medicaginea* A.H.R. Grisebach (*B–F*), *A.* spp. (*A*). *A*, Articles and fruit exerted from calyx ($\times 3.1$); *B*, drawing of two fruits ($\times 4$); *C*, seed ($\times 6.8$); *D–E*, testa ($\times 50$, $\times 1000$); *F*, embryos ($\times 15$).



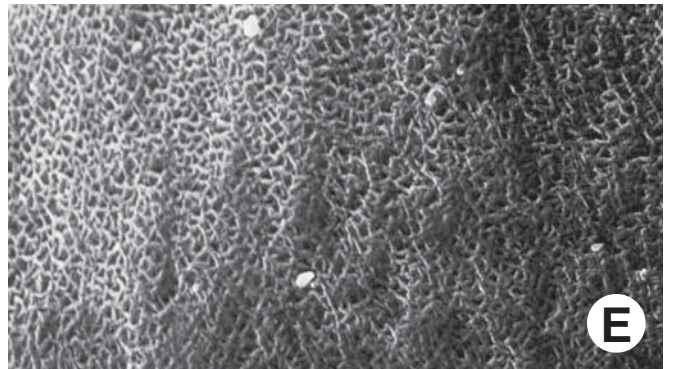
B



F



D



E

Genus: *Poiretia* E.P. Ventenat

Phylogenetic Number: 14.20.

Tribe: Aeschynomeneae.

Subtribe: Poiretiinae.

Species Studied—Species in Genus: 4 spp.—6 spp.

Fruit a loment; $1.2-4 \times 0.3-0.6 \times 0.5$ cm; with persistent or deciduous corolla; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight to curved (slightly); not plicate; not twisted; asymmetrical or symmetrical; linear to oblong; when asymmetrical with both sutures parallelly curved; not inflated; flattened; without beak; short tapered or rounded at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous to coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 3–8 mm long; widest across seed area; with all essentially similar in shape; rectangular. Epicarp semiglossy; monochrome; reddish to greenish brown or tan; glabrous; eglandular; without spines; not smooth; with elevated or recessed features; veined or not veined; reticulately veined; not tuberculate; dotted; pitted; not exfoliating; without cracks. Mesocarp absent. Endocarp glossy; monochrome; tan; smooth; septate; with septa thicker than paper, firm; with the septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1–8; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; flattened; straight. Aril absent.

Seed $1.5-3.5 \times 1-2$ mm; not overgrown; not angular; asymmetrical; ovate or reniform; flattened; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown; glabrous; not smooth; with recessed features; pitted with small separate pits; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid

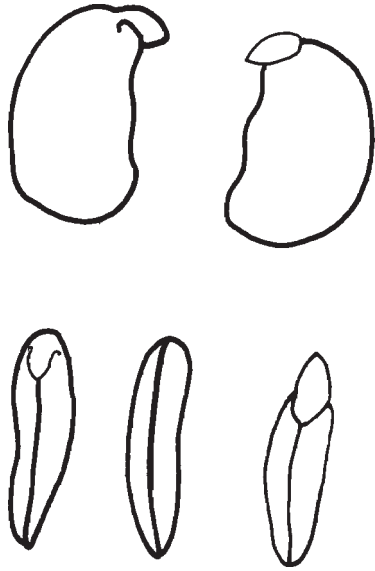
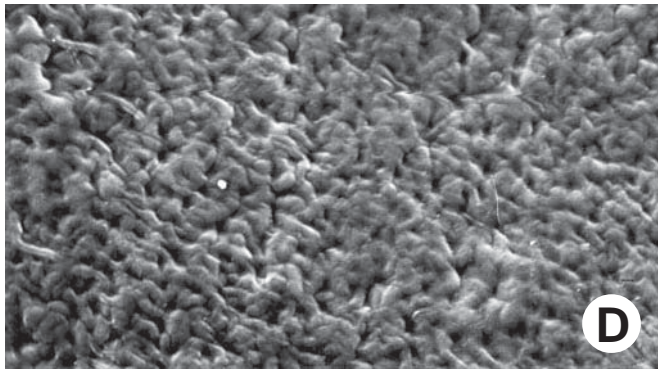
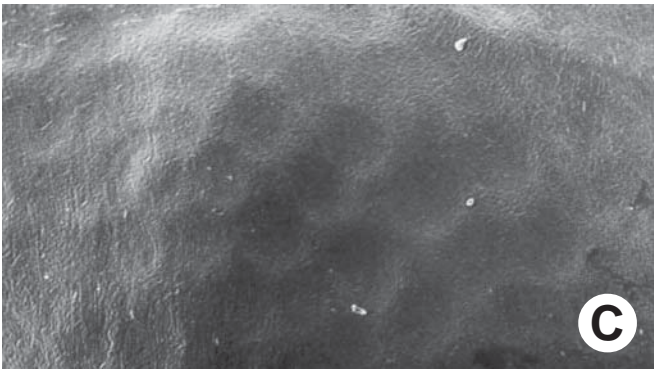
split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; within rim. Hilum rim color of testa. Lens discernible; less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; adjacent to hilum; 0.4 mm from hilum; mounded; dissimilar color from testa; darker than testa; black (ish); not within corona, halo, or rim. Endosperm thin; 1/2 covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; split over radicle; with lobes; with lobes not touching; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear; lobe tip straight or curved; deflexed and parallel to cotyledon width; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Mexico, Central America, tropical South America.

Notes: Rudd (1972b) summarized the genus and Janke et al. (1988) discussed the pharmacognostic value of *P. latifolia* J.R.T. Vogel and *P. tetraphylla*.

Poiretia: *P. tetraphylla* (J.L.M. Poiret) A.E. Burkart (C–E), *P. spp.* (A–B). A, Fruits and article ($\times 2.2$); B, seeds ($\times 6.8$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 8$).

D



Genus: *Zornia* J.F. Gmelin

Phylogenetic Number: 14.21.

Tribe: Aeschynomeneae.

Subtribe: Poiretiinae.

Species Studied—Species in Genus: 77 spp.—ca. 80 spp.

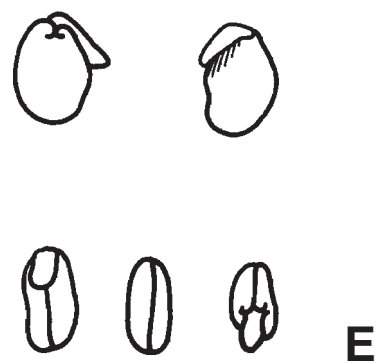
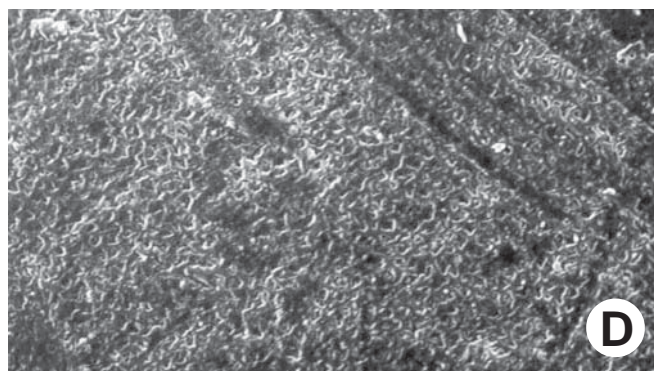
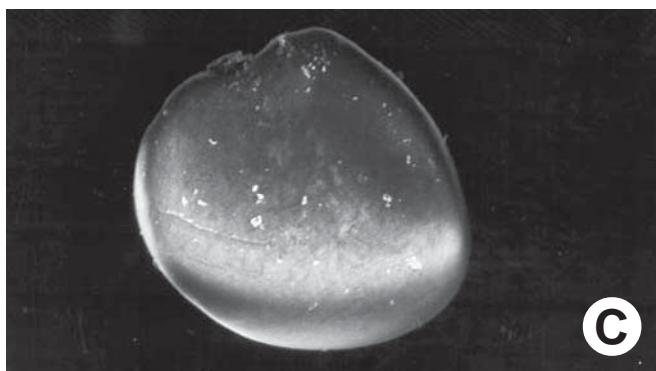
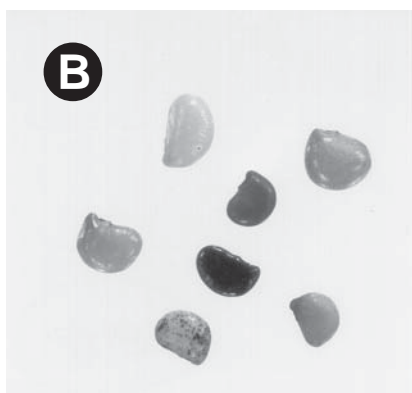
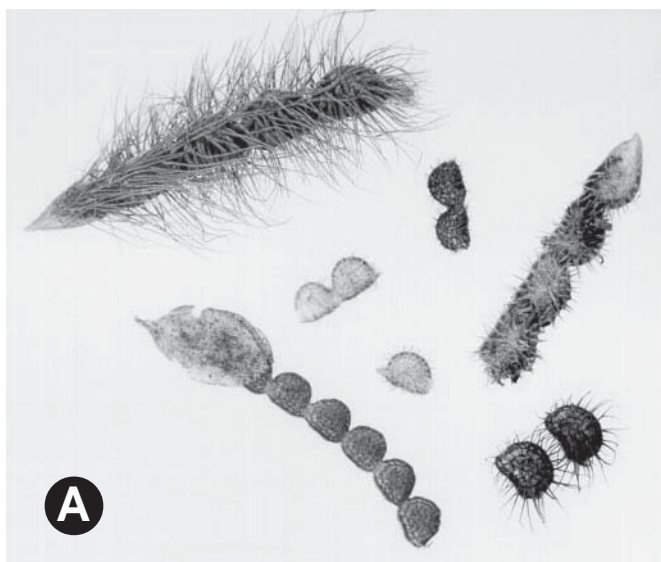
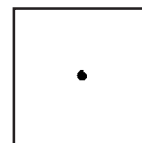
Fruit a loment; $1.1\text{--}1.8 \times 0.1\text{--}0.35 \times 0.1\text{--}0.2$ cm; with deciduous corolla; with persistent calyx; with calyx longer, equal in length to, or shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight to curved (slightly); not plicate; not twisted; asymmetrical or symmetrical; moniliform; when asymmetrical with 1 straight and 1 curved suture or with both sutures parallelly curved; narrowing in several places, resembling *Desmodium* fruit; not inflated; compressed; without beak; rounded at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted along both margins or constricted only on 1 margin; without sulcus; plain or embellished; with prickles. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 1.2–5 mm long; widest across seed area; with all essentially similar in shape; circular or D-shaped. Epicarp dull; monochrome (with or without different colored reticulum); brown, green, tan, or yellow; glabrous or pubescent and indurate; with 1 type of pubescence; pilose or villous; with pubescence gray or brown; with pubescence uniformly distributed; with simple or complex hairs; with plumose hairs, bristle-like hairs, or setae; pliable; with hair bases plain; antrorse or retrorse; straight, hooked, or coiled at apex; glandular or eglandular; with glandular dots; without spines; not smooth; with elevated features; veined or not veined; reticulately veined; not tuberculate; glandular dotted; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; brown; spongy; septate; with septa thicker than paper, firm; with the septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1–15; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent.

Seed $1.5\text{--}2.3 \times 1\text{--}1.5 \times 0.5\text{--}0.8$ mm; not overgrown; angular or not angular; asymmetrical; elliptic (reniform), irregular (reniform), or reniform (with or without beak); compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled; with frequent or infrequent mottles; brown (to reddish-brown or purplish-brown) or tan; with red overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; within rim or halo. Hilum halo color lighter than testa. Hilum rim color lighter than testa. Lens discernible or not discernible; less than 0.5 mm in length; with margins curved; 2 circular mounds separated by groove; not in groove of raphe; confluent with hilum (or at least to the hilar rim); mounded; dissimilar color from testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thick or thin; 1/2 covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; split over radicle; with lobes; with lobes not touching; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle bulbous or linear; lobe tip straight; deflexed and parallel to cotyledon width or oblique to cotyledons; centered between cotyledons; less than 1/2 or 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Tropical and warm temperate regions of Old and New Worlds.

Notes: Mohlenbrock (1961) monographed the genus and revised his monograph in Mohlenbrock (1962a). Reynolds and Holland (1989) corrected and expanded the Mohlenbrock monograph for the 17 species that occur in Australia.

Zornia: *Z. glochidiata* H.G.L. Reichenbach ex A.-P. de Candolle (C–E), *Z. spp.* (A–B). A, Fruits and articles ($\times 2.6$); B, seeds ($\times 5.6$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



Genus: *Arthrocarpum* I.B. Balfour

Phylogenetic Number: 14.22.

Tribe: Aeschynomeneae.

Subtribe: Stylosanthinae.

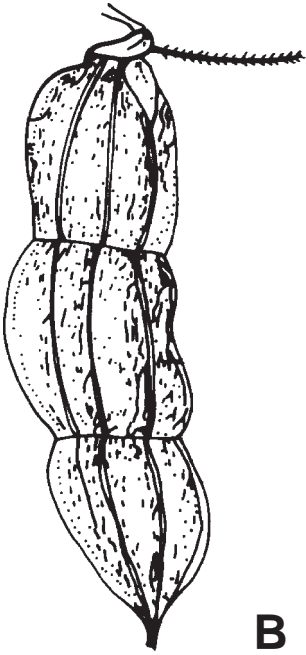
Species Studied—Species in Genus: 1 sp.—2 spp.

Fruit a loment; 2–3 (estimated) × 0.5–1 (estimated) × 0.15 cm; with deciduous corolla; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; irregular; when asymmetrical with both sutures unequally curved; not inflated; flattened; with beak; with solid beak the same color and texture as fruit; rounded at apex; apex oblique with longitudinal axis of fruit; rounded at base; base oblique with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin constricted along both margins; with sulcus (broad shallow depression on 1 face); plain. Fruit wings absent. Fruit substipitate. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 1.8–2 mm long; widest across seed area; with all essentially similar in shape; oblong. Epicarp dull; monochrome; brown; pubescent and indurate; with 1 type of pubescence; puberulent; with pubescence golden; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; longitudinally veined relative to fruit length; not tuberculate; not exfoliating; without cracks (2–3 prominent veins on each valve). Mesocarp present (spongy according to Balfour (1888) who labelled it endocarp). Seeds 1–5.

Distribution: Africa (Somalia and Socotra).

Notes: Gillett (1966b) recognized two species that are rarely collected, *A. gracile* and *A. somalense* J.O.D. Hillcoat & J.B. Gillett. Fruits of the latter species are unknown. Unfortunately, Gillett did not discuss the fruit or seed characters of *A. gracile* of Socotra. Our data presented above are based on two fruit samples and data from the text and illustrations of Balfour (1888). Balfour also noted that *A. gracile* is a “very beautiful tree.” Our fruit data are limited to external characters as well as the Balfour plate. We have no seed data.

Arthrocarpum: *A. gracile* I.M. Balfour (A–B). A, Fruits (× 4.4); B, fruit drawing (× 3.5, modified from Polhill and Raven 1981).



B

Genus: *Pachecoa* P.C. Standley & J.A. Steyermark

Phylogenetic Number: 14.23.

Tribe: Aeschynomeneae.

Subtribe: Stylosanthinae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a loment; $1.5-3 \times 0.4-0.5 \times 0.3-0.37$ cm; with deciduous corolla; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight to curved (slightly); not plicate; not twisted; barely asymmetrical to symmetrical; linear or oblong; when asymmetrical with both sutures parallelly curved; not inflated; terete; without or with beak; straight; with solid beak the same color and texture as fruit; long tapered at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; ligneous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) conspicuous; 2.5–10 mm long; widest across seed area; with upper or lower 1 different shape than middle ones; oblong or triangular. Epicarp dull; monochrome; dirty brown; glabrate or pubescent but soon deciduous; with 1 type of pubescence; villous; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; without spines; not smooth; with elevated features; longitudinally veined relative to fruit length (8–9 veins) or reticulately veined (interstices); not tuberculate; not exfoliating; without cracks. Mesocarp thick; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; ligneous (sub). Endocarp dull; monochrome; tan; smooth; septate; with septa thicker than paper, firm; with the septa eglandular; ligneous (sub); not exfoliating; remaining fused to epicarp; entire. Seeds 2–4; length oblique to fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; filiform; straight. Aril dry; rim-aril; tan.

Seed $3-3.5 \times 2.3-2.5 \times 0.9-1$ mm; not overgrown; not angular; asymmetrical; rhombic; compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome; tan; glabrous; smooth; coriaceous. Fracture lines absent.

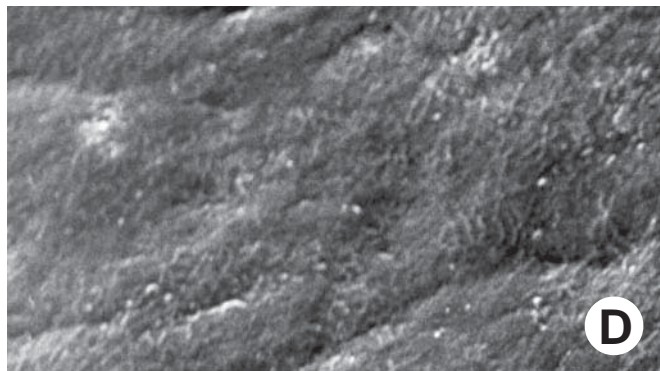
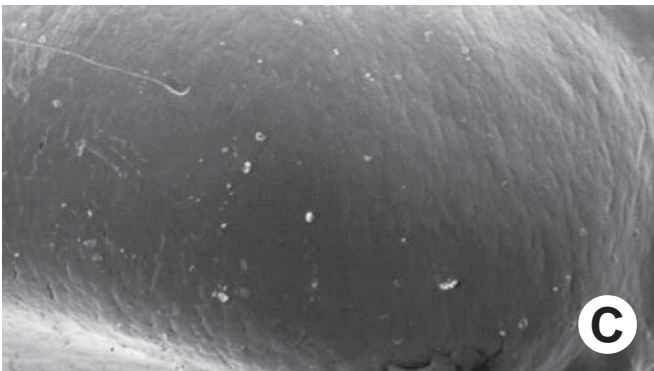
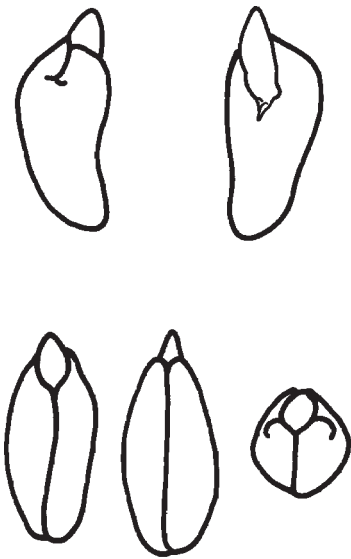
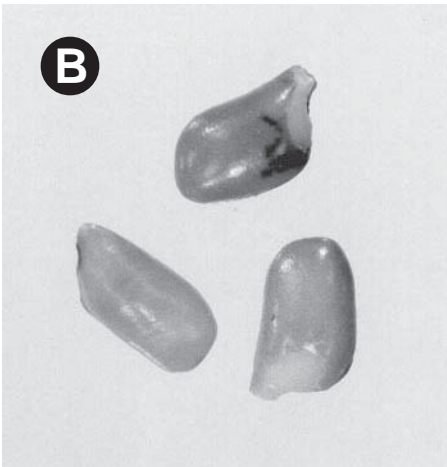
Rim absent. Raphe from hilum through lens to base of seed and terminating; not bifurcating; darker than testa; brown; flush. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; subapical to radicle tip; flush; within halo. Hilum halo color of or darker than testa. Lens discernible; less than 0.5 mm in length; with margins straight; wedge-shaped; not in groove of raphe; adjacent to hilum; mounded; dissimilar color from testa; darker than testa; dark brown; not within corona, halo, or rim. Endosperm absent. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; split over radicle; with lobes; with lobes overlapping; with the interface division terminating at base of radicle; without margins recessed; inner face flat; glabrous around base of radicle. Embryonic axis oblique; oblique to length of seed. Radicle linear; lobe tip straight; oblique to cotyledons; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Mexico and Guatemala; introduced in Venezuela.

Notes: Norman and Gunn (1985) monographed *Pachecoa*.

Pachecoa: *P. prismatica* (M. Sessé y Lacabra & J.M. Mociño) P.C. Standley & B.G. Schubert (A–B); *P. venezuelensis* A. Burkart (C–E). A, Articles and fruits ($\times 2$); B, seeds ($\times 7.3$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 6$).

0



Genus: *Chapmannia* J. Torrey & A. Gray

Phylogenetic Number: 14.24.

Tribe: Aeschynomeneae.

Subtribe: Stylosanthinae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a loment; 1–3 × 0.25–0.3 × 0.25–0.3 cm; with deciduous corolla; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; more or less linear; when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; widest near middle or D-shaped (more or less); not inflated; terete; without or with beak; straight; with solid beak the same color and texture as fruit; long tapered at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) conspicuous; 5–8 mm long; widest across seed area; with upper or lower 1 different shape than middle ones; more or less oblong. Epicarp dull; monochrome; pubescent but soon deciduous; with 1 type of pubescence; villous; with pubescence red (dish-brown and turning brown at maturity) or brown; with pubescence uniformly distributed; with simple hairs and with glandular hairs; pliable; with hair bases plain; glandular; with glandular hairs (reddish, turning brown on maturation); not smooth; with elevated features; longitudinally veined relative to fruit length; not tuberculate; not exfoliating; without cracks. Mesocarp thick; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp glossy; monochrome; white (ish); smooth; septate; with septa thicker than paper, firm; with the septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1–4; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent.

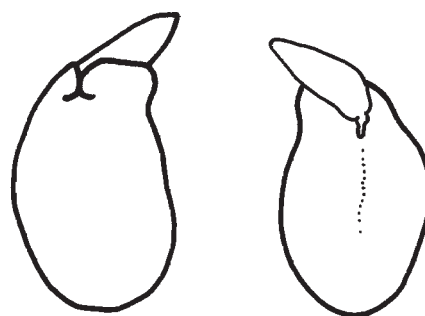
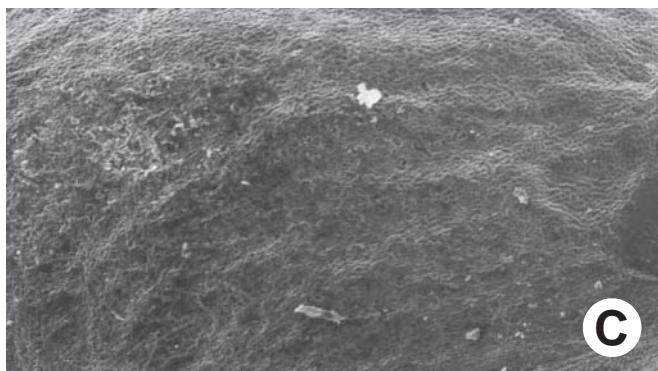
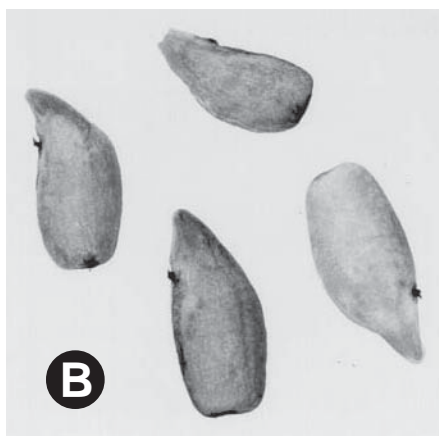
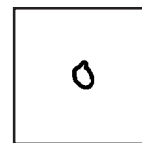
Seed 3.5–4 × 2–2.5 × 2 mm; not overgrown; not angular; asymmetrical; oblong (with radicle end tapered); terete; with visible radicle and cotyledon lobes; without umbo

on seed faces. Testa not adhering to endocarp; nearly glossy; not modified by a bloom; colored; monochrome; yellow; glabrous; not smooth; with elevated features; wrinkled; chartaceous. Fracture lines absent. Rim absent. Wings absent. Raphe from hilum to near base of seed and terminating; not bifurcating; color of testa; raised. Hilum fully concealed; concealed by funicular remnant; without faboid split; punctiform; between cotyledon and radicle lobe; flush; not within corona, halo, or rim. Lens not discernible. Endosperm absent. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; completely concealing radicle (nearly); split over radicle; with lobes; with lobes touching (auriculate); with the interface division terminating at base of radicle; tan; inner face flat; glabrous around base of radicle. Embryonic axis oblique; oblique to length of seed. Radicle nearly bulbous; lobe tip curved; oblique to cotyledons; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

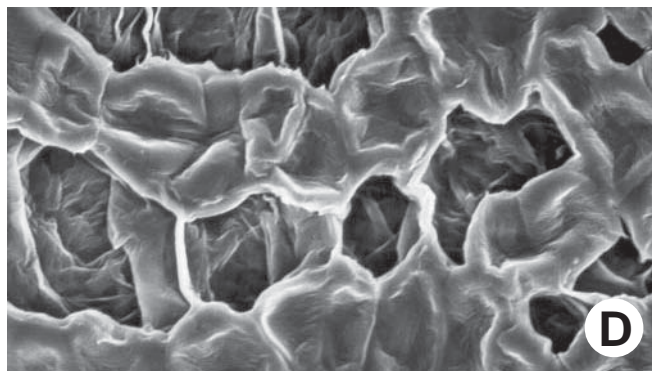
Distribution: United States (Florida).

Notes: Gunn et al. (1980) monographed the genus.

Chapmannia: *C. floridana* J. Torrey & A. Gray (A–E). A, Articles and incomplete fruits (× 2.1); B, seeds (× 6.5); C–D, testa (× 50, × 1000); E, embryos (× 10).



E



Genus: *Stylosanthes* O.P. Swartz

Phylogenetic Number: 14.25.

Tribe: Aeschynomeneae.

Subtribe: Stylosanthinae.

Species Studied—Species in Genus: 25 spp.—ca. 25 spp.

Fruit a loment; $0.4\text{--}0.9 \times 0.08\text{--}0.25 \times 0.01\text{--}0.02$ cm; with deciduous corolla; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; rectangular (with or without apical beak); when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; widest near middle or D-shaped; not inflated; compressed; with beak; straight, declined, or coiled; with solid beak the same color and texture as fruit; long tapered to tapered to short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered or truncate at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous to coriaceous or fragile, thinner than chartaceous like *Trifolium* (23.07); seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted or not constricted; constricted along both margins or constricted on 1 margin and slightly constricted on the other margin; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; 2–4.5 mm long; widest across seed area; with upper 1 different shape than middle one, lower 1 different shape than middle one, or upper 1 different shape than lower 1; D-shaped. Epicarp dull; monochrome; with surface texture uniform or not uniform, with patches of different texture not restricted to the base and apex; glabrous, pubescent and indurate, or pubescent but soon deciduous; with 1 type of pubescence; pilose, puberulent, or villous; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; longitudinally veined relative to fruit length or reticulately veined (with 2 prominent longitudinal veins); not tuberculate or tuberculate (minutely in *S. guianensis*); not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; smooth; septate; with septa thicker than paper, firm; with the septa eglandular; coriaceous to chartaceous; not

exfoliating; remaining fused to epicarp; entire. Seeds 1 or 2; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent.

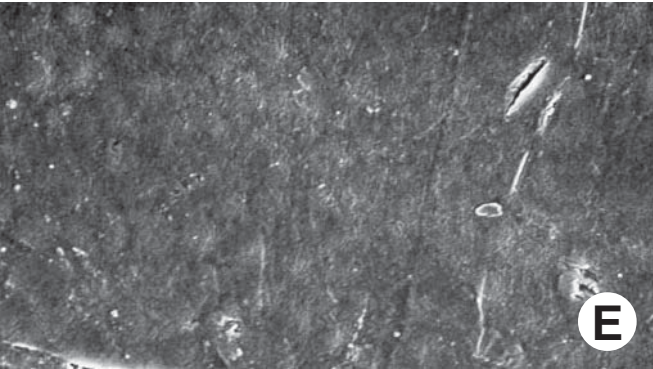
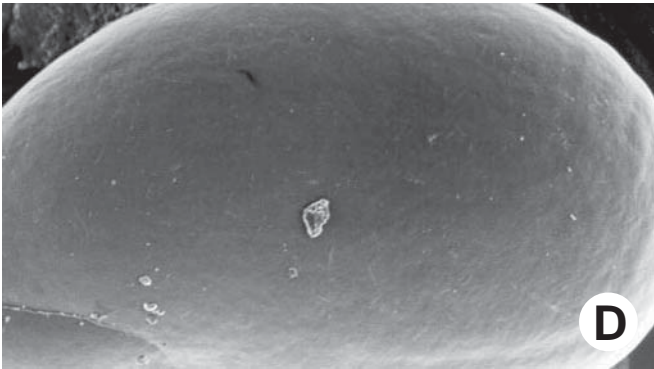
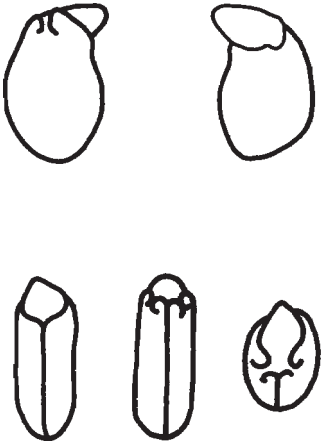
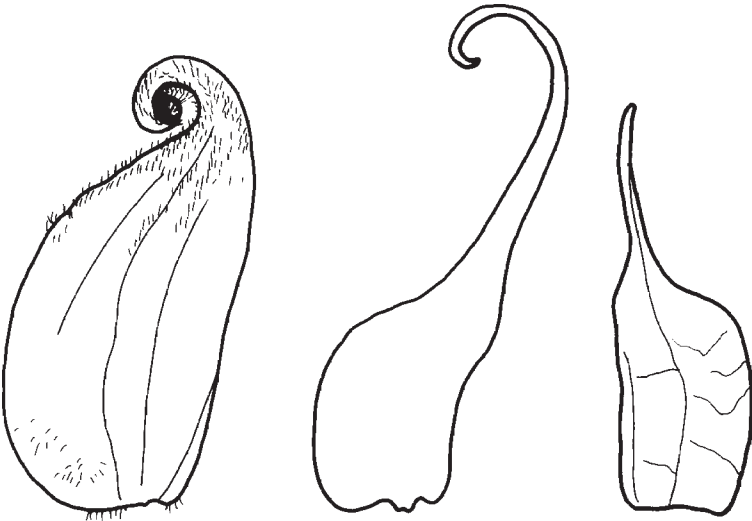
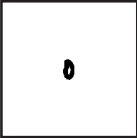
Seed $1.9\text{--}3 \times 1.4\text{--}2.5 \times 0.6\text{--}1.2$ mm; not overgrown; not angular; asymmetrical; ovate or reniform (with prominent radicle lobe (beaklike)); compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome; black, brown (to reddish-brown), or tan; smooth; chartaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; not within corona, halo, or rim. Lens discernible; less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; adjacent to hilum; 0.5 mm from hilum; mounded; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm present or absent; thin; 1/2 covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin not entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; split over radicle; with lobes; with lobes not touching; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle bulbous; lobe tip curved; deflexed and parallel to cotyledon width; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: United States, West Indies, Mexico, Central America, South America (to northern Argentina and Galapagos Islands), central and southern Africa, Madagascar, southern India, Sri Lanka, and adventive in Indonesia to Australia.

Notes: Mohlenbrock (1957) revised *Stylosanthes* and amended his revision (Mohlenbrock 1963). Kirkbride and Kirkbride (1987) established the correct names for the two sections in the genus, and our studied species were obtained nearly equally from both sections. Mohlenbrock (1963) provided a key and fruit illustrations of the 30 species that he recognized. Mohlenbrock (1957) noted that the lower (of two) articles is usually densely pilose to glabrescent and aborted to fertile while the upper article is glabrous or puberulent to

sericeous to minutely tuberculate. The relative beak-upper article lengths are diagnostic. T'Mannetje (1984) reported on the species of this genus and has excellent fruit drawings. Burkart (1952) and Sousa Costa and Ferreira (1984) contain excellent fruit and seed drawings. Reis and Martins (1989a,b) presented interesting data on seed germination of apical and basal section seeds and on the distributional potential of the upper one-half of the legume versus the lower one-half of the legume. Some species of *Stylosanthes* have agronomic potential, especially in Australia and South America (Stace and Edey 1984).

Stylosanthes: *S. guianensis* (J.B.C.F. Aublet) O.P. Swartz
(*D–F*), *S. spp.* (*A–C*). *A*, Articles ($\times 4.7$); *B*, fruit beaks
(coiled, hooked, and straight) ($\times 10$); *C*, seeds ($\times 6.8$);
D–E, testa ($\times 50$, $\times 1000$); *F*, embryos ($\times 8$).



Genus: *Arachis* C. Linnaeus

Phylogenetic Number: 14.26.

Tribe: Aeschynomeneae.

Subtribe: Stylosanthinae.

Species Studied—Species in Genus: 18 spp.—71 spp.

Fruit a legume; unilocular; $0.8\text{--}6 \times 0.5\text{--}2.1 \times 0.5\text{--}2.1$ cm; with deciduous corolla; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; oblong, ovate, or irregular; when asymmetrical with both sutures unequally curved; not inflated; terete; without beak; rounded at apex; apex oblique or right-angled with longitudinal axis of fruit; rounded at base; base oblique with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible or invisible; with the raised seed chambers not torulose. Fruit margin constricted or not constricted; constricted along both margins; without sulcus; plain. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome; tan; glabrous; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thick; surface uniformly veined; 1-layered; without balsamic vesicles; without fibers; firm-walled open empty cells; coriaceous. Endocarp dull; monochrome; white; cobwebby or scurfy; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1–3; length parallel with fruit length; touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent.

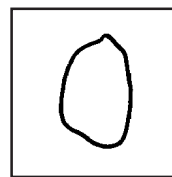
Seed $7\text{--}25 \times 4\text{--}15 \times 4\text{--}15$ mm; overgrown, 1 seed filling entire fruit cavity or not overgrown; angular or not angular; asymmetrical; elliptic, oblong, or ovate; terete; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or bichrome (reddish-brown and white); reddish brown or white; glabrous; smooth or not smooth; with elevated features; veined; chartaceous. Fracture lines absent. Rim absent. Raphe not visible. Hilum fully concealed; concealed by funicular remnant; without faboid split; larger than punctiform; 2 mm long; with curved outline; elliptic; subapical to radicle tip; flush; not within corona, halo, or rim. Lens not discernible. Endosperm

absent or present (according to Kubicek (1970) and see Notes); trace; $1/2$ covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; split over radicle; with lobes; with lobes not touching; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis straight; parallel to length of seed. Radicle bulbous; lobe tip straight or curved; straight with embryonic axis; centered between cotyledons; less than $1/2$ length of cotyledons. Plumule well developed; glabrous.

Distribution: Eastern South America; introduced and cultivated elsewhere.

Notes: Hoehne (1940) and Hermann (1954) monographed the genus, and Ressler (1980) reviewed the nomenclature. Rudd (1981a) used the same number of recognized species as Ressler, and both noted that possibly 40 (Rudd) to 70 (Ressler) species were undescribed. Wynne and Halward (1989) recognized 33 species, including several *nomum nuda* species names. Krapovickas and Gregory (1994) monographed *Arachis* and recognized 69 species in the genus. Several new species of *Arachis* have been discovered since publication of Krapovickas and Gregory's monograph (José F.M. Valls, personal communication, 1994). Kubicek (1970) stated that "contrary to reports by other investigators the endosperm appeared to be present as a single layer which covers the cotyledons in mature seeds." Gregory and Gregory (1979) studied interspecific hybrids. Bentham (1841) compared the structures and affinities of *Arachis* and *Voandzeia* (now *Vigna* 10.65). Charles F. Simpson, USDA/ARS, made a major contribution of seeds and fruits to the U.S. National Seed Herbarium (BARC).

Arachis: *A. hypogaea* C. Linnaeus (C–E), *A. spp.* (A–B). A, Fruits and valve ($\times 1.1$); B, seeds ($\times 2$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 2.5$).



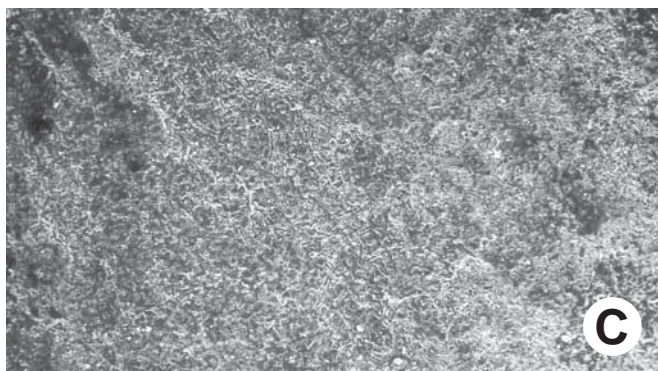
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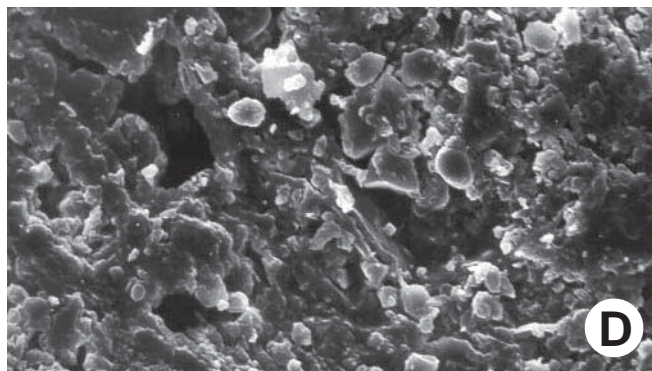
B



E



C



D

Adesmieae (15.01)

Genus: *Adesmia* A.-P. de Candolle

Phylogenetic Number: 15.01.

Tribe: Adesmieae.

Species Studied—Species in Genus: 35 spp.—ca. 230 spp.

Fruit a loment; $1.2\text{--}3 \times 2.5\text{--}7 \times 0.05\text{--}0.2$ cm; with deciduous corolla; with deciduous calyx; straight or curved (or slightly curved); not plicate; not twisted; asymmetrical; when asymmetrical with 1 straight and 1 curved suture; narrowing in several places, resembling *Desmodium* fruit; not inflated; flattened or compressed; without beak; rounded at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted only on 1 margin; without sulcus; embellished; with prickles. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscing (occasionally: Burkart (1967, p. 491)) or indehiscent; splitting along sutures. Dehiscence of valves passive. Replum invisible. Loment segments (articles) inconspicuous; 4–12 mm long; widest across seed area; with all essentially similar in shape; triangular or D-shaped. Epicarp dull; monochrome; black, brown (to reddish brown), or tan; glabrous or pubescent but soon deciduous; with 1 type of pubescence; pilose, tomentose, or villous; with pubescence golden, gray-brown, red, gray, or tan; with simple or complex hairs; with plumose or bristle-like hairs (up to 1 cm long); stiff or pliable; with hair bases plain; straight; straight at apex; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; glandular dotted; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp. Seeds 1–12; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only. Aril dry; rim-aril; brown.

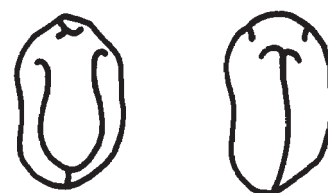
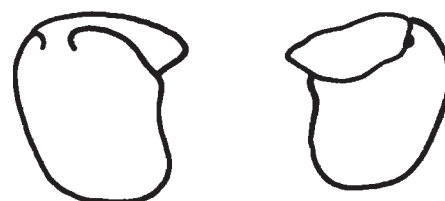
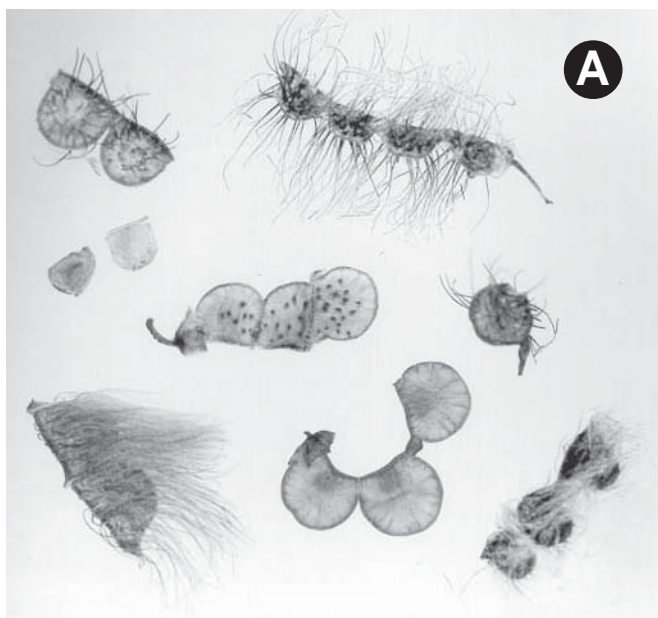
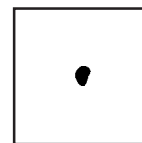
Seed $1.5\text{--}3.5 \times 1.5\text{--}3.5 \times 1\text{--}2.4$ mm; overgrown, 1 seed filling entire fruit cavity; not angular (though at first glance appearing to be angular) or angular; asymmetrical; mitaform (or nearly so); mounded on 1 side and straight on other side; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering

to endocarp; glossy; not modified by a bloom; colored; monochrome, mottled, or streaked; with frequent mottles; with frequent streaks; black, brown (to reddish), or tan; with brown overlay; glabrous; smooth; osseous to coriaceous. Fracture lines absent. Rim absent. Raphe not visible. Hilum fully concealed or partially concealed; concealed by aril, aril remnant, radicle lobe, or wing; with faboid split; with the lips of the faboid split lighter colored than the rest of the hilum and therefore conspicuous; punctiform; between cotyledon and radicle lobe; recessed; within rim. Hilum rim color darker than testa. Lens discernible; equal to or greater than 0.5 mm in length; 1–2 mm long; with margins curved; circular (as large as hilum); not in groove of raphe; adjacent to hilum; mounded; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thin; 1/2 covering entire embryo; adnate to testa. Cotyledons smooth; outer face of 1 cotyledon flat and other cotyledon convex; 1 thicker than the other; both more or less of equal length; with both folded or not folded; not sufficiently folded for inner face to touch itself; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle (nearly); split over radicle; with lobes; with lobes not touching; with the interface division terminating at base of radicle; without margins recessed; white or yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; parallel to length of seed. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons, equaling length of cotyledons, or exceeding length of cotyledons. Plumule rudimentary; glabrous.

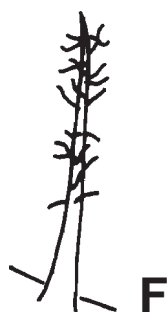
Distribution: Montane and temperate South America (Peru and southern Brazil to Tierra del Fuego).

Notes: Polhill (1981g) evaluated the phylogenetic position of Adesmieae. For additional seed and fruit drawings, see Burkart (1966, 1967), the latter a synopsis of the genus. In his synopsis, Burkart compared the seeds of *A. bicolor* (J.L.M. Poiret) A.-P. de Candolle to those of *Trifolium repens* C. Linnaeus (Trifolieae, 21.06). Ulibarri (1987) monographed the series *Microphyllae* and included 33 species. Miotto and Leitão filho (1993) treated the Brazilian species of *Adesmia*. Most of our fruit samples were composed of individual indehiscent articles, and our data for entire fruits were derived from the two papers of Burkart.

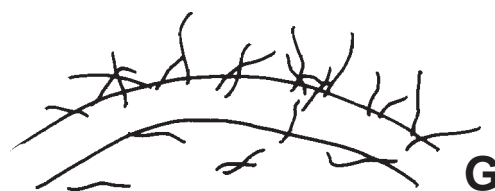
Adesmia: *A. aromatica* A. Burkart (*H*), *A. capitellata* A. Burkart (*G*), *A. incana* E. de Vogel (*C–E*), *A. lihuelensis* A. Burkart (*F*), *A. spp.* (*A–B*). *A*, Fruits ($\times 1.9$); *B*, seeds ($\times 4.3$); *C–D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 10$); *F*, bristlelike fruit hair ($\times 16$) redrawn from Burkart (1966); *G*, simple fruit hairs ($\times 30$) redrawn from Burkart (1966); *H*, plumose fruit hair ($\times 15$) redrawn from Burkart (1966).



E



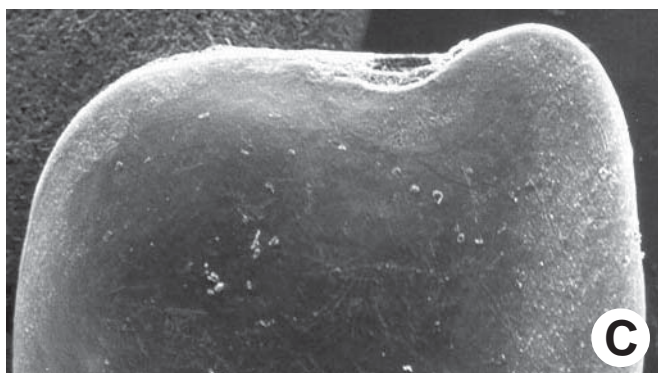
F



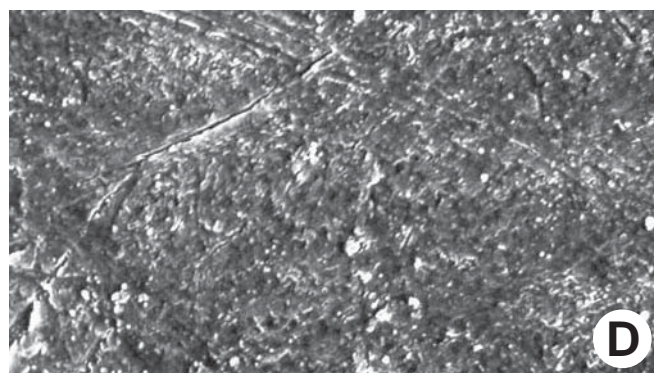
G



H



C



D

Galegeae (16.01–16.22)

Genus: *Clianthus* D.C. Solander ex J. Lindley

Phylogenetic Number: 16.01.

Tribe: Galegeae.

Subtribe: Coluteinae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; unilocular; up to 8×0.5 –1 (assumed) \times 0.5–1 (assumed) cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; slightly curved; not plicate; not twisted; asymmetrical; oblong; when asymmetrical with both sutures nearly straight; somewhat inflated; terete; with beak; straight; with solid beak the same color and texture as fruit; long tapered at apex; apex aligned with longitudinal axis of fruit; long tapered at base; base aligned or oblique (slightly) with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit stipitate; with the stipe up to 10 mm long. Fruit with all layers dehiscent; splitting along suture. Dehiscence of valves along 1 suture; apical and down; passive. Replum visible. Epicarp dull; monochrome; dirty dark brown; glabrous; eglandular; without spines; not smooth; with elevated features; transversely veined relative to fruit length and reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; brown; hairy; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds many; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 3–3.5 mm long; of 1 length only; filiform; more or less straight. Aril faintly present; dry; rim-aril; white.

Seed 3.5 – 4×3 – 3.5×1 – 1.3 mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering or partially adhering to endocarp (seeds often with tufts of endocarp hairs); dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with

frequent streaks; reddish brown or tan (reddish); with black overlay; glabrous; not smooth; with elevated features; reticulate or wrinkled; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible or fully concealed; concealed by radicle lobe; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; marginal according to radicle tip; flush; not within corona, halo, or rim. Lens discernible or not discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; up to 0.5 mm long; with margins straight or curved; linear or circular; not in groove of raphe; adjacent to hilum; up to 0.5 mm from hilum; mounded; same color as or dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to testa or embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow or tan (reddish); inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle differentiated from cotyledon; bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered or not centered between cotyledons (radicle outside 1 cotyledon and inside other, therefore junctions for each cotyledon different); less than 1/2 or 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

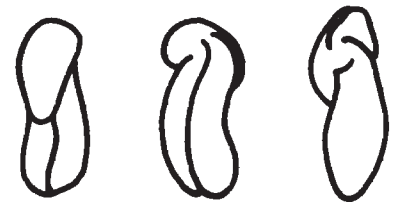
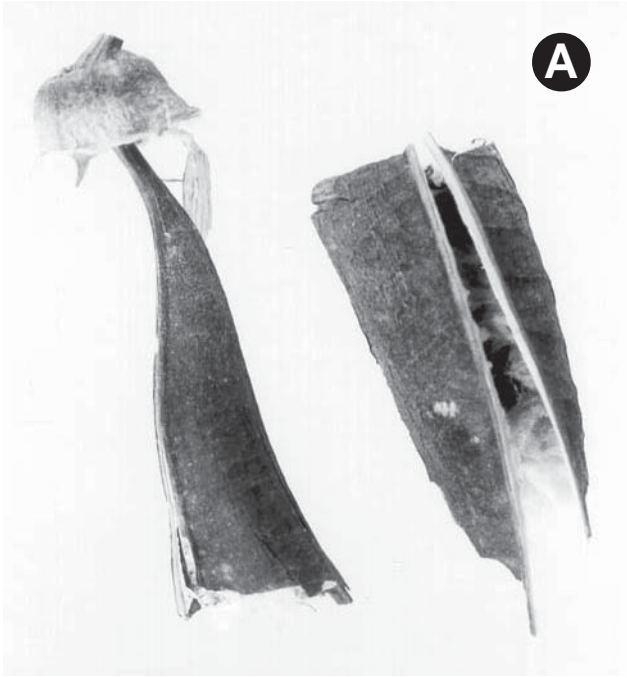
Distribution: Northeastern New Zealand.

Notes: Traditionally this tribe has been called Galegeae.

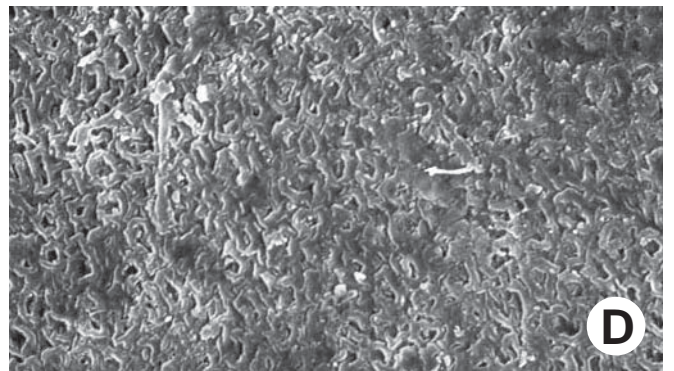
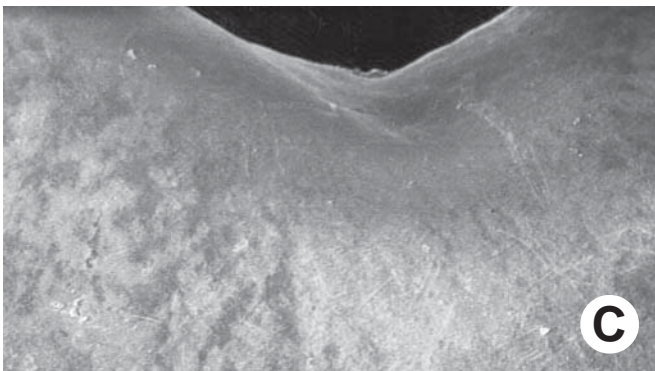
Reveal (1997) reported that the name Astragaleae was published before the name Galegeae. In accordance with the *International Code of Botanical Nomenclature* (Greuter et al. 1994), the oldest name for a taxon must be used, so Reveal suggested that this tribe should be called Astragaleae. In 1999, however, Reveal (1999) reversed himself, so this tribe remains the Galegeae. Welsh (1960) reported on the Galegeae of the North-Central United States. Sanderson and Liston (1995) carried out cladistic analyses of Galegeae genera using molecular data. They concluded that Galegeae is paraphyletic, having given rise to the tribes Cicereae (20), Hedysareae (18), Trifolieae (21), and Fabeae (19), and therefore requiring a re-evaluation of the circumscription of Galegeae. Heenan (1995, 1998c), using

unpublished nuclear ribosomal DNA ITS data, concluded that “*Carmichaelia* (17.05) is nested within [the] ‘Astragalean clade’ of Galegeae” and is the sister group of *Clianthus*. He therefore supported the proposal of Sanderson and Wojciechowski (1996) that Carmichaelieae should not be recognized at the tribal level, but instead should be included in Galegeae. Because the seeds of *Clianthus puniceus* are so unlike those of *C. formsus* (G. Don) N.C. Ford & J.W. Vickery, we are pleased with the transfer of the latter species to *Swainsona* (16.02). Polhill (1981h) noted that *C. puniceus* “is virtually extinct.” We were unable to study an entire fruit of this genus.

Clianthus: *C. puniceus* (G. Don) D.C. Solander ex J.
Lindley (*A-E*). *A*, Broken fruit ($\times 2.2$); *B*, seeds
($\times 10$); *C-D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 6$).



E



Genus: *Swainsona* R.A. Salisbury

Phylogenetic Number: 16.02.

Tribe: Galegeae.

Subtribe: Coluteinae.

Species Studied—Species in Genus: 15 spp.—85 spp.

Fruit a legume; unilocular or bilocular (see also *Astragalus* (16.15)); at least $1-5 \times 0.3-2.5 \times 0.1-0.35$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; asymmetrical or symmetrical; linear, oblong, elliptic, or falcate; when asymmetrical with both sutures parallelly curved or nearly straight; not inflated or inflated; flattened; with beak; straight or declined; with solid beak the same color and texture as fruit; short tapered or rounded at apex; apex aligned, oblique, or right-angled with longitudinal axis of fruit; short tapered at base; base right angled or oblique with longitudinal axis of fruit; with the apex and base uniform in texture; membranous, coriaceous, or ligneous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit stipitate, substipitate, or nonstipitate; with the stipe at least up to 10 mm long. Fruit indehiscent or with all layers dehiscent (to tardily dehiscent); splitting along suture. Dehiscence of valves along 1 suture; medial and up and down; passive. Replum invisible. Epicarp dull; monochrome; brown; glabrous or pubescent and indurate; with 1 type of pubescence; villous; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined and transversely veined relative to fruit length; not tuberculate or tuberculate (bases of hairs); wrinkled; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds few to numerous; length parallel (assumed) with fruit length; assumed overlapping; in 2 or more series. Funiculus measured; up to at least 2 mm long; of 1 length only; filiform; S-curved. Aril dry; rim-aril; white.

Seed $3.5-4 \times 3-3.5 \times 1$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes;

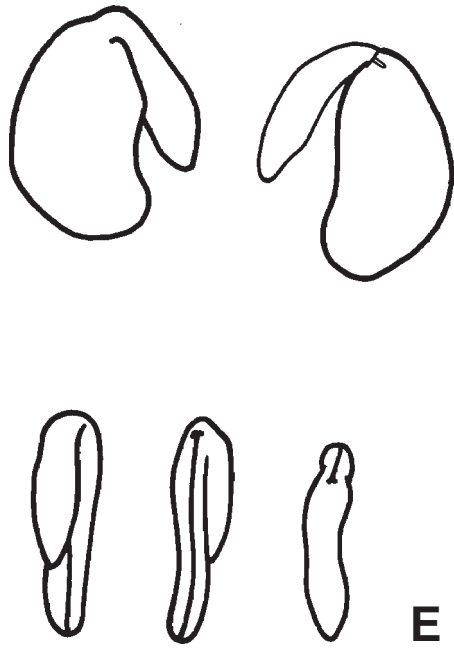
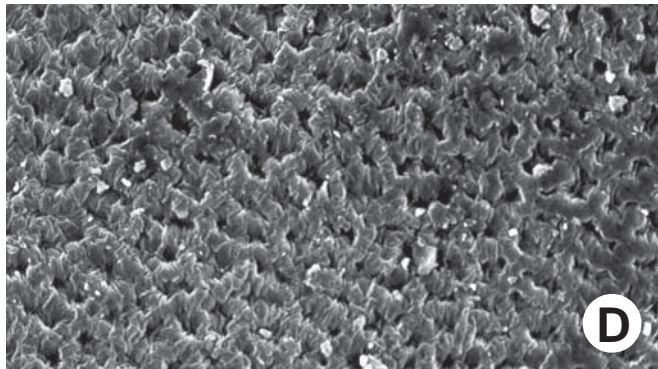
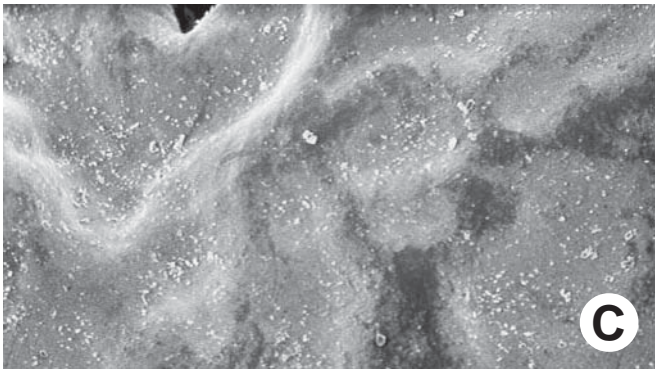
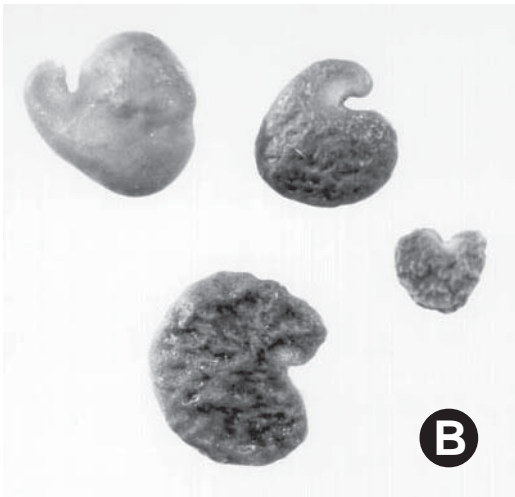
with external groove between radicle and cotyledon lobes same color as testa; without or with deep hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown; glabrous; not smooth or smooth; with elevated features; reticulate; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially or fully concealed; concealed by radicle lobe; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; within halo or not within corona, halo, or rim. Hilum halo color lighter than testa. Lens discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; 0.5 mm long; with margins straight; linear; not in groove of raphe; confluent with hilum; mounded; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim or within halo. Lens halo color lighter than testa. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; outer face of 1 cotyledon flat and other cotyledon convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight or hooked; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Australia (most species) and southern New Zealand (*S. novae-zelandiae* J.D. Hooker).

Notes: Thompson (1993) monographed *Swainsona* and recognized 85 species, the count that we used. Although fruits are seldom collected for most species, the fruits have great phylogenetic and diagnostic significance for the species. Thompson regarded the primitive and most unmodified fruits to be greatly inflated with seeds that are "erratic in their maturing into viable seeds." She also noted that "seeds have proved difficult to study, few being available in the mature state and those seeming to be somewhat inconsistent in size, shape, surface sculpturing and colour." Species of *Swainsona*, containing swainsonine, are a well known cause of livestock poisoning. *Swainsona* in Australia has many parallels with *Astragalus* (16.15) in North America.

Thompson transferred *Clianthus* (16.01) *formosus* (G. Don) N.C. Ford & J.W. Vickery to *Swainsona*. Heenan (1998c) carried out phylogenetic analyses of the *Carmichaelia* (17.05) complex, *Clianthus*, and 13 species of *Swainsona*, including *S. novae-zelandiae* J.D. Hooker. He concluded that “*Swainsona* is polyphyletic if *S. novae-zelandiae* is included,” and recommended the segregation of *S. novae-zelandiae* as a monotypic genus. The genus *Montigena* P.B. Heenan (Heenan 1998b) was established with the single New Zealand species *M. novae-zelandiae* (J.D. Hooker) P.B. Heenan. We have chosen to include *M. novae-zelandiae* in *Swainsona* pending an expression of a consensus opinion on the status of *Montigena* by the taxonomic community.

Swainsona: *S. maccullochiana* F.H. Mueller (*C-E*), *S. spp.*
(*A-B*). *A*, Fruits and valve ($\times 1.3$); *B*, seeds ($\times 6.4$);
C-D, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 6$).



Genus: *Sutherlandia* R. Brown

Phylogenetic Number: 16.03.

Tribe: Galegeae.

Subtribe: Coluteinae.

Species Studied—Species in Genus: 5 spp.—6 spp.

Fruit a legume; unilocular; 4–6 × 2–3.5 cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; oblong or circular; when asymmetrical with both sutures parallelly curved; inflated; without or with beak; hooked; with solid beak the same color and texture as fruit; short tapered at apex; apex oblique or right-angled with longitudinal axis of fruit; tapered at base; base oblique or right angled with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit indehiscent. Replum invisible. Epicarp dull or glossy; monochrome (and transparent); tan to purplish tan; glabrous; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; wrinkled; not exfoliating; without cracks. Mesocarp absent. Endocarp absent. Seeds 11–17; length transverse to fruit length; neither overlapping nor touching; in 2 or more series. Funiculus measured; up to 3 mm long; of 1 length only; nearly thick; straight or curved. Aril dry; rim-aril; tan.

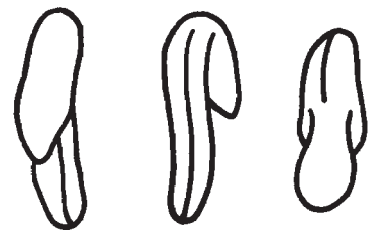
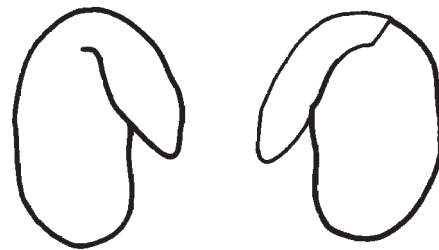
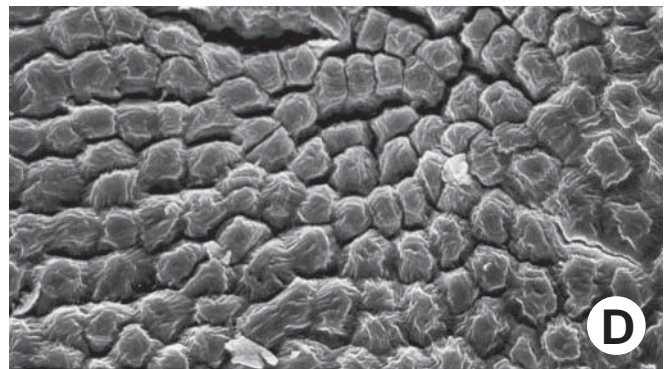
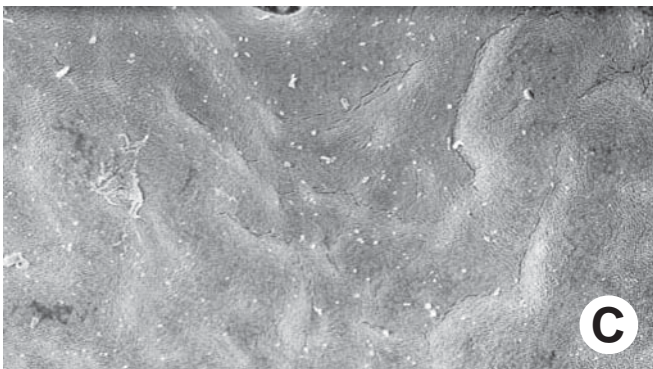
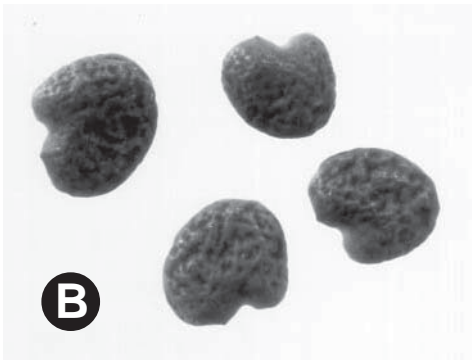
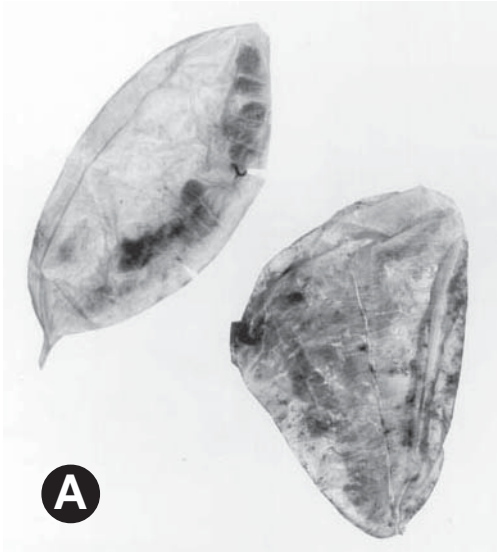
Seed 2–3.7 × 1.7–3 × 0.7–1.3 mm; not overgrown; not angular; asymmetrical; mitaform or reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; with shallow hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; black or brown (blackish to reddish); glabrous; not smooth; with recessed features; pitted with small separate pits; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; recessed; not within corona, halo, or rim or within halo. Hilum halo color lighter than testa. Lens discernible or not discernible; less than 0.5 mm or equal to or greater

than 0.5 mm in length; 0.5 mm long; with margins curved; more or less circular; not in groove of raphe; confluent with hilum; barely mounded; same color as testa; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: South Africa, extending to Namibia and Botswana; naturalized on Mexican, Bolivian, and Argentinian plateaux.

Notes: Schrire and Andrews (1992) briefly reviewed the systematics of the cultivated species, and their species number is used. The fruit wall of *Sutherlandia* is very thin and transparent. Using a dissecting microscope, only a single layer could be discerned, and it was presumed to be the epicarp. It is an unusual condition to have both the mesocarp and endocarp absent.

Sutherlandia: *S. frutescens* (C. Linnaeus) R. Brown (B–E), *S. spp.* (A). A, Fruits (× 1.2); B, seeds (× 6.6); C–D, testa (× 50, × 1000); E, embryos (× 9).



Genus: *Lessertia* A.-P. de Candolle

Phylogenetic Number: 16.04.

Tribe: Galegeae.

Subtribe: Coluteinae.

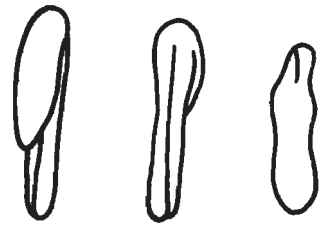
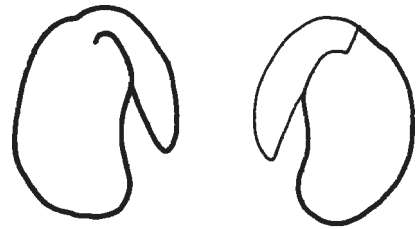
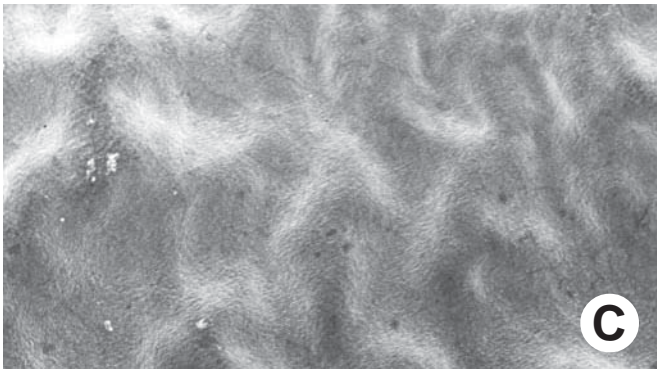
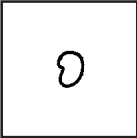
Species Studied—Species in Genus: 10 spp.—ca. 50 spp.

Fruit a legume; unilocular; $0.9-4 \times 0.5-2 \times 0.05-0.12$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical or asymmetrical; oblong, ovate, elliptic, linear (broadly), or circular (somewhat); when asymmetrical with 1 straight and 1 curved suture, both sutures unequally curved, or both sutures parallelly curved; widest near middle or D-shaped; not inflated or inflated; compressed, flattened, or terete; with beak; straight; with solid beak the same color and texture as fruit; short tapered or rounded at apex; apex aligned or oblique with longitudinal axis of fruit; short tapered or rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous; seed chambers externally visible; with the raised seed chambers torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent (though whole fruit winglike). Fruit substipitate. Fruit indehiscent or with all layers dehiscent (gaping at length at apex or subdehiscent); splitting along suture (at least apex). Dehiscence of valves along 1 suture; apical and down (apex only) or medial and up and down (when gaping); passive. Replum invisible. Epicarp dull (and usually transparent); monochrome or multicolored; mottled and streaked; tan to reddish tan; with black or purple overlay; glabrous or pubescent and indurate; with hairs erect or appressed; with 1 type of pubescence; puberulent; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; glandular; with glandular dots (reddish-brown); without spines; not smooth; with elevated features; reticulately veined; not tuberculate; wrinkled; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1–9; length oblique or parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; up to 3 mm long; of 1 length only; filiform; straight, curved, or hooked and contorted (somewhat near apex). Aril dry; rim-aril; white.

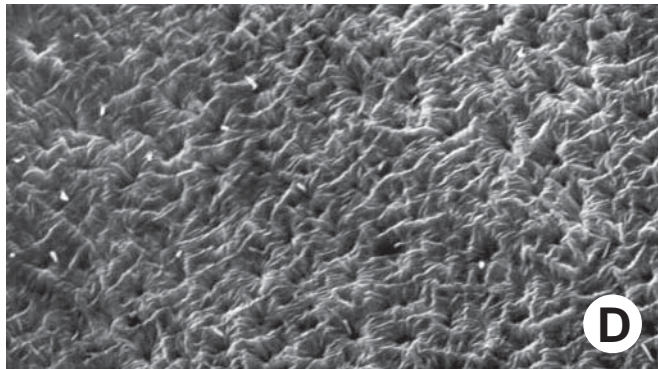
Seed $2.5-4.5 \times 2-3.5 \times 1-1.3$ mm; not overgrown; not angular; asymmetrical; mitaform or reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; with or without external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish to greenish brown or black (reddish); glabrous; smooth or not smooth; with elevated features; wrinkled; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible or visible; from hilum to lens; not bifurcating; color of or darker than testa; reddish brown; flush. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; recessed; within halo. Hilum halo color lighter than testa. Lens discernible or not discernible; less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; adjacent to hilum; 0.3 mm from hilum; mounded; same or similar color as testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow or white; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; with a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Eastern tropical Africa to South Africa.

Lessertia: *L. benguellensis* J.G. Baker (C–E), *L. spp.* (A–B). A, Fruits and valves ($\times 1.3$); B, seeds ($\times 5.3$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 5$).



E



Genus: *Colutea* C. Linnaeus

Phylogenetic Number: 16.05.

Tribe: Galegeae.

Subtribe: Coluteinae.

Species Studied—Species in Genus: 11 spp.—28 spp.

Fruit a legume; unilocular; $3-7 \times 2-3 \times 2-3$ cm; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; elliptic; when asymmetrical with both sutures parallelly curved; inflated; terete; without or with beak; straight or declined; with solid beak the same color and texture as fruit; long tapered, tapered, or short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered or rounded at base; base aligned or oblique with longitudinal axis of fruit; with the apex and base uniform in texture; membranous or fragile (more or less), thinner than chartaceous like *Trifolium* (21.06); seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit stipitate, substipitate, or nonstipitate; with the stipe up to 10 mm long. Fruit indehiscent or with all layers dehiscent (at apex); splitting along sutures (at apex). Dehiscence of valves passive. Replum invisible. Epicarp dull; monochrome or multicolored; mottled and streaked; tan; with purple overlay; glabrous or pubescent but soon deciduous; with 1 type of pubescence; with pubescence uniformly distributed; with simple hairs; pliable; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; wrinkled (on drying); not exfoliating; without cracks. Mesocarp present or absent; thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; chartaceous. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp or to epicarp; entire. Seeds 12–15; length transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 2 mm long; of 1 length only; filiform or thick; straight or curved. Aril dry; tongue-aril; tan.

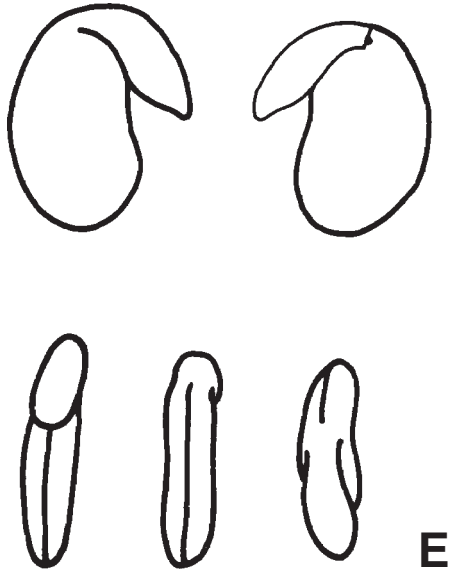
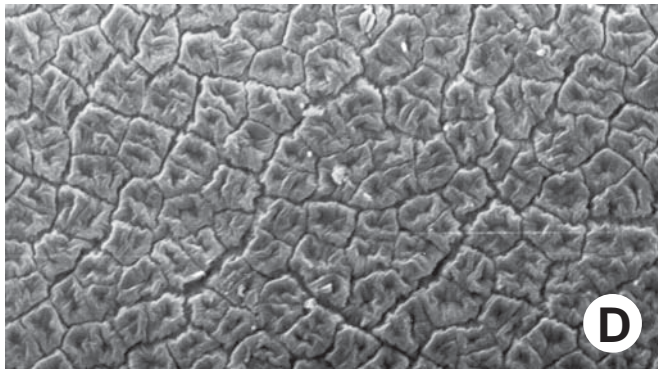
Seed $2-4.5 \times 2-4 \times 1-1.8$ mm; not overgrown; not angular; asymmetrical; oblong or reniform (sub-); compressed; with surface smooth; with or without visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not

adhering to endocarp; dull; not modified by a bloom; colored; monochrome or streaked (faintly and occasionally); with infrequent streaks; dark reddish or blackish brown or black (nearly); with tan (greenish) overlay; glabrous; smooth or not smooth; with recessed features; pitted with small separate pits; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.5 mm long; with curved outline; circular; marginal according to radicle tip or between cotyledon and radicle lobe; recessed; within rim. Hilum rim color lighter than testa. Lens not discernible or discernible (faint); equal to or greater than 0.5 mm in length; 1 mm long; with margins straight or curved; elliptic or oblong; not in groove of raphe; adjacent to hilum; 0.2 mm from hilum; mounded; similar color as testa; lighter than testa and darker than testa; reddish brown or tan (reddish); not within corona, halo, or rim. Endosperm present (clear to reddish-tan); thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; light reddish tan or yellow; inner face concave; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 or 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Mediterranean region to eastern and northeastern Africa and China and the Himalayas.

Colutea: *C. orientalis* P. Miller (*C-E*), *C. spp.* (*A-B*). *A*, Fruits (closed and dehiscent) ($\times 0.9$); *B*, seeds ($\times 3.8$); *C-D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 7$).

0



Genus: *Oreophysa* (A.A. von Bunge ex P.E. Boissier) J.F.N. Bornmüeller

Phylogenetic Number: 16.06.

Tribe: Galegeae.

Subtribe: Coluteinae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; unilocular; $2.7-4 \times 2 \times 2$ (assumed) cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; ovate, oblong, or obovate; when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; widest near middle or D-shaped; inflated; terete; without beak; rounded at apex; apex aligned or oblique with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous or chartaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscent (apex); splitting along sutures (apical only). Dehiscence of valves along both sutures; passive. Replum invisible. Epicarp glossy; monochrome or multicolored; mottled and streaked; tan; with purple overlay (faintly); glabrous; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; wrinkled; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 3–4 (assumed); length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent.

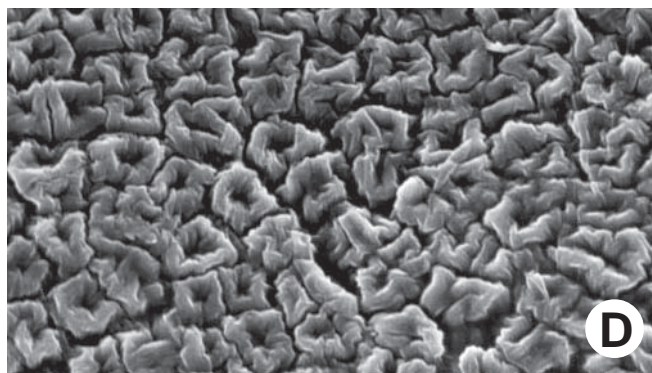
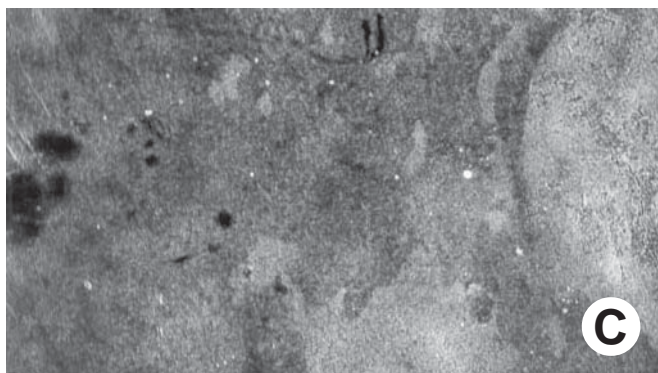
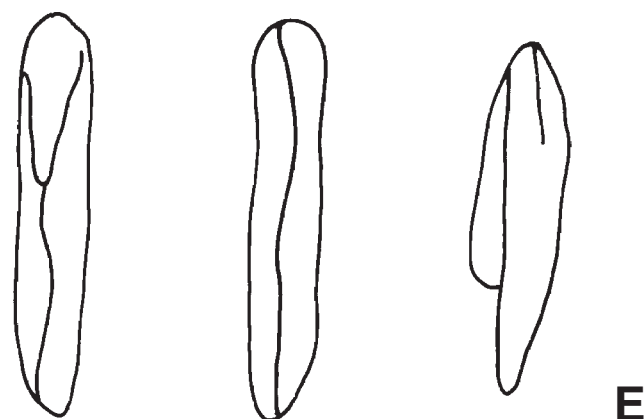
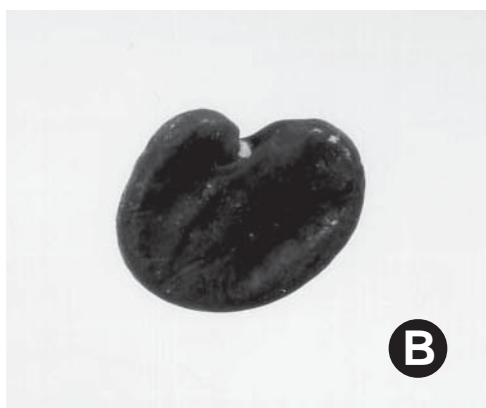
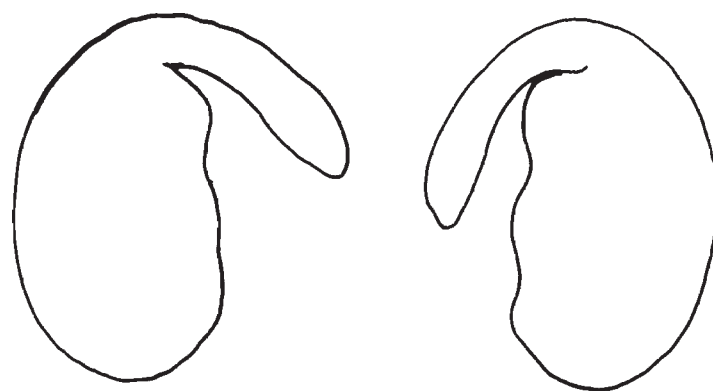
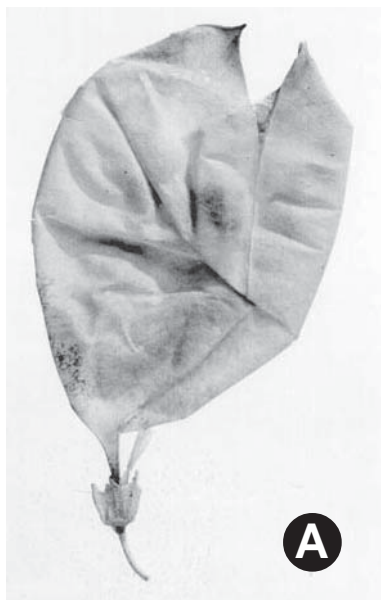
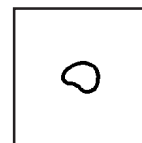
Seed $6 \times 6 \times 2$ mm; not overgrown; not angular; asymmetrical; mitaform; compressed; with surface smooth; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the

faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; not within corona, halo, or rim. Lens discernible; equal to or greater than 0.5 mm in length; 0.7 mm long; with margins straight; linear; not in groove of raphe; adjacent to hilum; 0.3 mm from hilum; flush; dissimilar color from testa; lighter than testa; black; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; green; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; with a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Northern Iran.

Notes: Jaubert and Spach (1843, plate 64) provides excellent fruit and seed drawings.

Oreophysa: *O. microphylla* (H.F. Jaubert & É. Spach) K. Browicz (A–E). A, Fruit ($\times 2.1$); B, seed ($\times 8.3$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 8$).



Genus: *Sphaerophysa* A.-P. de Candolle

Phylogenetic Number: 16.07.

Tribe: Galegeae.

Subtribe: Coluteinae.

Species Studied—Species in Genus: 1 sp.—2 spp.

Fruit a legume; unilocular; $1.3\text{--}2.4 \times 0.9\text{--}2 \times 0.5\text{--}1.2$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; oblong; when asymmetrical with both sutures nearly straight; inflated; terete; with beak (fragile) or without; straight; with solid beak the same color and texture as fruit; rounded at apex; apex oblique with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous (but firm); seed chambers externally invisible. Fruit margin not constricted; with sulcus; plain. Fruit wings absent. Fruit stipitate or substipitate; with the stipe up to 0.6 mm long. Fruit indehiscent or with all layers dehiscent (scarcely). Dehiscence of valves passive. Replum invisible. Epicarp dull; monochrome; tan; glabrous; without spines; not smooth; with elevated features; reticulately veined and transversely veined relative to fruit length; not tuberculate; wrinkled; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; spongy; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds at least 40; length oblique or transverse to fruit length; overlapping or touching; in 2 or more series. Funiculus measured; 1–2 mm long; of 1 length only; filiform (more so than thick); curved, straight, and hooked. Aril dry; rim-aril; white.

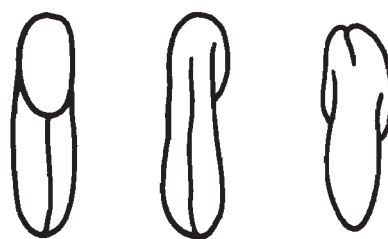
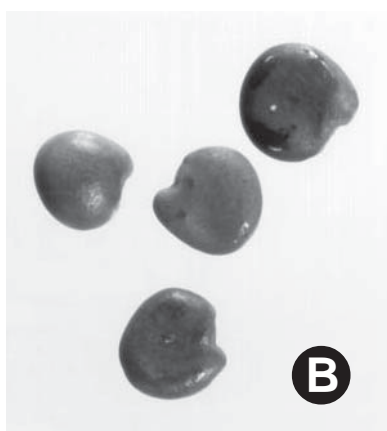
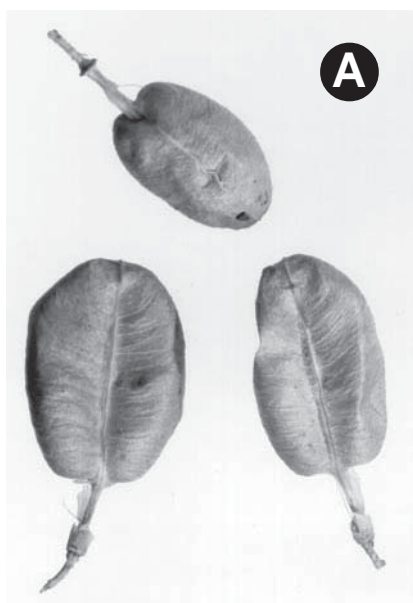
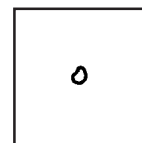
Seed $2\text{--}2.5 \times 2\text{--}2.5 \times 1\text{--}1.5$ mm; not overgrown; not angular; asymmetrical; reniform or mitaform; compressed; with surface smooth; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; brown to greenish or reddish brown, tan (greenish), or green; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as

the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; within halo. Hilum halo color lighter than testa. Lens discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; 0.5 mm long; with margins curved; elliptic; not in groove of raphe; confluent with hilum; mounded; similar color as testa; darker than testa; greenish brown; within halo. Lens halo color lighter than testa. Endosperm thin; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

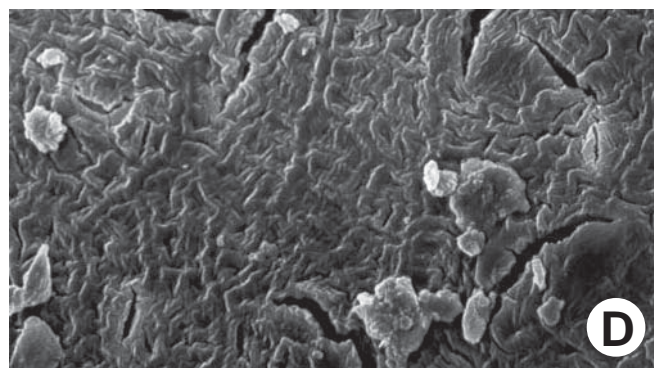
Distribution: Turkey, Syria, Caucasus, Siberia, central Asia, northern Mongolia, and northern China; introduced in United States.

Notes: Polhill (1981h) noted that *Sphaerophysa* is scarcely distinct from *Smirnowia* (16.08). The fruit and seed of *S. kotschyana* P.E. Boissier are unknown.

Sphaerophysa: *S. salsula* (P.S. von Pallas) A.-P. de Candolle (A–E). A, Fruits ($\times 1.2$); B, seeds ($\times 6.5$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 8$).



E



Genus: *Smirnowia* A.A. von Bunge

Phylogenetic Number: 16.08.

Tribe: Galegeae.

Subtribe: Coluteinae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; unilocular; $3.5 \times 2-2.5 \times 2-2.5$ cm (assumed because all fruits were seen from herbarium sheets); with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; circular; when asymmetrical with both sutures parallelly curved or 1 straight and 1 curved suture; widest near middle or D-shaped; inflated; terete; without beak; short tapered at apex; apex aligned or oblique with longitudinal axis of fruit; rounded at base; base aligned, oblique, or right angled with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous; seed chambers externally invisible. Fruit margin not constricted; with sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome; tan to slightly reddish tan; pubescent and indurate; with 1 type of pubescence; puberulent; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined and transversely veined relative to fruit length; not tuberculate; wrinkled; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; chartaceous. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds at least 5; length transverse to fruit length; overlapping or neither overlapping nor touching; in 2 or more series. Funiculus measured; 2 mm long; of 1 length only; thick; curved or hooked. Aril dry; rim-aril; tan.

Seed $4-6 \times 3.5-5 \times 1.5-2.5$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; with umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored;

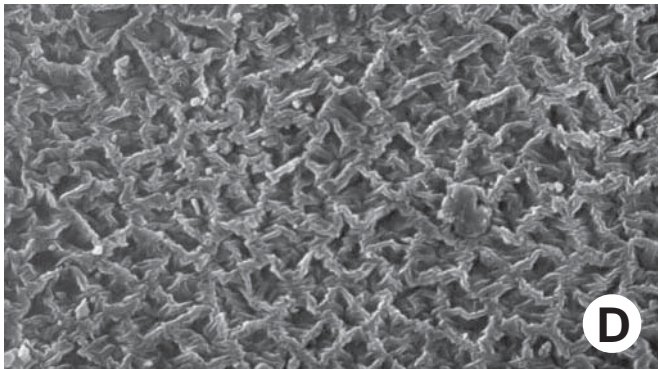
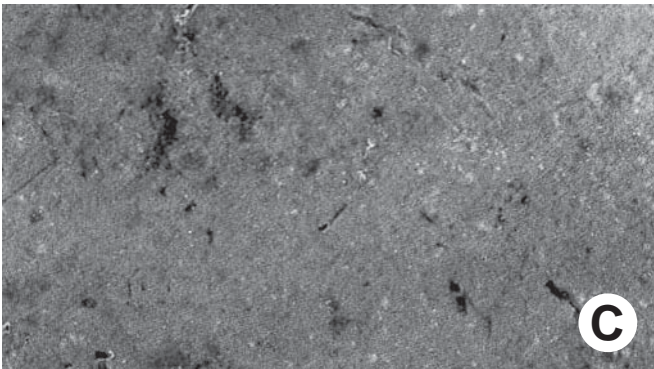
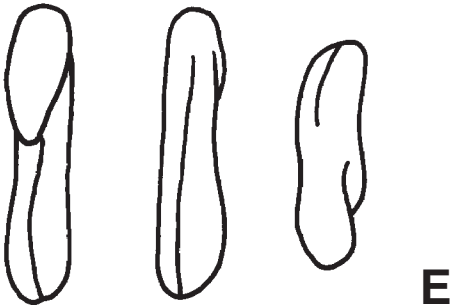
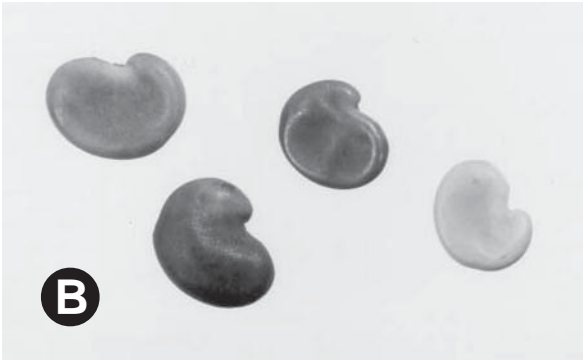
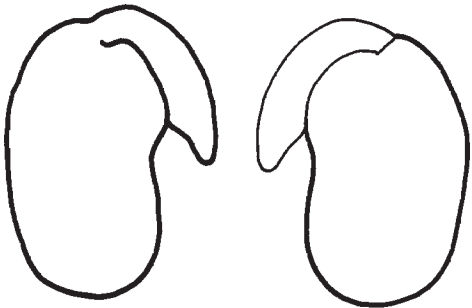
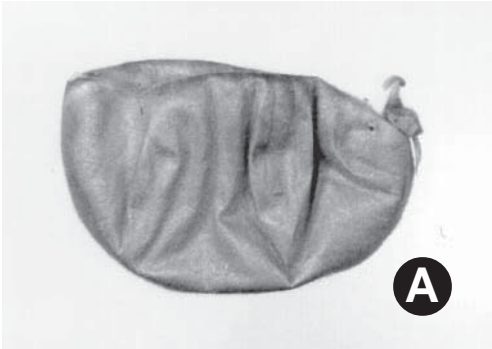
monochrome; reddish brown, tan, or orange; glabrous; smooth; coriaceous. Fracture lines absent. Rim present. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; recessed; not within corona, halo, or rim. Lens discernible; equal to or greater than 0.5 mm in length; 1–1.5 mm long; with margins straight or curved; oblong; not in groove of raphe; confluent with hilum; slightly mounded; similar color as testa; darker than testa; reddish brown or tan (reddish); not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Turkestan.

Notes: Polhill (1981h) noted that *Smirnowia* is “scarcely distinct from *Sphaerophysa*” (16.07).

Smirnowia: *S. turkestanica* A.A. von Bunge (A–E). A, Fruit ($\times 1.3$); B, seeds ($\times 3.2$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 5$).

9



Genus: *Eremosparton* F.E.L. von Fischer & B. Meyer

Phylogenetic Number: 16.09.

Tribe: Galegeae.

Subtribe: Coluteinae.

Species Studied—Species in Genus: 3 spp.—3 spp.

Fruit a legume; unilocular; $1-1.5 \times 0.8-1 \times 0.14-0.26$ cm; with deciduous or persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; ovate or falcate (broadly); when asymmetrical with 1 straight and 1 curved suture, both sutures unequally curved, or both sutures parallelly curved; widest near middle or D-shaped; inflated or not inflated; compressed; with beak; with solid beak the same color and texture as fruit; short tapered at apex; apex oblique with longitudinal axis of fruit; short tapered at base; base right angled with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally visible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent (though whole fruit is winglike). Fruit substipitate. Fruit with all layers dehiscing; splitting along suture. Dehiscence of valves along 1 suture; passive. Replum invisible. Epicarp dull; monochrome; tan; pubescent and indurate; with 1 type of pubescence; villous; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; smooth; nonseptate; coriaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1 or 2; length parallel with fruit length; overlapping or touching; in 1 series. Funiculus measured; up to 1 mm long; of 1 length only; thick; straight or curved. Aril dry; rim-aril; white.

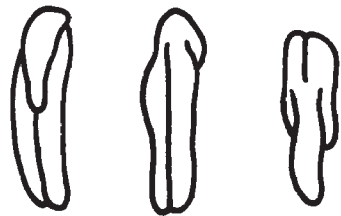
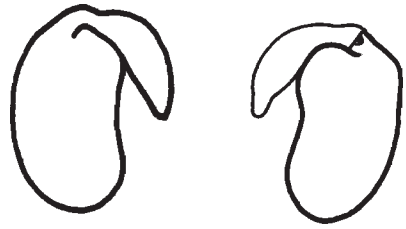
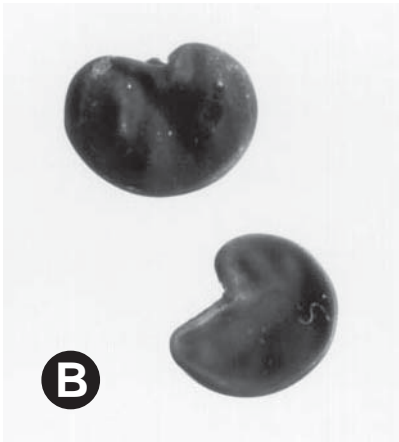
Seed $3.5-4.5 \times 3-3.5 \times 0.7-1$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish to greenish brown; glabrous; smooth; chartaceous. Fracture lines absent. Rim absent.

Wings absent. Raphe not visible. Hilum partially or fully concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; recessed; within halo. Hilum halo color lighter than testa. Lens faintly discernible; less than 0.5 mm in length; with margins curved; elliptic; not in groove of raphe; adjacent to or confluent with hilum; 0.5 mm from hilum; mounded; similar color as testa; within halo. Lens halo color lighter than testa. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; greenish brown or green; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; with a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; $1/2$ to nearly length of cotyledons. Plumule rudimentary; glabrous.

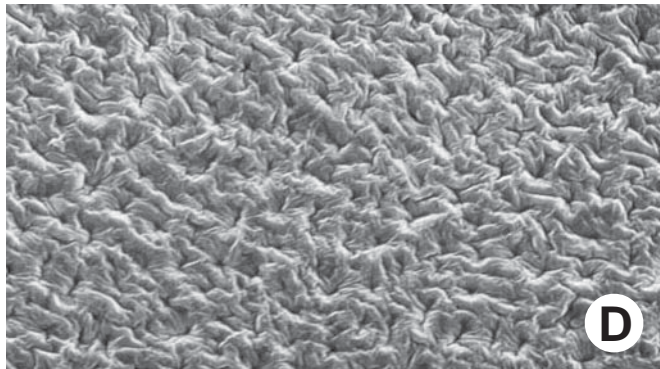
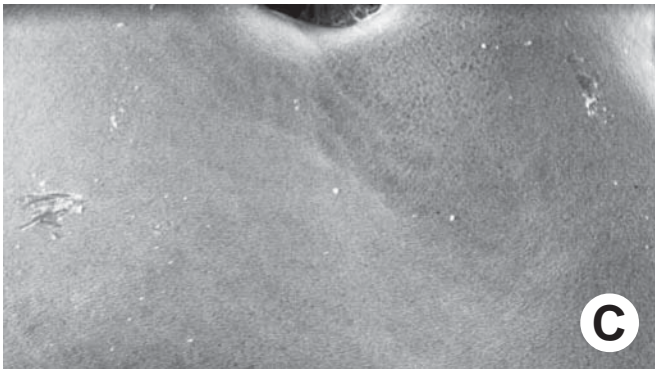
Distribution: Southeastern Russia and central Asia.

Eremosparton: *E. aphyllum* F.E.L. von Fischer & B. Meyer (C-E), *E. spp.* (A-B). A, Fruits ($\times 1.4$); B, seeds ($\times 6.3$); C-D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 6$).

D



E



Genus: *Halimodendron* F.E.L. von Fischer ex A.-P. de Candolle

Phylogenetic Number: 16.10.

Tribe: Galegeae.

Subtribe: Astragalinae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; unilocular; $2-4 \times 1-1.5 \times 0.7-1$ cm; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical; oblong or obovate; inflated; compressed; with beak; straight; with solid beak the same color and texture as fruit; short tapered or rounded at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; with sulcus (on dorsal suture); plain. Fruit wings absent. Fruit substipitate. Fruit indehiscent or with all layers dehiscing (tardily); splitting along suture. Dehiscence of valves along 1 suture; passive. Replum invisible. Epicarp dull; monochrome or multicolored; mottled; dark reddish brown, tan, or black; with black or tan overlay; glabrous; eglandular; without spines; not smooth; with elevated features; veined or not veined; reticulately veined; not tuberculate; faintly wrinkled; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; mottled; tan; with mottling (dark); with brown (reddish) overlay; smooth; nonseptate; coriaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 4–5; length parallel with fruit length; overlapping; in 2 or more series. Funiculus measured; up to 1.3 mm long; of 1 length only; thick; straight. Aril dry; rim-aril; white.

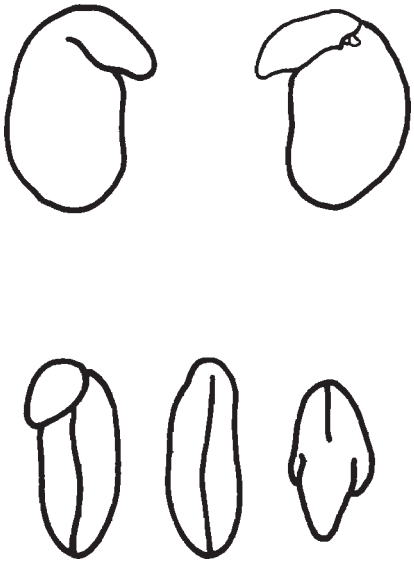
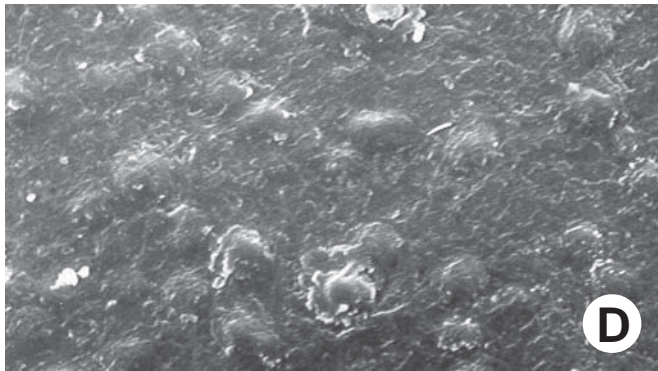
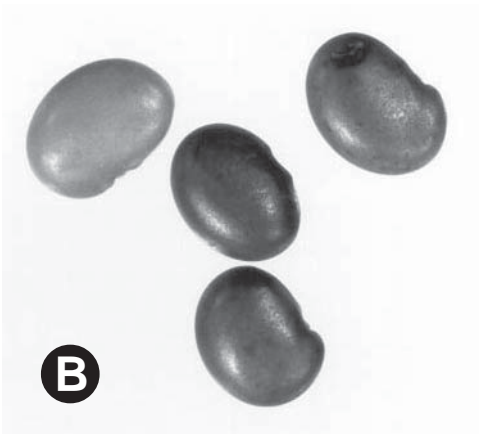
Seed $3-3.5 \times 2.4-2.8 \times 1.4-2.3$ mm; not overgrown; not angular; asymmetrical; oblong or reniform; compressed; with surface smooth; with or without visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome or mottled; with frequent mottles; reddish to greenish brown, orange, tan, or green; with black overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent.

Raphe not visible. Hilum fully concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.4 mm long; with curved outline; circular; marginal according to radicle tip or between cotyledon and radicle lobe; recessed; within rim. Hilum rim color darker than testa. Lens discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; 0.5 mm long; with margins straight or curved; triangular or irregular; not in groove of raphe; confluent with hilum; barely mounded; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; white or tan (pale); inner face flat. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary or moderately developed; glabrous.

Distribution: Turkey, Iran, Georgia to Siberia, and Afghanistan.

Halimodendron: *H. halodendron* (P.S. von Pallas) A. Voss (A–E). A, Fruits ($\times 1.4$); B, seeds ($\times 5.3$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 6$).

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Genus: *Caragana* P.C. Fabricius

Phylogenetic Number: 16.11.

Tribe: Galegeae.

Subtribe: Astragalinae.

Species Studied—Species in Genus: 21 spp.—ca. 80 spp.

Fruit a legume; unilocular; $2-6 \times 0.25-0.6 \times 0.15-0.4$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; linear; when asymmetrical with both sutures nearly straight; not inflated or inflated; compressed; without or with beak; declined; with solid beak the same color and texture as fruit; short tapered at apex; apex oblique with longitudinal axis of fruit; short tapered at base; base oblique with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible. Epicarp dull; monochrome; dark reddish brown; glabrous; glandular or eglandular; with glandular dots; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; somewhat wrinkled; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; reddish tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 2–5; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; up to 1 mm long; of 1 length only; thick; straight. Aril dry; rim-aril; white.

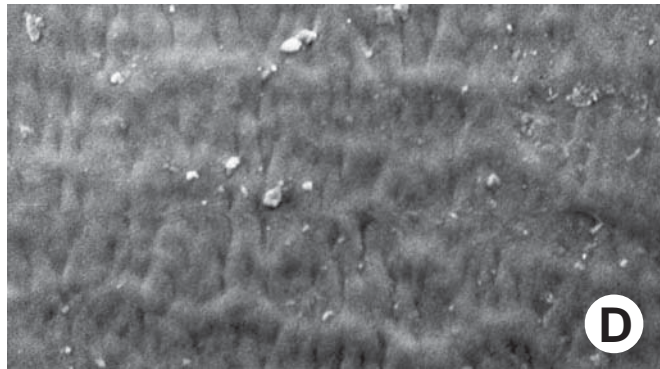
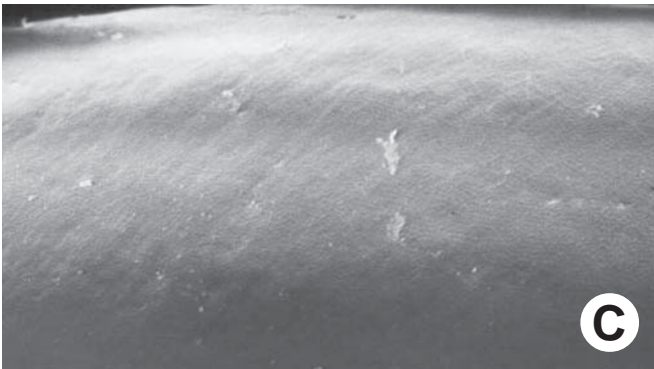
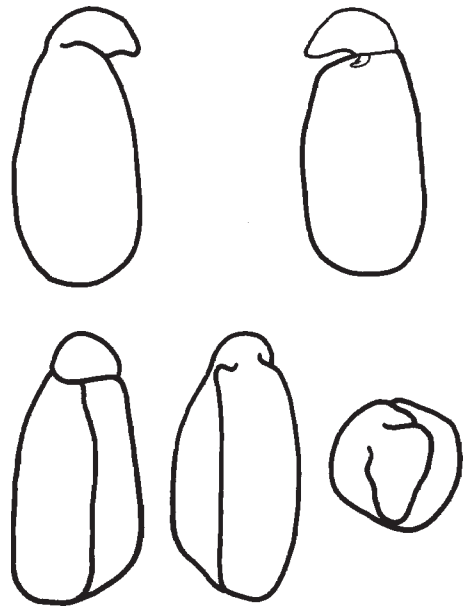
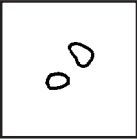
Seed $2.5-10 \times 2-4.5 \times 2-4.5$ mm; not overgrown; not angular or angular (barely); asymmetrical; oblong, linear, circular, or reniform; terete or compressed; with surface smooth; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull or glossy; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; dark reddish to orangish brown or orange; with brown (dark reddish) overlay; glabrous; smooth or not smooth; with recessed features; pitted

with small separate pits; chartaceous or coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe visible or not visible; from hilum to lens (at base of seed) or from lens to base of seed and terminating; not bifurcating; color of testa (barely darker); flush. Hilum partially concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform or larger than punctiform; 0.3–0.5 mm long; with curved outline; circular; marginal according to radicle tip or between cotyledon and radicle lobe; flush; not within corona, halo, or rim. Lens discernible or not discernible; equal to or greater than 0.5 mm or less than 0.5 mm in length; 0.2–1 mm long; with margins straight or curved; wedge-shaped, circular, or elliptic; not in groove of raphe; adjacent to or confluent with hilum; up to 3 mm from hilum; mounded or recessed; similar color as testa; barely darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length or 1 longer than other; not folded (though occasionally 1 cotyledon larger than other); margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; reddish tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary or moderately developed; glabrous.

Distribution: Eastern Europe, Asia, and naturalized in North America.

Notes: Yakovlev and Sviazeva (1984, 1985a, 1987) have treated some of the Russian species, and Gorbunova (1984) established a sectional and subsectional sequence for the genus.

Caragana: *C. densa* V.L. Komarov (*C-E*), *C. spp.* (*A-B*). *A*, Valves and dehisced fruits ($\times 2.1$); *B*, seeds ($\times 3.4$); *C-D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 6$).



Genus: *Calophaca* F.E.L. von Fischer ex A.-P. de Candolle

Phylogenetic Number: 16.12.

Tribe: Galegeae.

Subtribe: Astragalinae.

Species Studied—Species in Genus: 3 spp.—5 spp.

Fruit a legume; unilocular; $1-3 \times 0.3-0.5 \times 0.4-0.5$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; linear; when asymmetrical with both sutures nearly straight; inflated (when mature); terete (when mature); with beak; straight; with solid beak the same color and texture as fruit; short tapered at apex; apex aligned or oblique with longitudinal axis of fruit; tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain or embellished; with fringe (plain and glandular hairs). Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible. Epicarp dull; monochrome; dark reddish brown; pubescent and indurate; with 1 or 2 types of pubescence; puberulent or villous (restricted to sutures or throughout); with pubescence reddish brown or gray; with long and short gray plain-tipped hairs; with pubescence uniformly distributed; with simple and glandular hairs or glandular hairs; pliable; with hair bases plain; glandular; with glandular hairs (reddish-brown) or dots (reddish-brown); without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thick; surface not veined; 2-layered; without balsamic vesicles; without fibers; with vitreous layer over solid layer; coriaceous. Endocarp dull; monochrome; tan; cobwebby and spongy (but thinly filled); subseptate or nonseptate; with septa thin (tissue paper-like), flexible; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–8; length oblique to fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 1–2 mm long; of 1 length only; somewhat filiform; straight or curved. Aril absent.

Seed $4-8 \times 0.4-5 \times 0.1-3.3$ mm; not overgrown; not angular; asymmetrical; subreniform or oblong; com-

pressed; with surface smooth; with or without visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; with deep hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown; glabrous; smooth or not smooth; with elevated features; warty or wrinkled; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially or fully concealed; concealed by funicular remnant, radicle lobe, or wing; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform or punctiform; up to 0.7 mm long; with curved outline; elliptic; marginal according to radicle tip or between cotyledon and radicle lobe; flush; not within corona, halo, or rim. Lens discernible or not discernible; equal to or greater than 0.5 mm in length; 1 mm long; with margins straight; linear; not in groove of raphe; confluent with hilum; flush; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa or embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; reddish to dark reddish brown; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip curved or hooked; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 or 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

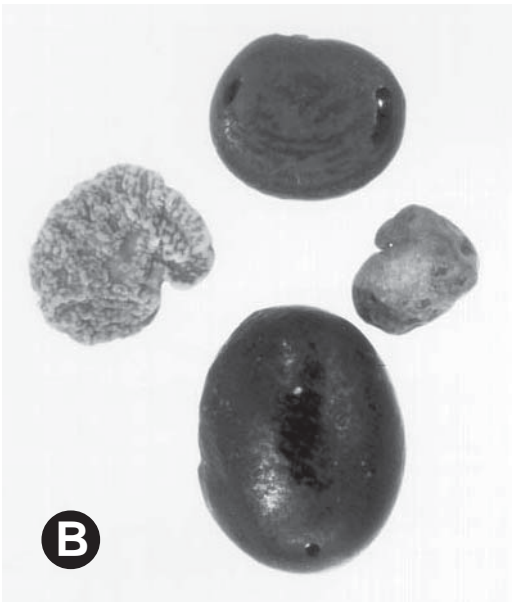
Distribution: Central Asia (4 spp.) and Russia (*C. wolgarica*).

Calophaca: *C. wolgarica* (C. Linnaeus f.) F.E.L. von Fischer ex A.-P. de Candolle (*C-E*), *C. spp.* (*A-B*). *A*, Fruits (dehiscent and closed) ($\times 1.4$); *B*, seeds ($\times 5.8$); *C-D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 6$).

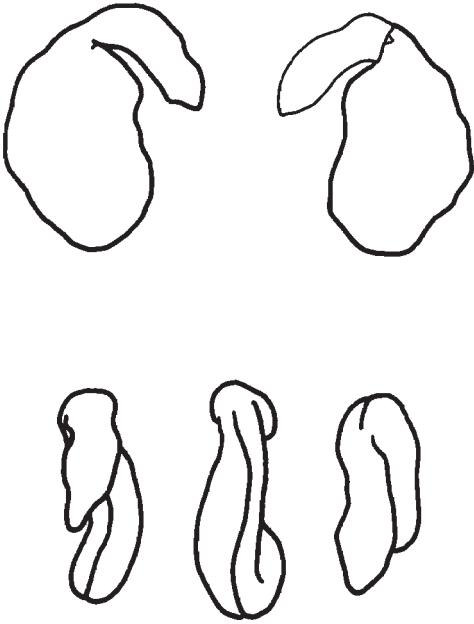
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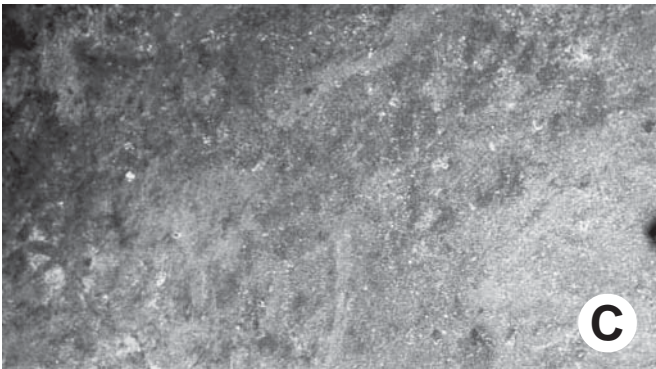
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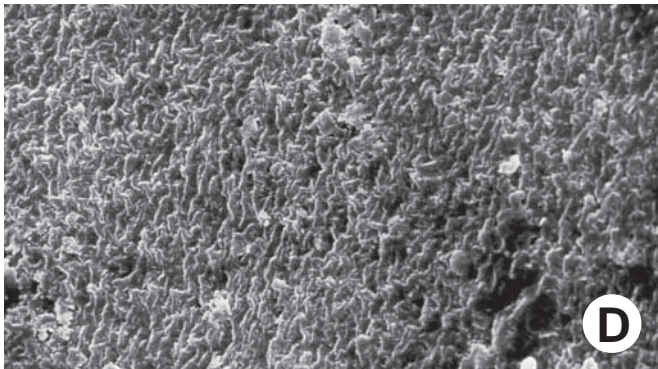
B



E



C



D

Genus: *Chesneya* J. Lindley ex S.F.L. Endlicher

Phylogenetic Number: 16.14.

Tribe: Galegeae.

Subtribe: Astragalinae.

Species Studied—Species in Genus: 9 spp.—20 spp.

Fruit a legume; unilocular; $2.5-8 \times 0.5-1.2 \times 0.2-0.5$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; lanceolate, linear (to lanceolate), or oblong; when asymmetrical with both sutures nearly straight; not inflated or inflated; compressed; with beak; straight; with solid beak the same color and texture as fruit; tapered at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally faintly visible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active or passive; with valves twisting. Replum invisible. Epicarp dull; monochrome; reddish brown; pubescent and indurate; with hairs erect or appressed; with 1 type of pubescence; puberulent or villous; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; brown; smooth and scurfy or cobwebby; septate or nonseptate; with septa thin (tissue paper-like), flexible; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 8–12; length parallel with fruit length; touching or neither overlapping nor touching; in 1 series. Funiculus measured; 0.5–4 mm long; of 1 length only; filiform (or nearly so); straight or curved (slightly). Aril absent.

Seed $2.5-6 \times 2-4 \times 1-1.2$ mm; not overgrown; not angular or angular; asymmetrical; mitaform (and bent on faces), reniform (and bent on faces), or irregular; compressed; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without umbo on

seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; brown to reddish brown or tan; with black overlay; glabrous; smooth or not smooth; with elevated or recessed features; wrinkled, warty, shagreen, or reticulate; pitted with small separate pits or large depressions on each face (2); chartaceous. Fracture lines absent. Rim absent. Wings absent. Raphe from hilum to lens; not bifurcating; darker than testa; blackish brown or black; flush. Hilum fully concealed; concealed by radicle lobe or wing; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; not within corona, halo, or rim. Lens barely discernible or not discernible; less than 0.5 mm in length; with margins curved; more or less circular; not in groove of raphe; adjacent to hilum; 1.5 mm from hilum; flush; dissimilar color from testa; darker than testa; blackish brown; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; reddish brown; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip hooked; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 or 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

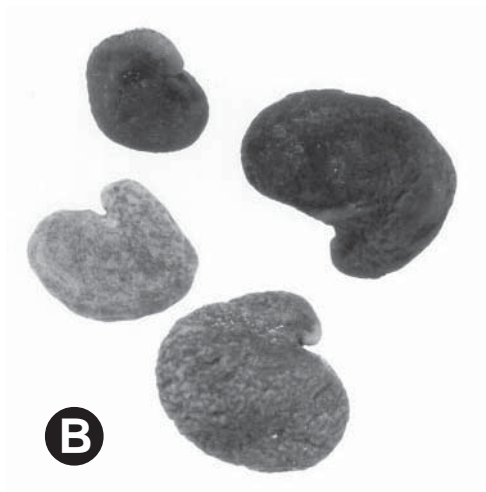
Distribution: Central and southwestern Asia to Mongolia.

Chesneya: *C. rytidosperra* H.F. Jaubert & É. Spach (*C-E*), *C. spp.* (*A-B*). *A*, Fruits (dehiscent) ($\times 1.1$); *B*, seeds ($\times 5.7$); *C-D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 6$).

a



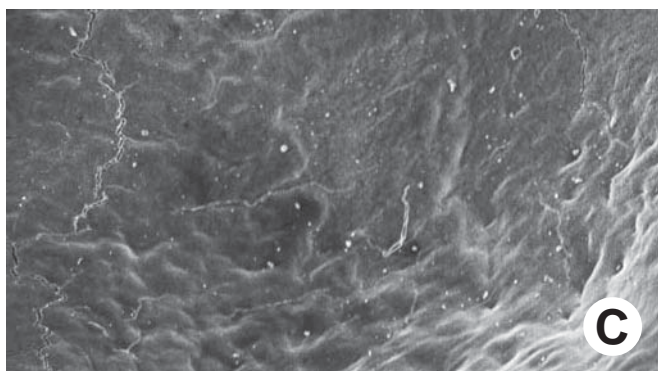
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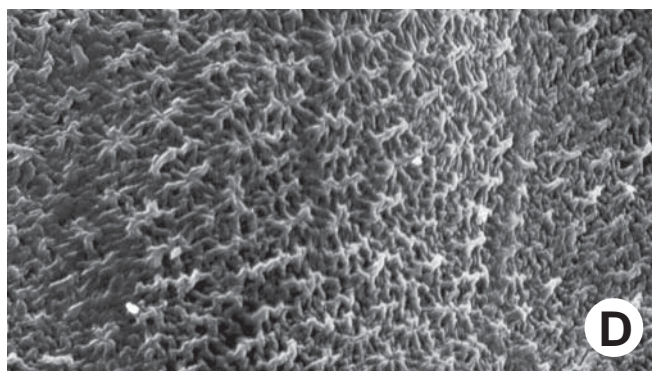
B



E



C



D

Genus: *Astragalus* C. Linnaeus

Phylogenetic Number: 16.15.

Tribe: Galegeae.

Subtribe: Astragalinae.

Species Studied—Species in Genus: 195 spp.—ca. 2,000 spp.

Fruit a legume; unilocular or bilocular (including semibilocular); $0.2\text{--}20 \times 0.15\text{--}6 \times 0.1\text{--}3$ cm; with persistent calyx; with calyx shorter than, equal in length to, or longer than fruit (and calyx inflated or not); without or with orifice formed by curving of fruit or fruit segments; straight, curved (or slightly curved), 0.5-coiled, 1-coiled, or S-curved; not plicate; not twisted; symmetrical or asymmetrical; linear, oblong, elliptic, circular, didymous, ovate, C-shaped, or falcate; when asymmetrical with both sutures parallelly curved, both sutures unequally curved, or 1 straight and 1 curved suture; widest near middle or D-shaped; not inflated or inflated; compressed, terete, subtriangular (to triangular), or quadrangular; without or with beak; straight, declined, coiled, or hooked; with solid beak the same color and texture as fruit; short tapered, tapered, long tapered, or rounded at apex; apex aligned or oblique with longitudinal axis of fruit; short tapered, tapered, long tapered, rounded, or truncate at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous, leathery, membranous, chartaceous, ligneous, drupaceous, or fleshy (when fresh); seed chambers externally invisible or visible; with the raised seed chambers not torulose. Fruit margin not constricted or constricted (one species, *A. shelkovnikovii* A.A. Grossheim); without or with sulcus (intrusion of dorsal or dorsal and ventral sutures); plain or embellished; with fringe (of spines). Fruit wings absent or present (narrow). Fruit nonstipitate (or sessile on stipelike gynophore), substipitate, or stipitate; with the stipe up to 35 mm long. Fruit with all layers dehiscent (valves may completely separate but because of the longitudinal walls which separate the 2 valves in bilocular legume, each half functioning as an “indehiscent fruit”) or indehiscent (fragile and usually inflated and easily fracturing); splitting along sutures. Dehiscence of valves along 1 suture or both sutures; apical and down or basal and up; active or passive; with valves reflexing (inflexed). Replum invisible. Epicarp dull; monochrome or multicolored; mottled; brown to reddish or blackish brown, tan (to purplish tan), black,

green, or purple; with purple, red, brown (purplish), or green overlay; with mottling over seed chambers; pubescent and indurate or glabrous; with hairs erect or appressed; with 1 or 2 types of pubescence; pilose, puberulent, tomentose, velutinous, villous, or sericeous; with pubescence gray or black (to rusty); with gray and black hairs intermixed; with pubescence uniformly distributed; with simple or complex hairs; T-shaped hairs (malpighiaceus); pliable or stiff; with hair bases plain or swollen (somewhat); antrorse; straight or hooked at apex; eglandular or glandular; with glandular dots (reddish); without spines; not smooth or smooth; with elevated features; veined (venation not ribbed to ribbed); reticulately veined or transversely veined relative to fruit length; not tuberculate; rugose (to reticulate), verrucose-rugose, or wrinkled (irregularly to regularly or cross to lengthwise); not exfoliating; without cracks. Mesocarp present or absent (or nearly so); thin or trace; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; ligneous (or subligneous), coriaceous, or chartaceous. Endocarp dull; monochrome; tan; smooth, cobwebby, or fibrous; nonseptate (longitudinal separation between seed chambers making 2 loculi); chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; remaining fused to epicarp; entire. Seeds 1–20; length parallel with or transverse to fruit length; neither overlapping nor touching, touching, or overlapping; in 2 or more or 1 series. Funiculus less than 0.5 mm long or measured; up to 15 mm long; of 1 length only (and with or without hairs); filiform, thick, or triangular; straight, curved, or hooked. Aril dry; rim-aril; greenish brown, tan, white, or green.

Seed $1\text{--}7 \times 0.8\text{--}5 \times 0.1\text{--}0.6$ mm; not overgrown or rarely overgrown, 1 seed filling entire fruit cavity; not angular or angular (dented or not on faces); asymmetrical or symmetrical (except hilum); mitaform, oblong, reniform, rectangular, rhombic, triangular, pyriform, elliptic, D-shaped, cordate, or irregular; compressed; with surface smooth; without or with visible radicle and cotyledon lobes; without or with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; with deep or shallow hilar sinus or without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull or glossy; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent or infrequent mottles; with frequent or infrequent streaks; reddish to yellowish brown to brown, tan (to greenish tan), cream, green (yellowish), olive, orange, yellow, purple, or black; with black,

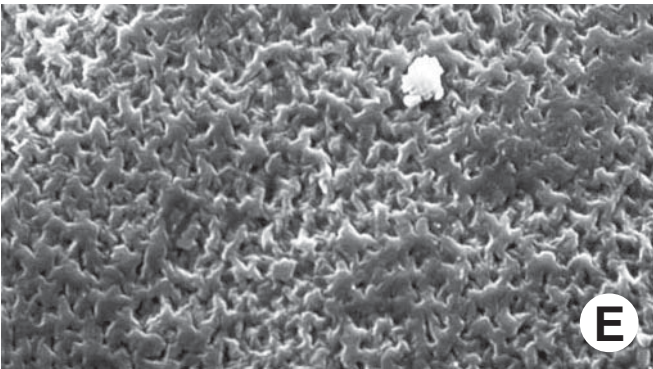
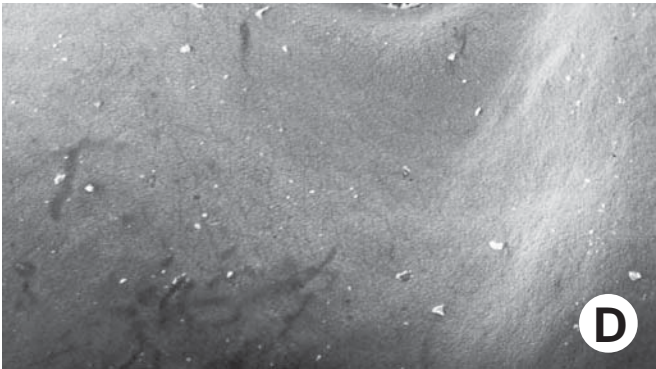
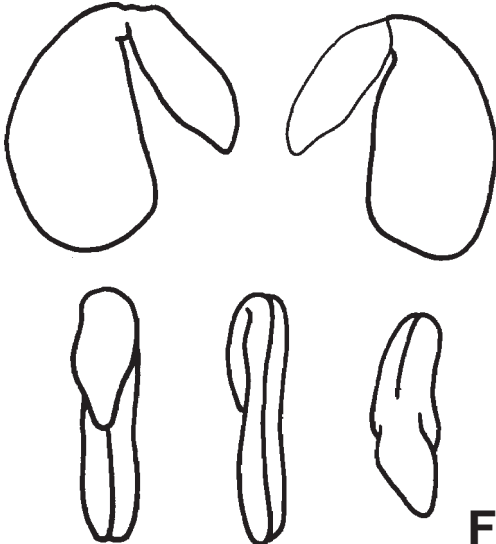
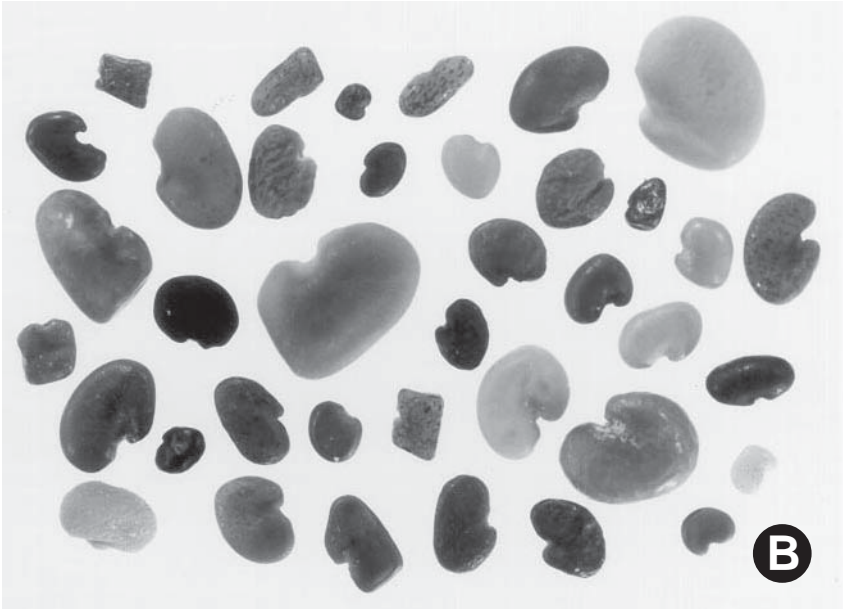
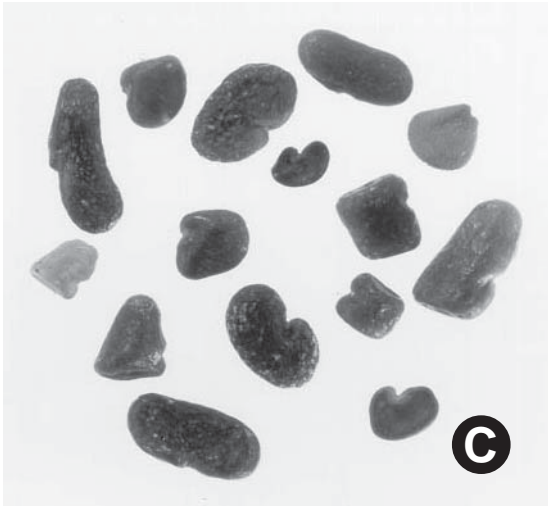
purple, or red overlay; glabrous; smooth (sometimes with a fine reticulate-colored pattern on smooth surface) or not smooth; with elevated or recessed features; rugose or wrinkled; pitted with small separate pits or concaved; coriaceous or chartaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible or visible; from hilum to lens; not bifurcating; darker than testa; reddish brown to brown; flush. Hilum visible or partially concealed; concealed by wing; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform or larger than punctiform; up to 0.5 mm long; with curved outline; circular; between cotyledon and radicle lobe; recessed; not within corona, halo, or rim or within halo. Hilum halo color lighter than testa. Lens discernible or not discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; up to 1 mm long; with margins straight or curved; oblong, linear, elliptic, or 2 circular mounds separated by groove; not in groove of raphe; adjacent to or confluent with hilum; 0.2 mm from hilum; mounded or flush; similar or same color as testa; darker than testa; brown or tan (greenish); not within corona, halo, or rim. Endosperm thick or thin; covering entire embryo; adnate to embryo or testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan or brown (reddish); inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous (some almost 1/2 size of cotyledons); lobe tip straight, curved, or hooked; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 or 1/2 to nearly length of cotyledons. Plumule rudimentary or moderately developed; glabrous.

Distribution: North America to South America (Patagonia), Europe, Russia, temperate northern Africa, tropical Africa (mountains), the Iranian Plateau, northern India, China, and Japan.

Notes: *Astragalus* has more species than any other legume genus and more than most other genera, regardless of family. There are a remarkable number of publications dealing with the species in various parts of the world, and a few of the major ones include: North America, Barneby (1964) and Isely (1983, 1984, 1985, 1986); southern temperate South America, Johnston (1938,

1947); highlands of tropical Africa, Gillett (1963a); Iran, Maassoumi (1986, 1989); Russia, Gontscharov and Borisova (1946); Pakistan and Himalayas, Ali (1961). In addition Maassoumi, Podlech, and others have issued a series of more than 30 papers for the Near East. Several sections of *Astragalus* have been monographed: Section *Acanthophaea* A.A. von Bunge and section *Aegacantha* A.A. von Bunge (Deml 1972); section *Alopecuroidei* A.-P. de Candolle (Becht 1978); section *Caprini* A.-P. de Candolle (Podlech 1988); sections *Chlorostachys* A.A. von Bunge, *Phyllobium* A.A. von Bunge, and *Skythropos* N.D. Simpson (Wenninger 1991); section *Chronopus* A.A. von Bunge (Ott 1978); section *Dasyphyllium* A.A. von Bunge (Aytaç 1997); section *Eremophysa* A.A. von Bunge and section *Eremophysopsis* N.F. Gontscharov (Podlech 1993); section *Herpocaulos* A.A. von Bunge (Podlech 1984); section *Laxiflori* C. Agerer-Kirchhoff (Agerer-Kirchhoff and Agerer 1977); section *Megalocystis* A.A. von Bunge (Tietz and Zarre 1994); section *Platyglottis* A.A. von Bunge (Podlech 1990); section *Sesamei* A.-P. de Candolle (Gazer 1993); and section *Theiochrus* A.A. von Bunge (Podlech and Kozik 1983). Sanderson and Liston (1995) cladistically analyzed the Galegeae genera using molecular data. They concluded that *Astragalus* is monophyletic with *Astracantha* (16.16) nested within it and that *Astracantha* should be included in it, possibly as a subgenus. Zarre and Podlech (1997), using morphological and anatomical data, concurred that *Astracantha* should not be maintained as a genus. They concluded that it should be synonymized with *Astragalus* and that it cannot be maintained even at subgeneric level. Polhill (1994b) maintained *Neodielsia* H.A.T. Harms (16.18) as a genus, but Mabblerley (1997) kept it as a synonym of *Astragalus*. We have chosen to follow Mabblerley. Barneby (1964) and others, including Hutchinson (1964), who noted that “an important feature of the *Astragalus* pod is the septum or longitudinal wall produced across the cavity from the dorsal suture.” Because we have restricted the term “septum” to the transverse wall of a legume that separates seeds, we will not use “septum” in the sense used by Barneby and others. We agree with Barneby that legumes endowed with a complete internal longitudinal wall are to be termed bilocular (replacing two-celled fruits of the literature). A partial walled cavity is termed “semibilocular,” and a pod lacking this wall is “unilocular.” Barneby (1964) has a detailed discussion of *Astragalus* fruits.

Astragalus: *A. crassicaarpus* T. Nuttall (*D–F*), *A. spp.* (*A–C*).
A, Fruits ($\times 1$); *B–C*, seeds ($\times 4.1$, $\times 4.5$); *D–E*, testa
($\times 50$, $\times 1000$); *F*, embryos ($\times 10$).



Genus: *Biserrula* C. Linnaeus

Phylogenetic Number: 16.15A.

Tribe: Galegeae.

Subtribe: Astragalinae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; bilocular; $1.2\text{--}5 \times 0.4\text{--}1 \times 0.3\text{--}0.7$ cm; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate (but occasionally irregularly bent); not twisted; symmetrical; linear; not inflated; flattened; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered and truncate at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; seed chambers externally invisible. Fruit margin constricted along both margins; without sulcus; embellished or plain (*B. pelecinus* subsp. *leiocarpa* (A. Richard) J.B. Gillett); with fringe (sinuate dentate with denticulate lobes). Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome; brown to reddish brown; glabrous or pubescent but soon deciduous; with 1 type of pubescence; pilose; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; transversely veined relative to fruit length and reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; reddish brown; smooth and cobwebby (near sutures and funiculi); nonseptate (longitudinal separation between seed chambers making 2 locules); chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 5–21; length parallel with or transverse to fruit length; neither overlapping nor touching; in 2 or more series. Funiculus measured; 0.5–0.8 mm long; of 1 length only; filiform; straight. Aril dry; rim-aril; reddish brown.

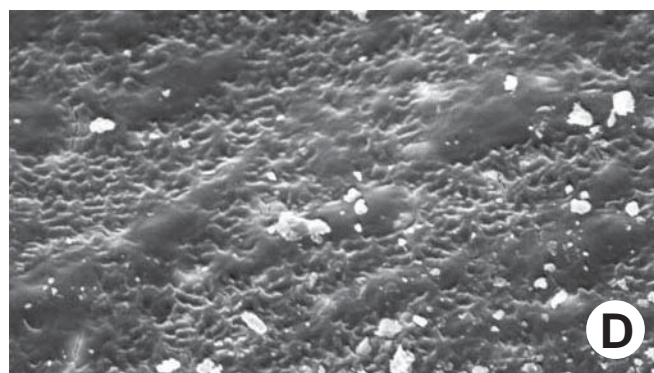
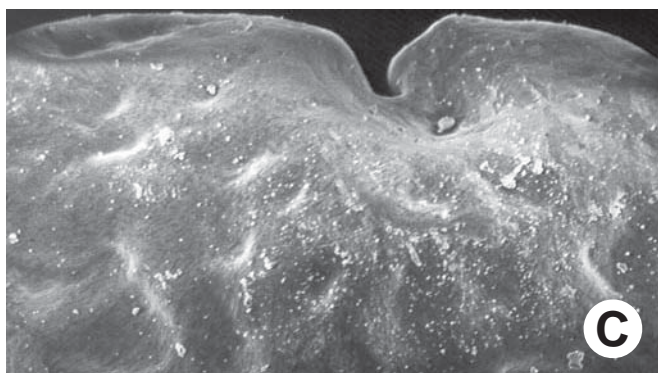
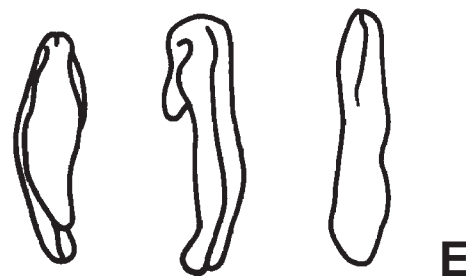
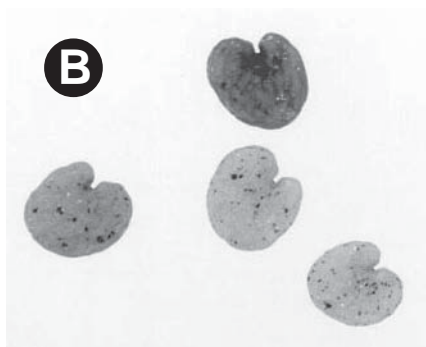
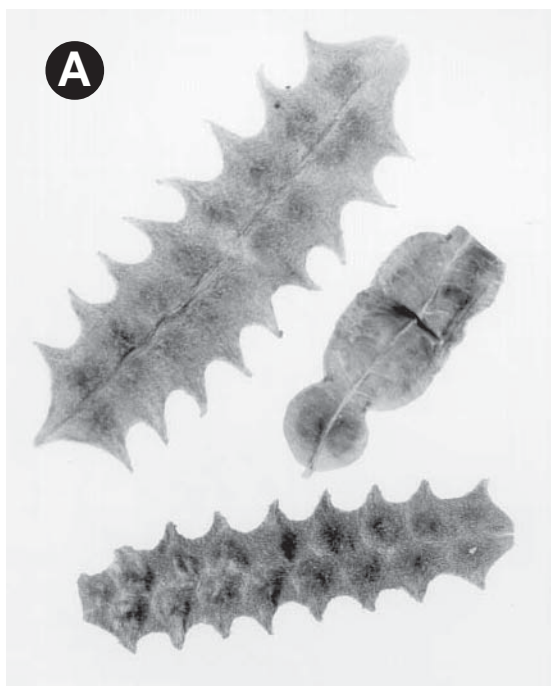
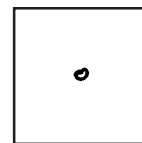
Seed $1.5\text{--}2 \times 1.5\text{--}2 \times 0.7\text{--}0.8$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; with deep hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; clear (except for mottles) or

colored; monochrome or mottled; with frequent mottles; reddish brown, tan, white, or yellow; with black or purple overlay; glabrous; not smooth; with elevated or recessed features; reticulately wrinkled; punctate; chartaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially or fully concealed; concealed by radicle lobe or wing; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; within rim. Hilum rim color of testa. Lens discernible; less than 0.5 mm in length; with margins straight; diamond-shaped; not in groove of raphe; confluent with hilum; mounded; dissimilar color from testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; reddish brown, tan, yellow, or white; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight or curved (slightly); deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Mediterranean region and northeastern and eastern tropical Africa.

Notes: Barneby (1964) included this taxon in *Astragalus* (16.15) as *A. pelecinus* (C. Linnaeus) R.C. Barneby.

Biserrula: *B. pelecinus* C. Linnaeus (A–E). A, Fruits ($\times 2.3$); B, seeds ($\times 8$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 15$).



Genus: *Astracantha* D. Podlech

Phylogenetic Number: 16.16.

Tribe: Galegeae.

Subtribe: Astragalinae.

Species Studied—Species in Genus: 5 spp.—215 spp.

Fruit a legume; unilocular; $0.3\text{--}0.6 \times 0.15\text{--}0.35 \times 0.15\text{--}0.35$ cm; with persistent calyx; with calyx longer or shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; circular; when asymmetrical with both sutures unequally or parallelly curved; inflated; terete; without beak; rounded at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive. Replum invisible. Epicarp dull; monochrome; black; pubescent and indurate; with 1 type of pubescence; somewhat villous; with pubescence dull and dark golden; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases swollen; eglandular; without spines; smooth or not smooth; with elevated features; not veined; not tuberculate; somewhat wrinkled; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp glossy; monochrome; brownish black; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1(–2); length parallel with or transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; assumed straight. Aril absent or present; dry; rim-aril; tan.

Seed $2\text{--}7 \times 2\text{--}4.5 \times 1\text{--}2$ mm; not overgrown; angular or not angular; asymmetrical; mitaform, oblong, rectangular (more or less), or D-shaped; compressed; with surface smooth; with visible radicle and cotyledon lobes; with or without external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as or lighter in color than testa; without hilar sinus; without umbo on

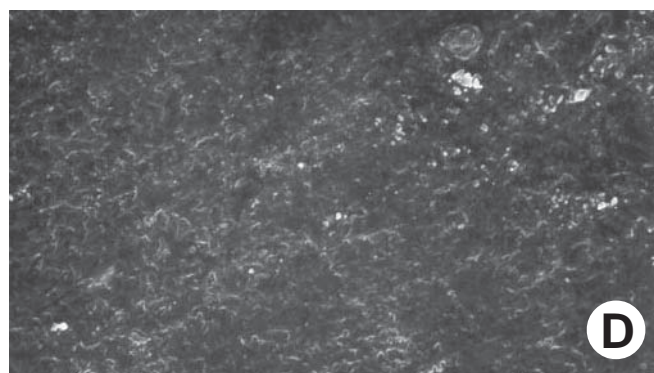
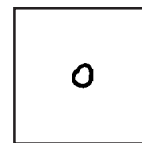
seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled; reddish brown or tan (reddish to greenish); glabrous; smooth or not smooth; with elevated or recessed features; rugose or wrinkled; pitted with small separate pits; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe visible or not visible; from hilum to lens; not bifurcating; darker than testa; reddish brown; raised. Hilum visible or fully concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform or larger than punctiform; $0.3\text{--}0.4$ mm long; with curved outline; more or less circular; between cotyledon and radicle lobe; slightly recessed; within rim. Hilum rim color of testa. Lens discernible; less than 0.5 mm in length; with margins straight or curved; triangular or circular; not in groove of raphe; adjacent to or confluent with hilum; up to 0.3 mm from hilum; mounded; similar color as testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; white; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; parallel to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than $1/2$ or $1/2$ to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Europe and Russia.

Notes: Podlech (1983) founded the genus, a segregate of *Astragalus* (16.15), and the species count is based on his work. Reer and Podlech (1986) expanded on the original paper, and this was followed by a seed morphology study with testa micrographs by Engel (1990). Sanderson and Liston (1995) performed cladistic analyses for the Galegeae genera using molecular data. They concluded that *Astragalus* (16.15) is monophyletic with *Astracantha* nested within it and that *Astracantha* should be returned to it, possibly as a subgenus. Zarre and Podlech (1997), using morphological and anatomical data, concurred that *Astracantha*

should not be maintained as a genus. They concluded that it should be synonymized with *Astragalus* and that it cannot be maintained even at the subgeneric level. Our number of seed and fruit samples is inadequate, but our morphological data were enhanced by the cited literature.

Astracantha: *A. echinus* (A.-P. de Candolle) D. Podlech (*A*),
A. gossypina (F.E.L. von Fischer) D. Podlech (*C-E*), *A.*
spp. (*B*). *A*, Fruit ($\times 2.8$); *B*, seeds ($\times 6.5$); *C-D*, testa
($\times 50$, $\times 1000$); *E*, embryos ($\times 1$).



Genus: *Oxytropis* A.-P. de Candolle

Phylogenetic Number: 16.17.

Tribe: Galegeae.

Subtribe: Astragalinae.

Species Studied—Species in Genus: 31 spp.—ca. 300 spp.

Fruit a legume; unilocular; $0.8-4 \times 0.3-0.8 \times 0.3$ cm; with persistent calyx; with calyx shorter or longer than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (or slightly curved); not plicate; not twisted; symmetrical or asymmetrical; oblong, linear, circular, falcate, or C-shaped; when asymmetrical with both sutures parallelly curved; not inflated or inflated; compressed or terete; with beak; straight or declined; with solid beak the same color and texture as fruit; short tapered, tapered, or long tapered at apex; apex aligned, oblique, or right-angled with longitudinal axis of fruit; long tapered or short tapered at base; base aligned or right angled with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous, membranous, coriaceous, or ligneous; seed chambers externally invisible. Fruit margin not constricted; with sulcus (seed bearing suture more or less intruded but legume undivided); plain. Fruit wings absent. Fruit nonstipitate, substipitate, or stipitate; with the stipe up to 15 mm long. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along 1 suture or both sutures; apical and down; passive or active; with valves twisting (loosely). Replum invisible. Epicarp dull; monochrome or multicolored; mottled; brown; with purple overlay; pubescent and indurate or pubescent but soon deciduous; with hairs appressed or erect; with 1 or 2 types of pubescence; puberulent, villous, or velutinous; with pubescence golden or gray and black; with gray and black hairs intermixed; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; glandular or eglandular; without spines; not smooth; with elevated features; reticulately veined or transversely veined relative to fruit length; not tuberculate; wrinkled; not exfoliating; without cracks. Mesocarp present or absent; thin or thick; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous or chartaceous. Endocarp dull or glossy; monochrome; tan; smooth or cowebby; nonseptate; chartaceous or coriaceous; not exfoliating; remaining fused to mesocarp and epicarp; remaining fused to epicarp; separating into 1-seeded winged

segments. Seeds (3–)5–11; length parallel with fruit length; neither overlapping nor touching; in 2 or more or 1 series. Funiculus measured; 1 mm long; of 1 length only; filiform; S-curved or curved. Aril dry; rim-aril; reddish brown.

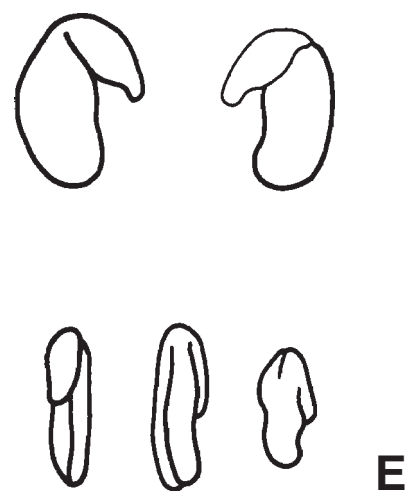
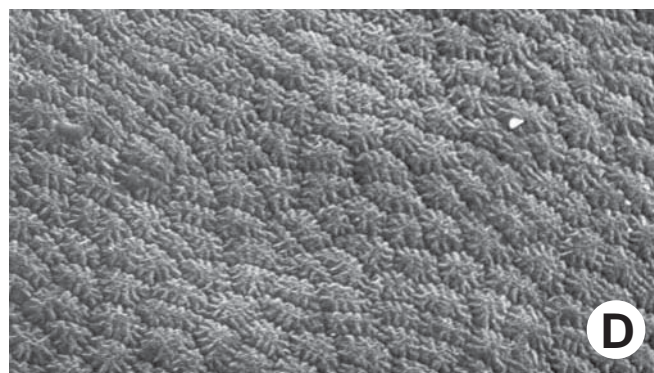
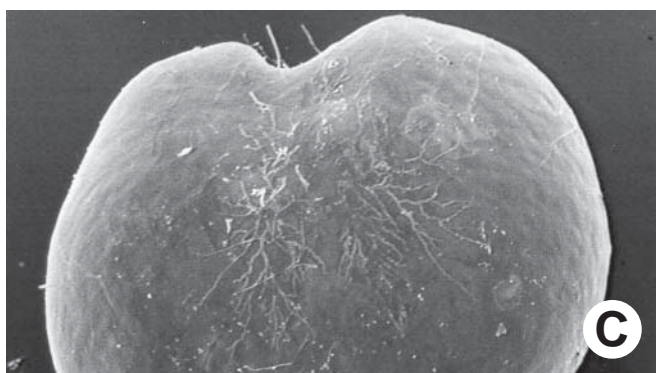
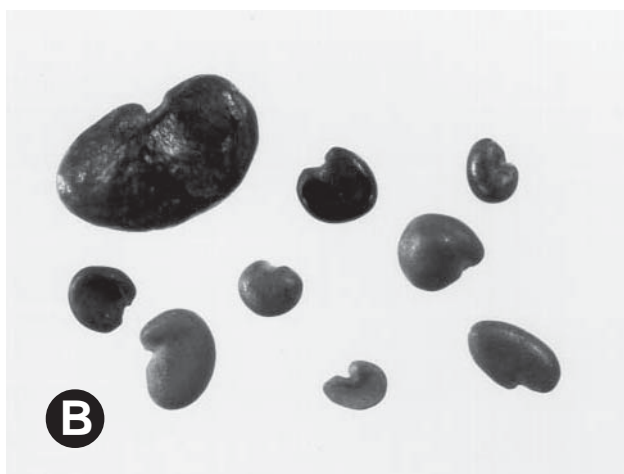
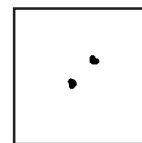
Seed $0.75-3.5 \times 1-1.5 \times 0.5-1$ mm; not overgrown; not angular; asymmetrical; mitaform, reniform, circular, or quadrangular; compressed; with surface smooth; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; brown to reddish to greenish or pinkish brown, tan, yellow (greenish), orange, olive, green, or black; with black or purple overlay; glabrous; smooth or not smooth; with elevated features; rugose or shagreen; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; not within corona, halo, or rim or within halo. Hilum halo color lighter than testa. Lens discernible; less than 0.5 mm in length; with margins curved; elliptic; not in groove of raphe; adjacent to or confluent with hilum; 0.2 mm from hilum; mounded; similar color as testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon width; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: North America (22 spp.) and Eurasia.

Notes: Barneby (1952) monographed the North American species and noted that only two species were found between 1802 and 1951 that challenged the original circumscription of *Oxytropis*. *Oxytropis* has an “intro-

flexion of the pod's ventral suture, as opposed to the muticous keel of *Phaca* and *Astragalus*, with their pods unilocular or bilocular (from the dorsal suture) respectively." *Phaca* C. Linnaeus is subsumed into *Astragalus* (16.15). Fedchenko et al. (1948) reported on the species in Russia, and Ulziykhutag (1979) summarized the 78 Mongolian species in 17 sections. The testa surfaces and transverse sections of *O. riparia* D.I. Litvinov and *O. campestris* (C. Linnaeus) A.-P. de Candolle were studied using SEM (Solum and Lockerman 1991). Pandey and Jha (1988) also reported on testa micrographs of three species of *Oxytropis*, including *O. campestris*.

Oxytropis: *O. pilosa* (C. Linnaeus) A.-P. de Candolle (*C–E*),
O. spp. (*A–B*). *A*, Fruits ($\times 1.5$); *B*, seeds ($\times 5.6$); *C–D*,
testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 10$).



Genus: *Gueldenstaedtia* F.E.L. von Fischer

Phylogenetic Number: 16.19.

Tribe: Galegeae.

Subtribe: Astragalinae.

Species Studied—Species in Genus: 9 spp.—14 spp.

Fruit a legume; unilocular; $1.2-3 \times 0.25-0.4 \times 0.13-0.15$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; linear or ovate (rarely); when asymmetrical with both sutures nearly straight; not inflated; terete; with beak; coiled (to almost so); with solid beak the same color and texture as fruit; short tapered at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible. Epicarp dull; monochrome or multicolored; streaked; reddish brown; with black overlay; pubescent and indurate or pubescent but soon deciduous; with 1 type of pubescence; puberulent, villous, or tomentose; with pubescence golden or gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; not veined; not tuberculate; shagreen (bases of deciduous hairs); not exfoliating; without cracks. Mesocarp trace; surface not veined; 1-layered; without balsamic vesicles; without fibers; vitreous (tiny separate dots); chartaceous. Endocarp dull; monochrome; tan; smooth or fibrous (somewhat between seeds); nonseptate (though thinly hairy between seeds) or subseptate; with septa thin (tissue paper-like), flexible; with septa eglandular; coriaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 3–17; length transverse to or parallel with fruit length; touching; in 2 or more series. Funiculus measured; 0.5–1 mm long; of 1 length only; filiform; straight or hooked. Aril absent.

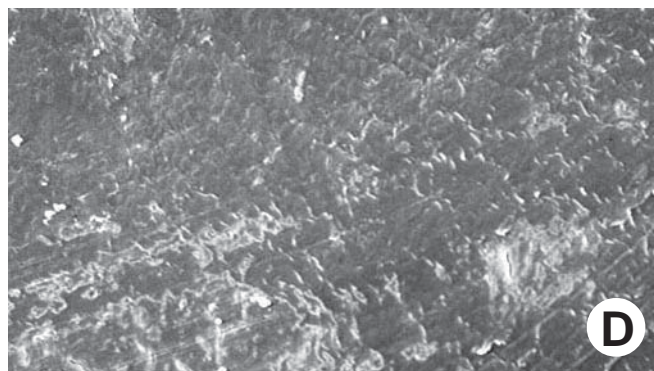
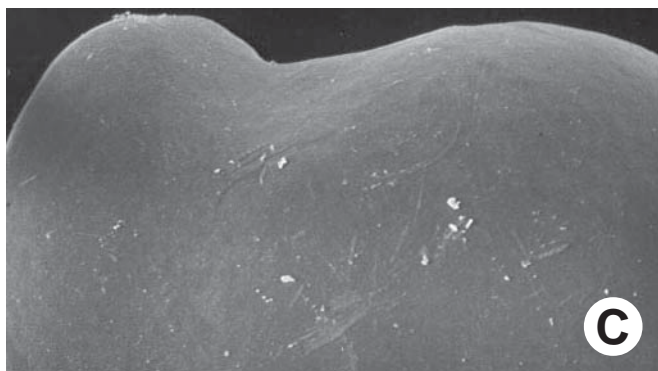
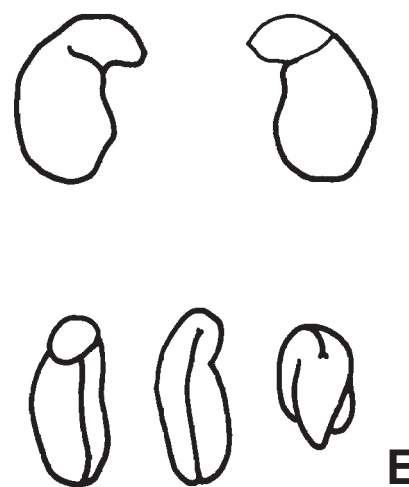
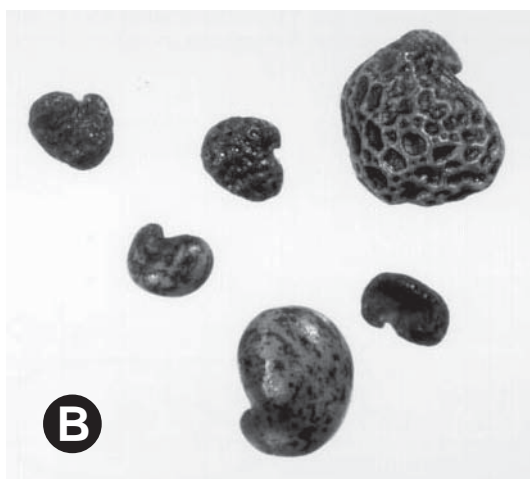
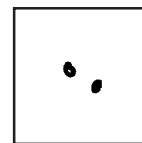
Seed $1-1.5 \times 1-1.5 \times 0.4-0.7$ mm; not overgrown; not angular or angular; asymmetrical; mitaform, reniform, oblong, or quadrangular (somewhat); compressed; with surface smooth; with visible radicle and cotyledon

lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome or mottled and streaked; greenish brown; with black overlay; glabrous; smooth or not smooth; with elevated or recessed features; reticulate; pitted with small separate pits; chartaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by radicle lobe or wing; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; within halo. Hilum halo color darker than testa. Lens discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; 0.5 mm long; with margins straight or curved; oblong; not in groove of raphe; confluent with hilum; mounded; dissimilar color from testa; darker than testa; reddish brown; within halo. Lens halo color darker than testa. Endosperm thin; covering entire embryo; adnate to embryo or testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan or white; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight or curved; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Sino-Himalayan region to Siberia.

Notes: Yakovlev (1980) reported on the two species in the former U.S.S.R. Mabberley (1997) cited 14 species in the genus, which is the number used here.

Gueldenstaedtia: *G. himalaica* J.G. Baker (C–E), *G.* spp. (A–B). A, Fruits ($\times 2.2$); B, seeds ($\times 7.7$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



Genus: *Galega* C. Linnaeus

Phylogenetic Number: 16.20.

Tribe: Galegeae.

Subtribe: Galeginae.

Species Studied—Species in Genus: 5 spp.—6 spp.

Fruit a legume; unilocular; $3\text{--}3.5 \times 0.2\text{--}0.9 \times 0.12\text{--}0.13$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; symmetrical; linear; not inflated; compressed; with beak; straight; with solid beak the same color and texture as fruit; tapered at apex; apex aligned with longitudinal axis of fruit; tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible or visible; with the raised seed chambers not torulose. Fruit margin not constricted or constricted; constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; active; with valves twisting. Replum invisible. Epicarp dull; monochrome; dark reddish brown; glabrous or pubescent and indurate; with 1 type of pubescence; puberulent; with pubescence gray; with pubescence uniformly distributed; with glandular hairs; pliable; with hair bases plain; glandular; with glandular hairs; without spines; not smooth; with elevated features; longitudinally veined relative to fruit length; not tuberculate; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; smooth; nonseptate; coriaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1–6; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 1 mm long; of 1 length only; filiform; curved. Aril dry; rim-aril; reddish brown.

Seed $3.5\text{--}4.5 \times 1.8\text{--}2 \times 1\text{--}1.5$ mm; not overgrown; not angular; asymmetrical; reniform or linear; compressed; with surface smooth; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; orange or yellow; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings

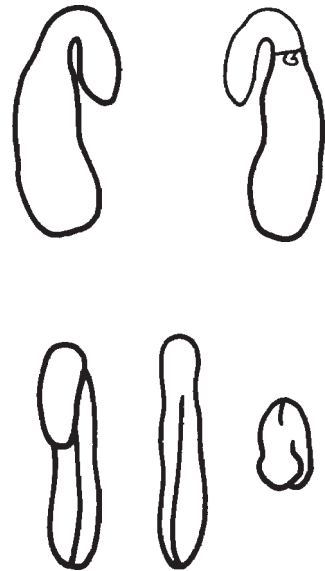
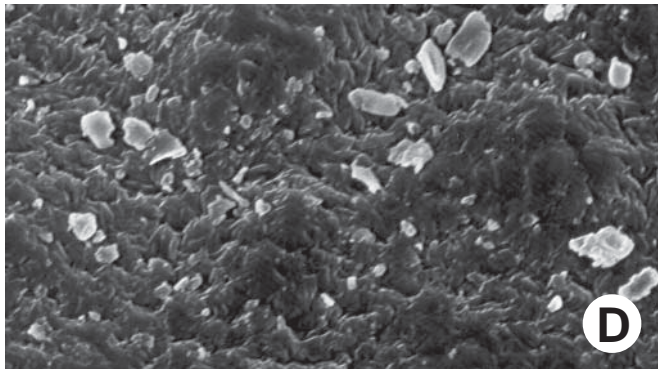
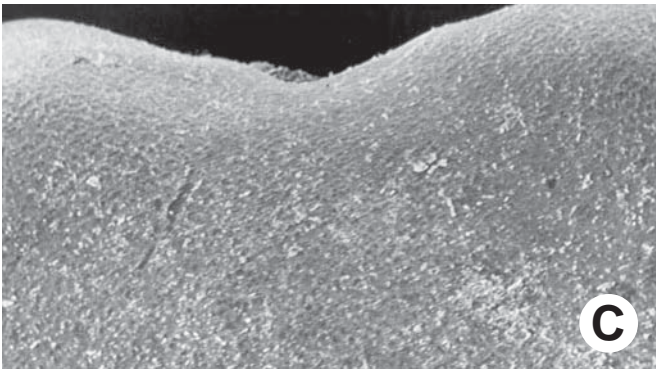
absent. Raphe not visible. Hilum visible or partially concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.4–0.5 mm long; with curved outline; circular; marginal according to radicle tip; recessed; within halo. Hilum halo color lighter than testa. Lens discernible; equal to or greater than 0.5 mm in length; up to 1 mm long; with margins straight or curved; oblong or triangular; not in groove of raphe; confluent with or adjacent to hilum; 0.3 mm from hilum; mounded; dissimilar color from testa; darker than testa; reddish brown or orange; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow or brown (reddish); inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; with a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed or rudimentary; glabrous.

Distribution: Eastern Africa and Eurasia.

Notes: Gillett (1963b) studied the *Galega* species in the mountains of eastern tropical Africa. Pandey and Jha (1988) described the testa of *G. officinalis* using the SEM.

Galega: *G. officinalis* C. Linnaeus (C–E), *G. spp.* (A–B). A, Fruits ($\times 1.7$); B, seeds ($\times 7.6$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 6$).

6



Genus: *Alhagi* F. Gagnepain

Phylogenetic Number: 16.21.

Tribe: Galegeae.

Subtribe: Alhagiinae.

Species Studied—Species in Genus: 3 spp.—3 spp.

Fruit a legume or loment (or loment segment, only tardily separating: see Notes); unilocular; $0.8\text{--}2 \times 0.2\text{--}0.4 \times 0.2\text{--}0.4$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (or slightly curved); not plicate; not twisted; asymmetrical; linear or moniliform; when asymmetrical with both sutures unequally curved, 1 straight and 1 curved suture, or both sutures nearly straight; narrowing in several places, resembling *Desmodium* (9.09) fruit; not inflated; terete; with beak; straight or declined; with solid beak the same color and texture as fruit; rounded at apex; apex aligned or oblique with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous or coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin constricted (some constrictions may be well developed) or not constricted; constricted along both margins or constricted only on 1 margin; without sulcus; plain. Fruit wings absent. Fruit substipitate or stipitate (because of aborting of lowest seed chamber); with the stipe up to 5 mm long. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments widest across seed area; oblong. Epicarp dull; monochrome; reddish to blackish brown or tan; glabrous, pubescent and indurate (especially between seed chamber), or pubescent but soon deciduous; with hairs appressed or erect; with 1 type of pubescence; sericeous (to sparingly); with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; glandular or eglandular; with glandular dots (reddish-brown); without spines; smooth or not smooth; with elevated features; not veined; not tuberculate; warty or wrinkled; not exfoliating; without cracks. Mesocarp thick; surface not veined; 2-layered; without balsamic vesicles; without fibers; with solid layer over vitreous layer; coriaceous. Endocarp dull; monochrome or mottled; white; with mottling (dark); with brown (reddish-brown (vitreous layer of mesocarp)) overlay; smooth; septate; with septa

thicker than paper, firm; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–9; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril dry; rim-aril; blackish brown or black.

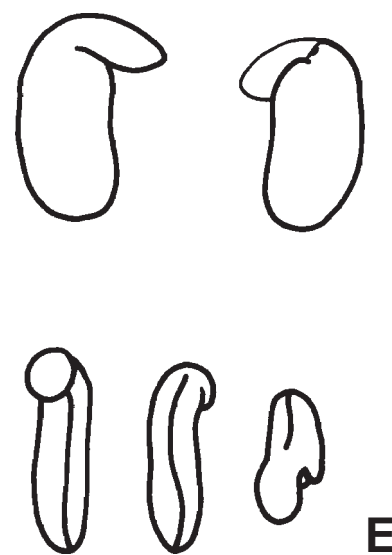
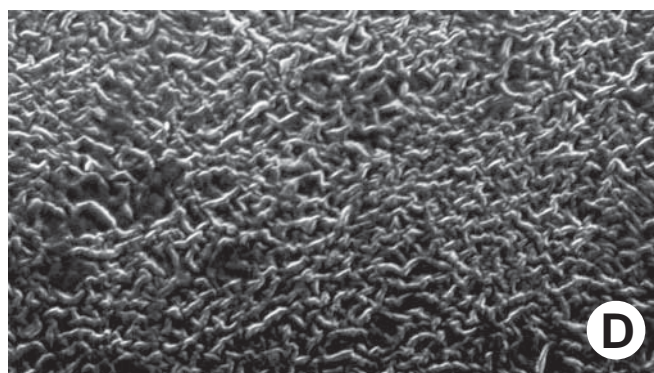
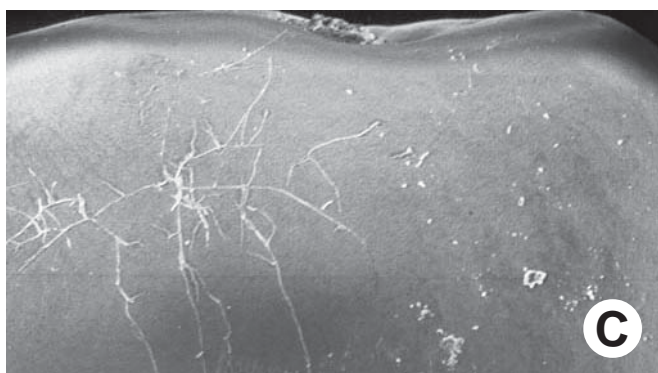
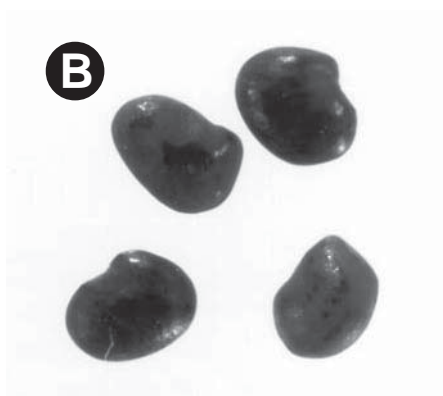
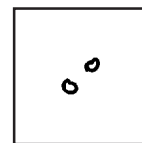
Seed $2\text{--}3 \times 0.8\text{--}2.3 \times 1.3$ mm; overgrown, 1 seed filling entire fruit cavity; angular; asymmetrical; reniform or quadrangular; compressed; with surface smooth; with visible radicle and cotyledon lobes; with or without external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled; with frequent mottles; brown to blackish brown, tan, yellow, green, or black; with black (to purplish black) overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; recessed; not within corona, halo, or rim. Lens discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; 0.5 mm long; with margins straight; diamond-shaped or irregular; not in groove of raphe; confluent with or adjacent to hilum; 0.1 mm from hilum; mounded; dissimilar color from testa; darker than testa; blackish brown or black; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; white; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Mediterranean region to Nepal.

Notes: Polhill (1981h) noted that *Alhagi* is usually placed in the *Hedysareae*, “but as discovered there the flowers and fruits do not agree well with the current narrow

circumscription of that tribe.” Yakovlev (1979) discussed the species *A. maurorum* as occurring in the former U.S.S.R. Hutchinson (1964) reported “embryo covered by a fleshy membrane,” which is the endosperm adnate to the embryo. The fruit of *Alhagi* is technically and functionally an indehiscent legume and not a loment, notwithstanding the fact that the fruits may tardily and irregularly fracture at the isthmuses, which occur between seed chambers. The fruit has been described accurately as lomentoid or lomentaceous, and, recognizing this situation, we have scored it both ways. Pandey and Jha (1988) described the testa of *A. maurorum* using the SEM.

Alhagi: *A. maurorum* F.C. Medikus (C–E), *A. spp.* (A–B). A,
Fruits and fruit segment ($\times 3.9$); B, seeds ($\times 7.6$);
C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 12$).



Genus: *Glycyrrhiza* C. Linnaeus

Phylogenetic Number: 16.22.

Tribe: Galegeae.

Subtribe: Glycyrrhizinae.

Species Studied—Species in Genus: 9 spp.—ca. 20 spp.

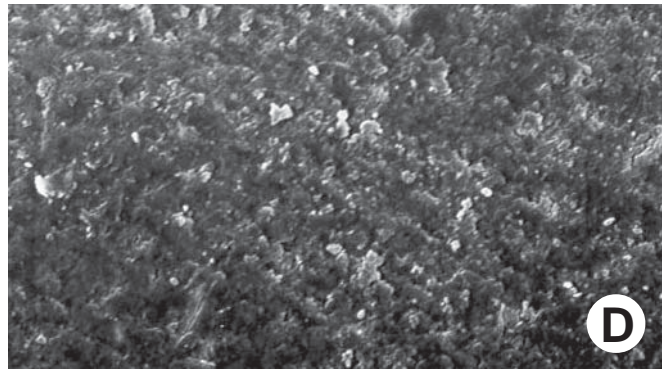
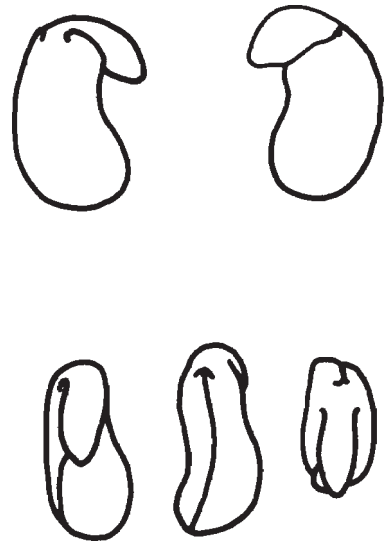
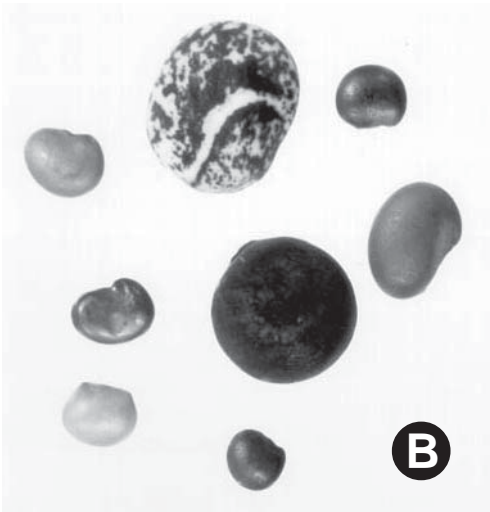
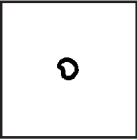
Fruit a legume; unilocular; $1.2\text{--}3.5 \times 0.5\text{--}1.2 \times 0.2\text{--}1$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; slightly curved, curved, or 0.5-coiled; not plicate or plicate (somewhat folded: wavy); not twisted or twisted; symmetrical; elliptic, linear, or moniliform; not inflated; compressed or terete; with beak; straight; with solid beak the same color and texture as fruit; short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers torulose or not torulose. Fruit margin constricted along both margins; without sulcus; plain or embellished; with spines (with straight or hooked apices). Fruit wings absent. Fruit stipitate or nonstipitate; with the stipe up to 30 mm long. Fruit with all layers dehiscent; splitting along suture. Dehiscence of valves along 1 suture; apical and down (or just apical); passive. Replum invisible. Epicarp dull; monochrome; reddish brown; glabrous or pubescent and indurate; with 1 type of pubescence; puberulent; with pubescence golden (and gland tipped); with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; glandular; with glandular hairs or dots; with spines (with straight or hooked or plain or glandular tips) or without spines; with spines persistent or broken off and their bases evident; with spines same color as the rest of the fruit; not smooth; with elevated or recessed features; veined or not veined; reticulately veined or longitudinally veined relative to fruit length; not tuberculate; tuberculate (bases of spines); pitted (centers of spine bases); not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; vitreous; coriaceous. Endocarp dull; monochrome or mottled; tan; with brown (reddish) overlay; smooth; septate, subseptate, or nonseptate; with septa thin (tissue paper-like), flexible or thicker than paper, firm; with septa eglandular; coriaceous; not

exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–8; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; up to 1 mm long; of 1 length only; thick; straight or curved. Aril absent.

Seed $2.5\text{--}7.5 \times 2\text{--}6 \times 1.8\text{--}3.3$ mm; not overgrown; not angular; asymmetrical; reniform, oblong, D-shaped, or circular; compressed; with surface smooth; with visible radicle and cotyledon lobes; with or without external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; yellowish, reddish, or greenish brown or green (yellowish or brownish); with black overlay; glabrous; smooth; coriaceous. Fracture lines reticulate. Rim absent. Wings absent. Raphe visible or not visible; from hilum through lens to base of seed and terminating; not bifurcating; darker than testa; black; flush. Hilum visible or partially concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.8 mm long; with curved outline; circular; between cotyledon and radicle lobe; recessed; within rim or within halo. Hilum halo color of or darker (slightly) than testa. Hilum rim color of or darker (slightly) than testa. Lens discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; 0.2–1 mm long; with margins curved; circular; not in groove of raphe; adjacent to hilum; 0.5–1.5 mm from hilum; mounded; same color as testa; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon width; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: North America, temperate South America, Eurasia to Australia.

Glycyrrhiza: *G. lepidota* F.T. Pursh (*C–E*), *G. spp.* (*A–B*).
A, Fruits ($\times 1.4$); B, seeds ($\times 3.1$); *C–D*, testa ($\times 50$,
 $\times 1000$); *E*, embryos ($\times 6$).



Carmichaelieae (17.01–17.05)

Genus: *Streblorrhiza* S.F.L. Endlicher

Phylogenetic Number: 17.01.

Tribe: Carmichaelieae.

Species Studied—Species in Genus: 1 sp.—1 sp.

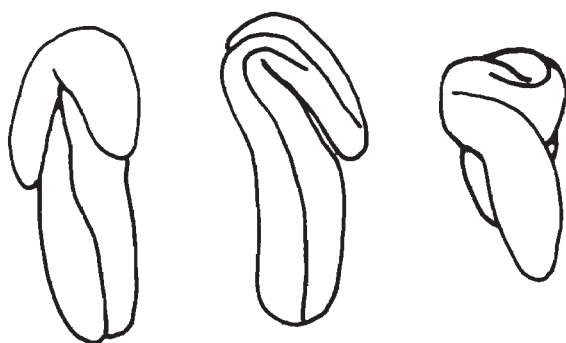
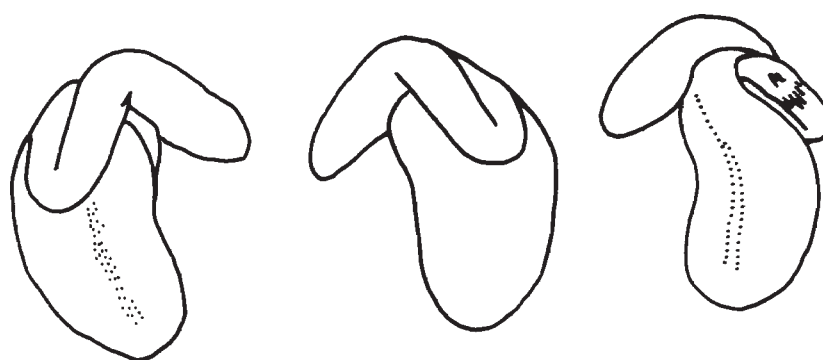
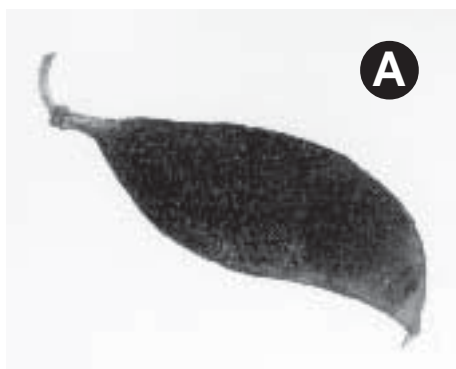
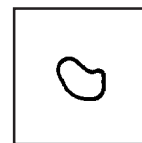
Fruit a legume; unilocular; $4.5 \times 1.8 \times 0.3$ cm; with deciduous corolla; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; oblong or falcate (obliquely subfalcate); when asymmetrical with both sutures parallelly to unequally curved; not inflated; compressed; without beak; tapered at apex; apex right-angled with longitudinal axis of fruit; tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible (barely). Fruit margin not constricted; without sulcus; plain. Fruit stipitate; with the stipe 6 mm long. Replum invisible. Epicarp dull; monochrome; dark brown; pubescent but soon deciduous to glabrous (with age); with 1 type of pubescence; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; transversely veined relative to fruit length; not tuberculate; not exfoliating; without cracks. Seeds length parallel with fruit length; neither overlapping nor touching; in 1 series. Aril absent.

Seed $6 \times 4.5 \times 3$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; brown (dark reddish); glabrous; smooth; coriaceous (assumed). Fracture lines absent. Rim absent. Raphe from hilum to lens; not bifurcating; color of testa; recessed. Hilum fully concealed or partially concealed; concealed by radicle lobe or wing; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 1 mm long; with curved outline; elliptic; marginal according to radicle tip; recessed; not within corona, halo, or rim. Lens discernible; less than 0.5 mm in length; with margins curved; circular; in groove of raphe; adjacent to hilum; 1.5 mm from hilum; recessed; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Radicle lobe tip curved.

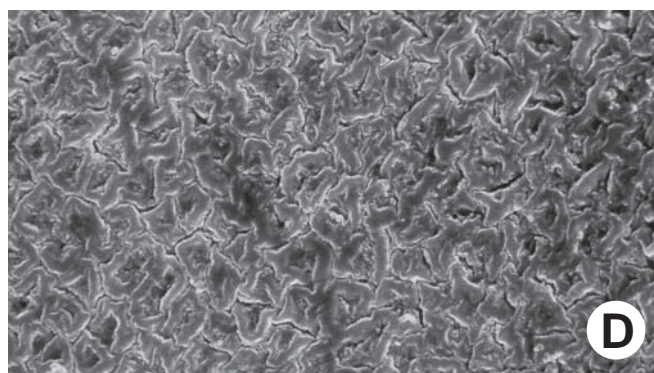
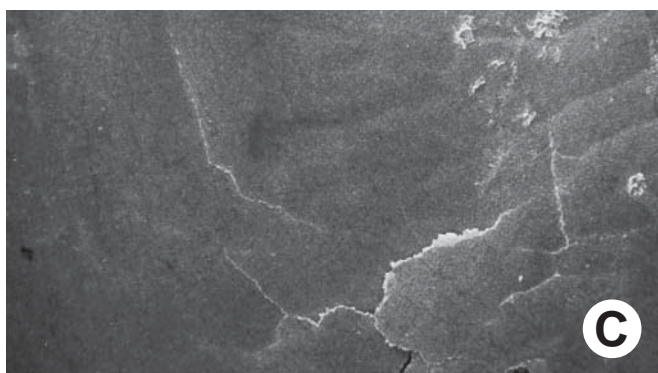
Distribution: Philip Island.

Notes: Hutchinson (1964) established the tribe Carmichaelieae, and Polhill (1981i, 1994a,b) accepted it. Heenan (1995, 1998c), using unpublished nuclear ribosomal DNA ITS data, concluded that “*Carmichaelia* (17.05) is nested within [the] ‘Astragalean clade’ of Galegeae” and is the sister group of *Clianthus* (16.01). He therefore supported the proposal of Sanderson and Wojciechowski (1996) that Carmichaelieae should not be recognized at tribal level but rather should be included in Galegeae (16). Heenan (1998c) also carried out cladistic analyses of *Carmichaelia* (17.05), *Chordospartium* (17.03), *Corollospartium* (17.04), and *Notospartium* (17.02) using morphological and anatomical characters. Heenan (1998a,c) concluded that “*Carmichaelia* is paraphyletic with *Chordospartium*, *Corollospartium*, and *Notospartium* excluded,” and reunited them with *Carmichaelia*. Polhill (1981i) noted that *Streblorrhiza* is extinct. Hutchinson (1964) stated that the “embryonic axis is twice folded.” We were able to study only one mature pod and one mature seed.

Streblorrhiza: *S. speciosa* S.F.L. Endlicher (A–E). A, Fruit ($\times 1.2$); B, seed ($\times 3.3$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 4.7$).



E



Genus: *Notospartium* J.D. Hooker

Phylogenetic Number: 17.02.

Tribe: Carmichaelieae.

Species Studied—Species in Genus: 3 spp.—3 spp.

Fruit a legume; unilocular; $2.5\text{--}2.8 \times 0.5\text{--}0.6 \times 0.17\text{--}0.3$ cm; with deciduous corolla; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; asymmetrical; linear (nearly); when asymmetrical with both sutures parallelly curved to 1 straight and 1 curved suture; not inflated; compressed; without beak; rounded at apex; apex aligned with longitudinal axis of fruit; tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome; tan; glabrous; eglandular; without spines; not smooth; with elevated features; transversely veined relative to fruit length; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; tan; cobwebby; subseptate; with septa thin (tissue paper-like), flexible; with the septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 3–5; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 1 mm long; of 1 length only; filiform; straight. Aril absent.

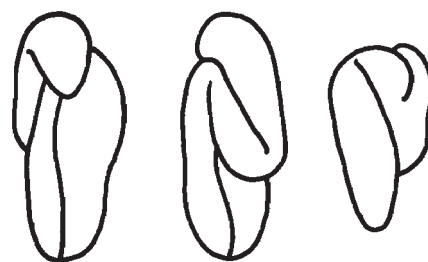
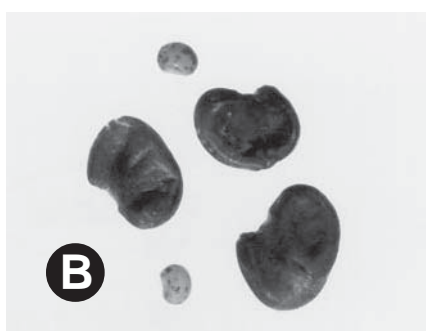
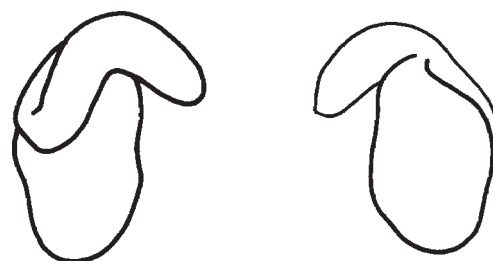
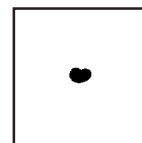
Seed $2.5\text{--}3.5 \times 2\text{--}2.8 \times 1.2\text{--}1.3$ mm; not overgrown; angular or not angular; asymmetrical; mitaform; compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; brownish red; with black overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe from hilum to lens; not bifurcating; darker than testa; raised. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; marginal according to radicle tip; recessed; not within corona, halo, or rim. Lens discernible; less than 0.5 mm in length; with margins curved; punctiform; not in groove of raphe; adjacent to hilum; 1 mm from hilum;

mounded; similar color as testa; darker than testa; brownish red; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear; lobe tip straight; with 360-degree turn; not centered between cotyledons (radicle outside 1 cotyledon and inside other, therefore junctions for each cotyledon different); exceeding length of cotyledons. Plumule rudimentary; glabrous.

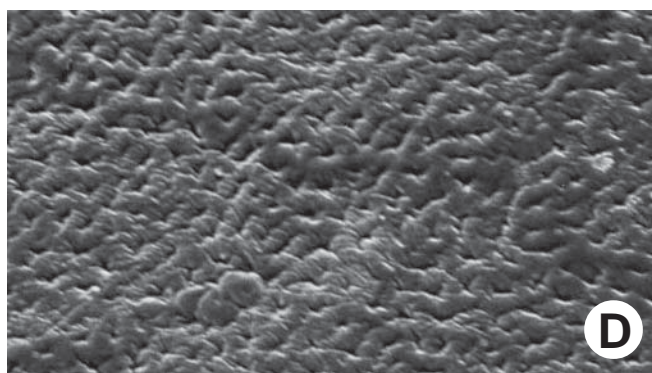
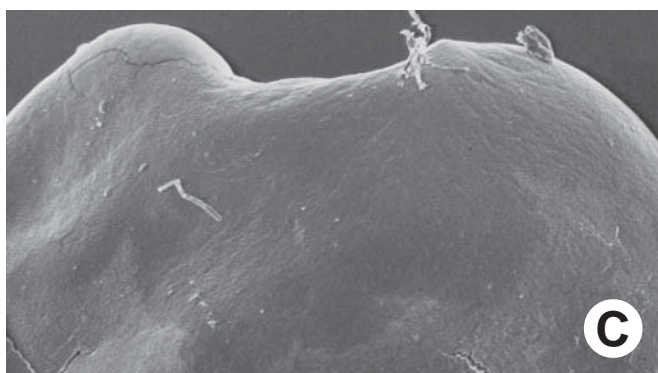
Distribution: New Zealand (South Island).

Notes: Heenan (1998a,c) carried out cladistic analyses of *Carmichaelia* (17.05), *Chordospartium* (17.03), *Corollospartium* (17.04), and *Notospartium* using morphological and anatomical characters and concluded that this genus should be merged with *Carmichaelia*.

Notospartium: *N. carmichaeliae* J.D. Hooker (C–E), *N.* spp. (A–B). A, Fruits and valve ($\times 2$); B, seeds ($\times 5.3$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



E



Genus: *Chordospartium* T.F. Cheeseman

Phylogenetic Number: 17.03.

Tribe: Carmichaelieae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; bilocular; $0.4\text{--}0.5 \times 0.2\text{--}0.26 \times 0.13\text{--}0.18$ cm; with deciduous corolla; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; when asymmetrical with 1 straight and 1 curved suture; widest near middle or D-shaped; not inflated; compressed; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit or right-angled with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit indehiscent. Replum invisible. Epicarp dull; multicolored; mottled; brown; with brown overlay; pubescent and indurate; with 1 type of pubescence; pilose (crinkled); with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; transversely veined relative to fruit length; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp glossy; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp. Seed 1; length parallel with fruit length. Funiculus measured; to 1 mm long; filiform; straight. Aril absent.

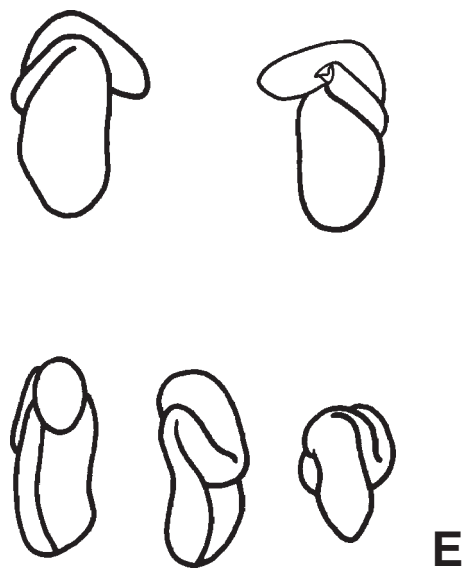
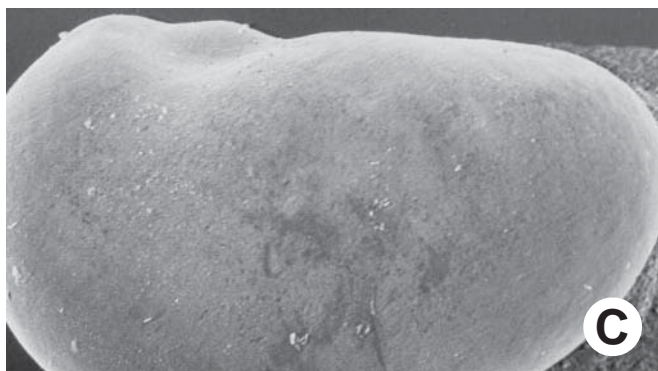
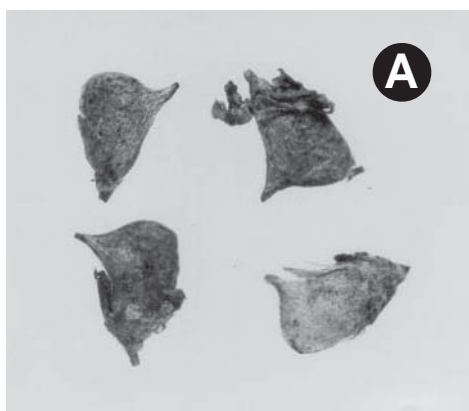
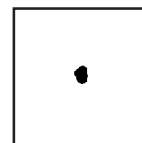
Seed $2.5\text{--}3 \times 1.8\text{--}2 \times 1\text{--}1.2$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; red; glabrous; not smooth; with recessed features; pitted with small separate pits; coriaceous. Fracture lines absent. Rim absent. Raphe from hilum to lens; darker than testa (slightly); flush. Hilum visible; without faboid split; punctiform; marginal according to radicle tip; recessed; not within corona, halo, or rim. Lens discernible; less than 0.5 mm in length; with margins curved; punctiform; not in groove of raphe; adjacent to hilum; 0.7 mm from hilum; mounded; same color as testa or dissimilar color from testa; darker than testa;

red; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; differing at apex (1 concealed by overarched radicle and other auriculate and concealing radicle); not concealing radicle; 1 cotyledon scooped out to accommodate plicate radicle and other cotyledon entire; without lobes; with the interface division terminating at base of radicle; brownish red; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; plicate to length of seed. Radicle linear; lobe tip curved; with 360 degree turn; centered between cotyledons; exceeding length of cotyledons. Plumule rudimentary; glabrous.

Distribution: New Zealand (South Island).

Notes: Heenan (1998a,c) carried out cladistic analyses of *Carmichaelia* (17.05), *Chordospartium*, *Corallospartium* (17.04), and *Notospartium* (17.02) using morphological and anatomical characters and concluded that this genus should be merged with *Carmichaelia*.

Chordospartium: *C. stevensonii* T.F. Cheeseman (A–E). A, Fruits ($\times 3.9$); B, seeds ($\times 4$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 8$).



Genus: *Corallospartium* J.B. Armstrong

Phylogenetic Number: 17.04.

Tribe: Carmichaelieae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; unilocular; $0.5\text{--}0.6 \times 0.25\text{--}0.3 \times 0.2\text{--}0.22$ cm; with deciduous corolla; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; when asymmetrical with 1 straight and 1 curved suture; widest near middle or D-shaped; not inflated; compressed; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down (assumed); passive. Replum invisible. Epicarp dull; monochrome; gray; pubescent and indurate; with 1 type of pubescence; velutinous; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; transversely veined relative to fruit length; not tuberculate; not exfoliating; without cracks. Mesocarp absent or present (if present, very thin). Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1(–2); length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; less than 1 mm long; of 1 length only; filiform; straight. Aril absent.

Seed $1.9\text{--}2.1 \times 1.4\text{--}1.6 \times 1.4\text{--}1.6$ mm; overgrown, 1 seed filling entire fruit cavity; not angular; symmetrical; circular; terete; with visible radicle and cotyledon lobes (barely); without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; mottled and streaked; with frequent mottles; with frequent streaks; brown or green; with green or black (bluish) overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; without faboid split; punctiform; marginal according to radicle tip; recessed. Lens discernible; less than 0.5 mm in length; with margins curved; punctiform; not in groove of raphe; adjacent to hilum; 0.5 mm from hilum; flush; dissimilar color from

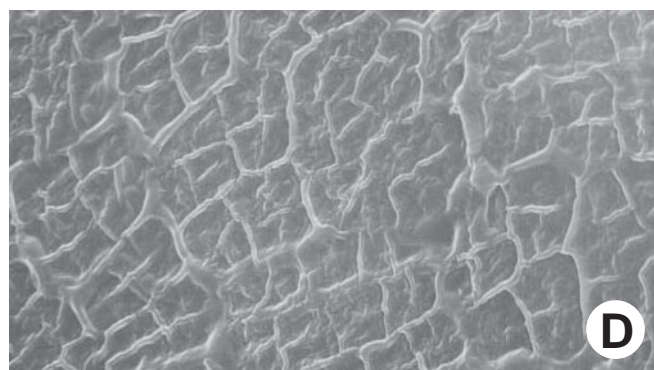
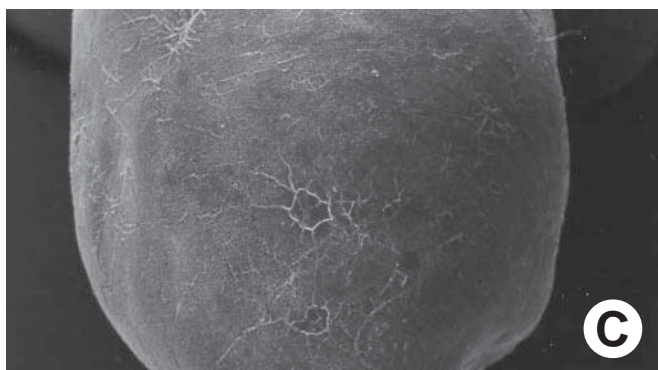
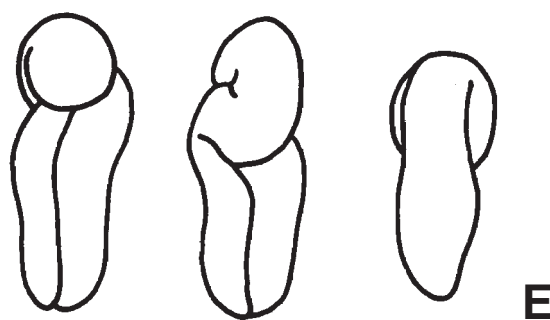
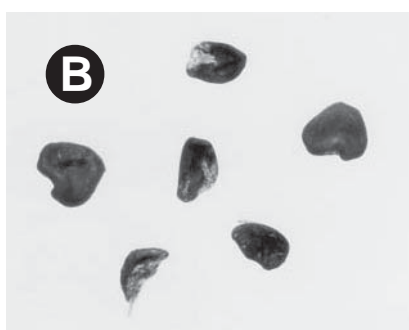
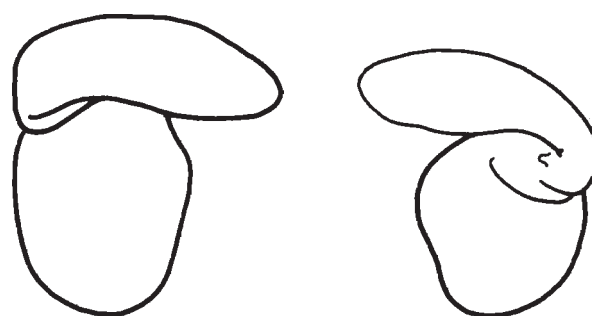
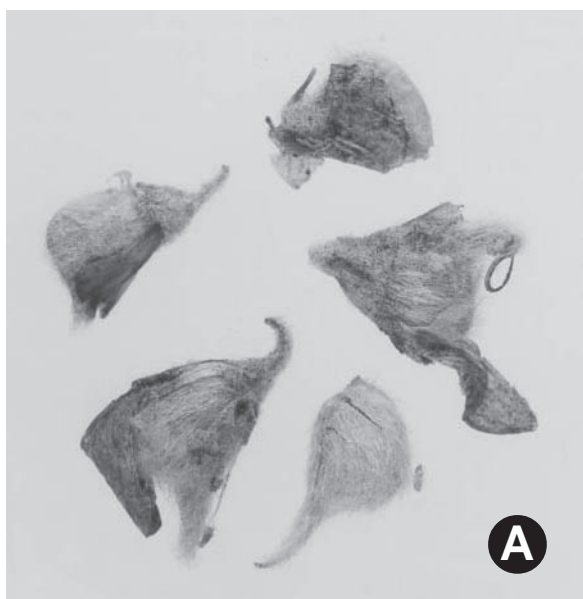
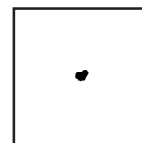
testa; darker than testa; brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; reddish tan; inner face flat; glabrous around base of radicle. Embryonic axis oblique; perpendicular to length of seed. Radicle linear; lobe tip curved; with 180 degree turn; not centered between cotyledons (radicle outside 1 cotyledon and inside other, therefore junctions for each cotyledon different); exceeding length of cotyledons. Plumule rudimentary; glabrous.

Distribution: New Zealand (South Island).

Notes: Heenan (1998a,c) carried out cladistic analyses of *Carmichaelia* (17.05), *Chordospartium* (17.03), *Corallospartium*, and *Notospartium* (17.02) using morphological and anatomical characters and concluded that *Corallospartium* should be merged with *Carmichaelia*. Cheeseman (1906) noted that *Corallospartium* “is technically separated from *Carmichaelia* by the 2-valved pod without a persistent replum.”

Corallospartium: *C. crassicaule* (J.D. Hooker) J.B.

Armstrong (A–E). A, Fruits (with calyx and floral parts) ($\times 4.1$); B, seeds ($\times 7.3$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 20$).



Genus: *Carmichaelia* R. Brown

Phylogenetic Number: 17.05.

Tribe: Carmichaelieae.

Species Studied—Species in Genus: 7 spp.—18 spp.

Fruit a legume; unilocular; $0.5\text{--}5 \times 0.15\text{--}0.8 \times 0.1\text{--}0.15$ cm; with deciduous corolla; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; subcircular, oblong, ovate, elliptic, linear, or falcate; when asymmetrical with both sutures parallelly curved; not inflated; compressed to terete; with beak; straight; with solid beak the same color and texture as fruit; abruptly long acuminate at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; ligneous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; embellished; with thickened sutural areas. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscing or indehiscent; splitting along suture. Dehiscence of valves along 1 suture; basal and up; active; with valves twisting. Replum visible or invisible. Epicarp dull; monochrome; black, brown, or tan; glabrous; without spines; not smooth; with elevated features; transversely veined relative to fruit length; not tuberculate; wrinkled; not exfoliating; without cracks. Mesocarp thin; 1-layered; without balsamic vesicles; without fibers; solid; ligneous. Endocarp dull; monochrome; brown; fibrous; subseptate or nonseptate; with septa thin (tissue paper-like), flexible; with the septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp. Seeds 1–12; length parallel with fruit length; overlapping or neither overlapping nor touching; in 1 series. Funiculus measured; $0.3\text{--}2.5$ mm long; of 1 length only; filiform or thick; straight, S-curved, hooked, or plicate. Aril dry; rim-aril; brown.

Seed $2\text{--}4.5 \times 2\text{--}3 \times 1.5\text{--}3$ mm; not overgrown; angular (because of pressure of adjacent seeds in fruit) or not angular; symmetrical or asymmetrical; irregular, mitaform, oblong, or reniform; terete or compressed; with or without visible radicle and cotyledon lobes; without umbo on seed faces. Testa present or absent; not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent or infrequent mottles; with frequent or

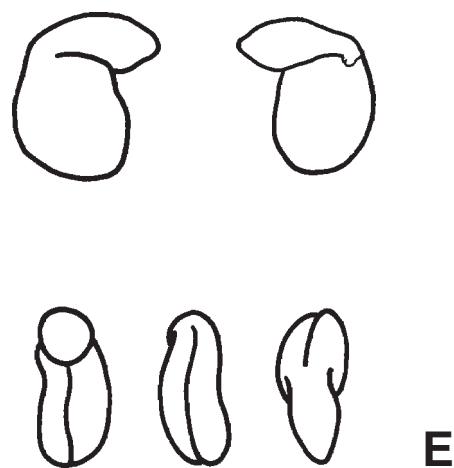
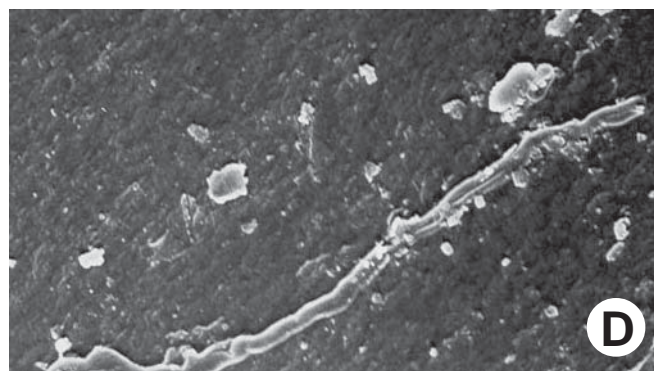
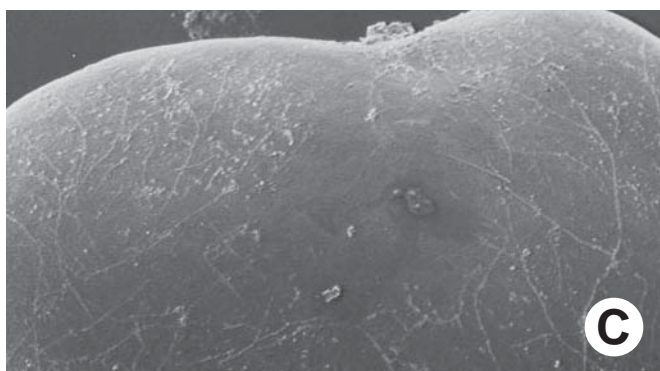
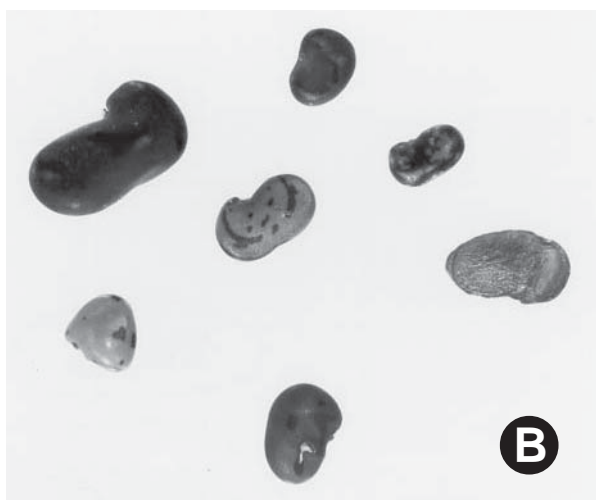
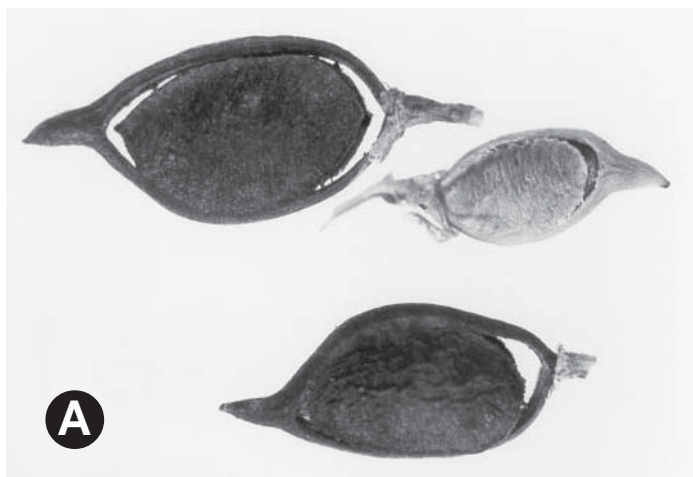
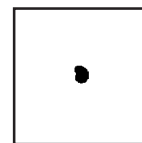
infrequent streaks; black (to bluish-black), brown, green (pale), orange (reddish), red, tan, white (to bluish-white), yellow, or blue; with black overlay (to bluish-black); glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Raphe not visible. Hilum visible or fully concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; up to 7 mm long; with straight outline; oblong; marginal according to radicle tip or between cotyledon and radicle lobe; recessed; not within corona, halo, or rim. Lens discernible or not discernible; less than 0.5 mm in length; with margins curved; punctiform; not in groove of raphe; adjacent to hilum; 0.5 mm from hilum; mounded or flush; same color as testa; darker than testa; black or red (dish); not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to testa or embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; differing at apex (1 concealed by overarched radicle and other auriculate and concealing radicle); not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; white or red; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; perpendicular to length of seed. Radicle bulbous; lobe tip curved; with 180-degree or 90-degree turn; centered between cotyledons; $1/2$ to nearly length of or equaling length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Seventeen species in New Zealand and one (*C. exsul* H.F. Mueller) on Lord Howe Island.

Notes: Simpson (1945) revised the genus recognizing eight subgenera and 41 species based on whether pods dehisce or not and their dehiscence mechanisms and presented a key to the subgenera essentially using pod characters. Allan (1961) used pod characters as primary divisions in his New Zealand species key. Heenan (1995, 1996, 1998a,c) revised the genus for New Zealand and carried out cladistic analyses of *Carmichaelia* and related genera. He concluded that “*Carmichaelia* is paraphyletic if *Chordospartium* (17.03), *Corallospartium* (17.04), and *Notospartium* (17.02) are excluded.” Therefore Heenan (1998a) merged the four genera and created new combinations in *Carmichaelia* for the species of *Chordospartium*, *Corallospartium*, and *Notospartium*. We have chosen to use Polhill’s (1981i, 1994b) generic delimitations pending the expression of a general consensus of opinion concerning Heenan’s work by taxonomic

botanists. Although we studied seeds and fruits of 7 species, the literature cited above provided brief descriptions of seeds and fruits for all species. Heenan's (1995, 1996, 1998a) species count was used.

Carmichaelia: *C. uniflora* T. Kirk (C–E), *C. spp.* (A–B). A, Fruits (× 4.4); B, seeds (× 4.9); C–D, testa (× 50, × 1000); E, embryos (× 10).



Hedysareae (18.01–18.07)

Genus: *Eversmannia* A.A. von Bunge

Phylogenetic Number: 18.01.

Tribe: Hedysareae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume (apparently breaking between seed chambers (like a loment)); unilocular; $3 \times 0.6\text{--}0.7 \times 0.2$ cm; with deciduous corolla; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; slightly curved; plicate (loosely) or not plicate; not twisted; asymmetrical or symmetrical; linear; when asymmetrical with both sutures nearly straight; not inflated; compressed; without beak; short tapered or rounded at apex; apex aligned with longitudinal axis of fruit; short tapered or rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers torulose. Fruit margin constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent (probably). Replum visible (“articles” falling free from replum). Epicarp dull; monochrome; reddish brown; glabrous; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; tan; smooth; nonseptate (seed fits into fruit like a ball in a socket and walls of fruit form pseudosepta); chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1–4; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; triangular; straight. Aril absent.

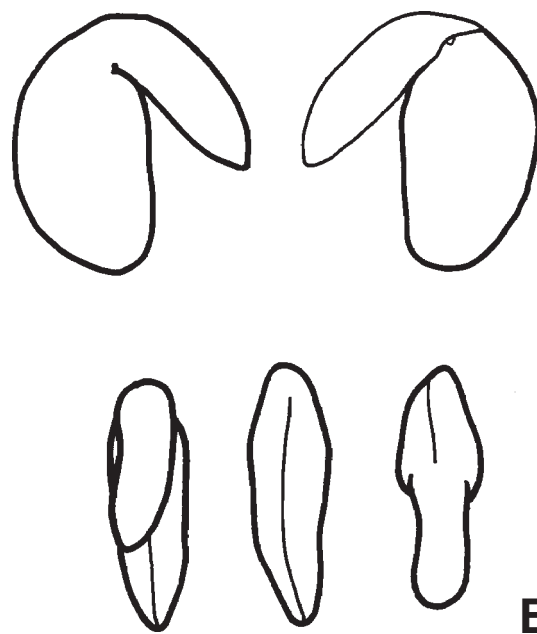
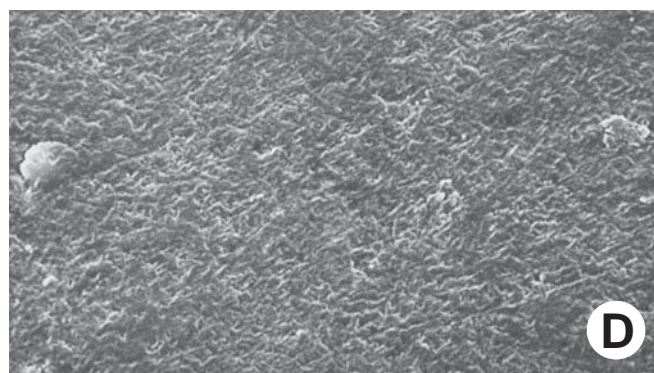
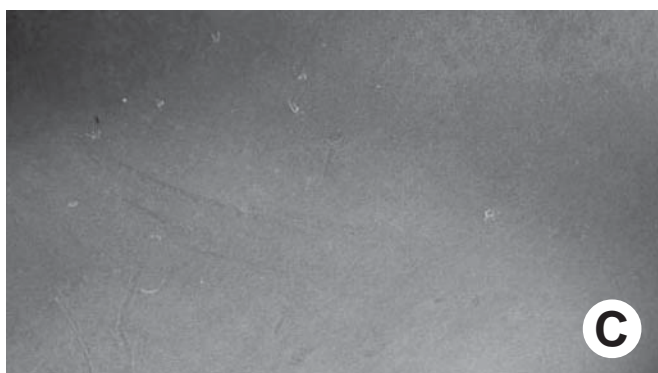
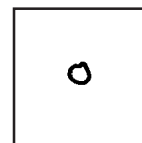
Seed $3\text{--}3.7 \times 3 \times 1.3\text{--}1.5$ mm; not overgrown; not angular; asymmetrical; D-shaped, mitaform, or rhombic; compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum fully concealed; concealed by funicular remnant; without faboid split; punctiform; between cotyledon and radicle lobe;

recessed; within halo. Hilum halo color darker than testa. Lens discernible or not discernible; less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; adjacent to hilum; 0.5 mm from hilum; mounded; similar color as testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; more than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Russia and Iran from the Caspian to Tian Shan (border of former U.S.S.R. and China).

Notes: Polhill (1981j) primarily used fruit characters for his key to genera of this tribe. The fruits of *E. subspinosa* (formerly *E. hedysaroides* A.A. von Bunge) function as a loment, though they are not true loment. The fruit tissue between the seed chambers is thin and easily broken (but by no regular separation) into one-seeded fruit segments leaving the replum.

Eversmannia: *E. subspinosa* (F.E.L. von Fischer ex A.-P. de Candolle) B.A. Fedtschenko (A–E). A, Fruits ($\times 2.4$); B, seeds ($\times 5.5$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 15$).



Genus: *Hedysarum* C. Linnaeus

Phylogenetic Number: 18.02.

Tribe: Hedysareae.

Species Studied—Species in Genus: 50 spp.—ca. 100 spp.

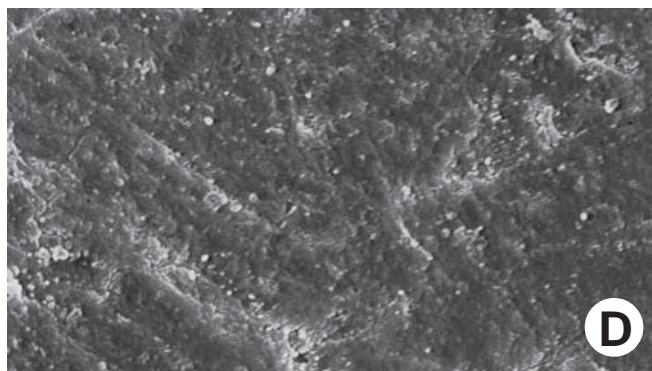
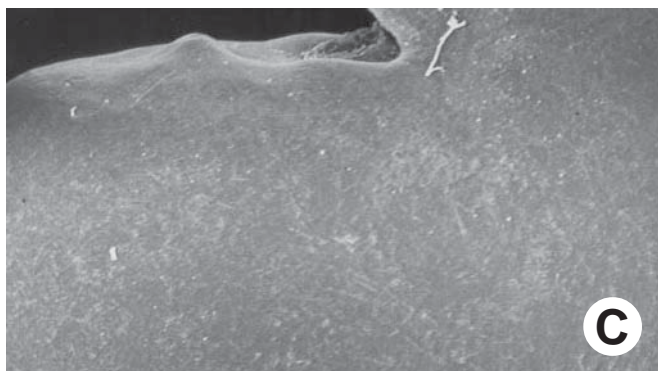
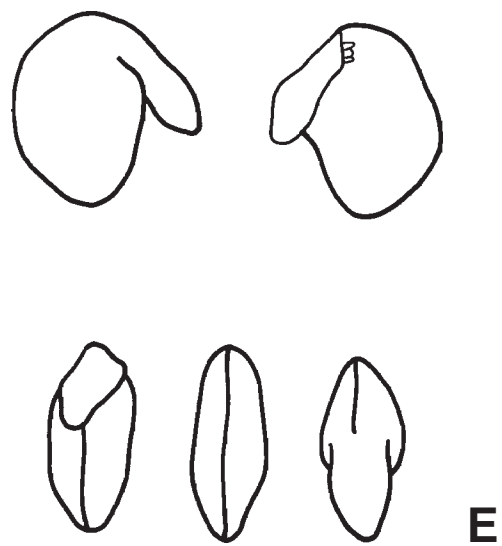
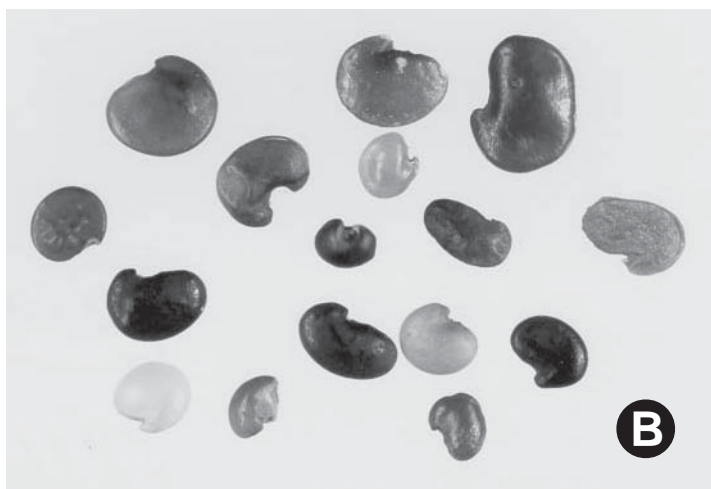
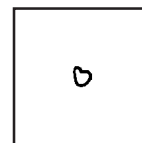
Fruit a loment (with 2 to several joints); $2-4 \times 0.3-1 \times 0.15-0.25$ cm; with deciduous corolla; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical or asymmetrical; linear, elliptic, or ovate; when asymmetrical with both sutures parallelly curved; not inflated; compressed or terete; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; rounded or short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous, membranous, or ligneous; seed chambers externally visible; with the raised seed chambers torulose. Fruit margin constricted along both margins; without or with sulcus; plain or embellished; with spines (with usually curved or occasionally straight apex), prickles, or wing. Fruit wing present or absent; 1; $0.5-3$ mm wide; sutural. Fruit nonstipitate or substipitate. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; $3.5-16$ mm long; widest across seed area; with all essentially similar in shape or lower 1 different shape than middle ones; elliptic to oblong, D-shaped, quadrangular, or circular. Epicarp dull; monochrome; brown; glabrous, glabrate, or pubescent but soon deciduous; with hairs appressed or erect; with 1 type of pubescence; pilose or tomentose; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; with or without spines; with spines persistent or broken off and their bases evident; with spines same color as the rest of the fruit; not smooth; with elevated features; reticulately veined; tuberculate (if apices of spines removed); with solid tubercles on each valve; rugose, wrinkled, tuberculate, or muricate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; ligneous (sub) or coriaceous. Endocarp dull; monochrome; tan; smooth; septate; with septa thicker than paper, firm; with the septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds (1-)2-8; length parallel with fruit length; neither overlapping nor touching; in 1

series. Funiculus less than 0.5 mm long or measured; up to 3 mm long; of 1 length only; filiform; straight. Aril absent.

Seed $2.8-4.5 \times 2-4 \times 1-2$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; with shallow hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome; reddish or greenish brown, tan (to greenish), yellow, or cream; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by funicular remnant or concealed by wing; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; within rim. Hilum rim color darker than testa or color of testa. Lens discernible or not discernible (because may be color of testa); less than 0.5 mm in length; with margins straight or with margins curved; circular or oblong; not in groove of raphe; adjacent to or confluent with hilum; 0.4 mm from hilum; mounded; dissimilar color from or same color as testa; darker than testa; black; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; white or yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip hooked or straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 or 1/2 to nearly length of cotyledons. Plumule rudimentary or moderately developed; glabrous.

Distribution: Europe, Mediterranean region, Asia, and North America.

Hedysarum: *H. coronarium* C. Linnaeus (C-E), *H.* spp. (A-B). A, Fruits and articles ($\times 1.4$); B, seeds ($\times 4$); C-D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



Genus: *Taverniera* A.-P. de Candolle

Phylogenetic Number: 18.03.

Tribe: Hedysareae.

Species Studied—Species in Genus: 9 spp.—ca. 10 spp.

Fruit a loment (with 2–4 joints); 1.25–1.5 × 0.3–0.7 × 0.5–0.7 cm; with deciduous or persistent corolla; with standard; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; oblong; when asymmetrical with 1 straight and 1 curved suture (or nearly straight); narrowest near middle, B-shaped; not inflated; compressed; without beak; rounded or short tapered at apex; apex aligned or oblique with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers torulose. Fruit margin constricted along both margins; without sulcus; embellished or plain; with prickles or spines. Fruit wings absent. Fruit substipitate. Fruit indehiscent. Replum invisible. Loment indehiscent. Loment segments (articles) inconspicuous; widest across seed area; with all essentially similar in shape; D-shaped or circular. Epicarp dull or glossy; monochrome; dark to reddish brown or tan; pubescent and indurate; with hairs erect or appressed; with 1 type of pubescence; pilose; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; with spines (either glabrous or hairy and with straight or hooked apices) or without spines; with spines persistent; with spines same color as the rest of the fruit; not smooth; with elevated features; veined or not veined; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; tan; smooth; septate; with septa thicker than paper, firm; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 2–3; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long or measured; 0.5 mm long; of 1 length only; filiform; curved. Aril absent.

Seed 1.5–2.5 × 1.1–2 × 0.5–1.1 mm; not overgrown; not angular; asymmetrical; mitaform or reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not

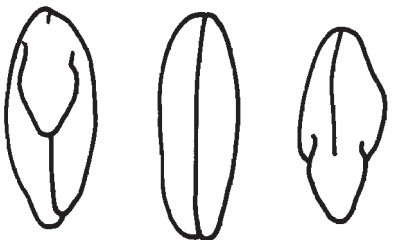
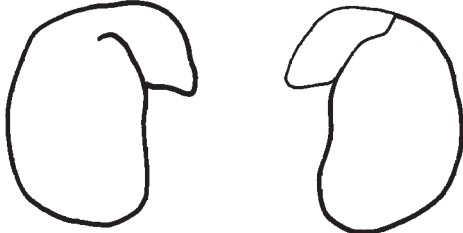
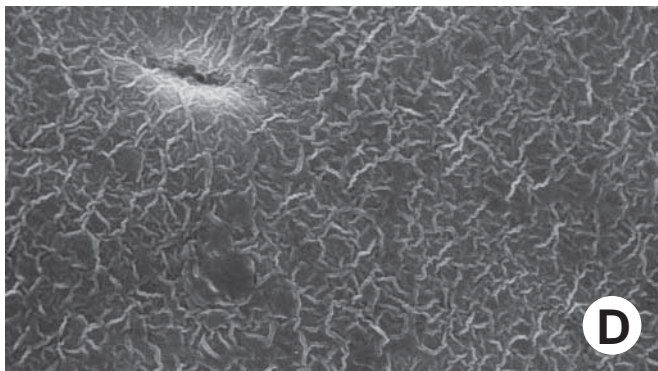
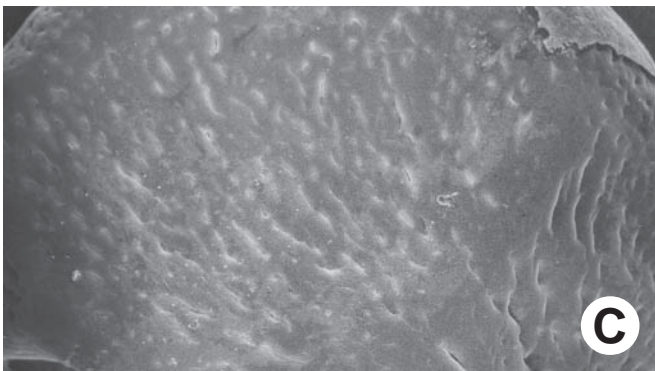
adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome; brown (to greenish); glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by funicular remnant; without faboid split; punctiform; between cotyledon and radicle lobe; recessed; within rim. Hilum rim color of testa or color darker than testa. Lens discernible; less than 0.5 mm in length or equal to or greater than 0.5 mm in length; up to 0.5 mm long; with margins straight or curved; circular or oblong; not in groove of raphe; confluent with or adjacent to hilum; 0.1–0.5 mm from hilum; mounded (light colored mound within darker area); similar color as or dissimilar color from testa; darker than testa; black or brown (greenish); not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; green; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Horn of Africa and Socotra through Middle East to western India.

Notes: Polhill (1981j) noted that the genus has “about ten species (several undescribed).”

Taverniera: *T. lappacea* (P. Forsskål) A.-P. de Candolle (C–E), *T. spp.* (A–B). A, Fruits and articles (× 3.6); B, seeds (× 8); C–D, testa (× 50, × 1000); E, embryos (× 8).

D



E

Genus: *Stracheya* G. Bentham

Phylogenetic Number: 18.04.

Tribe: Hedysareae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; unilocular; $2-3 \times 0.6-0.7$ (excluding spines) $\times 0.2$ (excluding spines) cm; with deciduous corolla; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; slightly curved or straight; not plicate; not twisted; asymmetrical or symmetrical; linear or oblong; when asymmetrical with both sutures nearly straight; not inflated; compressed (but spines along sutures and midvalve (4 rows of spines)); without beak; truncate at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; embellished; with spines. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome; reddish brown; pubescent and indurate; with hairs appressed; with 1 type of pubescence; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; with spines (along sutures and midvalves (4 rows) on fruit); with spines persistent; with spines same color as the rest of the fruit; not smooth; with elevated features; not veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface uniformly veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; tan; smooth; nonseptate (but seeds seated like a ball and socket in fruit); chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 5; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent.

Seed $2-2.7 \times 1.3-2 \times 0.7$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified or modified by a bloom; colored; monochrome; dark reddish brown; glabrous; not smooth; with elevated features; shagreen; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe from hilum to lens;

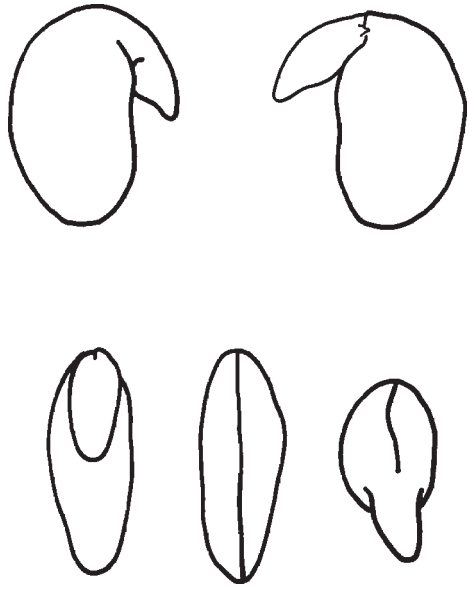
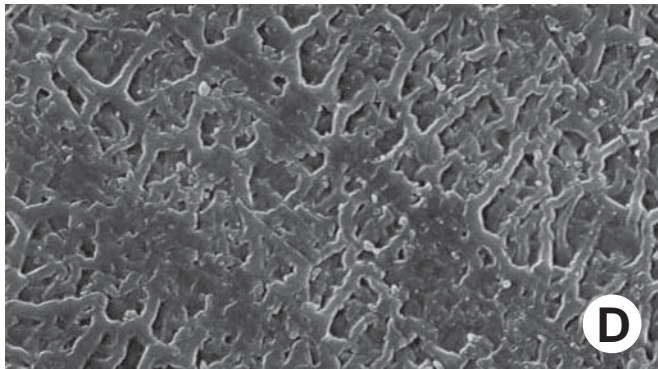
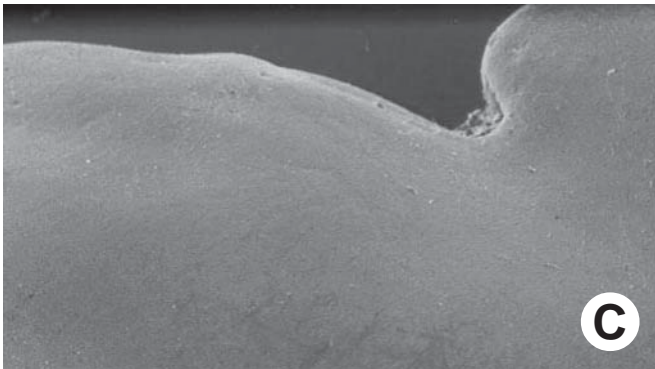
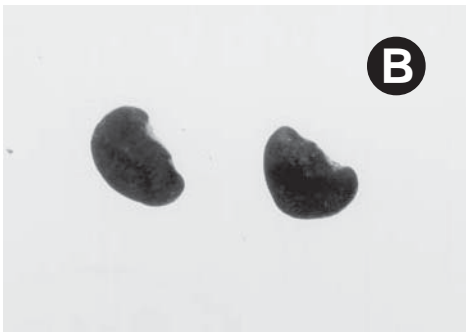
not bifurcating; darker than testa; black; flush. Hilum fully concealed; concealed by funicular remnant; without faboid split; punctiform; between cotyledon and radicle lobe; recessed; not within corona, halo, or rim. Lens discernible or not discernible; less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; adjacent to hilum; 0.8 mm from hilum; flush; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Kashmir, Tibet, Sikkim, and Nepal.

Notes: Little is known about this monotypic genus, and Viswanathan (1995) revised it. The fruits appear to be indehiscent and are not loment. The fruits are definitely echinate-dentate and have spines in four rows. Only pressed fruits were seen.

Stracheya: *S. tibetica* G. Bentham (A–E). A, Fruits ($\times 2.9$); B, seeds ($\times 7.4$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).

6



Genus: *Onobrychis* P. Miller

Phylogenetic Number: 18.06.

Tribe: Hedysareae.

Species Studied—Species in Genus: 66 spp.—ca. 130 spp.

Fruit a legume; unilocular; $0.4\text{--}1.5 \times 0.15\text{--}1$ cm; with deciduous corolla; with persistent or deciduous calyx; with calyx shorter than, longer than, or equal in length to fruit; without or with orifice formed by curving of fruit or fruit segments; straight, curved, or 1-coiled (nearly); not plicate; not twisted; asymmetrical; circular, reniform, or samaroid; when asymmetrical with 1 straight and 1 curved suture, both sutures parallelly curved or both unequally curved; widest near middle or D-shaped; not inflated; compressed or terete; without or with beak; hooked (at apex), straight, or declined; with solid beak the same color and texture as fruit (3–10 mm long); short tapered at apex; apex aligned with or almost reaching longitudinal axis of fruit; tapered or short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible. Fruit margin constricted or not constricted; constricted along both margins; without sulcus; embellished or plain; with spines, wing (entire or cut), prickles, or fringe. Fruit wing absent or present; 1; up to 3 mm wide; samaroid, sutural, or continuous wing around fruit; on both sutures. Fruit nonstipitate or substipitate. Fruit indehiscent. Replum invisible. Fruit a nutlet; an intact article; entire. Epicarp dull; monochrome; brown or tan; glabrous or pubescent and indurate; with hairs erect or appressed; with 1 type of pubescence; minutely puberulent or tomentose; with pubescence golden or gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; with or without spines; with spines persistent or broken off and their bases evident; with spines same color as the rest of the fruit; not smooth; with elevated or recessed features; veined or not veined; reticulately veined (and with or without spines and reticulum can be removed); not tuberculate or tuberculate; with solid tubercles on each valve; pitted (broad pits); not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seed 1; length parallel with fruit length. Funiculus less than 0.5 mm long; filiform; straight. Aril absent.

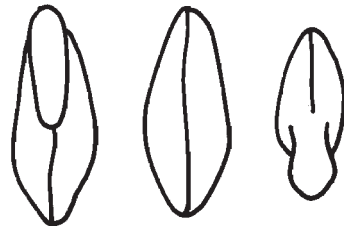
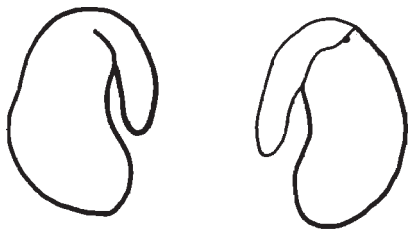
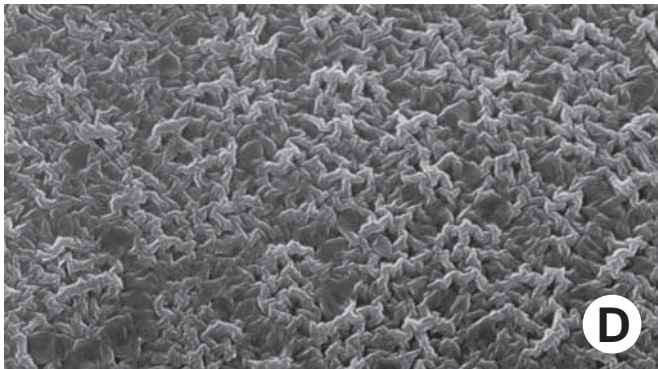
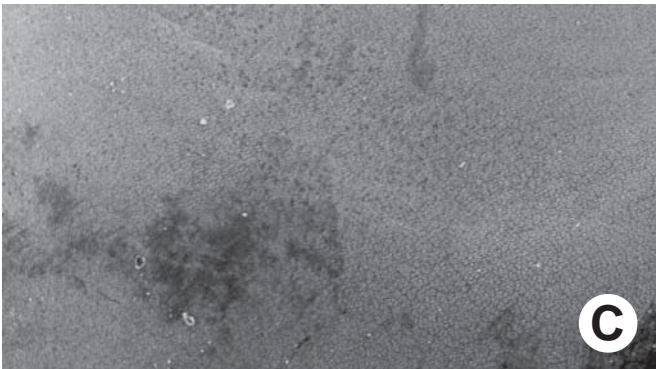
Seed $2\text{--}5 \times 2.6\text{--}3 \times 2.1\text{--}2.2$ mm; not overgrown; not angular; asymmetrical; reniform or oblong; compressed; with surface smooth; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome or mottled; brown, yellow, cream, or black; with black overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible or visible; from hilum to lens; not bifurcating; darker than testa or color of testa; reddish brown; recessed. Hilum partially concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; within halo. Hilum halo color darker than testa. Lens discernible; less than 0.5 mm in length; with margins curved; circular or elliptic; not in or in groove of raphe; adjacent to or confluent with hilum; 1 mm from hilum; mounded; dissimilar color from or similar color as testa; darker than testa; reddish brown or black; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less to more than $1/2$ length of cotyledons. Plumule rudimentary or moderately developed; glabrous.

Distribution: Europe, Mediterranean region, western and central Asia, and Ethiopia.

Notes: Cooper and Carleton (1968) edited a symposium proceeding dealing with the agronomic aspects of sainfoin (*O. viciifolia* J.A. Scopali).

Onobrychis: *O. melanotricha* P.E. Boissier (C–E), *O.* spp. (A–B). A, Fruits ($\times 1.3$); B, seeds ($\times 3.7$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 5$).

9



E

Genus: *Ebenus* C. Linnaeus

Phylogenetic Number: 18.07.

Tribe: Hedysareae.

Species Studied—Species in Genus: 7 spp.—20 spp.

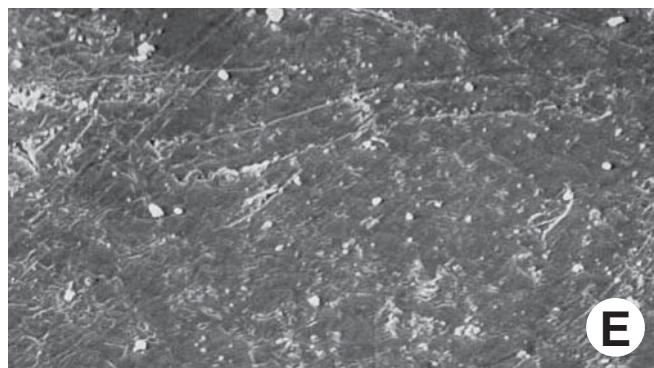
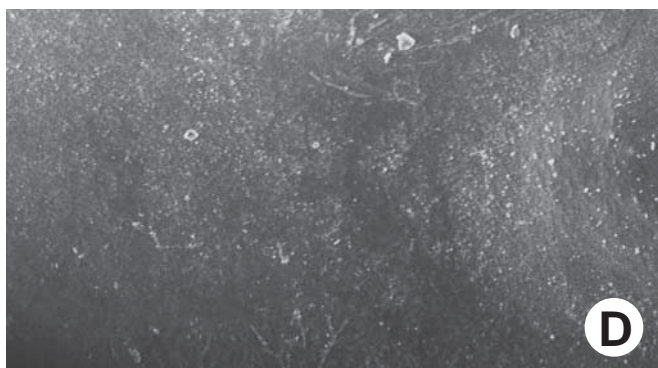
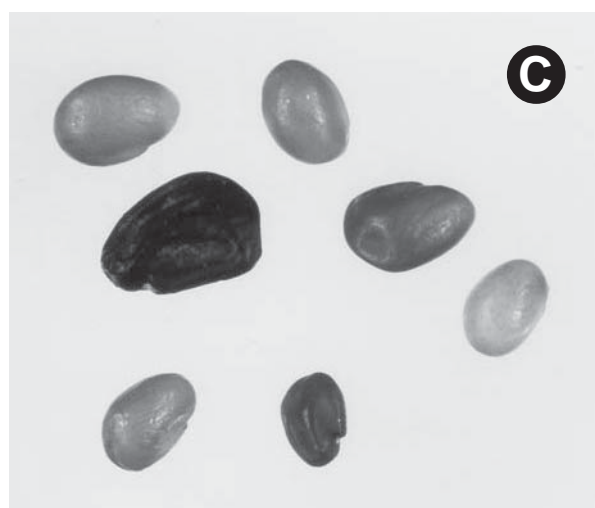
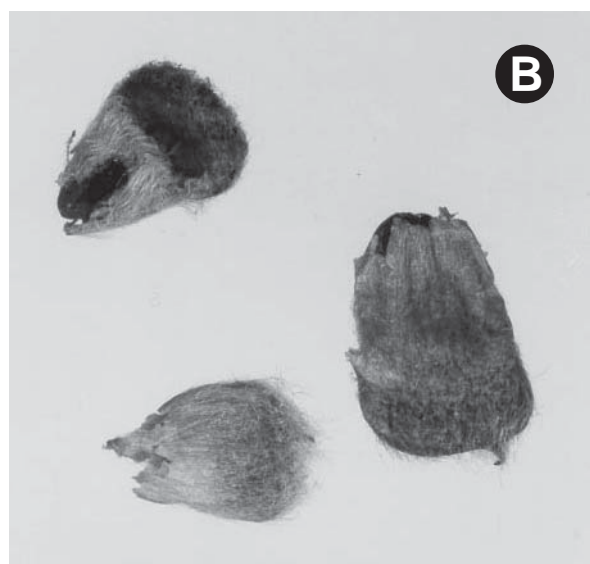
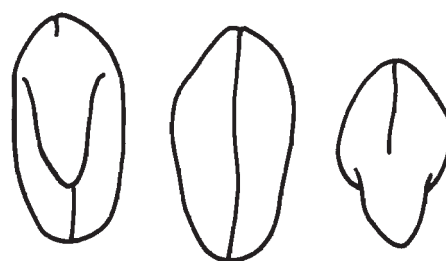
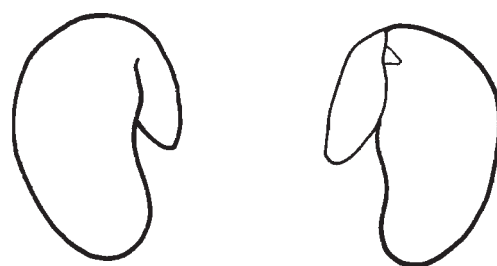
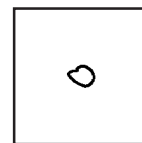
Fruit a legume; unilocular; $0.45\text{--}0.6 \times 0.3\text{--}0.4 \times 0.13\text{--}0.2$ cm; with deciduous corolla; with persistent calyx; with calyx longer than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical; oblong or obovate; not inflated; compressed; without beak; rounded at apex; apex aligned with longitudinal axis of fruit; tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous or fragile, thinner than chartaceous like *Trifolium*; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit nonstipitate. Fruit indehiscent (rupturing at base). Replum invisible. Epicarp dull; monochrome; tan; pubescent and indurate; with 1 type of pubescence; tomentose; with pubescence golden; with apical pubescence different from basal pubescence; with apical $3/4$ tomentose and basal $1/4$ glabrous or with apical $1/2$ crinkly tomentose and basal $1/2$ densely villose with straight hairs; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1(–2); length transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; filiform; straight. Aril absent.

Seed $2.5\text{--}3.2 \times 1.8\text{--}2 \times 1.6\text{--}2$ mm; not overgrown; not angular; asymmetrical; mitaform or ovate; terete; with surface smooth; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled; with frequent mottles; reddish brown or tan; with black overlay (minute mottles may be present on tan testae); glabrous; smooth or not smooth; with recessed features; faintly striate or concaved; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by funicular remnant;

with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; marginal according to radicle tip or between cotyledon and radicle lobe; flush; not within corona, halo, or rim or within halo. Hilum halo color darker than testa. Lens not discernible or discernible; less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; adjacent to hilum; 0.2 mm from hilum; mounded; similar color as testa; darker than testa; reddish brown or tan; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow or tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than $1/2$ length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Mediterranean region.

Ebenus: *E. cretica* C. Linnaeus (*D–F*), *E. spp.* (*A–C*). *A*, Fruits in calyx ($\times 2.1$); *B*, fruits with calyx removed ($\times 7$); *C*, seeds ($\times 5.7$); *D–E*, testa ($\times 50$, $\times 1000$); *F*, embryos ($\times 8$).



Fabae (19.01–19.05)

Genus: *Vicia* C. Linnaeus

Phylogenetic Number: 19.01.

Tribe: Fabae.

Species Studied—Species in Genus: 85 spp.—166 spp.

Fruit a legume; unilocular; $0.6\text{--}2.5 \times 0.2\text{--}3 \times 0.2\text{--}3$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight to curved (to slightly curved); not plicate; not twisted; asymmetrical; linear, falcate, or rhombic; when asymmetrical with both sutures nearly straight; inflated (*V. faba*) or not inflated; compressed, terete, or flattened; without or with beak; straight; with solid beak the same color and texture as fruit; short tapered to tapered to rounded at apex; apex aligned or oblique (slightly) with longitudinal axis of fruit; short tapered to tapered to long tapered to rounded at base; base oblique or aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous or leathery; seed chambers externally invisible or visible; with the raised seed chambers not torulose or torulose. Fruit margin not constricted or constricted; slightly constricted along both margins to constricted along both margins or slightly constricted only on 1 margin; without sulcus; plain. Fruit wings absent. Fruit nonstipitate or substipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting (tightly or loosely). Replum invisible. Epicarp dull; monochrome; brown (various shades and in combination with other colors), tan, or black; glabrous or pubescent and indurate to pubescent but soon deciduous; with 1 type of pubescence; puberulent or pilose; with pubescence gray or golden; with simple or glandular hairs; pliable; with hair bases swollen or plain; glandular; with glandular hairs; without spines; not smooth; with elevated or recessed features; reticulately veined; not tuberculate or tuberculate; with solid tubercles (widely scattered) on each valve; pustulate (indurate bases of hairs) or tuberculate (scattered and rarely); occasionally punctate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; tan; smooth; nonseptate (New World spp.) or septate (some Old World spp.); with septa thin (tissue paper-like), flexible

or thicker than paper, firm; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–16; length parallel with fruit length (without regard to hilum position in *V. faba*); neither overlapping nor touching or touching; in 1 series. Funiculus measured; up to 2 mm long; of 1 length only; thick or flattened; straight or S-curved. Aril absent or present (not a true aril, but an expanded funiculus); fleshy; expanded funiculus; covering less than 1/2 of seed; tan or white.

Seed 1.5–30.5 (without regard to hilum position in *V. faba*) $\times 1.4\text{--}17 \times 1.3\text{--}9$ mm; not overgrown; not angular or angular; asymmetrical or symmetrical; circular, oblong, ovate, quadrangular, or triangular; terete or compressed; without visible radicle and cotyledon lobes; with umbo on seed faces. Testa not adhering to endocarp; dull, glossy, or velvet; not modified or modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; brown (including most shades and combinations with other colors), tan (reddish, greenish), or black (purplish); with black, brown (including most shades and combinations with other colors), or red overlay; glabrous; smooth or not smooth; with elevated features; tuberculate; osseous or coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible, partially concealed, or fully concealed; concealed by funiculus, funicular remnant, or aril; with faboid split; with the lips of the faboid split lighter colored than the rest of the hilum and therefore conspicuous or the same color as the rest of the hilum; larger than punctiform or punctiform; 0.3–12 mm long; with curved, angular, or straight outline; circular, wedge-shaped, linear, or oblong; marginal according to radicle tip; flush; not within corona, halo, or rim or within halo. Hilum halo color lighter than testa. Lens discernible or not discernible; equal to or greater than 0.5 mm or less than 0.5 mm in length; 0.7–4 mm long; with margins straight or curved; irregular, linear, or circular; not in groove of raphe; adjacent to, confluent with, 180 degrees from, or 270 degrees from hilum; up to 13 mm from hilum (longest distances in *V. faba*); mounded; dissimilar color from, similar color to, or same color as testa; darker than testa; black, brown, or tan; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa (enclosing radicle in sheath). Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with lobes not touching; with the

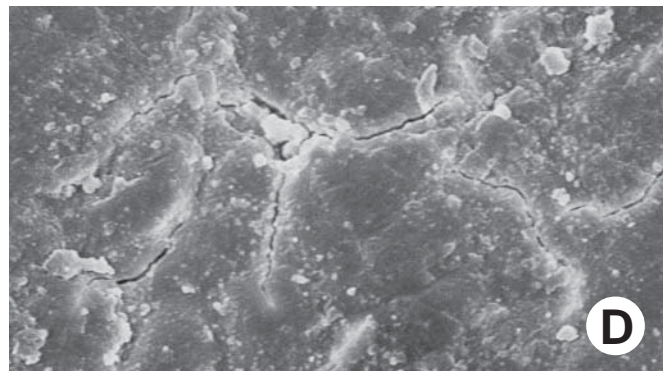
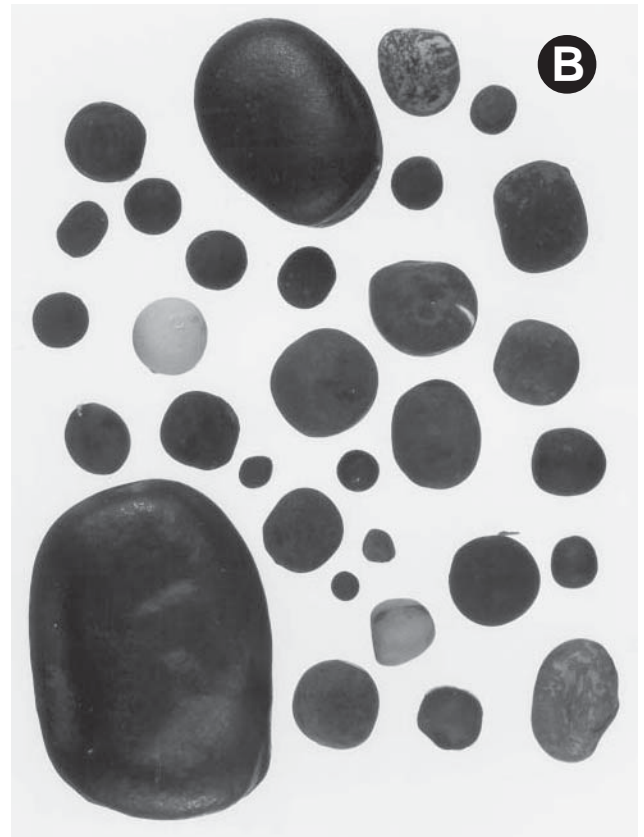
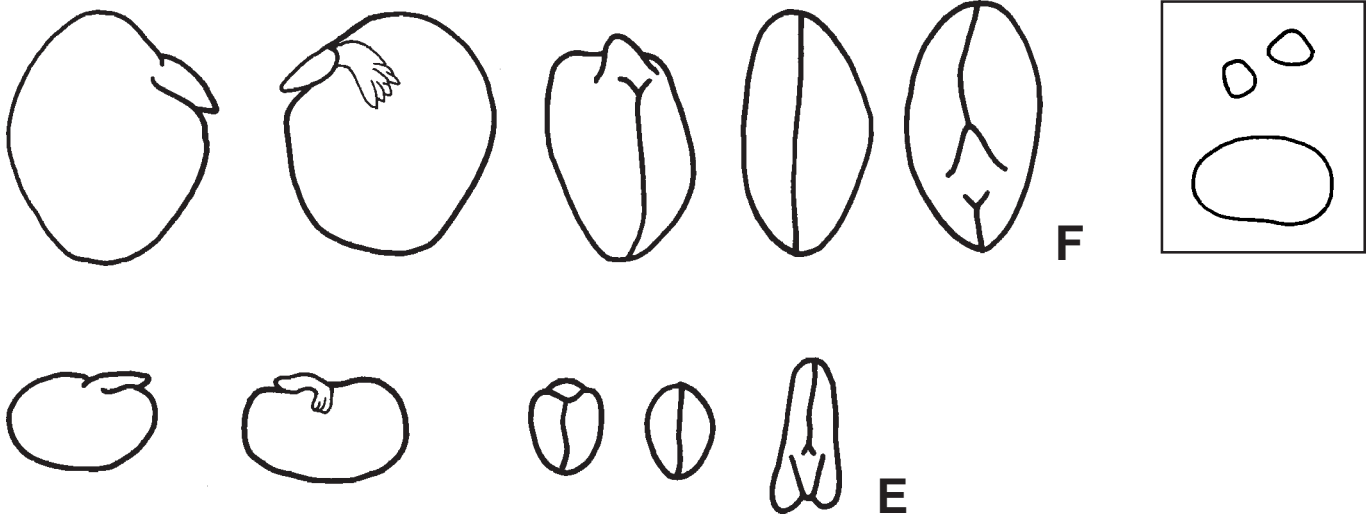
interface division terminating at base of radicle; without margins recessed; white or yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle triangular; deflexed and parallel to cotyledon length or width; centered between cotyledons; less than 1/2 length of cotyledons. Plumule well developed; glabrous.

Distribution: North and South America, Europe, Canary Islands, North and East Africa, Asia, and Hawaii.

Notes: This tribe has traditionally been called Viciae.

Article 19.4 of the *International Code of Botanical Nomenclature* (Greuter et al. 1994) states that, "The name of any subdivision of a family that includes the type of the adopted, legitimate name of the family to which it is assigned is to be based on the generic name equivalent to the type." *Faba* P. Miller is the type of Fabaceae and is synonymous with *Vicia*. Therefore because *Faba* is included in this tribe, the tribe must be called Fabeae. After performing a cladistic analysis using morphological characters, including internal seed morphology, Endo and Ohashi (1997) proposed that Cicereae (20) and Fabeae (Viciae) formed a monophyletic group whose sister group is Trifolieae (21). Kupicha (1976) treated, for the first time, *Vicia* on a worldwide basis. She recognized two subgenera and twenty-two sections, and some fruit and seed characters have value as sectional characters. Maxted (1993, 1995) revised *Vicia* subgen. *Vicia* and proposed nine sections and nine series. He distinguished *Vicia* sect. *Hypechusa* (F.G.C. Alefeld) P.F.A. Acherson & K.O.R.P.P. Graebner by its seed characteristics and revised the section with Colin Douglas (Maxted and Douglas 1997), recognizing two series, 14 species, and six subspecies in the section. Potokina (1997) revised the *V. sativa* aggregate for the former U.S.S.R. Like *Lens* (19.03) and *Pisum* (19.04), a few species of *Vicia*, such as *V. faba* and *V. ervilia* (C. Linnaeus) C.L. von Willdenow, appeared "in the Neolithic and Bronze Age cultures in the Near East and Europe" (Zohary and Hopf 1973). Hermann (1960) treated the genus in the United States; Gunn (1979) treated the genus in Mexico and Central America; Lassetter and Gunn (1979) monographed *V. menziesii* C.P.J. Sprengel, a native species of the island of Hawaii; and Bastos and Miotto (1996) revised the native Brazilian species of *Vicia*. Gunn (1970a,b, 1971) and Žertová (1962) studied the seed morphology of *Vicia*, and Gunn (1968) provided a key and diagrams for the seeds of 100 species of *Vicia*. *Vicia sativa* subsp. *amphicarpa* (C. Linnaeus) J.A. Battandier produces both aerial and subterranean fruits.

Vicia: *V. faba* C. Linnaeus (*C–E*), *V. sativa* C. Linnaeus (*F*),
V. spp. (*A–B*). *A*, Fruits (intact and dehisced) ($\times 1.1$);
B, seeds ($\times 2.4$); *C–D*, testa ($\times 50$, $\times 1000$); *E*,
embryos ($\times 1$); *F*, embryos ($\times 5$).



Genus: *Lathyrus* C. Linnaeus

Phylogenetic Number: 19.02.

Tribe: Fabaeae.

Species Studied—Species in Genus: 75 spp.—161 spp.

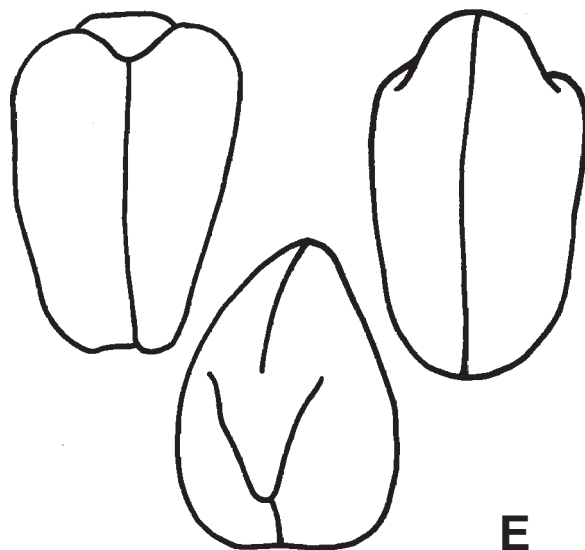
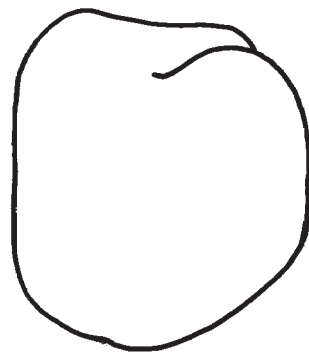
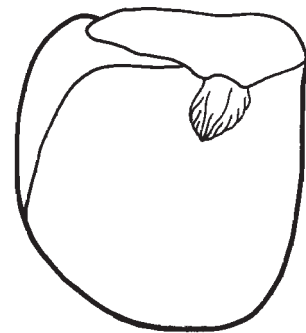
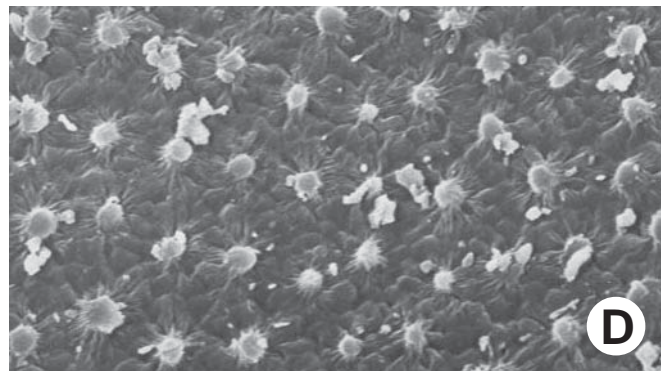
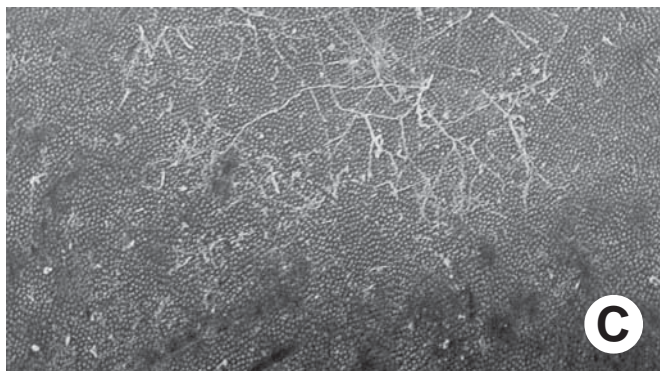
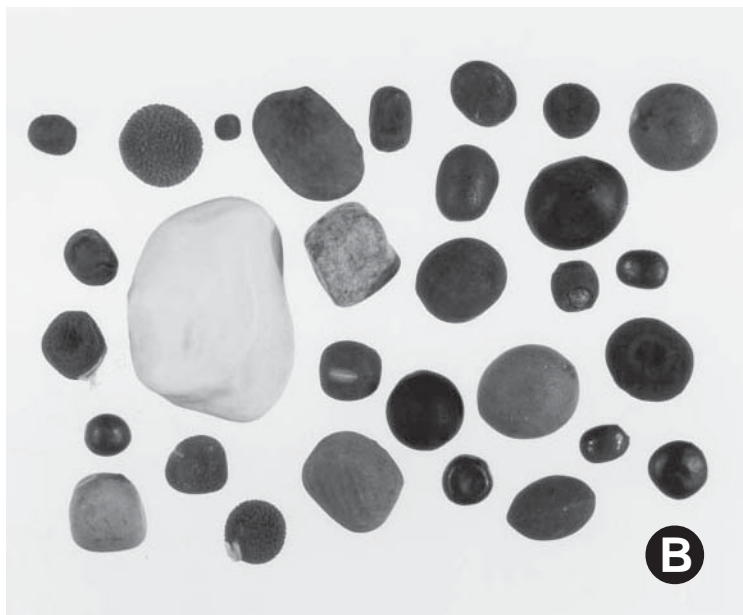
Fruit a legume; unilocular; 2.5–10 × 0.2–1 × 0.15–0.4 cm; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; asymmetrical or symmetrical; linear to rhombic (linear); when asymmetrical with both sutures nearly straight; not inflated; flattened or compressed; without beak; short tapered at apex; apex aligned or oblique with longitudinal axis of fruit; long tapered or short tapered at base; base aligned or oblique with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous, membranous, chartaceous, or ligneous (*L. lentiformis* U. Plitman); seed chambers externally visible (faintly to visible) or invisible; with the raised seed chambers not torulose or torulose. Fruit margin not constricted; without sulcus; plain or embellished. Fruit wings absent or present; sutural or valvular (occasionally); on both valves; on both sutures. Fruit nonstipitate or stipitate (infrequent, see *L. setifolius* C. Linnaeus). Fruit with all layers dehiscent or indehiscent (*L. lentiformis*); splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible. Epicarp dull; monochrome; reddish brown or tan; glabrous or pubescent and indurate; with hairs erect or appressed; with 1 type of pubescence; pilose; with pubescence gray; with simple hairs; pliable; with hair bases swollen or plain; glandular; with glandular hairs (*L. cassius* P.E. Boissier); without spines; not smooth; with elevated features; reticulately veined; not tuberculate; papillose (*L. hirsutus* C. Linnaeus) or glandular dotted (section *Orobus* (C. Linnaeus) J.G. Baker); not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous or chartaceous. Endocarp dull; monochrome; tan; smooth; nonseptate or septate; with septa thin (tissue paper-like), flexible; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–25; length parallel with or transverse to fruit length; touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent (funiculus may be expanded and remain over hilum and is not an aril).

Seed 1.5–10 × 1.5–10 × 1.3–7 mm; not overgrown; not angular or angular; symmetrical or asymmetrical (with or without dents because of adjacent seed pressures); oblong, circular (to subcircular), rectangular, quadrangular, triangular (compressed), or irregular (angular); terete or compressed (rarely); without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull or glossy; not modified or modified by a bloom; colored; monochrome or mottled; with frequent mottles; brown (diverse shades and in combinations with other colors), black (with or without purplish tinge), or tan; with brown (blackish) overlay; glabrous; smooth or not smooth; with elevated features; tuberculate (either aligned or not in rows or united into short ridges or not) or wrinkled (faintly); coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible or visible; from hilum through lens and base of seed to point opposite hilum; not bifurcating; darker than testa; black (color of mottles). Hilum visible, partially concealed, or fully concealed; concealed by funiculus or funicular remnant; with faboid split; with the lips of the faboid split lighter colored than the rest of the hilum and therefore conspicuous; larger than punctiform; up to 5 mm long; with curved, angular, or straight outline; circular, elliptic, wedge-shaped, oblong, or linear; subapical or marginal according to radicle tip; flush or recessed; not within corona, halo, or rim (though some species with light colored seeds with mottles concentrated around hilum somewhat like a necklace). Lens discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; up to 1.5 mm long; with margins straight or curved; oblong, linear, triangular, rhombic, or circular; not in groove of raphe; adjacent to or confluent with hilum; touching to 1 mm from hilum; mounded or recessed; dissimilar color from testa; darker than testa; reddish brown, black, or red; not within corona, halo, or rim. Endosperm absent or present; thin; covering entire embryo; adnate to testa (but enclosing radicle). Cotyledons not smooth; both outer faces convex; both the same thickness or 1 thicker than the other; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear or bulbous; deflexed and parallel to cotyledon width; centered between cotyledons; less than 1/2 length of cotyledons. Plumule well developed; glabrous.

Distribution: North and South America; Europe; North, East, and tropical Africa; and Asia.

Notes: Kupicha (1983) classified the Old World and New World species and recognized 13 sections. Asmussen and Liston (1998) conducted cladistic analyses of 42 *Lathyrus* species from 12 of Kupicha's sections using chloroplast DNA. Their results indicated that *Lathyrus* should be organized in 6–8 sections, not 13. Hitchcock (1952) monographed the North American species. Bässler (1966, 1971, 1981) studied some of the Old World species, and Hung-Pin (1984) extended his studies to China. Butler (1986) investigated the testa of *Lathyrus* using the scanning electron microscope, and her results are published in the Kaul and Combes (1986) book "*Lathyrus* and Lathyrism." Lathyrism is an animal expression of the toxic components of *Lathyrus* species, especially *L. sativus*. Several species produce aerial and subterranean fruits; for example, *L. amphicarpos* C. Linnaeus and *L. ciliolatus* K. H. Rechinger. Kupicha discussed the fruits of *Lathyrus* and illustrated their external variations in a full-page plate. The drawing of *L. lentiformis* fruit is especially interesting (fig. 5, k). Kupicha also recorded the relative hilum lengths for the 13 sections. The number of species is from Asmussen and Liston (1998).

Lathyrus: *L. sativus* C. Linnaeus (*C-E*), *L. spp.* (*A-B*). *A*,
Fruits (intact and dehisced) ($\times 1$); *B*, seeds ($\times 2.3$);
C-D, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 5$).



Genus: *Lens* P. Miller

Phylogenetic Number: 19.03.

Tribe: Fabaeae.

Species Studied—Species in Genus: 2 spp.—6 spp.
(Maxted, personal communication, 1998).

Fruit a legume; unilocular; $0.9\text{--}1.6 \times 0.4\text{--}1.2 \times 0.15\text{--}0.2$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; oblong; when asymmetrical with both sutures nearly straight; not inflated; compressed; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base oblique with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous; seed chambers externally visible or invisible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active or passive; with valves enrolling or twisting. Replum invisible. Epicarp dull; monochrome; reddish brown or tan; glabrous or pubescent and indurate; with 1 type of pubescence; puberulent; with pubescence gray; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; chartaceous. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds (1–)2; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 1 mm long; of 1 length only; filiform; straight. Aril absent (funiculus dilated).

Seed $3\text{--}8 \times 3\text{--}8 \times 1.5\text{--}3$ mm; not overgrown; not angular; symmetrical; circular; compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; colored; monochrome or mottled and streaked (mainly streaks); with frequent mottles; with frequent streaks; reddish brown or tan (cream); with black overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split lighter colored than the rest of the hilum and therefore con-

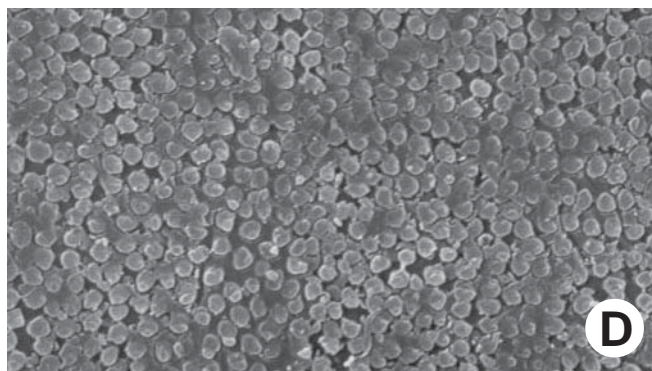
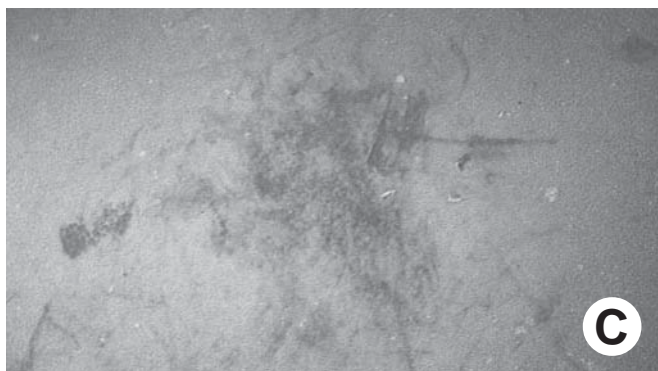
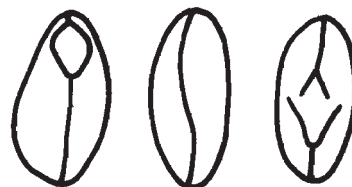
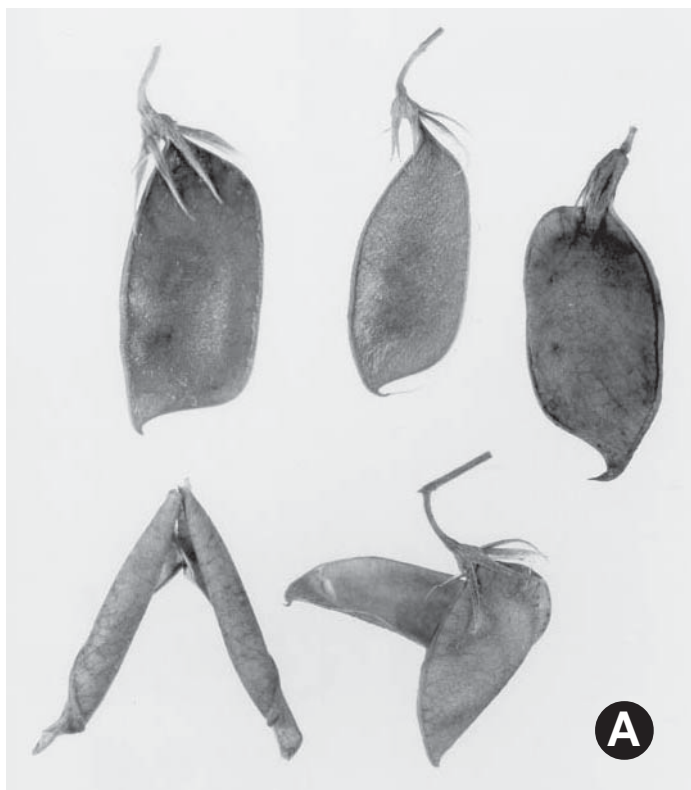
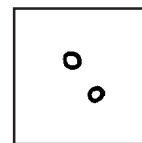
spicuous; larger than punctiform; 1–1.5 mm long; with straight outline; linear; marginal according to radicle tip; flush; not within corona, halo, or rim. Lens discernible; equal to or greater than 0.5 mm to less than 0.5 mm in length; 0.3–0.7 mm long; with margins straight or curved; linear or circular; not in groove of raphe; adjacent to hilum; 0.5–1.2 mm from hilum; mounded; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm trace; restricted to region of embryo (around radicle area); adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with lobes not touching; with the interface division terminating at base of radicle; without margins recessed; white, yellow, or orange; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear; deflexed and parallel to cotyledon length (more or less); centered between cotyledons; less than 1/2 length of cotyledons. Plumule well developed; glabrous.

Distribution: Mediterranean region, West and Central Asia, Ethiopia, and Zaire, and now widely cultivated.

Notes: The number of species in this genus has been open to question for many years. Most authors recognized the cultivated and commercially important lentil, *L. culinaris* F.C. Medikus. In the past, at least three wild species have been recognized. Ladizinsky et al. (1984), using extensive crossability and cytological studies, recognized one additional species, *L. nigricans* (F.A. Marchall von Bieberstein) D.A. Godman. The two other often recognized species of *Lens*, *L. ervoides* and *L. orientalis* (P.E. Boissier) H. Handel-Mazzetti, are now *L. nigricans* subsp. *ervoides* (G. de Brignoli di Brunnhoff) G. Ladizinsky and *L. culinaris* subsp. *orientalis* (P.E. Boissier) B.S. Williams, respectively. The fifth species, *L. montbretii* (F.E.L. von Fischer & C.A.A. von Meyer) P.H. Davis & U. Plitmann, had been assigned to *Lens* (Barulina 1930, Davis and Plitmann 1970), but Ladizinsky and Sakar (1982) provided morphological and karyological data suggesting that this species be returned to *Vicia* (19.01) where it was originally placed as *V. montbretii* (Hoffman et al. 1986). Ladizinsky (1997) described a new species of *Lens* from southeastern Turkey, *L. tomentosus* G. Ladizinsky, using evidence from morphological, crossing, and cpDNA studies. Our species count of five follows the count of Maxted (personal communication,

1998) for this genus. The history of *L. culinaris* extends as far back as agriculture itself. Like *Pisum* (19.04), *Lens* has been closely associated with grain cultivation in the Near East (Zohary and Hopf 1973).

Lens: *L. ervoides* (G. de Brignoli di Brunnhoff) L. Grande (C-E), *L. spp.* (A-B). A, Fruits (intact and dehisced) ($\times 3.9$); B, seeds ($\times 4.9$); C-D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 8$).



Genus: *Pisum* C. Linnaeus

Phylogenetic Number: 19.04.

Tribe: Fabaeae.

Species Studied—Species in Genus: 2 spp.—2 spp.

Fruit a legume; unilocular; 3–12 × 0.8–2.5 × 0.25–0.5 cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; asymmetrical; oblong or linear; when asymmetrical with both sutures nearly straight or both sutures parallelly curved; not inflated or inflated; terete or compressed; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; long tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible or visible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible. Epicarp dull; monochrome; brown, yellow, or green; glabrous; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds up to 10; length parallel with fruit length; touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent (funiculus dilated at apex).

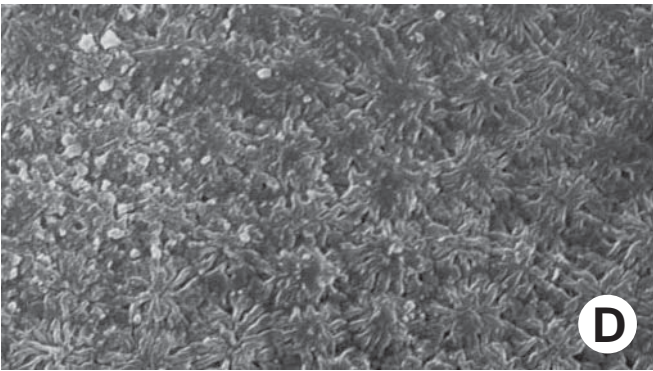
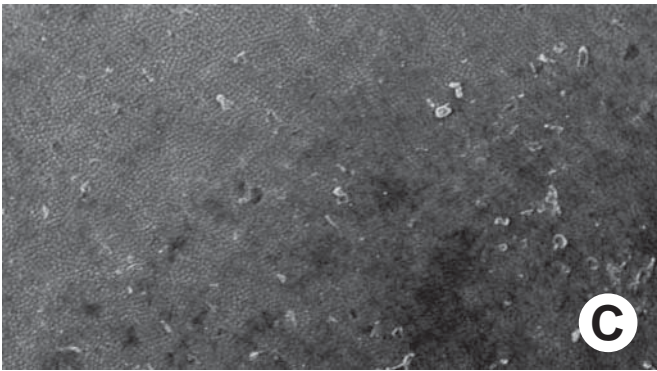
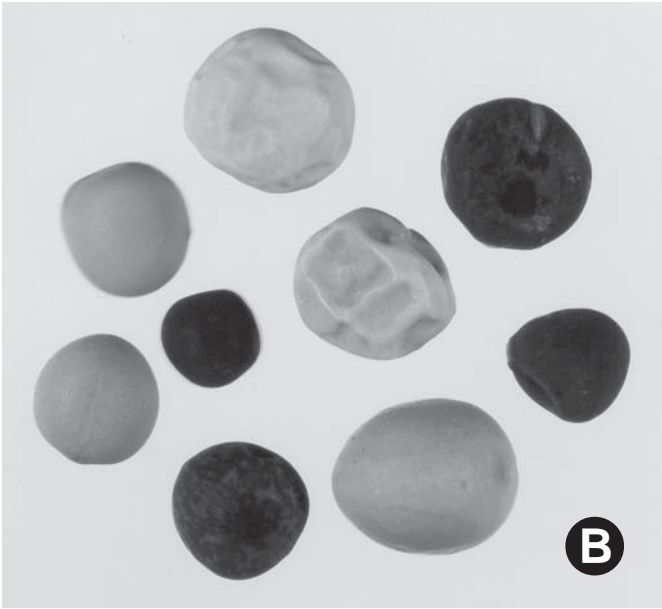
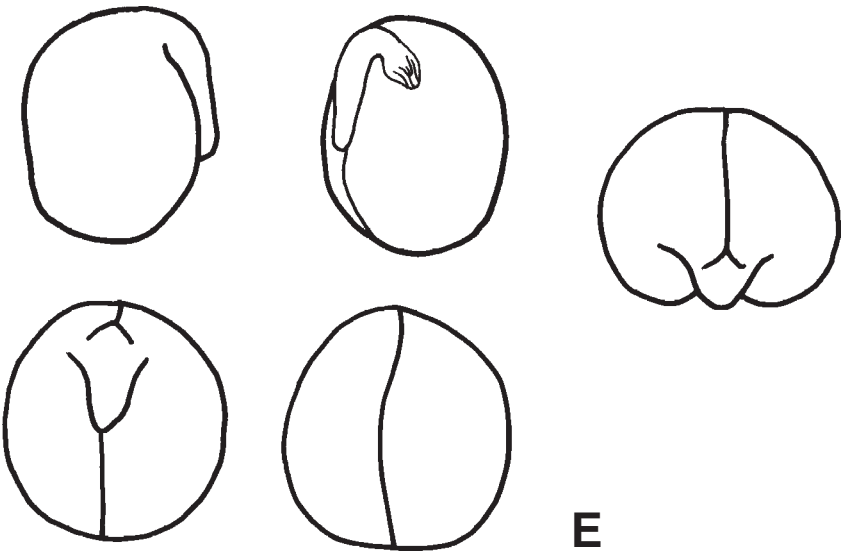
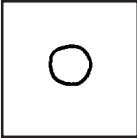
Seed 3.7–9 × 3.7–9 × 3.7–7 mm; not overgrown; angular or not angular; symmetrical or asymmetrical; circular or irregular (angular); terete; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified or modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; dark or dark reddish brown, tan (to greenish), red, or green; with brown (dark reddish) overlay; glabrous; smooth or not smooth; with elevated features; rugose, tuberculate (minutely), or wrinkled; chartaceous or coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible or partially concealed; concealed by funicular remnant; with faboid

split; with the lips of the faboid split the same color as the rest of the hilum or lighter colored than the rest of the hilum and therefore conspicuous; larger than punctiform; 1.6–2.1 mm long; with curved outline; elliptic; marginal according to radicle tip; flush; not within corona, halo, or rim. Lens discernible; equal to or greater than 0.5 mm in length; 1–2 mm long; with margins curved; circular or elliptic; not in groove of raphe; adjacent to hilum; 1.5–2 mm from hilum; mounded; dissimilar color from testa; darker than testa; black, brown, or tan; not within corona, halo, or rim. Endosperm thin; covering entire embryo (and forming sheath around radicle); adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; white or tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle bulbous; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule well developed; glabrous.

Distribution: Mediterranean region and now widely cultivated.

Notes: The past literature on the genus *Pisum* is replete with numerous scientific names used at various taxonomic levels because of the intense breeding of the pea, *P. sativum*, a major crop. Currently only two species of *Pisum* are recognized, and the other species is *P. fulvum* J. Sibthorp & J.E. Smith. *Pisum fulvum* can have both aerial and subterranean fruits. *Pisum sativum* was cultivated in “early Neolithic farming villages of the Near East (7,000 to 6,000 B.C.)” (Zohary and Hopf 1973).

Pisum: *P. sativum* C. Linnaeus subsp. *elatius* (C. von Steven ex F.A.M. von Bieberstein) P.F.A. Ascherson & K.O.R.P.P. Graebner (*C–E*), *P. spp.* (*A–B*). *A*, Fruits (× 0.6); *B*, seeds (× 3); *C–D*, testa (× 50, × 1000); *E*, embryos (× 5).



Genus: *Vavilovia* A.A. Fedorov

Phylogenetic Number: 19.05.

Tribe: Fabaeae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; unilocular; $1.5-3.5 \times 0.8-0.9 \times 0.8-0.9$ (assumed) cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; linear; when asymmetrical with both sutures nearly straight; not inflated; terete; without beak; rounded at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves enrolling. Replum invisible. Epicarp dull; monochrome; reddish brown or tan; glabrous; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; reddish brown or tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 2–5; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent.

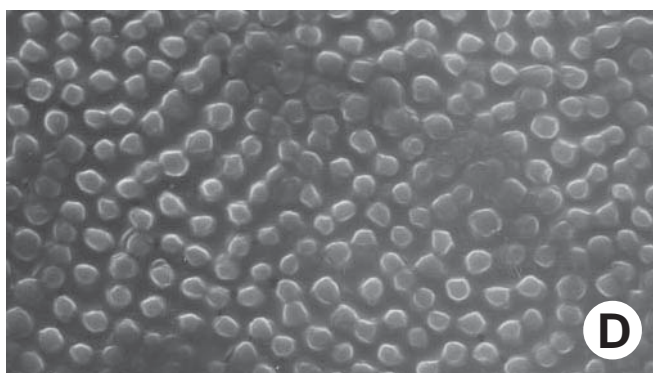
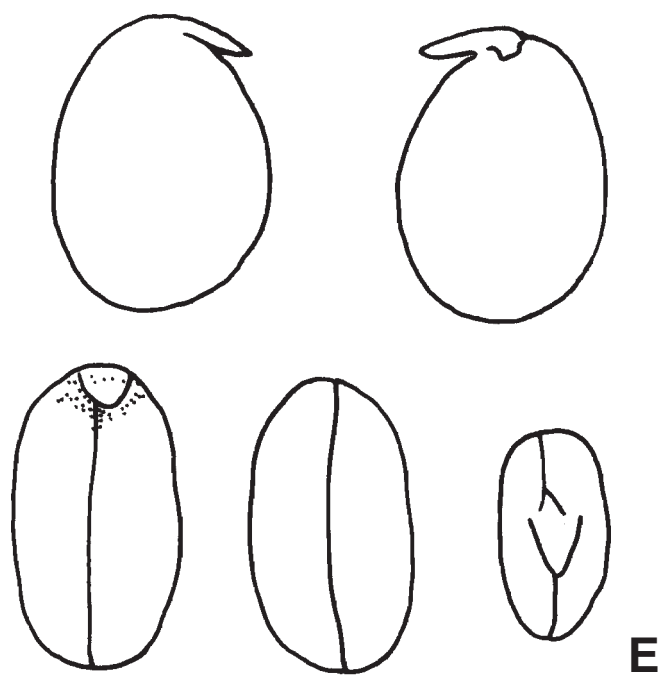
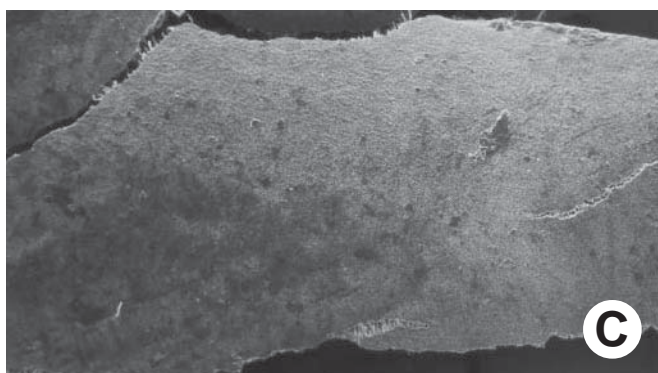
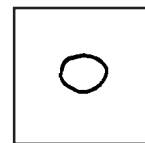
Seed $4-5 \times 3.3-4 \times 1.7-2.7$ mm; not overgrown; not angular; symmetrical; oblong; compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled; with frequent mottles; reddish brown; with black overlay; glabrous; smooth; chartaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible or partially concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split lighter colored than the rest of the hilum and therefore conspicuous; larger than punctiform; 0.7 mm long; with curved outline; elliptic; marginal according to radicle tip; flush; not within corona, halo, or rim. Lens faintly discernible or not discernible; less than 0.5 mm in length; with margins curved; circular;

not in groove of raphe; adjacent to hilum; 0.7 mm from hilum; mounded; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm absent. Cotyledons smooth; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; brown; inner face flat; glabrous around base of radicle. Embryonic axis straight; almost perpendicular to length of seed; without a joint evident between the radicle and the cotyledons. Radicle differentiated from cotyledon; triangular; lobe tip straight; straight with embryonic axis; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Turkey, Lebanon, Iraq, Iran, Russia, Georgia, and Armenia.

Notes: *Vavilovia formosa* has been placed in *Orobus* C. Linnaeus (now *Lathyrus*, 19.02) and a segregate genus, *Alophotropis* (H.F. Jaubert & É. Spach) A.A. Grossheim, now a synonym of *Vavilovia*. We were unable to obtain an intact fruit, and our studied seeds were flattened during pressing.

Vavilovia: *V. formosa* (C. von Steven) A.A. Fedorov (A–E). A, Fruits (dehiscent) ($\times 3.1$); B, seeds ($\times 4$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 8$).



Cicereae (20.01)

Genus: *Cicer* C. Linnaeus

Phylogenetic Number: 20.01.

Tribe: Cicereae.

Species Studied—Species in Genus: 28 spp.—43 spp.

Fruit a legume; unilocular; $1.8\text{--}3.6 \times 0.7\text{--}2$ cm; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical; elliptic to oblong to obovate to rhombic (elongate); not inflated; terete; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active or passive; with valves twisting. Replum invisible. Epicarp dull; monochrome; brown or yellow (-brown); glabrous or pubescent and indurate; with 1 type of pubescence; pilose; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; glandular or eglandular; with glandular hairs; without spines; not smooth; with elevated features; obliquely veined relative to fruit length; not tuberculate; not exfoliating; without cracks. Mesocarp thin; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp glossy; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–2(–7); touching, or neither overlapping nor touching; in 1 series. Funiculus measured; 1.5 mm long; of 1 length only; thick; straight. Aril absent.

Seed 4–11 \times 2.5–9 \times 3–7 mm; overgrown, 1 seed filling entire fruit cavity; angular or not angular; asymmetrical; ovate or bilobed, ramshead-shaped (typically beaked); terete to quadrangular; with surface grooved; with grooves longitudinal; with or without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored or clear (*C. arietinum*); monochrome or mottled; with frequent mottles; black, brown, cream, gray, green, ivory, olive, orange (yellowish), pink (gray-brown), red, tan, white, or yellow; glabrous; smooth or not smooth; with elevated features;

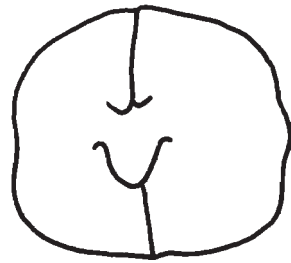
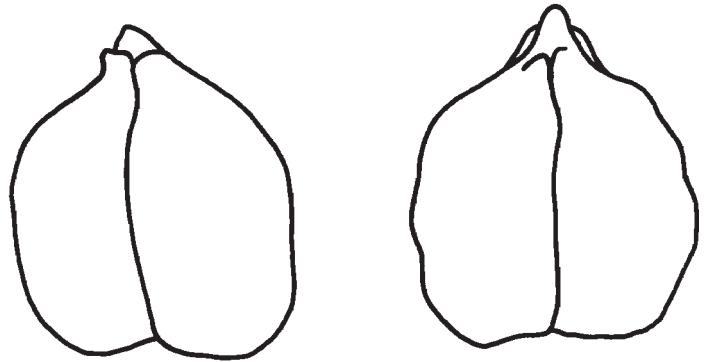
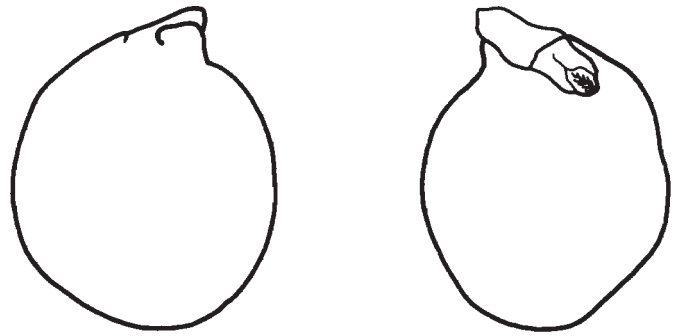
shagreen, tuberculate, warty, wrinkled, or echinate; coriaceous. Fracture lines absent. Rim absent. Raphe from lens to base of seed and bifurcating (*C. arietinum*); bifurcating at base of seed with each arm going up antiraphe side, then turning (U-shaped) down and approaching bifurcation; color of or darker than testa; tan, brown, or black; flush or recessed. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.5–1.7 mm long; with curved outline; circular or elliptic; marginal according to radicle tip or between cotyledon and radicle lobe; recessed; within rim or not within corona, halo, or rim. Hilum rim color lighter than or color of testa. Lens discernible; equal to or greater than 0.5 mm in length; 2 mm long; with margins straight or curved; triangular; elliptic; not in groove of raphe; adjacent to hilum; 1.5–2 mm from hilum; mounded or recessed; same color as or dissimilar color from testa; darker than testa; red; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth or not smooth; wrinkled (replicating testa surface); both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; split over radicle; with lobes; with lobes touching (auriculate); with basal groin formed by lobes; with the interface division terminating at base of radicle; without margins recessed; white; inner face flat; glabrous around base of radicle. Embryonic axis straight, or deflexed; parallel or oblique to length of seed. Radicle linear; lobe tip straight or curved; straight with embryonic axis or oblique to cotyledons; centered between cotyledons; less than 1/2 length of cotyledons. Plumule well developed; glabrous.

Distribution: Turkey south to Israel and east to the Himalayas and Central Asia; also in Morocco, Egypt, Ethiopia, Greece, and Crete. *Cicer arietinum* is widely cultivated.

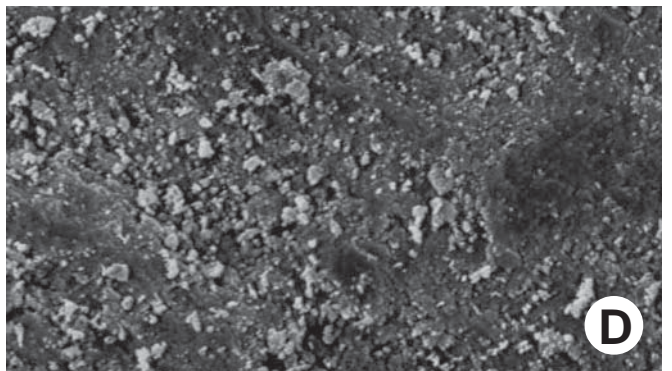
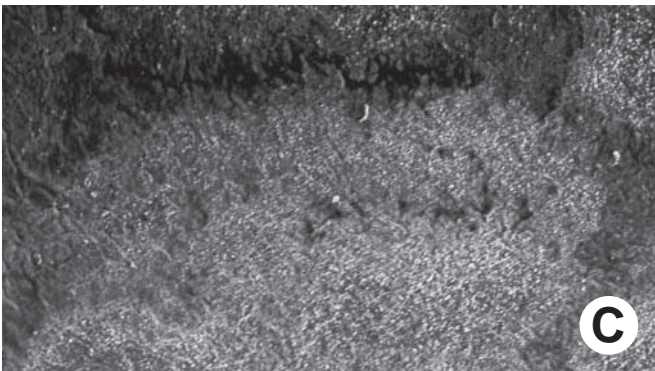
Notes: After a cladistic analysis using morphological characters, including internal seed morphology, Endo and Ohashi (1997) proposed that Cicereae and Fabeae (19) form a monophyletic group whose sister group is Trifolieae (21). Van der Maesen (1972, 1987) monographed *Cicer*. Lersten and Gunn (1981, 1982) discussed the seed morphology and testa topography of *Cicer* species, which supported the separation of Cicereae from the Fabeae (19) (Werker 1997). Following traditions in the Indian subcontinent, Summerfield and Roberts (1985a) recognized two groups for the

guidance of plant breeders: Genotypes producing large, rounded, pale cream-colored seeds (greater than 25 g per 100 seeds) borne on tall plants (Kabuli), and genotypes producing smaller irregularly shaped, variously-colored seeds (less than 25 g per 100 seeds) borne on relatively short to prostrate plants (Desi).

Cicer: *C. arietinum* C. Linnaeus (*C–E*), *C. spp.* (*A–B*). *A*,
Fruits ($\times 1.6$); *B*, seeds ($\times 2.1$); *C–D*, testa ($\times 50$,
 $\times 1000$); *E*, embryos ($\times 5$).



E



Trifolieae (21.01–21.06)

Genus: *Ononis* C. Linnaeus

Phylogenetic Number: 21.01.

Tribe: Trifolieae.

Species Studied—Species in Genus: 27 spp.—ca. 75 spp.

Fruit a legume; unilocular; $0.8\text{--}1.6 \times 0.2\text{--}0.4 \times 0.02\text{--}0.04$ cm; with persistent or deciduous calyx; with calyx longer than, equal in length to, or shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; linear, oblong, rhombic, or ovate (rarely); when asymmetrical with 1 straight and 1 curved suture; widest near middle or D-shaped; not inflated; compressed; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin constricted or not constricted; slightly constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible. Epicarp dull; monochrome; tan; pubescent and indurate; with 1 type of pubescence; pilose or puberulent; with pubescence golden or gray; with pubescence uniformly distributed; with glandular and simple hairs; pliable; with hair bases plain or swollen; glandular; with glandular hairs; without spines; not smooth; with elevated features; not veined; not tuberculate; tuberculate (bases of hairs); not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull or glossy; monochrome; tan; smooth; septate or nonseptate; with septa thin (tissue paper-like), flexible; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 5–10; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; up to 1 mm long; of 1 length only; thick; straight. Aril absent.

Seed $0.5\text{--}5.5 \times 0.5\text{--}5 \times 1\text{--}4.5$ mm; not overgrown; not angular or angular; asymmetrical; mitaform, ovate, reniform, C-shaped (with cotyledon and radicles more or less of equivalent size and on each side of a deep hilar sinus), or triangular; compressed or terete; with

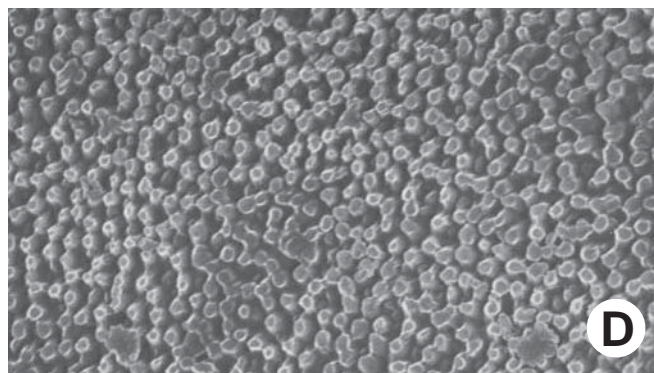
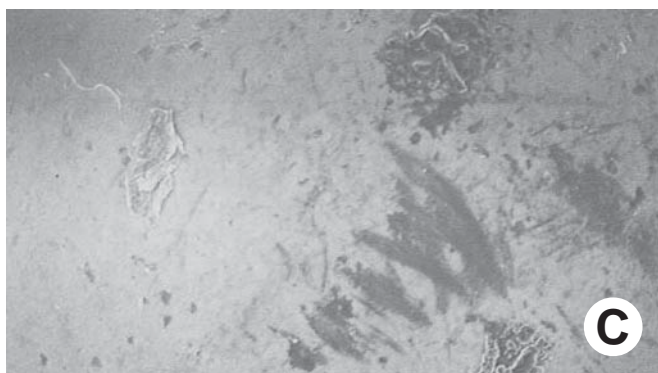
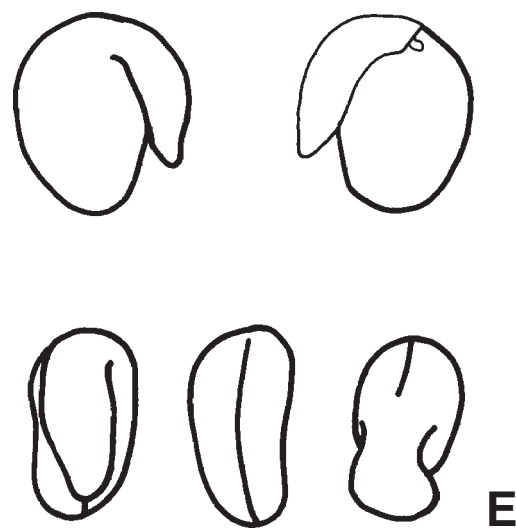
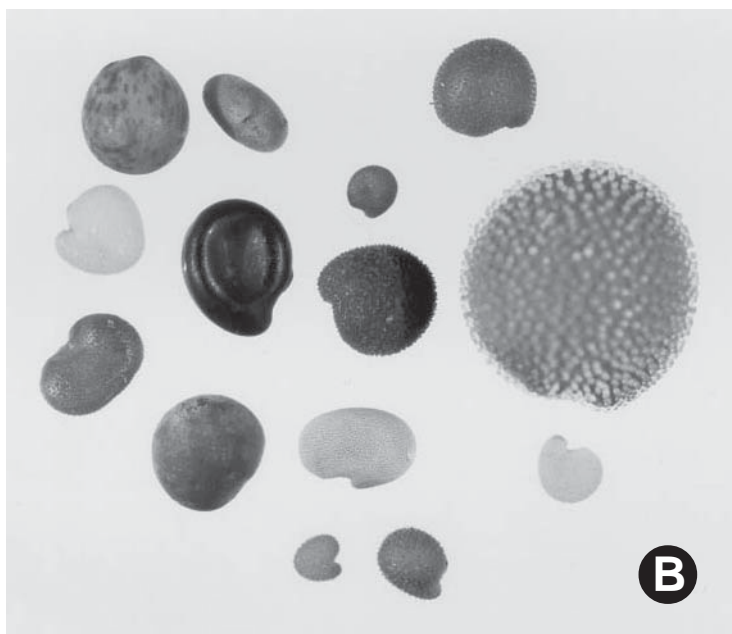
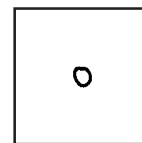
visible radicle and cotyledon lobes; with deep hilar sinus or without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome (occasionally with white tubercles); dark to light reddish brown, tan, or yellow; glabrous; not smooth or smooth; with elevated or recessed features; tuberculate (some quite prominent in size and/or color) or rugose (rarely); punctate; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe from hilum to lens; not bifurcating; darker than testa; tan; flush. Hilum visible, fully concealed, or partially concealed; concealed by funiculus or wing; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; recessed; within rim. Hilum rim color of testa. Lens discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; 0.5–1 mm long; with margins straight or curved; linear, circular, elliptic, or oblong; not in groove of raphe; adjacent to hilum; 0.1–0.2 mm from hilum; mounded; similar color as testa; darker than testa; reddish brown, tan (reddish), or black (ish); not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa or embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis straight; oblique to length of seed. Radicle linear; lobe tip straight, curved, or hooked; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary or moderately developed; glabrous.

Distribution: Northern Europe to Canary Islands, Ethiopia, and Iran.

Notes: After a cladistic analysis using morphological characters, including internal seed morphology, Endo and Ohashi (1997) have proposed that Cicereae (20) and Fabeae (19) formed a monophyletic group whose sister group is Trifolieae. *Ononis* and *Parochetus* (21.02) “are not nearly as closely related to the remaining four genera as the latter are to each other, and indeed ... the two genera are not at all closely related to each other (or so far as I know to anything else)” (E. Small, personal communication, 1997). Butler (1996) presented a table with eight seed characteristics of 14 *Medicago* (21.05) spp., 7 *Melilotus* (21.03) spp., 25

Trifolium (21.06) spp., 11 *Trigonella* (21.04) spp. and 2 *Ononis* spp. as an aid for their identification in archaeological sites. Förther and Podlech (1991) revised the polymorphic *O. natrix* C. Linnaeus group of seven species. La Sota (1978) studied the testa morphology of 10 *Ononis* species.

Ononis: *O. pubescens* C. Linnaeus (*C–E*), *O. spp.* (*A–B*). *A*,
Fruits with and without calyx (intact and dehisced)
($\times 2.5$); *B*, seeds ($\times 6.4$); *C–D*, testa ($\times 50$, $\times 1000$);
E, embryos ($\times 8$).



Genus: *Parochetus* F. Buchanan-Hamilton ex D. Don

Phylogenetic Number: 21.02.

Tribe: Trifolieae.

Species Studied—Species in Genus: 1 sp.—2 spp.

Fruit a legume; unilocular; $1.5\text{--}2.3 \times 0.4\text{--}0.5$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical; linear or oblong (narrowly); inflated; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscent (to tardily dehiscent); splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible. Epicarp dull; monochrome; dark brown; glabrous or pubescent but soon deciduous; with 1 type of pubescence; rarely pilose; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; not veined; faintly tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; greenish tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 4–15; length transverse to fruit length; in 2 or more series. Funiculus less than 0.5 mm long; of 1 length only; filiform; straight. Aril absent.

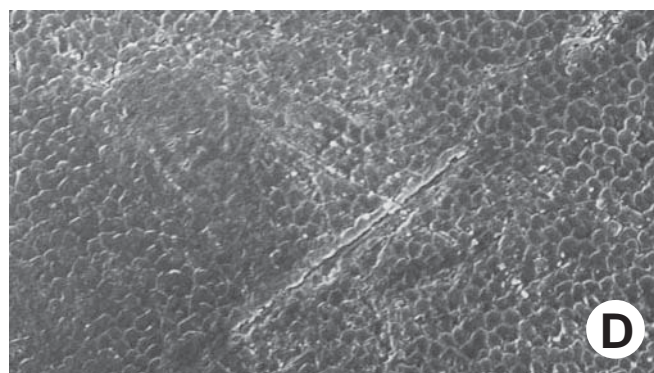
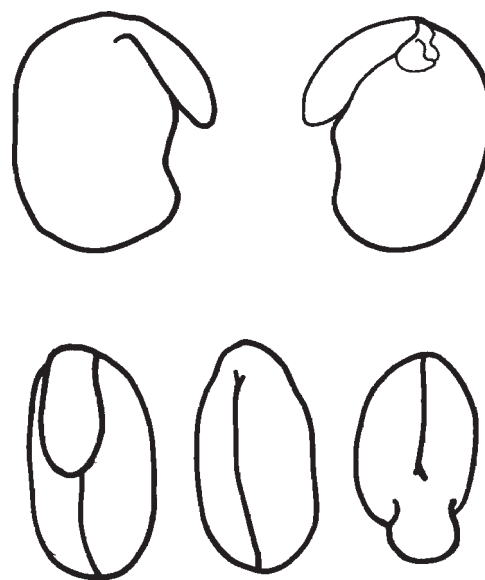
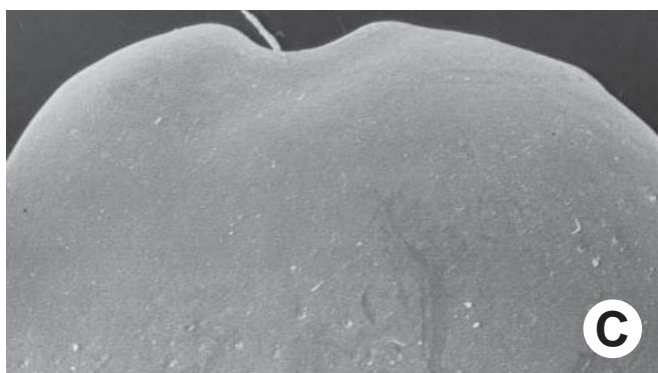
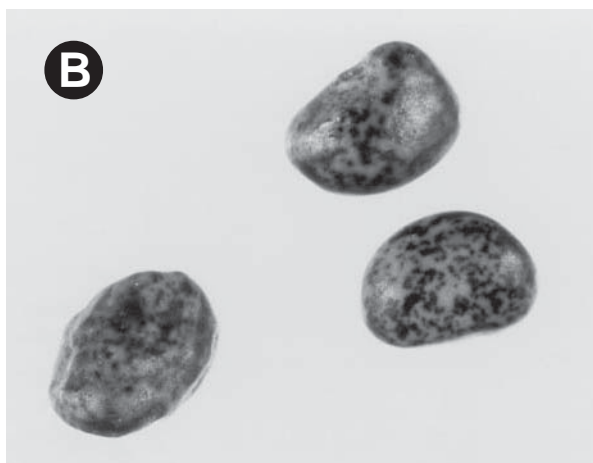
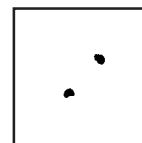
Seed $1.5\text{--}2.5 \times 1.4\text{--}2 \times 1\text{--}1.5$ mm; not overgrown; not angular; asymmetrical; oblong; compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; blackish brown; with brown overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; recessed; within rim. Hilum rim color slightly darker than testa. Lens not discernible or discernible (barely sometimes); less than 0.5 mm in

length; with margins curved; circular; not in groove of raphe; adjacent to hilum; 0.5 mm from hilum; flush; similar color as or dissimilar color from testa; darker than testa; reddish brown. Endosperm quite thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; white; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Tropical Africa, Asia (Himalaya Mountains to Sri Lanka and eastern China) to Indonesia (southeastern Java), and Europe (cultivated).

Notes: For additional information, see the Notes for *Ononis* (21.01). Polhill, in Beckett and Polhill (1991), named a second species, *P. africanus* R.M. Polhill.

Parochetus: *P. communis* F. Buchanan-Hamilton ex D. Don (A–E). A, Fruits (dehiscent) with calyx ($\times 3.7$); B, seeds ($\times 11$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 15$).



Genus: *Melilotus* P. Miller

Phylogenetic Number: 21.03.

Tribe: Trifolieae.

Species Studied—Species in Genus: 16 spp.—19 spp.

Fruit a legume; unilocular; $0.15\text{--}0.8 \times 0.15\text{--}0.45 \times 0.12\text{--}0.4$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; circular, lanceolate, oblong, obovate, or ovate; when asymmetrical with both sutures parallelly curved; not inflated; compressed or terete; without beak; short tapered or rounded at apex; apex aligned or oblique (slightly) with longitudinal axis of fruit; short tapered or rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous, chartaceous, or fragile, thinner than chartaceous like *Trifolium* (21.06); seed chambers externally visible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent or with all layers dehiscing (*M. altissimus* J.L. Thuillier); splitting along suture. Dehiscence of valves along 1 suture; medial and up and down; passive. Replum invisible. Epicarp dull; monochrome; black, brown, or tan; glabrous or pubescent and indurate; with hairs appressed; with 1 type of pubescence; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; veined or not veined; obliquely veined relative to fruit length or reticulately veined; not tuberculate; concentric whorls like a fingerprint, ribbed, or wrinkled; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; brown or tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1 or 2; length parallel with fruit length; neither overlapping nor touching or touching; in 1 series. Funiculus less than 0.5 mm long or measured; up to 0.8 mm long; of 1 length only; filiform; straight or curved. Aril absent.

Seed $1.5\text{--}4.5 \times 1\text{--}3 \times 1\text{--}2.2$ mm; not overgrown; not angular or angular (somewhat); asymmetrical; circular, elliptic, mitaform, or reniform; compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome, mottled, or streaked; with frequent mottles; with

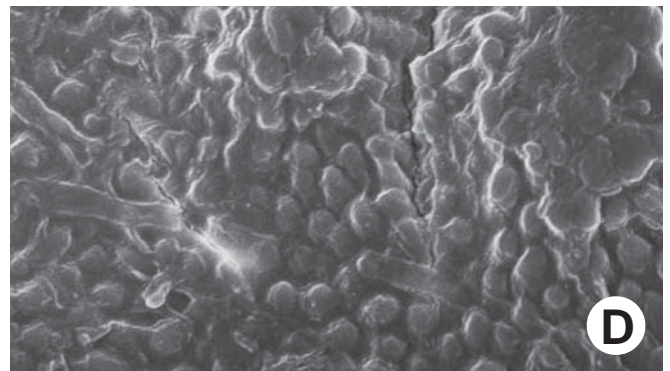
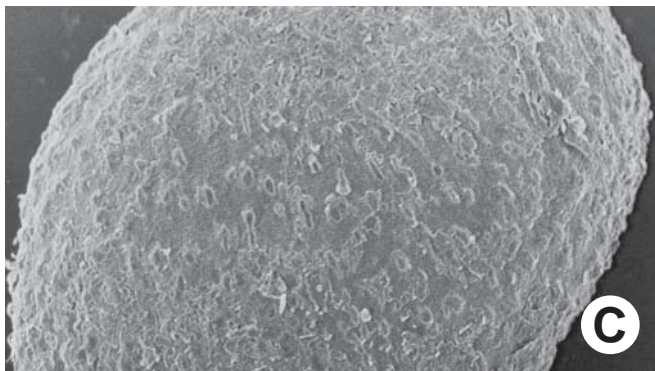
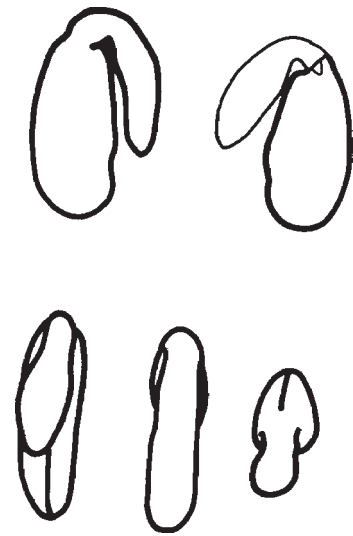
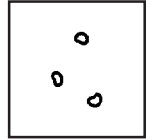
frequent streaks; brown (and yellowish, greenish), green (and yellowish), tan, or yellow; with purple overlay; glabrous; smooth or not smooth; with elevated features; shagreen or warty; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform or larger than punctiform; with curved or angular outline; circular or triangular; between cotyledon and radicle lobe; flush; not within corona, halo, or rim. Lens discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; 0.6 mm long; with margins straight or curved; oblong; not in groove of raphe; confluent with hilum (at least discolor area); mounded; dissimilar color from testa; darker than testa; brown; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; not folded or with both folded; not sufficiently folded for inner face to touch itself (essentially cotyledons longer than testa); portions of inner folded face equal; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over or notched at radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle bulbous; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule rudimentary or moderately developed; glabrous.

Distribution: Europe, Asia, and North Africa.

Notes: Stevenson (1969) reviewed *Melilotus*, recognized 18 species, and illustrated its fruits. Jha and Pandey (1989) studied the seeds, especially the testae, of 11 species of *Melilotus*. They concluded that the testa coat ornamentation for a species is characteristic “and of great importance in specific diagnosis of a seed.” Isely (1954) provided flower-fruit keys to the 20 species of *Melilotus*. Voronchikhin and Bazilevskaya (1974) described fruits and seeds of the nine species of *Melilotus* in the former U.S.S.R. Small (1989) noted that *M. bicolor* P.E. Boissier & B. Balansa may perhaps be better placed in *Trigonella* (21.04). Our number of species includes *M. bicolor* and is the same as the count used by Small (1989); we do not agree with the species count of ca. 20 by Heyn (1981). We are not adopting Small’s selection of “*a*” to end species names currently ending in “*us*” in Wiersema et al. (1990). Schulz

(1901:667) noted that the two seeds in a pod may be differently colored: one light yellowish brown and the other dark reddish brown.

Melilotus: *M. indicus* (C. Linnaeus) C. Allioni (C–E), *M.*
spp. (A–B). A, Fruits, most with calyx ($\times 3$); B, seeds
($\times 6$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



Genus: *Trigonella* C. Linnaeus

Phylogenetic Number: 21.04.

Tribe: Trifolieae.

Species Studied—Species in Genus: 25 spp.—ca. 61 spp.

Fruit a legume; unilocular; $1-11 \times 0.09-1.3 \times 0.07-0.08$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight to curved (slightly), 0.5-coiled, or contorted; loosely plicate; not twisted; asymmetrical or symmetrical; linear, ovate, circular, moniliform, C-shaped, or falcate; when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; widest near middle or D-shaped; inflated or not inflated; compressed, flattened, or terete; without or with beak; straight or declined; with solid beak the same color and texture as fruit; long tapered or rounded at apex; apex aligned with longitudinal axis of fruit; tapered or short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous or coriaceous; seed chambers externally visible; with the raised seed chambers not torulose or torulose. Fruit margin not constricted or constricted; slightly constricted along both margins or constricted only on 1 margin; without sulcus; plain or embellished; with prickles. Fruit wing absent or present (rarely); 1; 1–2 mm wide; sutural; on both sutures or 1 suture. Fruit nonstipitate or substipitate. Fruit indehiscent (gaping or not along seed-bearing suture) or with all layers dehiscent (rarely); splitting along sutures. Dehiscence of valves along both sutures or 1 suture; apical and down; passive. Replum invisible. Epicarp dull; monochrome; tan (to white); glabrous or pubescent and indurate; with hairs appressed or erect; with 1 type of pubescence; puberulent; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined or longitudinally veined relative to fruit length (and veins twisted); not tuberculate; warty; not exfoliating; without cracks. Mesocarp present or absent; thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp or to epicarp; entire. Seeds 1–20; length parallel with or transverse to fruit length; neither overlapping nor touching or

touching; in 1 series. Funiculus less than 0.5 mm long or measured; up to 0.6 mm long; of 1 length only; filiform; curved. Aril absent.

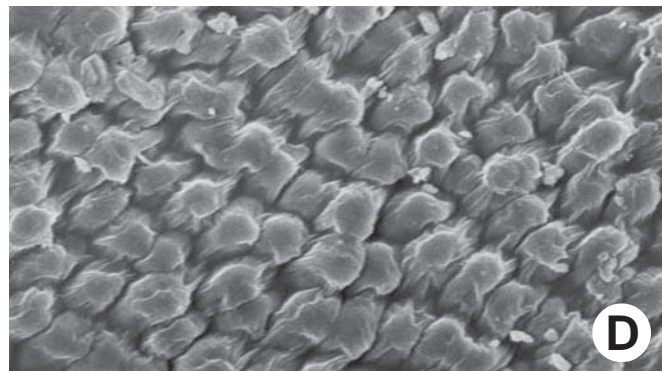
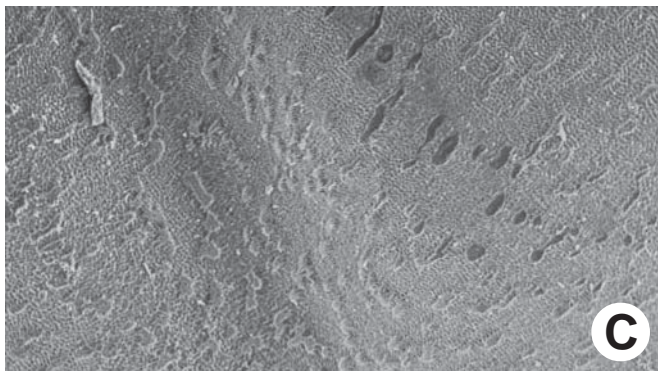
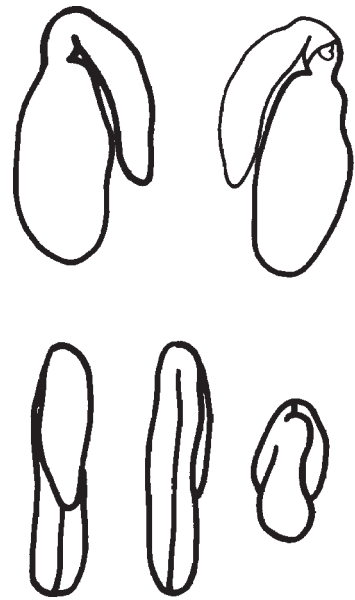
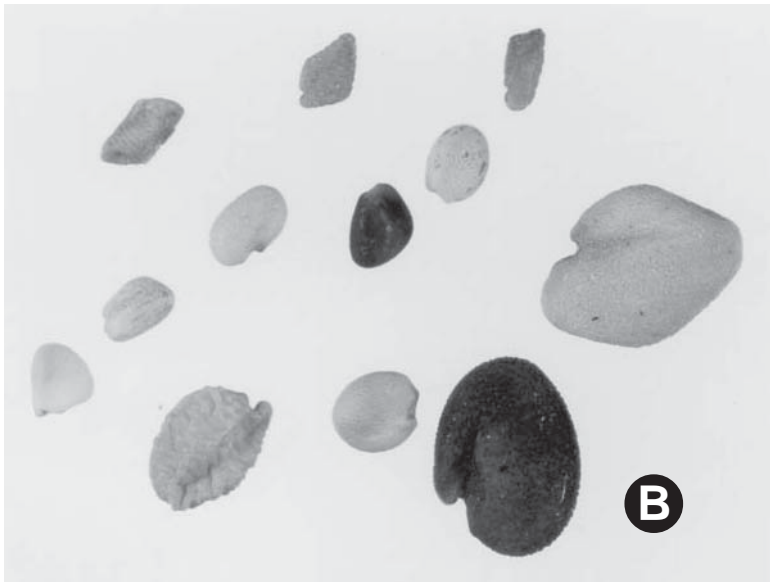
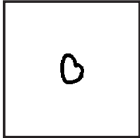
Seed $1.5-5 \times 0.5-3 \times 0.5-1.6$ mm; not overgrown; angular or not angular; asymmetrical; mitaform, oblong, ovate, quadrangular, rectangular, rhombic, elliptic, linear, or circular (sub); compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent or infrequent mottles; with frequent or infrequent streaks; yellowish, greenish, or dark brown, yellow (or pale), orange, or green (grayish); with black or brown overlay; glabrous; not smooth or smooth; with elevated features; tuberculate, wrinkled, or verrucose; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible or partially concealed; concealed by funicular remnant or wing; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; recessed; not within corona, halo, or rim. Lens not discernible or discernible; less than 0.5 mm in length; with margins straight or curved; triangular or irregular; circular or irregular; not in groove of raphe; adjacent to hilum; 0.1–0.3 mm from hilum; mounded; similar color as testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thin or thick; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow or tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear or bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 or 1/2 to nearly length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Central Europe to South Africa to Canary Islands and Central Asia, and Australia (1 sp.).

Notes: There is a rich history of authors trying to separate *Trigonella* and *Medicago* (21.05), and most of this history was summarized by Baum (1968). The recent publications of Small (1986, 1987a,b) have clarified this separation. Small and Jomphe (1989a) transferred

some species of *Trigonella* to *Medicago*, and our species count reflects these and other transfers. Our species count is based on Small (1989) and not on Heyn (1981), who had ca. 80. The number of perennial Asian species can only be roughly estimated (Small, personal communication, 1997).

Trigonella: *T. foenum-graecum* C. Linnaeus (C–E), *T. spp.*
(A–B). A, Fruits (few with calyx) ($\times 1.2$); B, seeds
($\times 6.7$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 6$).



Genus: *Medicago* C. Linnaeus

Phylogenetic Number: 21.05.

Tribe: Trifolieae.

Species Studied—Species in Genus: 83 spp.—86 spp.

Fruit a legume or nutlet; unilocular; $0.2\text{--}10 \times 0.1\text{--}1 \times 0.2\text{--}1.5$ cm; with persistent calyx; with calyx shorter than fruit; with orifice formed by curving of fruit or fruit segments (with 1 or more than 1 per fruit); straight, curved (slightly), 0.5-coiled, 1-coiled, 1.5-coiled, 2-coiled, 3-coiled, 4-coiled, or 5- to 10-coiled (rarely); not plicate or plicate (*M. plicata* (P.E. Boissier) G.I. Sirjaev); not twisted or twisted; asymmetrical or symmetrical; circular, falcate, or coiled; when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; widest near middle or D-shaped; not inflated; compressed, terete, or flattened; without beak; short tapered at base; base right angled with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous, membranous, or lignous; seed chambers externally invisible. Fruit margin not constricted or constricted; constricted along both margins; without sulcus; plain or embellished; with prickles or fringe. Fruit wing absent or present (*M. popovii* (E.I. Korneva) G.I. Sirjaev); 1; sutural; on 1 valve; on 1 suture. Fruit substipitate or nonstipitate. Fruit with all layers dehiscing or indehiscent; splitting along sutures. Dehiscence of valves passive. Replum invisible. Epicarp dull; monochrome; brown or black; glabrous or pubescent and indurate; with 1 or 2 types of pubescence; tomentose (*M. hypogaea* E. Small); with pubescence gray or brown; with simple or glandular hairs; pliable; with hair bases plain; glandular or eglandular; with glandular hairs; without or with spines (spines forked or more often not); smooth or not smooth; with elevated features; reticulately veined; not tuberculate or tuberculate; with solid tubercles on each valve; exfoliating in part; without cracks. Mesocarp absent. Endocarp dull; monochrome; nonseptate, subseptate, or septate; with septa thin (tissue paper-like), flexible or thicker than paper, firm; with septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1–6(–20) (20 or more in *M. scutella* (C. Linnaeus) P. Miller (Small, personal communication, 1997)); length parallel with fruit length; neither overlapping nor touching or touching; in 1 series. Aril absent.

Seed $1.2\text{--}7 \times 1\text{--}4.5 \times 0.7\text{--}1.9$ mm; not overgrown; not angular or angular; asymmetrical; mitaform, oblong, rhombic, or triangular; compressed; with or without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; brown (or yellowish, reddish, or blackish) or yellow; glabrous; smooth or not smooth; with elevated features; rugose, wrinkled, papillate, or transversely ridged; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; not within corona, halo, or rim. Cotyledons not concealing radicle; entire over radicle; brown to tan; with the interface division terminating at base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle lobe tip straight; deflexed and parallel to cotyledon length; $1/2$ to nearly or equaling length of cotyledons. Plumule rudimentary; glabrous.

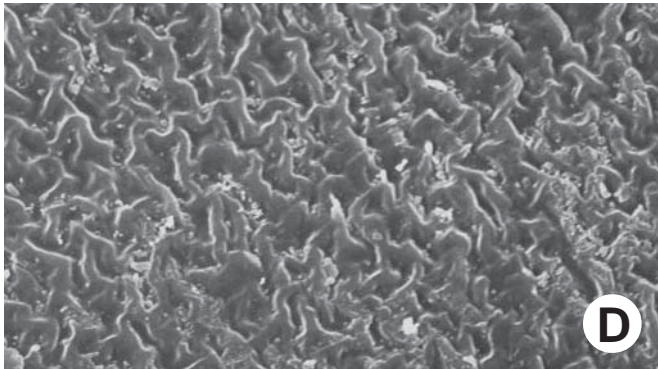
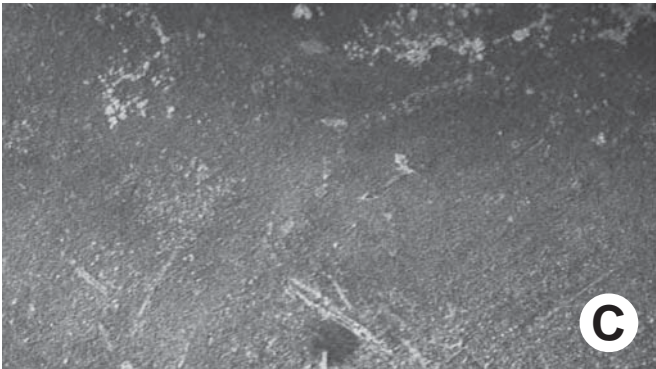
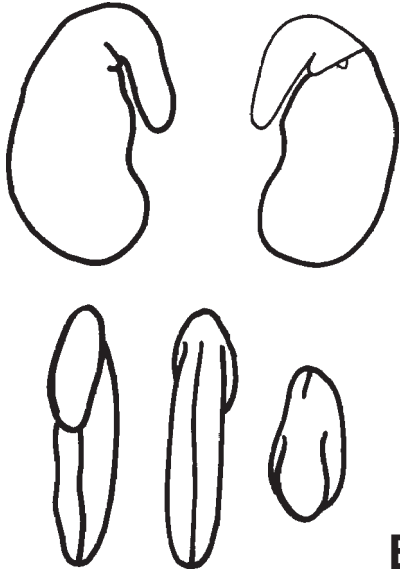
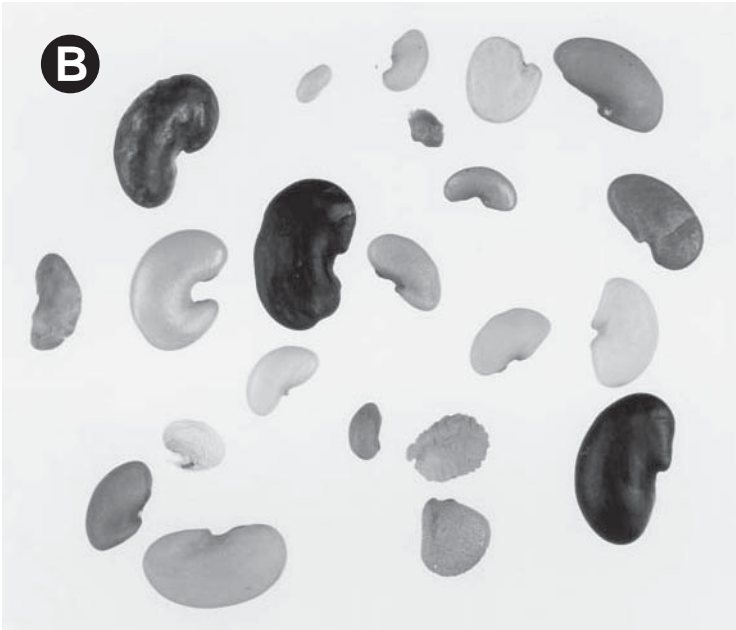
Distribution: Europe to South Africa and western Asia; widely cultivated.

Notes: In an impressive number of papers over the past 20 years dealing with *Medicago* and related genera, Small has resolved many of the problems related to *Medicago*. Our species count follows that of Small et al. (1988), Small and Jomphe (1989a,b), Small (1990a,b), and Small and Brookes (1991), who included in *Medicago* species previously in *Trigonella* (21.04). We did not follow the species count of ca. 50 of Heyn (1981). Small and Jomphe illustrated seeds and fruits in line drawings, and Small et al. (1990) illustrated seeds in photographs and micrographs. *Factorovskya* Eig, a monotypic and geocarpic genus recognized by Heyn, was reduced to *Medicago hypogaea* by Small and Brookes (1984) and is included as such here. The authors used the characteristic coiling of the fruit as one of the main traits supporting the transfer to *M. hypogaea*. Small and Jomphe (1989b) presented a key to the 12 sections and 8 subsections of the genus and a comprehensive illustrated key to the 83 species. The following year he circumscribed the genus based on seed characters (Small et al. 1990). Some species of *Medicago* are important crops throughout the temperate world. The fruits of *Medicago* are as diverse as they are in any faboid genus: Straight, curved, or coiled; terete, compressed, or flat; and sutures spiny, tuberculate,

winged, frimbiate, or plain. Most *Medicago* species have numerous conspicuous veins in the fruit. These veins are located in the epicarp, unlike most other legumes, which have the veins in the mesocarp.

Medicago: *M. ciliaris* (C. Linnaeus) C. Allioni (*C–E*), *M.*
spp. (*A–B*). *A*, Fruits with and without calyx ($\times 1.2$);
B, seeds ($\times 3.9$); *C–D*, testa ($\times 50$, $\times 1000$); *E*,
embryos ($\times 6$).

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Genus: *Trifolium* C. Linnaeus

Phylogenetic Number: 21.06.

Tribe: Trifolieae.

Species Studied—Species in Genus: 121 spp.—ca. 250 spp.

Fruit a legume or nutlet; unilocular; 0.14–1.5 × 0.04–0.5 cm; with persistent calyx; with calyx longer or shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; oblong (to linear or ovate), ovate, elliptic, fusiform, lanceolate, linear, dolabriform, or falcate; when asymmetrical with both sutures parallelly curved; inflated or not inflated; compressed; without beak; short tapered or rounded at apex; with the apex and base uniform or differing in texture; fragile, thinner than chartaceous, membranous, chartaceous, coriaceous, or leathery (rarely); seed chambers externally visible or invisible. Fruit margin constricted or not constricted; slightly constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit substipitate or nonstipitate. Fruit indehiscent or with all layers dehiscing (with 2 or 1 prominent sutures); splitting along sutures. Dehiscence of valves along 1 suture or both sutures; passive. Replum invisible. Epicarp dull; monochrome; brown (various shades, yellowish); glabrous or glabrate; with 1 type or 2 types of pubescence; pilose or puberulent (slightly); with pubescence gray; with apical pubescence different from basal pubescence; with apical 1/4 tomentose and basal 3/4 glabrous or apical 3/4 tomentose and basal 1/4 glabrous; with simple hairs; pliable; with hair bases plain; with elevated features; veined or not veined; longitudinally veined relative to fruit length (occasionally) or reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp absent. Endocarp remaining fused to epicarp. Seeds 1–10. Aril absent.

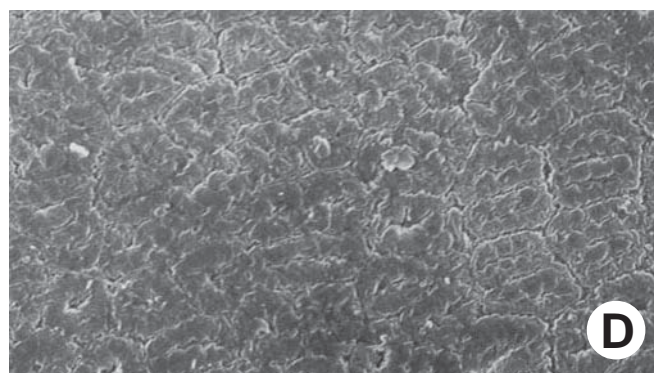
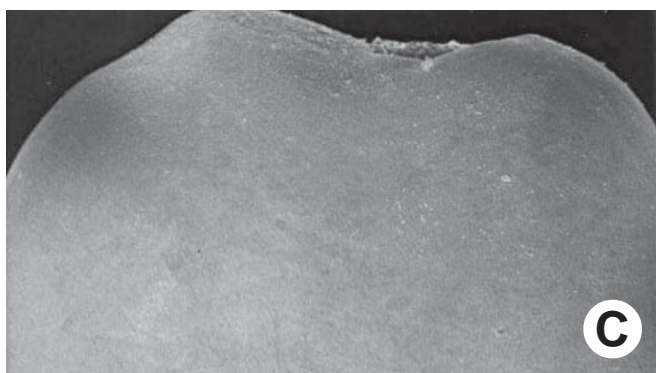
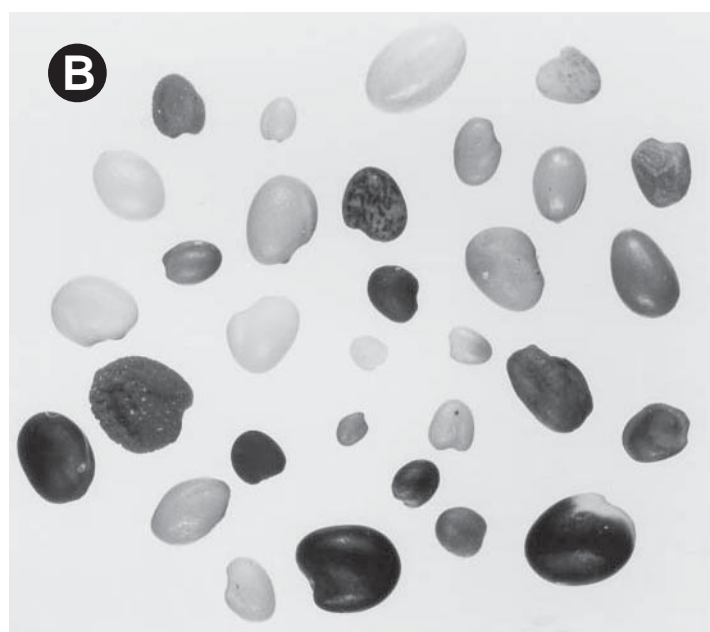
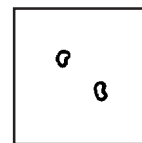
Seed 0.8–5 × 0.8–3 mm; not overgrown; not angular; symmetrical or asymmetrical; circular, mitaform, oblong, pyriform, quadrangular, reniform, rhombic, or triangular; terete, compressed, or flattened; with or without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome, mottled, or streaked; with frequent mottles; with frequent streaks; black (to reddish, greenish, purplish, yellowish, dark, or reddish), green (yellowish to pale), red, tan, or yellow (to lemon); with black, brown (various shades), or purple overlay;

glabrous; smooth or not smooth; with elevated or recessed features; shagreen, tuberculate (minutely), warty (finely), or wrinkled; pitted with small separate pits; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe. Endosperm thin; covering entire embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle bulbous or linear; lobe tip straight; deflexed and parallel to cotyledon length; 1/2 to nearly or equaling length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Temperate and subtropical regions of the Northern and Southern Hemispheres.

Notes: In discussing the evolution of the legume (their legumen) in the genus *Trifolium*, Zohary and Heller (1984) noted that the section *Lotoidea* has the most primitive legume in the genus. These legumes are often 2–9-seeded and dehiscent by both sutures. From this primitive state, the advanced one-seeded “utricle or nutlet” evolved with a membranous pericarp that may consist of only an epidermal layer. These legumes do not dehisce but instead split transversely (circumscissily) or irregularly and are found in the section *Trifolium* and even in advanced species in section *Lotoidea* H. J. N. von Crantz. Some fruits are operculate. Unlike the fruiting heads of other legume genera, the fruiting heads of a few species of *Trifolium* separate from the plants and serve as the unit of dispersal. In *Trifolium subterraneum* C. Linnaeus, fertile flowers are pushed into the ground, where the fruits and seeds mature. See *Arachis* (14.26) and *Medicago* (21.05).

Trifolium: *T. pannonicum* N. von Jacquin (C–E), *T.* spp. (A–B). A, Fruits (mostly within calyxes) (× 2.1); B, seeds (× 6); C–D, testa (× 50, × 1000); E, embryos (× 10).



Brongniartieae (22.01–22.02)

Genus: *Brongniartia* K.S. Kunth

Phylogenetic Number: 22.01.

Tribe: Brongniartieae.

Species Studied—Species in Genus: 15 spp.—56 spp.

Fruit a legume; unilocular; $1.3\text{--}6 \times 0.8\text{--}2.5 \times 0.4\text{--}0.5$ cm; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; elliptic or oblong; when asymmetrical with 1 straight and 1 curved suture, both sutures parallelly curved, or both sutures unequally curved; not inflated; compressed; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down (assumed); active; with valves twisting. Replum invisible. Epicarp dull; monochrome; brown or tan; pubescent and indurate; with 1 type of pubescence; with pubescence gray; pliable; with hair bases plain; eglandular; without spines; not smooth; obliquely veined relative to fruit length; not tuberculate; not exfoliating; without cracks. Mesocarp thin; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; tan or yellow; fibrous (but fibrous around margins of seeds or not) or smooth; subseptate or nonseptate; with septa thin (tissue paper-like), flexible; with septa eglandular; coriaceous; not exfoliating; remaining fused to mesocarp and epicarp. Seeds 1–8; length transverse (to slightly oblique) or oblique to fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 1–4 mm long; of 1 length only; flattened; straight. Aril fleshy; hooked; covering less than 1/2 of seed; brown to tan.

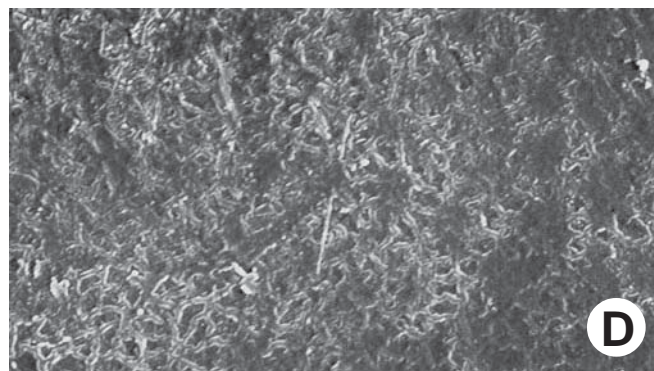
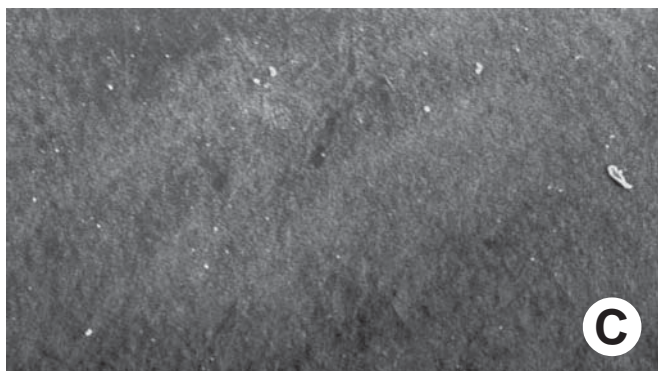
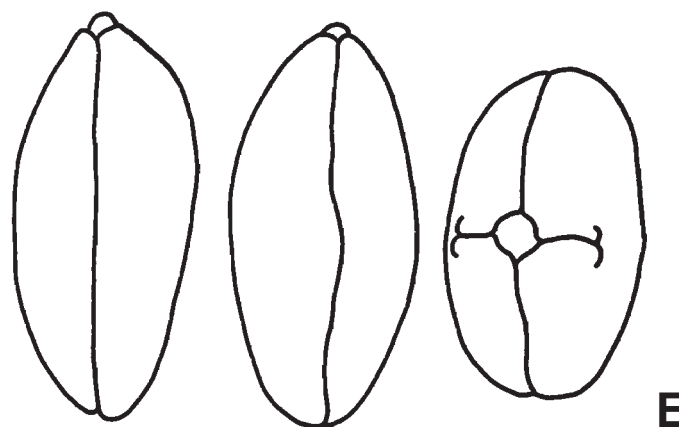
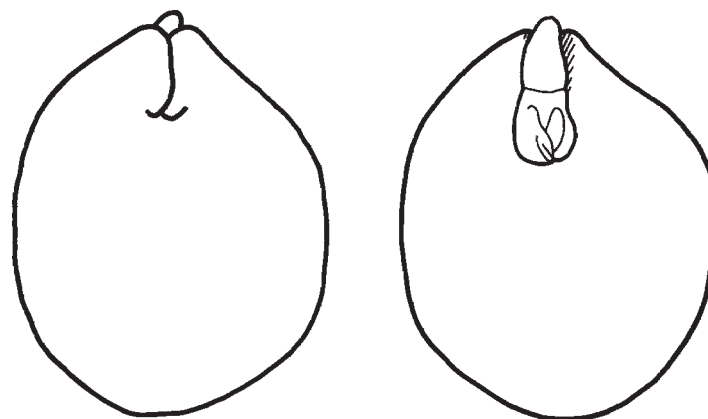
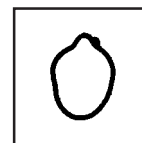
Seed $6\text{--}20 \times 3.5\text{--}6.5 \times 2.5\text{--}4$ mm; not overgrown; angular or not angular; asymmetrical; irregular (because of pressure of adjacent seeds) or oblong to ovate; compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome or mottled; with frequent mottles; brown

or tan; with brown (dark) overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Raphe visible or not visible; from lens to base of seed and terminating; color of to lighter than testa; tan; flush. Hilum fully concealed; concealed by funiculus or funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.8–1 mm long; with curved outline; circular; subapical to radicle tip; recessed; within rim or not within corona, halo, or rim. Hilum rim color of (but not mottled if testa mottled) or darker than testa (but not mottled if testa mottled). Lens discernible; equal to or greater than 0.5 mm in length; 1–1.2 mm long; with margins straight or curved; linear or elliptic; not in groove of raphe; adjacent to hilum; 0.5 mm from hilum; mounded; same color as testa; brown or tan; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; split over radicle; with lobes; with lobes overlapping; with basal groin formed by lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis straight; parallel to length of seed. Radicle linear; straight with embryonic axis; centered between cotyledons; less than 1/2 length of cotyledons. Plumule well developed; glabrous.

Distribution: Southern United States, Mexico, Central America, South America.

Notes: Arroyo (1981) noted that the “legumes and seeds in *Harpalyce* and *Brongniartia* are quite similar and on this basis the genera are closely related.” She regarded this tribe as “a probably reticulate American group, with ancient austral roots.” Crisp and Weston (1987, pp. 105–107) provided compelling evidence that the *Templetonia* group of the Bossiaeeae should be transferred to the Brongniartieae, but they did not resolve all aspects of the transfer. See the Notes for *Lamprolobium* (23.02). Chappill’s (1995) cladistic analysis of the entire family indicated that the transfer should not be made and that the two tribes should be circumscribed in the traditional manner (Crisp and Weston 1995).

Brongniartia: *B. intermedia* S. Moricand (C–E), *B.* spp. (A–B). A, Valves ($\times 0.9$); B, seeds ($\times 1.5$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 5$).



Genus: *Harpalyce* A.-P. de Candolle

Phylogenetic Number: 22.02.

Tribe: Brongniartieae.

Species Studied—Species in Genus: 9 spp.—20 spp.

Fruit a legume; unilocular; $1-12 \times 0.8-3.5 \times 0.3-0.6$ (estimated) cm; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight to curved (slightly); not plicate; not twisted; symmetrical; oblong to obovate to ovate (when obovate, lower portion of fruit sterile); not inflated; compressed; without beak; short tapered at apex; apex oblique with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; fleshy (when fresh), coriaceous, or ligneous (*H. mexicana* J.N. Rose); seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscing. Dehiscence of valves along both sutures; apical and down; active or passive (*H. mexicana*); with valves revolute. Replum invisible. Epicarp dull or glossy; monochrome; black, brown (reddish-brown to darker), purple, or tan; glabrous; eglandular; without spines; not smooth; with elevated features; obliquely veined relative to fruit length; not tuberculate; obscurely rugose; not exfoliating; without cracks. Mesocarp thin; 1-layered; without balsamic vesicles; without fibers; solid; subligneous. Endocarp dull or glossy (at least lustrous); monochrome; tan; cobwebby, smooth, or spongy; septate or nonseptate; with septa thin (tissue paper-like), flexible or thicker than paper, firm; with septa eglandular; coriaceous; not exfoliating. Seeds 1–15; length oblique (*H. macrocarpa* N.L. Britton & P. Wilson) or transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 2–4 mm long; of 1 length only; filiform or triangular; straight. Aril fleshy; topknotlike, cupshaped, or hooked; covering less than 1/2 of seed; brown or tan.

Seed $5-15 \times 2-12 \times 2.5-5$ mm; not overgrown; not angular; asymmetrical; oblong to rectangular; compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; black, brown, cream (*H. parvifolia* H.S. Irwin & M.T.K. Arroyo), ivory, or olive; glabrous or minutely pubescent (*H. robusta* H.S. Irwin & M.T.K.

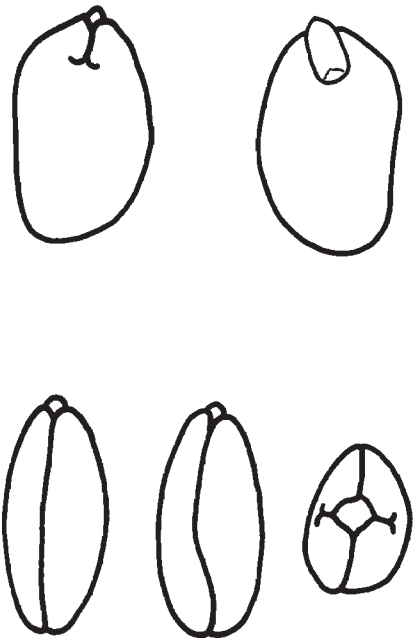
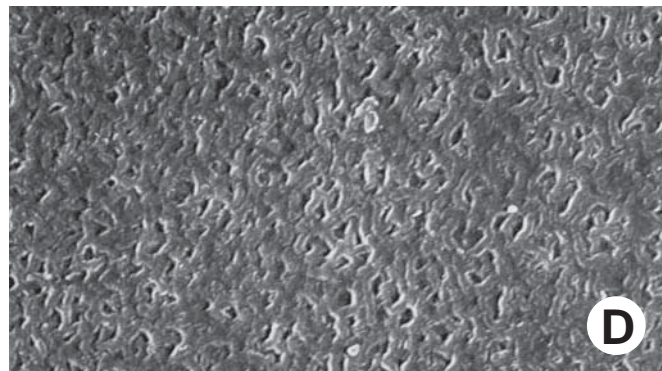
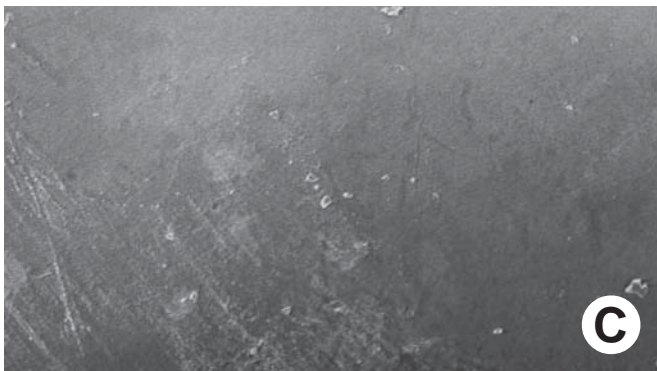
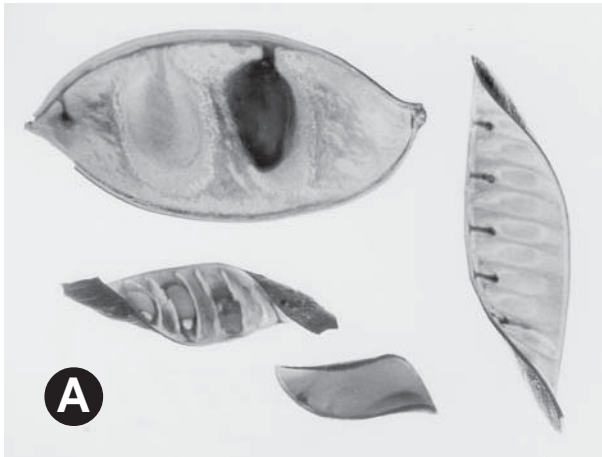
Arroyo fide Arroyo (1976)); smooth; coriaceous. Fracture lines absent. Rim absent. Raphe visible or not visible; from lens to base of seed and terminating; color of testa; recessed. Hilum fully concealed; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.5–0.7 mm long; with curved outline; elliptic; subapical to radicle tip; recessed; within rim or not within corona, halo, or rim. Hilum rim color of testa. Lens discernible or not discernible; less than 0.5 mm in length; with margins straight or curved; linear; punctiform; in groove of raphe; adjacent to hilum; recessed; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; split over radicle; with lobes; with lobes touching (auriculate); with basal groin formed by lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis oblique; oblique to length of seed. Radicle linear; oblique to cotyledons; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Mexico, Central America, Cuba, Brazil.

Notes: Arroyo (1976) monographed the genus and provided general fruit and seed descriptions for most recognized species. Our studied species were selected from all three sections: *Harpalyce*, *Brazilianae* M.T.K. Arroyo, and *Cubenses* P.A. Rydberg. The lens is a black line in the raphe groove and is surrounded by a punctiform pit.

Harpalyce: *H. brasiliensis* G. Benth (C–E), *H. spp.* (A–B). A, Valves ($\times 1$); B, seeds ($\times 4$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 5$).

0



E

Bossiaeeae (23.01–23.10)

Genus: *Templetonia* R. Brown

Phylogenetic Number: 23.01.

Tribe: Bossiaeeae.

Group: Templetonia.

Species Studied—Species in Genus: 4 spp.—9 spp.

Fruit a legume; unilocular; $1.5\text{--}8 \times 0.6\text{--}1.6 \times 0.25$ cm; with deciduous corolla; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; elliptic or linear; when asymmetrical with both sutures parallelly curved to unequally curved; not inflated; flattened; without beak; short tapered or rounded at apex; apex aligned to oblique with longitudinal axis of fruit; short tapered or rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible or invisible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit stipitate or nonstipitate; with the stipe up to 10 mm long. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active or passive; with valves twisting. Replum invisible. Epicarp dull or semiglossy; monochrome; dark reddish and dark greenish brown; glabrous; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; brown; smooth; septate or nonseptate; with septa thin (tissue paper-like), flexible; with septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1–12; length parallel or oblique to fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight or hooked. Aril fleshy; caplike (*T. biloba* (G. Bentham) R.M. Polhill) or cupshaped (lipped or not); covering less than 1/2 of seed; brown.

Seed $3.5\text{--}14.5 \times 2\text{--}8.5 \times 1.2\text{--}3.3$ mm; not overgrown; not angular; symmetrical (except for hilum); elliptic to ovate; compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not

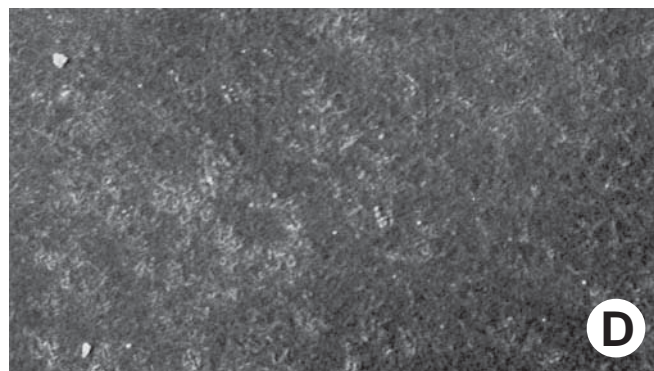
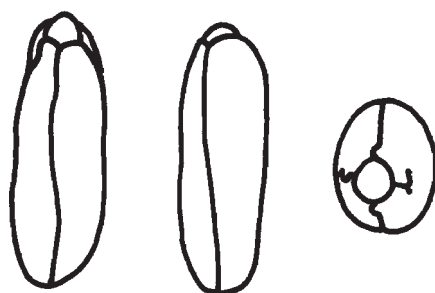
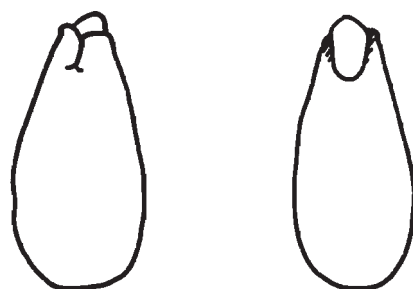
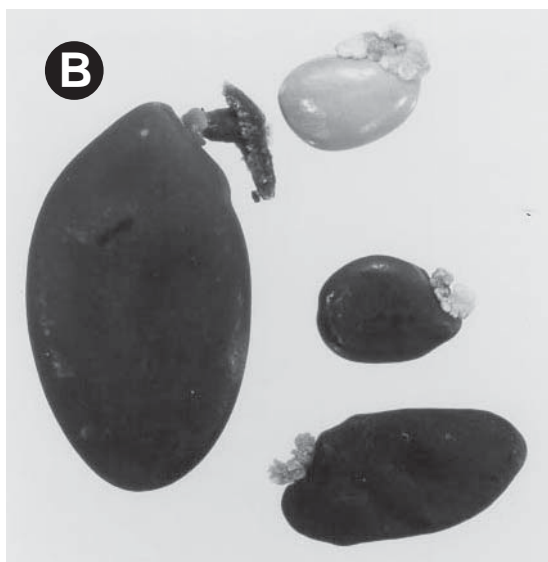
adhering to endocarp; glossy; not modified by a bloom; colored; monochrome; yellowish to reddish or olive brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum fully concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 1 mm long; with curved outline; elliptic; subapical to radicle tip; flush; within rim. Hilum rim color darker than testa. Lens discernible; equal to or greater than 0.5 mm in length; 1 mm long; with margins straight or curved; rhombic; not in groove of raphe; adjacent to hilum; 1 mm from hilum; barely mounded; dissimilar color from testa; darker than testa; brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; split over radicle; with lobes; with lobes touching (auriculate); with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis almost straight; parallel to length of seed. Radicle nearly linear; straight with embryonic axis; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Australia.

Notes: The Bossiaeeae traditionally consisted of 10 genera and has been divided into two groups, in part on fruit and seed characters. The Templetonia group contains the first four genera (including *Lamprolobium*, 23.02) and has nonwinged, coriaceous legumes with compressed seeds bearing a collarlike, often lipped aril (except for *Templetonia biloba* (G. Bentham) R.M. Polhill) and a short, straight radicle. The Bossiaea group contains the remaining genera and has legumes that are keeled to winged or not so; the group has plump seeds that are often covered by a hooded caplike aril (which is lacking in *Muelleranthus* (23.08) and *Ptychosema* (23.09)) and a radicle that is slender, deflexed, and exerted from the cotyledons. Crisp and Weston (1987, pp. 105–107) in their cladistic analysis of the Bossiaeeae, Brongniartieae (22), and Mirbelieae (24), provided compelling evidence that the Bossiaeeae should be redefined to include only the *Bossiaea* group (genera 23.05–23.10). They proposed that the Templetonia group be moved to the Brongniartieae, becoming genera three through eight, after *Brongniarta* (22.01) and *Harpalyce* (22.02). The proposed generic

sequence would therefore be: 3, *Templetonia* (23.01); 4, *Lamprolobium*; 5, *Plagiocarpus* (23.03); 6, ?Genus A (*Templetonia incana* J.H. Ross); 7, ?Genus B (*Templetonia biloba* (G. Bentham) R.M. Polhill); and 8, *Hovea* (23.04). They (Crisp and Weston 1995) retracted their proposal to transfer the *Templetonia* group because of Chappill's (1995) cladistic analysis of the entire family, and we have used the traditional circumscriptions of the two tribes (Polhill 1994a,b). Polhill (1981n) reported 9 species in this genus, but Ross (1982) recognized 11 species, the number used in our study. Polhill (1976) has a full plate of the external and internal morphology of the seeds of *Templetonia biloba* (G. Bentham) R.M. Polhill.

Templetonia: *T. retusa* (E.P. Ventenat) R. Brown (*C–E*), *T.*
spp. (*A–B*). *A*, Fruits (with and without calyx) and valve
($\times 1.6$); *B*, seeds ($\times 4.1$); *C–D*, testa ($\times 50$, $\times 1000$);
E, embryos ($\times 6$).



Genus: *Lamprolobium* G. Bentham

Phylogenetic Number: 23.02.

Tribe: Bossiaeeae.

Group: Templetonia.

Species Studied—Species in Genus: 1 sp.—2 spp.

Fruit a legume; unilocular; $4 \times 0.8-1 \times 0.5$ (estimated) cm; with deciduous corolla; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical; oblong; not inflated; flattened; without beak; rounded at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down (assumed); active; with valves twisting. Replum invisible. Epicarp semiglossy; monochrome; brown; glabrous; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; wrinkled (faintly); not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; brown; smooth; subseptate; with septa thicker than paper, firm; with septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 5–7; length transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 3 mm long; of 1 length only; thick; straight. Aril fleshy; cupshaped (with 1 side longer (liplike) than other); covering less than 1/2 of seed; tan.

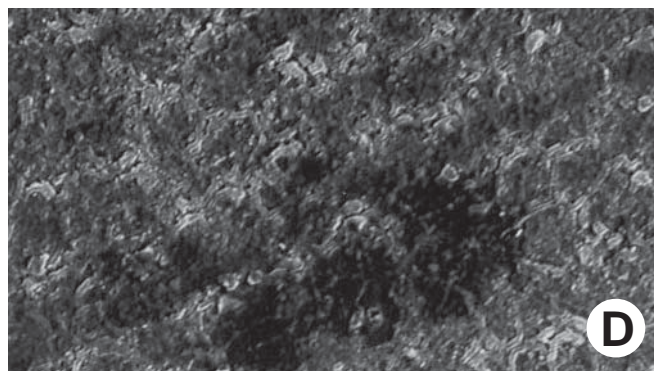
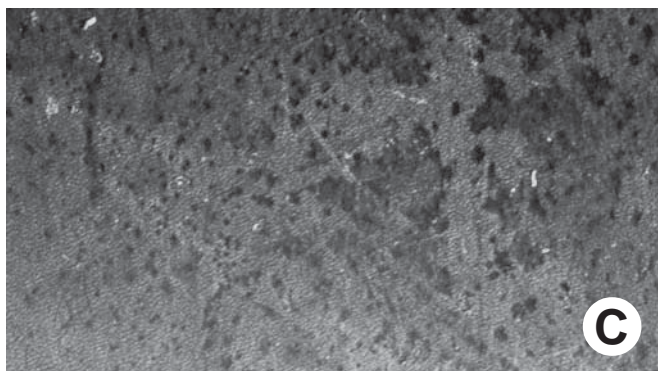
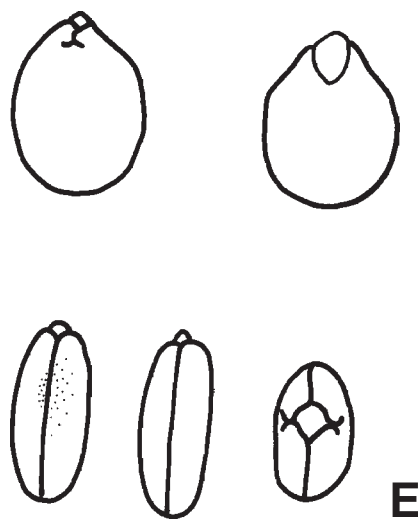
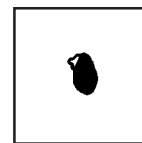
Seed $5.3-6 \times 3.5-4 \times 1.7-2.5$ mm; not overgrown; not angular; asymmetrical; oblong; compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome (when immature), mottled (when mature), or streaked (when mature); with frequent mottles; with frequent streaks; reddish brown; with brown (darker reddish) overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe from hilum through lens to base of seed and terminating (beyond base of seed); not bifurcating; darker than testa; recessed.

Hilum partially concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 2 mm long; with curved outline; elliptic; apical according to radicle tip but marginal according to seed length; recessed; not within corona, halo, or rim. Lens discernible; less than 0.5 mm in length; with margins curved; elliptic; in groove of raphe; adjacent to hilum; 1.5 mm from hilum; mounded; similar color as testa; darker than testa; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; split over radicle; with lobes; with lobes touching (auriculate); with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle bulbous; oblique to cotyledons; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Australia (north Queensland).

Notes: The hilum length:seed length ratio is similar to the ratios seen in seeds of genera in tribe Phaseoleae (10) and *Hovea* (23.04).

Lamprolobium: *L. fruticosum* G. Bentham (A–E). A, Valve ($\times 2.3$); B, seeds ($\times 5.1$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 5$).



Genus: *Plagiocarpus* G. Bentham

Phylogenetic Number: 23.03.

Tribe: Bossiaeeae.

Group: Templetonia.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; unilocular; $1 \times 0.4\text{--}0.5$ cm; with deciduous corolla; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; oblong; when asymmetrical with both sutures nearly straight; not inflated; compressed; without beak; rounded at apex; apex right-angled with longitudinal axis of fruit; rounded at base; base oblique with longitudinal axis of fruit; with the apex and base uniform in texture; ligneous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive. Replum invisible. Epicarp glossy; multicolored; bichrome (outer margin of valve greenish-brown surrounding a tan inner area); glabrous; without spines; not smooth; with elevated features; reticulately veined (faintly); not tuberculate; faintly wrinkled; not exfoliating; without cracks. Mesocarp thick; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; ligneous (sub). Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp. Seeds 1 or 2; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; curved. Aril fleshy; cupshaped (if funiculus absent; if funiculus is present, then aril center plugged by a curved, thick, stalklike funiculus); covering less than 1/2 of seed; tan.

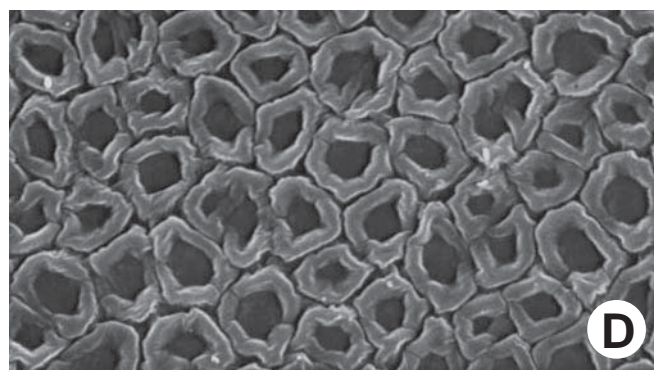
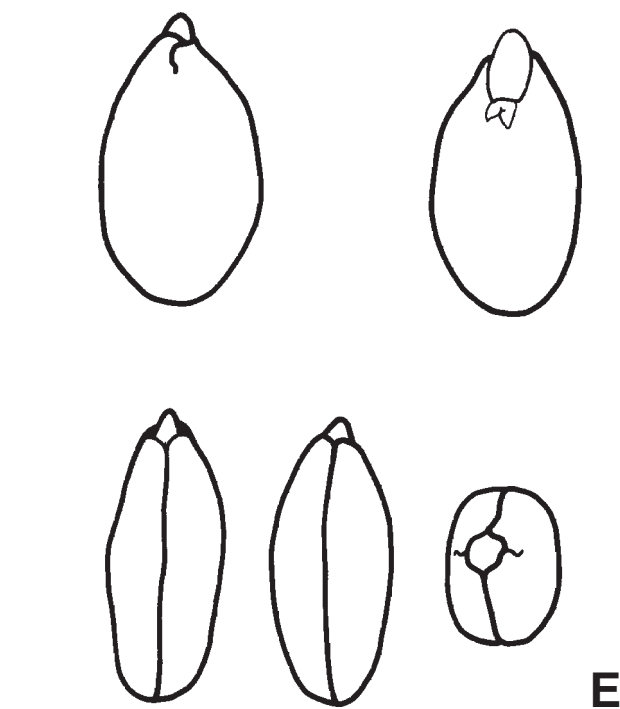
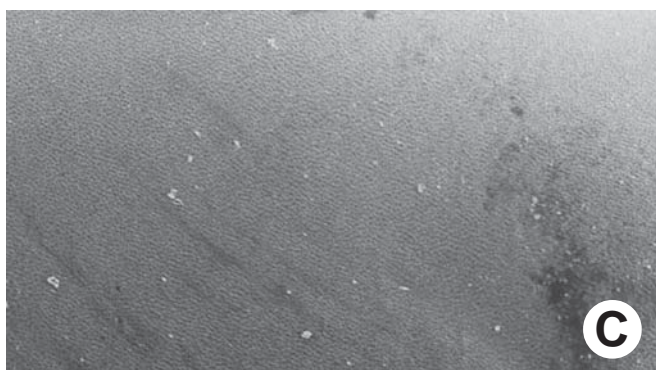
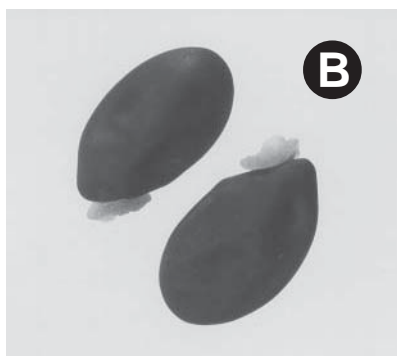
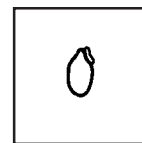
Seed $4.5\text{--}6.5 \times 3\text{--}3.8 \times 1.5\text{--}3$ mm; not overgrown; not angular; asymmetrical; elliptic; compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; greenish to reddish or dark brown; glabrous; smooth (at $\times 10$, see Notes); coriaceous. Fracture lines absent. Rim absent. Raphe from hilum through lens to base of seed and terminating to from hilum to lens (and just beyond lens); not bifurcating; color of, lighter than, or darker than testa (color of raphe may vary: Between hilum and

lens darker than between lens and base of seed); brown; flush. Hilum partially or fully concealed; concealed by funiculus and aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.9–1 mm long; with curved outline; elliptic; subapical to radicle tip; flush; not within corona, halo, or rim. Lens discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; 0.5 mm long; with margins curved; roughly circular; not in groove of raphe; adjacent to hilum; 0.6 mm from hilum; slightly mounded; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; split over radicle; with lobes; with lobes touching (auriculate); with the interface division terminating at base of radicle; without margins recessed; yellow or brown; inner face flat; glabrous around base of radicle. Embryonic nearly axis straight; parallel to length of seed. Radicle bulbous; straight with embryonic axis; centered between cotyledons; less than 1/2 length of cotyledons. Plumule well developed; glabrous.

Distribution: Australia (northern Queensland).

Notes: At a magnification of $\times 10$, the seed coat of *Plagiocarpus* appears to be smooth. At $\times 50$ (fig. C) the surface of the testa appears to be minutely pitted; and at $\times 1000$ (fig. D) the surface cells of the testa have thick lateral walls and the lumen of the cell is a pit.

Plagiocarpus: *P. axillaris* G. Bentham (A–E). A, Fruit with calyx and valves ($\times 3.4$); B, seeds ($\times 4.3$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 6$).



Genus: *Hovea* R. Brown ex W.T. Aiton

Phylogenetic Number: 23.04.

Tribe: Bossiaeeae.

Group: Templetonia.

Species Studied—Species in Genus: 11 spp.—ca. 20 spp.

Fruit a legume; unilocular; $1.2 \times 2.1 \times 0.35\text{--}0.5$ cm; with deciduous corolla; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; circular (subcircular); when asymmetrical with both sutures parallelly curved; not inflated; compressed; without beak; rounded at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves enrolling. Replum invisible. Epicarp dull; monochrome; brown; glabrous or pubescent and indurate; with 1 type of pubescence; puberulent or villous; with pubescence golden; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seed 1; length parallel with fruit length. Funiculus less than 0.5 mm long; thick; curved. Aril fleshy or dry (rarely); when fleshy cupshaped; entire; covering less than 1/2 of seed; when dry cupshaped; entire; covering less than 1/2 of seed; brown or tan.

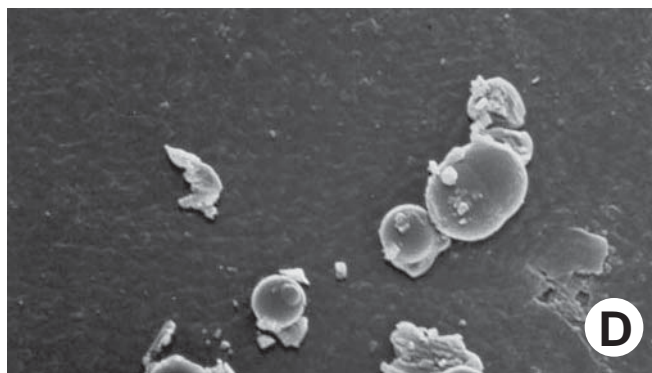
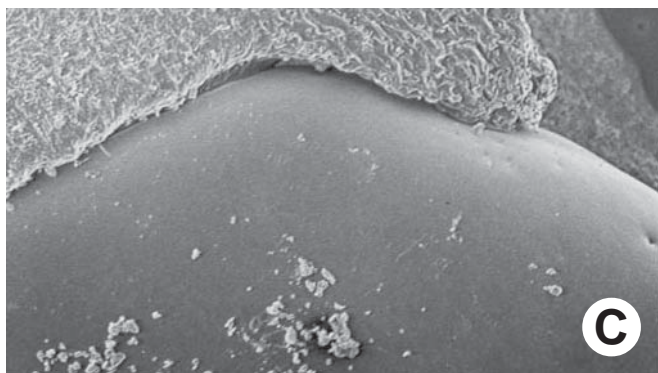
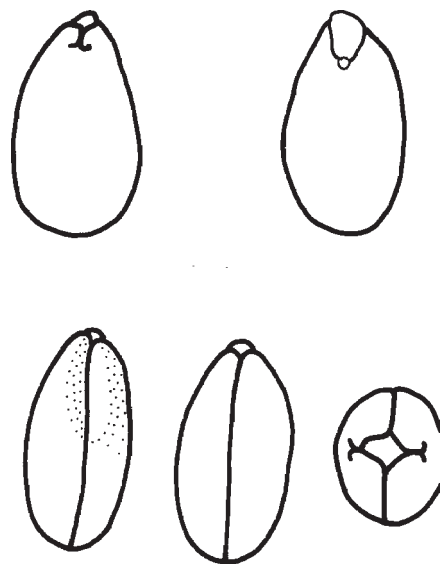
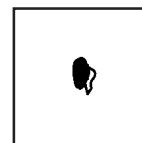
Seed $4\text{--}6 \times 4\text{--}5 \times 2\text{--}2.5$ mm; not overgrown; not angular; asymmetrical; elliptic to oblong; compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Raphe from hilum through lens to base of seed and terminating; not bifurcating; darker than testa. Hilum partially concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 2

mm long; with curved outline; elliptic; marginal according to radicle tip; flush; not within corona, halo, or rim. Lens discernible; less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; adjacent to hilum; 1 mm from hilum; mounded; similar color as testa; darker than testa; brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; split over radicle; with lobes; with lobes touching (auriculate); with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis straight; oblique to length of seed. Radicle bulbous; oblique to cotyledons; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Eastern to southwestern Australia (Queensland to Tasmania).

Notes: Polhill (1981*n*) listed ca. 12 species, Ross (1988) listed ca. 20 species, and we are following Ross's count. Polhill (1976) provided a full-page plate of external and internal seed characters of *Hovea heterophylla* A. Cunningham ex J.D. Hooker (now *H. linearis* (J. Smith) R. Brown). Valves of *Hovea* fruits curve inward from the apex to the base, bringing both closer together because they are wider than they are long. These fruit characters are unusual legume characters because most faboid valves curve inward from their sides, leaving the apex and base in the same relative position, and are usually much longer than wide. The seeds of *Hovea* species have a surprisingly large hilum. The hilum length:seed length ratio is similar to the ratios seen in seeds of some genera in tribe Phaseoleae (10) and *Lamprolobium* (23.02).

Hovea: *H. elliptica* A.-P. de Candolle (C–E), *H.* spp. (A–B). A, Fruits and valves ($\times 2.1$); B, seeds ($\times 5$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 8$).



Genus: *Goodia* R.A. Salisbury

Phylogenetic Number: 23.05.

Tribe: Bossiaeeae.

Group: Bossiaea.

Species Studied—Species in Genus: 2 spp.—2 spp.

Fruit a legume; unilocular; $0.9\text{--}3.8 \times 0.55\text{--}0.8 \times 0.2\text{--}0.3$ (estimated) cm; with deciduous corolla; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; oblong or rhombic; when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; widest near middle or D-shaped; not inflated; flattened; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain or embellished; with thickened sutural areas (margin thickened). Fruit wings absent. Fruit stipitate or substipitate; with the stipe up to 5 mm long. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive. Replum invisible. Epicarp dull; monochrome; reddish brown; glabrous; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; tan; smooth; nonseptate; coriaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1–4; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 1.5 mm long; of 1 length only; thick; hooked. Aril fleshy; hooked; covering less than 1/2 of seed; tan or brown.

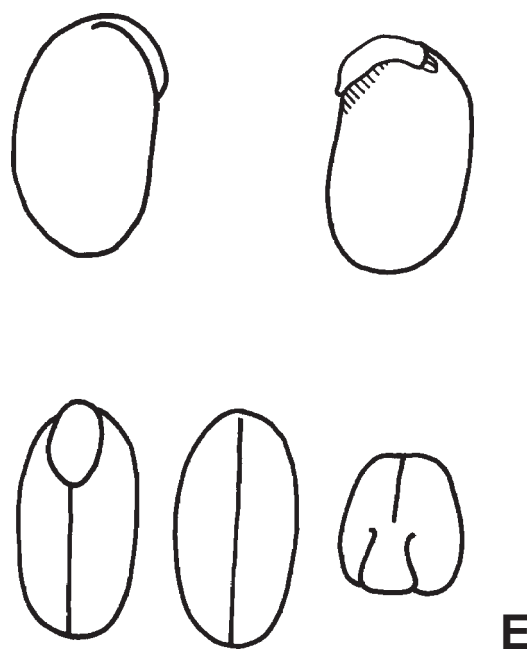
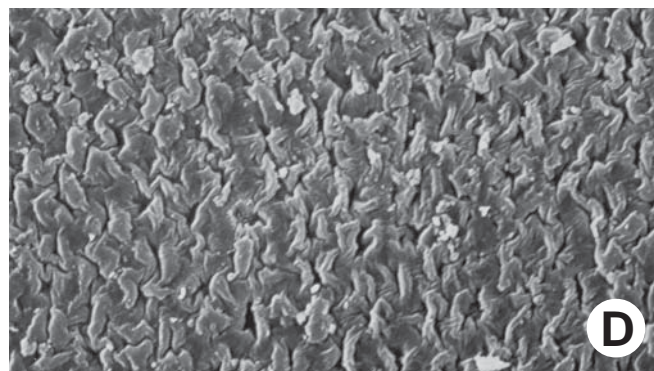
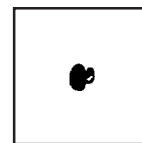
Seed $2.7\text{--}4 \times 2.2\text{--}3 \times 2.2\text{--}3$ mm; not overgrown; not angular; asymmetrical; oblong; terete; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; black; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum fully concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; marginal according to radicle tip;

recessed; not within corona, halo, or rim. Lens not discernible. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; with 1 or both margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle bulbous or linear; deflexed and parallel to cotyledon width; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule rudimentary or moderately developed; glabrous.

Distribution: Southern Australia including Tasmania.

Notes: Ross (1997) monographed the genus and recognized two species. The only reliable character separating the two species is the length of the aril foot at its point of attachment to the seed—up to 1.1 mm long in *G. medicagnea* and 1.4–2 mm long in *Goodia lotifolia* G. Salisbury. Polhill (1976) provided a full-page plate of external and internal seed characters of *G. lotifolia*.

Goodia: *G. medicagnea* F.H.J. von Mueller (C–E), *G. spp.* (A–B). A, Fruits (closed and dehiscent) ($\times 1.7$); B, seeds ($\times 5.1$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 8$).



Genus: *Bossiaea* E.P. Ventenat

Phylogenetic Number: 23.06.

Tribe: Bossiaeeae.

Group: Bossiaea.

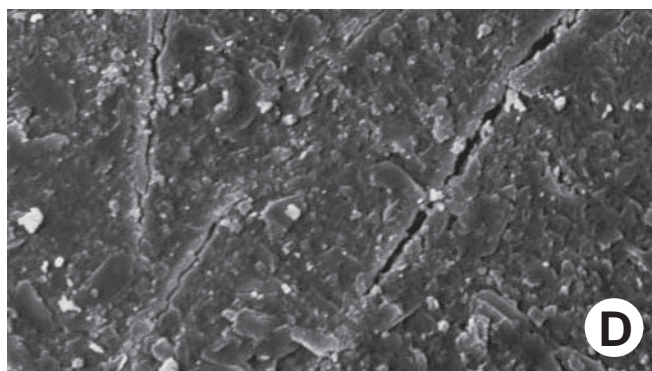
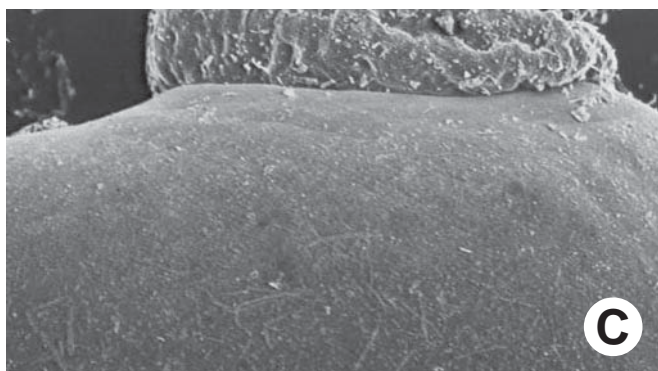
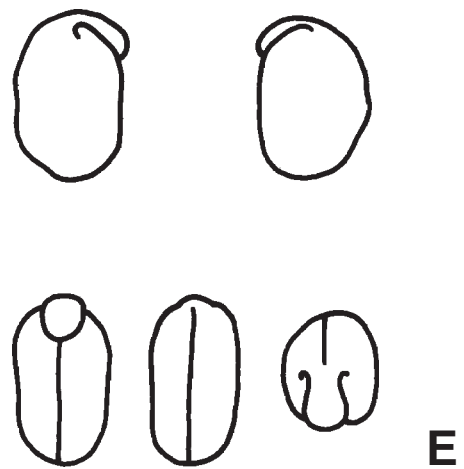
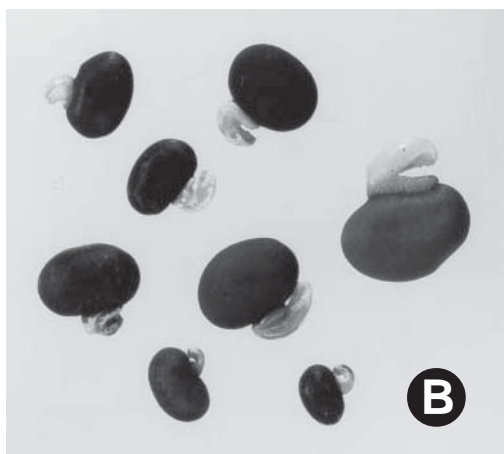
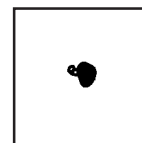
Species Studied—Species in Genus: 15 spp.—ca. 40 spp.

Fruit a legume; unilocular; $1.2-1.7 \times 0.7-1 \times 0.15-0.25$ cm; with deciduous corolla; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; oblong, circular, or linear; when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; widest near middle or D-shaped; not inflated; flattened; without or with beak; straight; with solid beak the same color and texture as fruit; short tapered to rounded at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous to chartaceous; seed chambers externally visible or invisible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain or embellished; with thickened sutural areas (thick or keeled especially upper suture). Fruit wings absent. Fruit stipitate to substipitate to nonstipitate; with the stipe to 5 mm long. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down (assumed); active or passive; with valves revolute. Replum invisible. Epicarp dull; monochrome; black, brown, or gray; glabrous or pubescent and indurate; villous; with pubescence golden or gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; without spines; not smooth; with elevated features; veined or not veined; not tuberculate; striate (at right angles to fruit length); not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; brown; spongy (corklike); septate or nonseptate; with septa thicker than paper, firm; with septa eglandular; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1-2(-3); length transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; straight. Aril fleshy; flat from apex to near base; covering less than 1/2 of seed; tan.

Seed $3-3.5 \times 2.3-2.5 \times 1.8-2$ mm; not overgrown; not angular; symmetrical or asymmetrical; elliptic to ovate; compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled; with frequent mottles; dark brown to brown; with black overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum fully concealed; concealed by aril; without faboid split; larger than punctiform; with curved outline; elliptic; marginal according to radicle tip; not within corona, halo, or rim. Lens not discernible (may be concealed by aril). Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; split over radicle; with lobes; with lobes not touching; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear; deflexed and parallel to cotyledon width; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Temperate Australia, including Tasmania.

Bossiaea: *B. cinerea* R. Brown (C-E), *B. spp.* (A-B). A, Fruits (dehiscid and closed) ($\times 1.5$); B, seeds ($\times 4$); C-D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 8$).



Genus: *Platylobium* J.E. Smith

Phylogenetic Number: 23.07.

Tribe: Bossiaceae.

Group: Bossiacea.

Species Studied—Species in Genus: 4 spp.—4 spp.

Fruit a legume; unilocular; $1.3\text{--}5.5 \times 0.7\text{--}2 \times 0.2$ cm; with deciduous corolla; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; when asymmetrical with 1 straight and 1 curved suture; widest near middle or D-shaped; not inflated; flattened; without beak; rounded or truncate at apex; apex oblique with longitudinal axis of fruit; truncate at base; base oblique with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain or embellished; with wings. Fruit wings 2–5; 2–3 mm wide; sutural; on 1 suture (upper). Fruit stipitate to substipitate; with the stipe 0.5–16 mm long. Fruit with all layers dehiscent. Dehiscence of valves along both sutures; active; with valves revolute. Replum invisible. Epicarp dull; monochrome; dark reddish brown; glabrous or pubescent and indurate; puberulent; with pubescence gray; with pubescence uniformly distributed; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; chartaceous. Endocarp dull; monochrome; brown and tan (especially dark-brown beneath seeds and tan along wing); smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds (1–)2–8; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 1 mm long; of 1 length only; thick; curved. Aril fleshy; hooked; covering less than 1/2 of seed; tan.

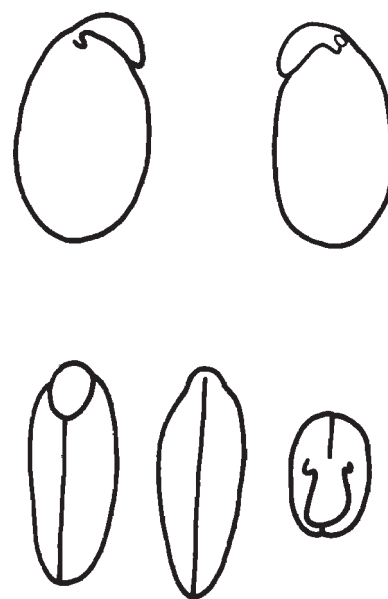
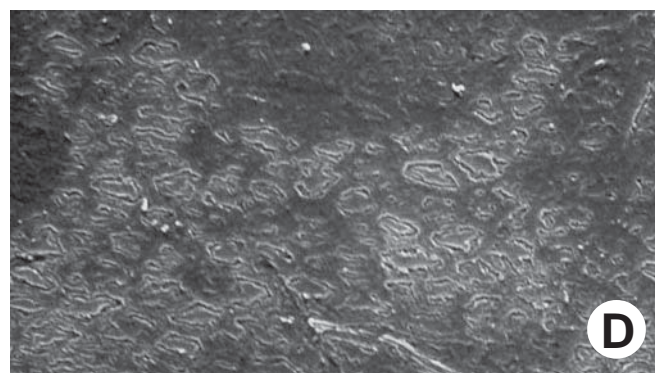
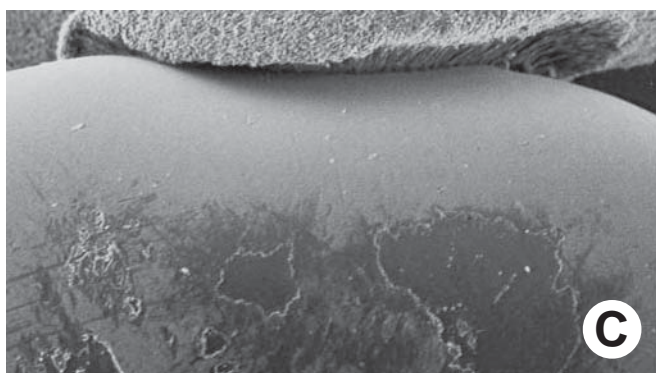
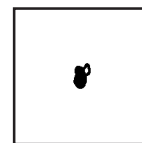
Seed $2.5\text{--}4 \times 1.6\text{--}2.5 \times 1.5\text{--}1.7$ mm; not overgrown; not angular; asymmetrical; elliptic or ovate; compressed; without visible radicle and cotyledon lobes; with umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled; with frequent mottles; reddish to dark (nearly black) reddish brown; with black overlay; glabrous; smooth;

coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum fully concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 1.3 mm long; with straight outline; oblong; marginal according to radicle tip; flush; not within corona, halo, or rim. Lens discernible; less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; confluent with hilum (at least hilar rim); flush; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Eastern and southern Australia, including Tasmania.

Notes: Ross (1983) monographed the genus.

Platylobium: *P. formosum* J.E. Smith (C–E), *P.* spp. (A–B). A, Fruits (closed and dehiscent) ($\times 1.3$); B, seeds ($\times 4.5$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 8$).



Genus: *Muelleranthus* J. Hutchinson

Phylogenetic Number: 23.08.

Tribe: Bossiaeeae.

Group: Bossiaea.

Species Studied—Species in Genus: 2 spp.—3 spp.

Fruit a legume; unilocular; (13–)17–25(–29) × 0.4–0.5 (–0.6) × 0.12–0.2 cm; with deciduous corolla; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; linear; when asymmetrical with both sutures nearly straight; not inflated; flattened; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive. Replum invisible. Epicarp dull; monochrome; reddish brown; glabrous; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 6–10; length parallel with fruit length (because seeds are round, both length or width can be considered parallel to fruit length); neither overlapping nor touching; in 1 series. Funiculus of 1 length only; thick; curved. Aril dry; rim-aril; white.

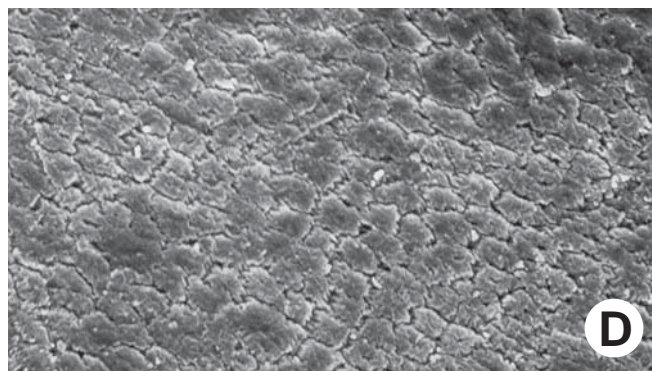
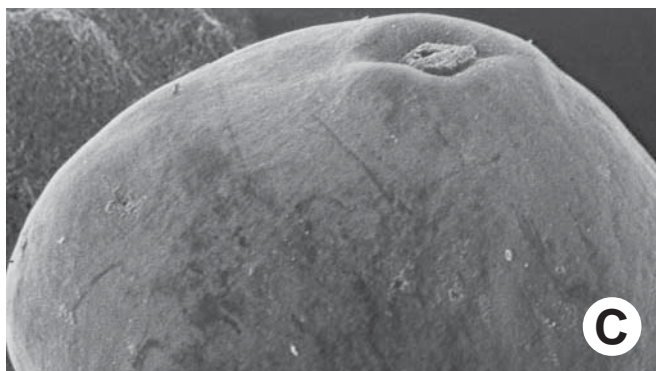
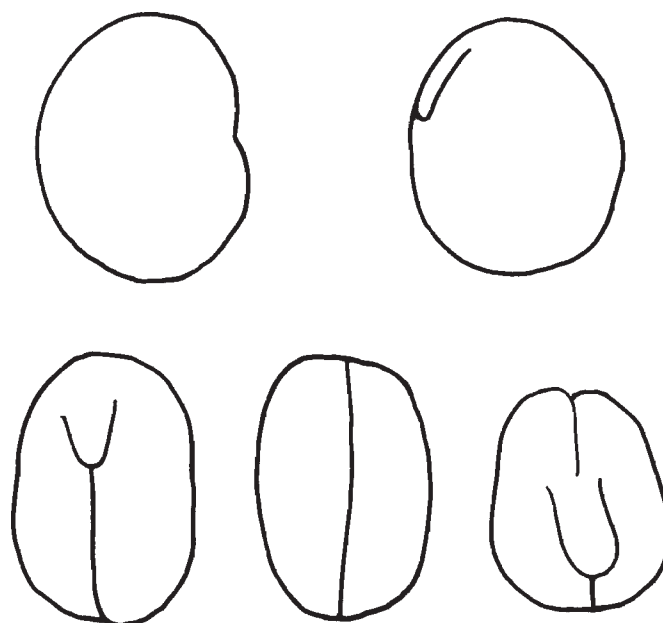
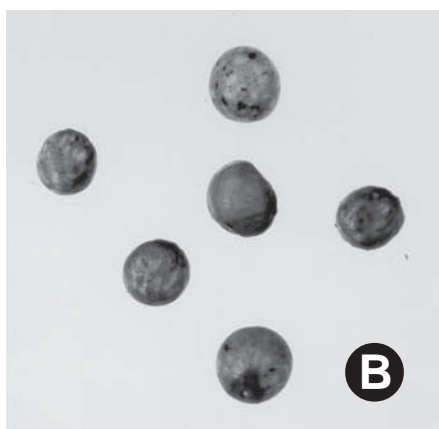
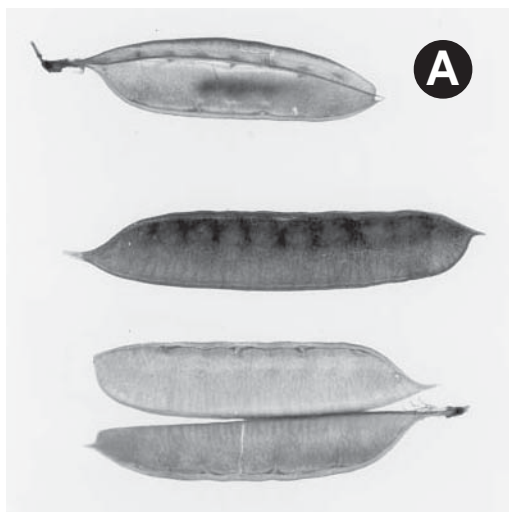
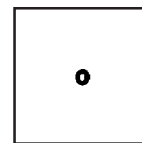
Seed 2–2.2 × 2–2.2 × 1.5 mm; not overgrown; not angular; symmetrical; circular; terete; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; mottled and streaked or monochrome (when immature); with frequent mottles; with frequent streaks; tan; with orange, yellow, brown, red (the orange overlay forming a reticulate pattern from hilum to base, the brown overlay reddish, and the red overlay with a brick tone), or black (when fully mature (Lee 1973)) overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Raphe not visible. Hilum partially concealed; concealed by aril; with faboid split; with the

lips of the faboid split the same color as the rest of the hilum; punctiform; marginal according to radicle tip; recessed; within rim. Hilum rim color darker than testa. Lens discernible; less than 0.5 mm in length; not in groove of raphe; adjacent to hilum; 0.2 mm from hilum; mounded; dissimilar color from testa; darker than testa; black (ish); within rim. Lens rim color darker than testa. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Australia.

Notes: Lee (1973) noted that *M. trifoliatum* (F.H. Mueller) J. Hutchinson ex A.T. Lee has at first a “reduced hooded aril as in *Aenictophyton*” (23.10) and later is “finally not arillate.” She also noted that *M. stipularis* seeds are not arillate. Based on our observations the seeds of both species of *Muelleranthus* and the one species of *Aenictophyton* have a dry rim aril. Perhaps Lee thought the curved funiculus was a “hooded aril” that disappeared on maturation. Fruits and seeds of *M. crenulatus* A.T. Lee are unknown. The attractive seeds of *M. stipularis* and *M. trifoliatum* resemble a stained glass window. Similar colors may be found in seeds of some species of *Vicia* (19.01).

Muelleranthus: *M. stipularis* (J.M. Black) A.T. Lee (A–E). A, Fruits (dehiscid and closed) (× 2); B, seeds (× 4.8); C–D, testa (× 50, × 1000); E, embryos (× 10).



Genus: *Ptychosema* G. Bentham ex J. Lindley

Phylogenetic Number: 23.09.

Tribe: Bossiaeeae.

Group: Bossiaea.

Species Studied—Species in Genus: 1 sp.—2 spp.

Fruit a legume; unilocular; $1.4\text{--}2.2 \times 0.45\text{--}0.5 \times 0.08$ cm; with deciduous corolla; with persistent calyx; with calyx shorter than fruit; straight; not plicate; not twisted; symmetrical; oblong; not inflated; flattened; without beak; short tapered or emarginate at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned or oblique with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible (faintly) or invisible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit stipitate to substipitate; with the stipe 4–7 mm long. Replum invisible. Epicarp dull; multicolored; mottled and streaked; tan; with brown (reddish) overlay; glabrous; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 2–7; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril dry; tongue-aril; white.

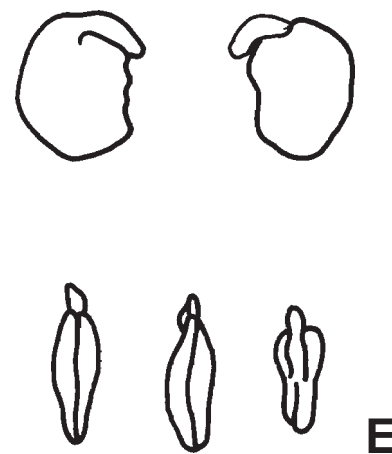
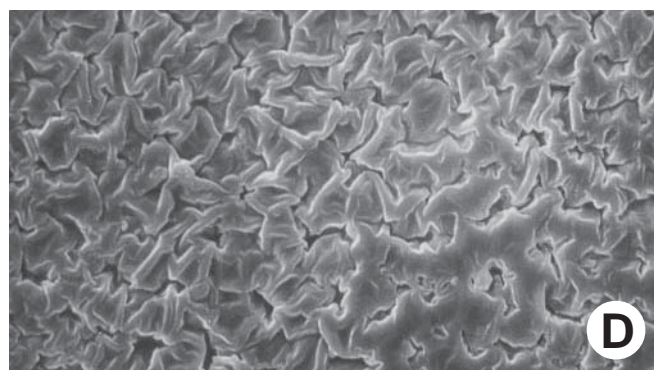
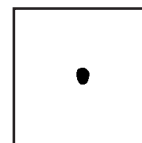
Seed $2.3\text{--}2.5 \times 1.7\text{--}2 \times 0.5\text{--}0.7$ mm; not overgrown; not angular; symmetrical (except for hilum); elliptic to oblong; compressed; with surface smooth; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; black (blackish-brown when mature) or green (greenish-brown when immature); glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum fully concealed; concealed by aril; without faboid split; punctiform; marginal according to radicle tip; flush; within halo. Hilum halo color lighter than testa. Lens faintly discernible; less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; adjacent to hilum; 0.1–0.2 mm from hilum; barely mounded; similar color as testa (but in lighter

colored halo); within halo. Lens halo color lighter than testa. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin not entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Central and Western Australia.

Notes: The fruits and seeds of the type species, *Ptychosema pusillum* G. Bentham, are not known to science (Lee 1973).

Ptychosema: *P. anomalum* G. Bentham (A–E). A, Fruit ($\times 3.2$); B, seed ($\times 5$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



Genus: *Aenictophyton* A. Lee

Phylogenetic Number: 23.10.

Tribe: Bossiaeeae.

Group: Bossiaea.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; unilocular; $1.5\text{--}1.7 \times 0.4\text{--}0.5 \times 0.1\text{--}0.2$ cm; with deciduous corolla; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; oblong; when asymmetrical with both sutures parallelly curved; not inflated; flattened; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit stipitate; with the stipe up to 10 mm long. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; passive. Replum invisible. Epicarp dull; monochrome; reddish brown to brown; glabrous; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp present (and reddish-brown); thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp glossy; monochrome; white (ish) or red (dish-brown because whitish thin endocarp does not conceal mesocarp color); smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1–4; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; filiform; straight. Aril dry; hooded; white.

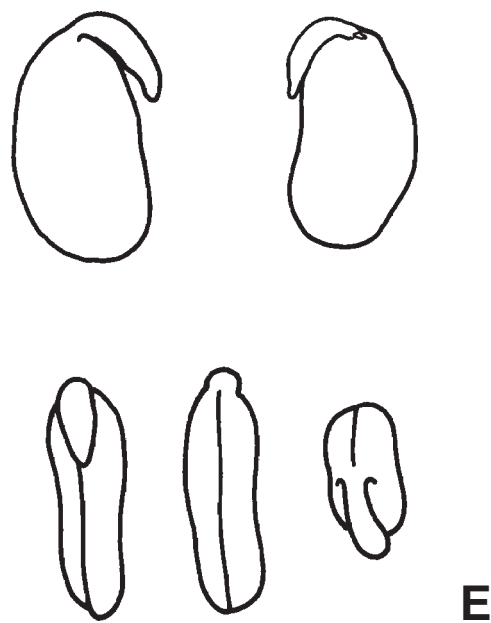
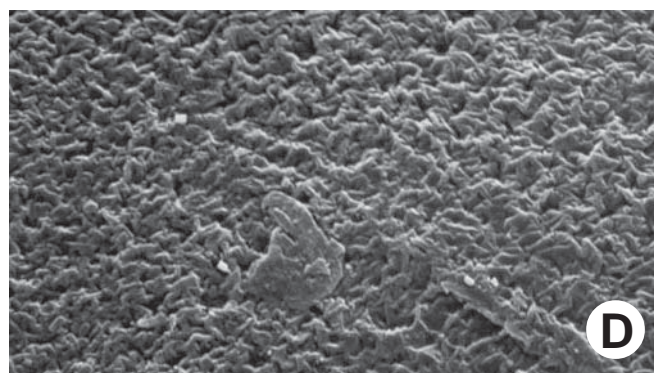
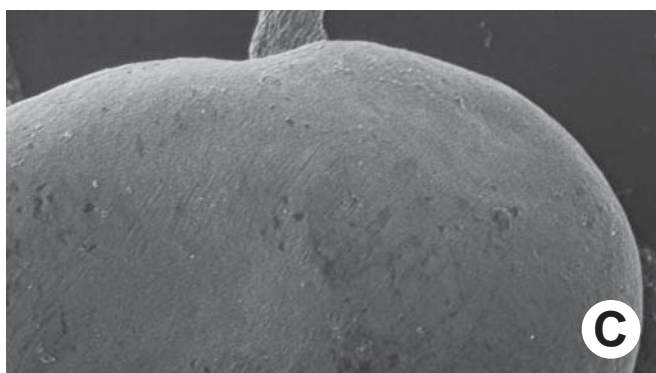
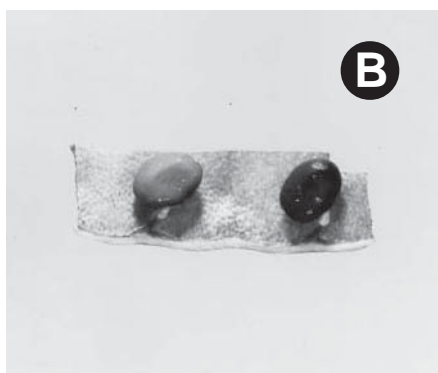
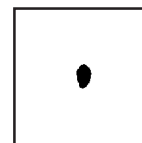
Seed $4\text{--}5 \times 1.5\text{--}2.5 \times 1.5\text{--}2.5$ mm; not overgrown; not angular; symmetrical; circular to oblong; compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; black (ish-brown); glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum fully concealed; concealed by aril; without faboid split; punctiform; marginal according to radicle tip; flush; not within corona, halo, or rim. Lens not discernible. Endosperm thin; covering entire

embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear; oblique to cotyledons; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Australia (Northern Territory and Western Australia).

Notes: Lee (1973) founded the genus and related it to other genera in the Bossiaeeae. Only two seed-fruit samples were available for our study, and both were consistent with each other and with Lee's limited seed-fruit data.

Aenictophyton: *A. reconditum* A.T. Lee (A–E). A, Fruits ($\times 3.7$); B, seeds in situ ($\times 4.7$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 8$).



Mirbelieae (24.01–24.26)

Genus: *Gompholobium* J.E. Smith

Phylogenetic Number: 24.01.

Tribe: Mirbelieae.

Species Studied—Species in Genus: 16 spp.—ca. 35 spp.

Fruit a legume; unilocular; $0.4\text{--}2 \times 0.4\text{--}1.3 \times 0.3\text{--}1$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; circular or oblong; when asymmetrical with both sutures parallelly curved or both sutures nearly straight; not inflated; terete; without beak; rounded at apex; apex oblique with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures or 1 suture; apical and down; passive. Replum invisible. Epicarp dull; monochrome; black; glabrous or glabrate (with hairs along sutures); with 1 type of pubescence; puberulent; with pubescence gray; with pubescence uniformly distributed; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; not veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull or glossy; monochrome or streaked; tan; with streaking (dark); with brown overlay; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 6–12; length transverse to fruit length; overlapping or touching; in 1 series. Funiculus measured; up to 3 mm long; of 1 length only; thick; S-curved or hooked. Aril absent or present; dry; well developed rim-aril; reddish brown.

Seed $1.6\text{--}3 \times 1.2\text{--}2.5 \times 1\text{--}2.1$ mm; not overgrown; not angular; asymmetrical; mitaform, reniform, or circular; compressed or terete; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Cuticle inflated (like bubbles) or not inflated (around hilum). Testa not adhering to endocarp; dull; not modified by a bloom;

colored; monochrome or mottled; with frequent mottles; reddish brown, tan (reddish), orange, or black; with black overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.7 mm long; with curved outline; oval; marginal according to radicle tip; recessed; within rim. Hilum rim color of testa. Lens discernible; less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; confluent with hilum; mounded; same color as, similar color as, or dissimilar color from testa; darker than testa; reddish brown or black; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa or embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; pale tan or brown (reddish); inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately or well developed; glabrous.

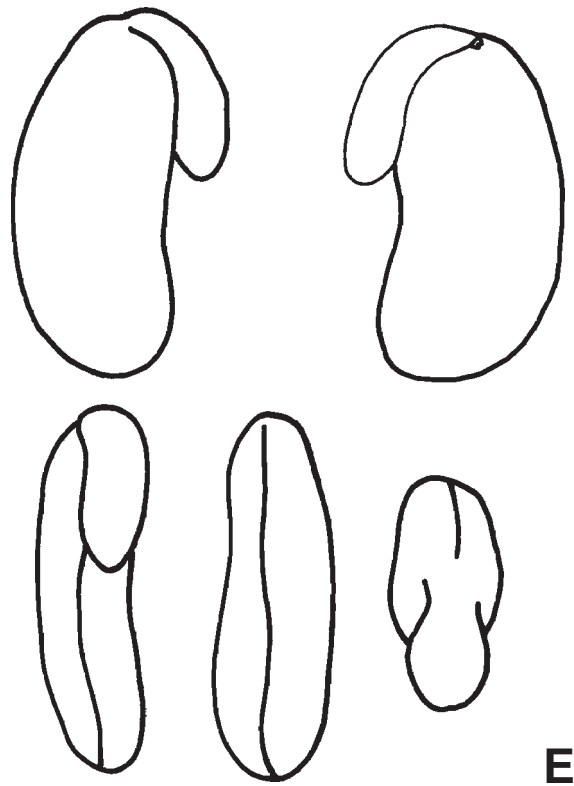
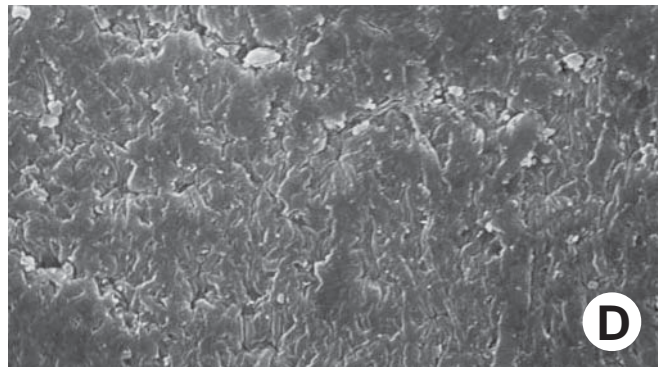
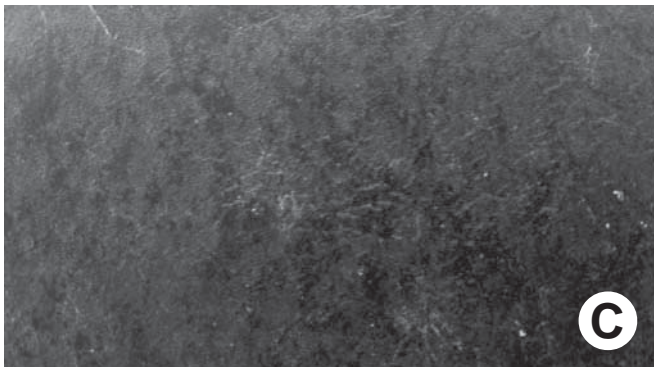
Distribution: Australia and New Guinea (*G. papuanum* E.D. Merrill & L.M. Perry).

Notes: Crisp and Weston (1987) analyzed the Mirbelieae, and we are following their species counts. We did not treat the following new taxa of Crisp and Weston: the *Pultenaea incurvata* A. Cunningham group of five species; *Pultenaea neurocalyx* P.K.N.S. Turczanivow, a single species; *Aotus phyllicoides* G. Benth, a single species; and *Oxylobium microphyllum* G. Benth, a two-species genus. The genus *Cupulanthus* J. Hutchinson is listed on page 85 of Crisp and Weston (1987) and not mentioned by them again. Crisp and Weston (1995) proposed the following two major generic changes: the resurrection of *Podolobium* R. Brown with six species of *Oxylobium* (24.09, see Notes for *Oxylobium*) and a new genus, tentatively to be named *Otion*. *Otion*, as projected, will have six species, two new ones and four from four different genera: *Aotus phyllicoides* G. Benth, *Burtonia simplicifolia* F. von Mueller & R. Tate, *Oxylobium microphyllum* G. Benth, and *Phyllota luehmannii* F. von Mueller.

Crisp and Weston (1987), in Appendix II, united *Burtonia* R. Brown with *Gompholobium* under the latter name.

Gompholobium: *G. latifolium* J.E. Smith (*E*), *G. scabra* R. Brown (*C–D*), *G. spp.* (*A–B*). *A*, Fruits with and without calyx and valves ($\times 2.3$); *B*, seeds ($\times 10$); *C–D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 12$).

0



D

E

C

Genus: *Sphaerolobium* J.E. Smith

Phylogenetic Number: 24.02.

Tribe: Mirbelieae.

Species Studied—Species in Genus: 7 spp.—ca. 15 spp.

Fruit a legume; unilocular; $0.4\text{--}0.55 \times 0.3\text{--}0.4 \times 0.3\text{--}0.4$ cm; with deciduous or persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; more or less circular or oblong; when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; widest near middle or D-shaped; not inflated; terete; without beak; rounded at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; ligneous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate or stipitate; with the stipe up to 5 mm long. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive. Replum invisible. Epicarp dull; monochrome; reddish brown, tan (to greenish or barely reddish tan), green, or black; glabrous; eglandular; without spines; not smooth; with elevated features; veined or not veined; reticulately veined; not tuberculate; wrinkled; not exfoliating; without cracks. Mesocarp thick; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; sub ligneous. Endocarp glossy; monochrome; reddish brown, tan, or white (nearly); smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1 or 2; length parallel with or transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; flattened; straight (from a thickened suture wall). Aril dry; rim-aril; tan.

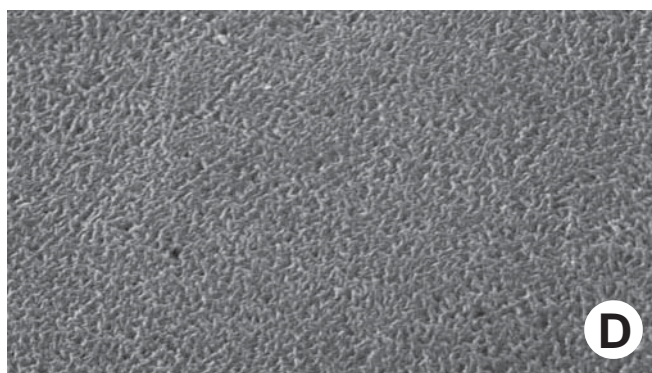
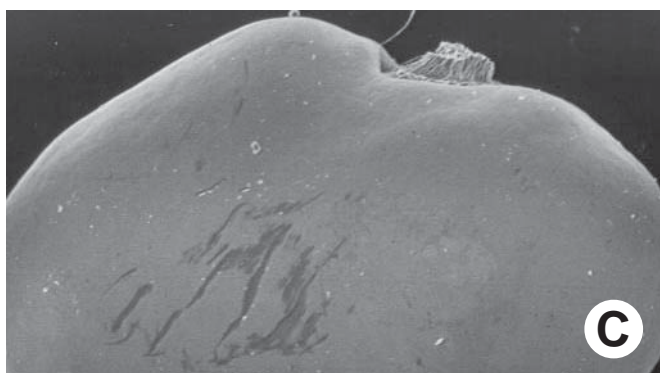
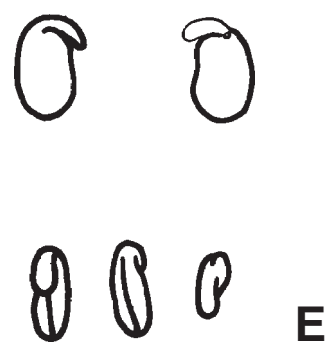
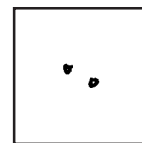
Seed $1.2\text{--}1.8 \times 1.1\text{--}1.3 \times 0.9$ mm; not overgrown; not angular; asymmetrical; reniform, circular, or mitaform; compressed; with surface smooth; without or with visible radicle and cotyledon lobes; without or with external groove between radicle and cotyledon lobes; same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown; glabrous; smooth or not smooth; with elevated features; tuberculate; coriaceous. Fracture lines absent.

Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; marginal according to radicle tip; flush; not within corona, halo, or rim or within rim. Hilum rim color of testa. Lens discernible; less than 0.5 mm in length; with margins straight or curved; circular or oblong; not in groove of raphe; adjacent to or confluent with hilum; 0.2 mm from hilum; flush; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Southwestern and southeastern Australia.

Notes: The fruits of *Sphaerolobium* are slightly to noticeably longitudinally compressed so that the long axis is equivalent to the width of most other legume fruits. The upper fruit in fig. A (of *S. grandiflorum* G. Benth) is an example of this compression.

Sphaerolobium: *S. vimineum* J.E. Smith (C–E), *S.* spp. (A–B). A, Fruits with or without calyx ($\times 6.9$); B, seeds ($\times 10.5$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 13$).



Genus: *Viminaria* J.E. Smith

Phylogenetic Number: 24.03.

Tribe: Mirbelieae.

Species Studied—Species in Genus: 1 sp.—1 sp.

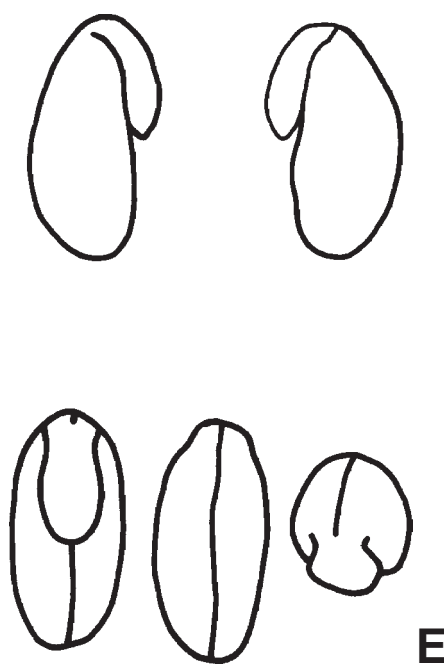
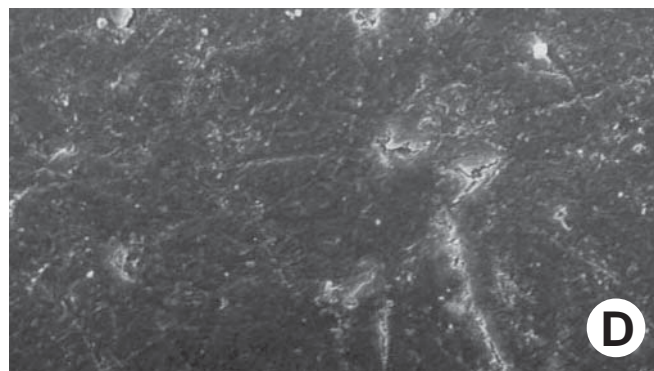
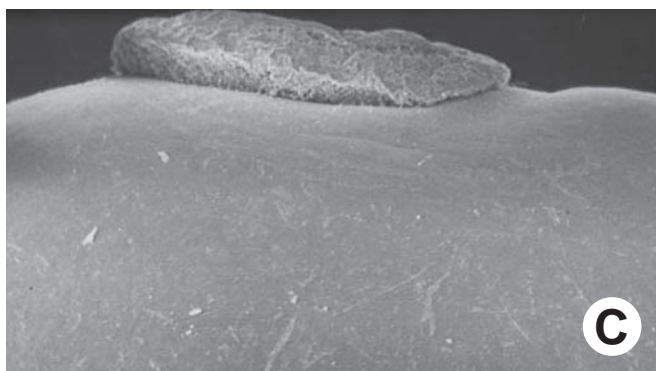
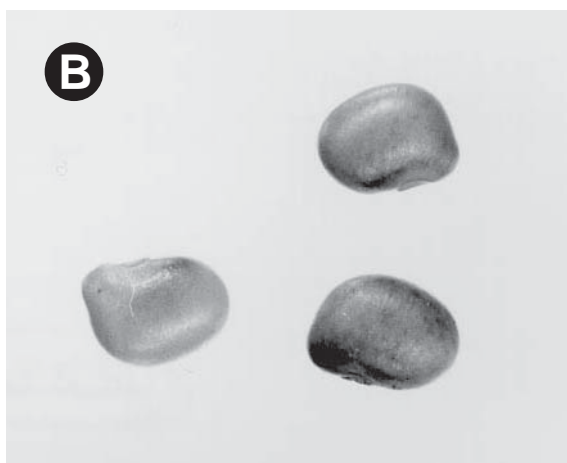
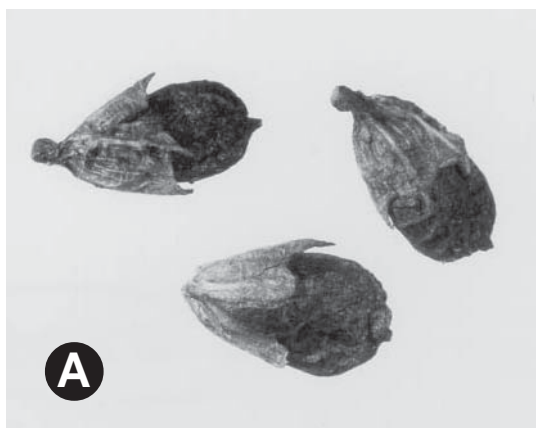
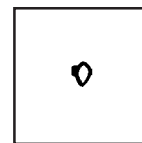
Fruit a legume; unilocular; $0.9-1 \times 0.5-0.6 \times 0.3$ cm; with persistent calyx; with calyx shorter than fruit ($3/4$ length of fruit); without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; oblong or ovate; when asymmetrical with both sutures parallelly curved; not inflated; compressed; without beak; rounded at apex; apex oblique with longitudinal axis of fruit; rounded at base; base slightly oblique with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome; black; glabrous; eglandular; without spines; not smooth; with elevated features; not veined; not tuberculate; wrinkled (especially portion above calyx); not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome (but epicarp color is visible); tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp. Seed 1; length parallel with fruit length. Funiculus less than 0.5 mm long; flattened; straight. Aril dry; rim-aril; tan.

Seed $2-3 \times 1.4-2 \times 1-1.8$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim present. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.5 mm long; with curved outline; circular; between cotyledon and radicle lobe; recessed; not within corona, halo, or rim. Lens discernible; less than 0.5 mm in length (0.3–0.4 mm); with margins curved; circular; not in groove of raphe; adjacent to hilum; 0.1 mm from hilum; slightly mounded; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo.

Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; pale tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon width; centered between cotyledons; less than $1/2$ length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Southwestern and southeastern Australia.

Viminaria: V. juncea (H.A. Schader) J.C. von Hoffmann-segg (A–E). A, Fruits with calyx ($\times 5.6$); B, seeds ($\times 10$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 16$).



Genus: *Daviesia* J.E. Smith

Phylogenetic Number: 24.04.

Tribe: Mirbelieae.

Species Studied—Species in Genus: 22 spp.—120 spp.

Fruit a legume; unilocular; $0.5\text{--}1.5 \times 0.4\text{--}1 \times 0.3\text{--}0.5$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; more or less asymmetrical; triangular or irregular; when asymmetrical with both sutures unequally curved, 1 straight and 1 curved suture, or both sutures parallelly curved; more or less widest near middle or D-shaped; not inflated; compressed; without or with beak; with solid beak the same color and texture as fruit; tapered, short tapered, or truncate at apex; apex aligned, oblique, or right-angled with longitudinal axis of fruit; long tapered to tapered at base; base aligned or oblique with longitudinal axis of fruit; with the apex and base uniform in texture; membranous or chartaceous. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting (each valve or both valves forming a cone). Replum invisible. Epicarp dull or glossy; monochrome or multicolored; mottled; light to dark or reddish brown, tan, green, purple, or gray; with tan overlay; glabrous or pubescent and indurate; with 1 type of pubescence; villous; with pubescence golden; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; smooth or not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; brown; smooth, hairy (crinkled and golden), or cobwebby; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1 or 2; length parallel with fruit length; overlapping and touching or neither overlapping nor touching; in 1 series. Funiculus measured; 1 mm long; of 1 length only; thick; straight (may be bifurcate at base with seed on each stalk. Aril fleshy; cupshaped (with thicker apex); covering 1/2 to nearly all of seed; reddish brown or yellow.

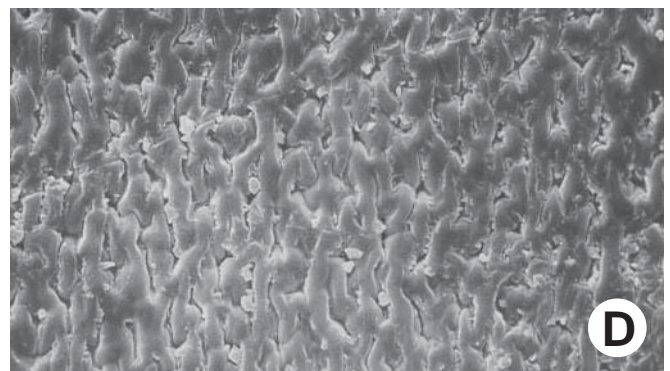
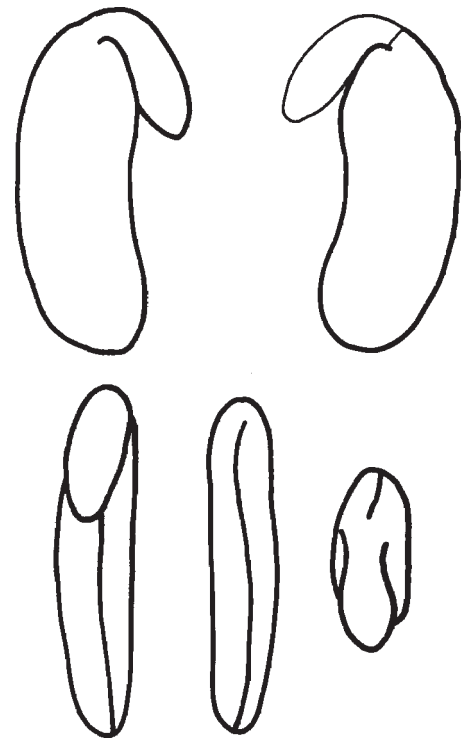
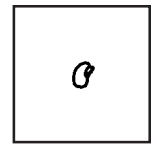
Seed $3\text{--}6 \times 1.5\text{--}3.5 \times 0.8\text{--}2.4$ mm; overgrown, 1 seed filling entire fruit cavity; not angular; asymmetrical;

oblong or elliptic; compressed; with surface smooth; without visible radicle and cotyledon; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; brown to greenish or reddish brown, tan (to reddish tan), yellow, orange, or black; with black overlay; glabrous; smooth or not smooth; with recessed features; punctate; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 1 mm long; with straight outline; oblong; marginal according to radicle tip; recessed; not within corona, halo, or rim or within halo. Hilum halo color (black) darker than testa. Lens discernible or not discernible; less than 0.5 mm in length; with margins curved; elliptic; not in groove of raphe; confluent with hilum (at least with halo); mounded; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa or embryo. Cotyledons smooth; both outer faces convex; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Australia.

Notes: Crisp and Chandler (Crisp 1980, 1982, 1984, 1985, 1991; Crisp and Chandler 1997; Chandler and Crisp 1998) have treated parts of *Daviesia*. Crisp (1985) dealt with conservation of the genus.

Daviesia: *D. acicularis* J.E. Smith (C–E), *D.* spp. (A–B). A, Fruits and valves with calyx ($\times 2.9$); B, seeds ($\times 5$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



Genus: *Isotropis* G. Bentham

Phylogenetic Number: 24.06.

Tribe: Mirbelieae.

Species Studied—Species in Genus: 4 spp.—10 spp.

Fruit a legume; unilocular; $1.5-3 \times 0.35-0.7 \times 0.37$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; asymmetrical; falcate, oblong (linear), linear, or lanceolate; when asymmetrical with both sutures nearly straight; not inflated; terete; without or with beak; straight or declined; with solid beak the same color and texture as fruit; tapered or short tapered at apex; apex aligned, oblique, or right-angled with longitudinal axis of fruit; short tapered at base; base aligned or oblique with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate or nonstipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible. Epicarp dull; monochrome; tan; pubescent but soon deciduous; with 1 type of pubescence; tomentose or villous; with pubescence golden or gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular or glandular; with glandular dots (black); without spines; not smooth; with elevated features; not veined; not tuberculate; shagreen; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp glossy; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds up to 11; length parallel with fruit length; overlapping and touching or neither overlapping nor touching; in 1 series. Funiculus measured; 1 mm long; of 1 length only; filiform; straight or curved. Aril dry; rim-aril; white.

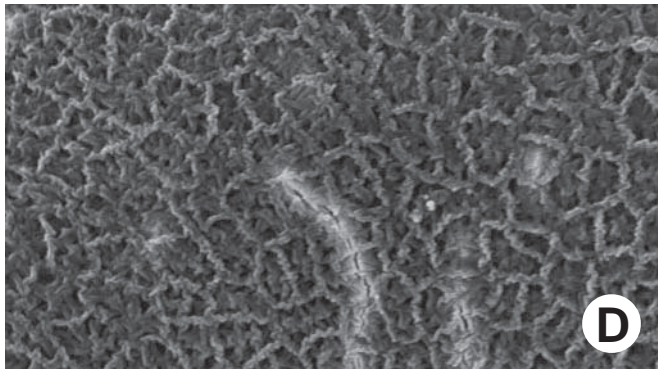
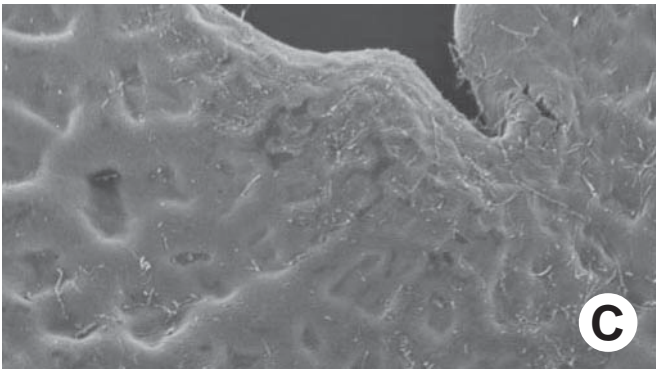
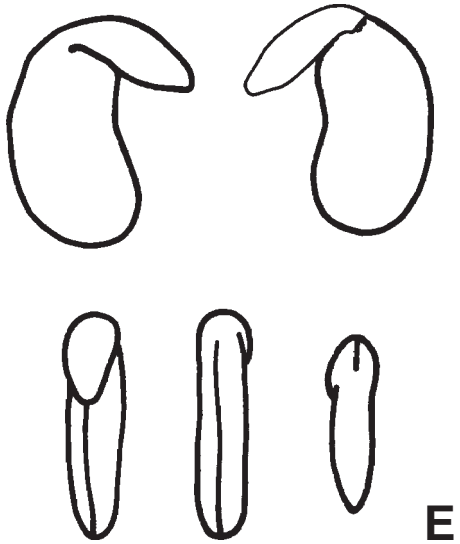
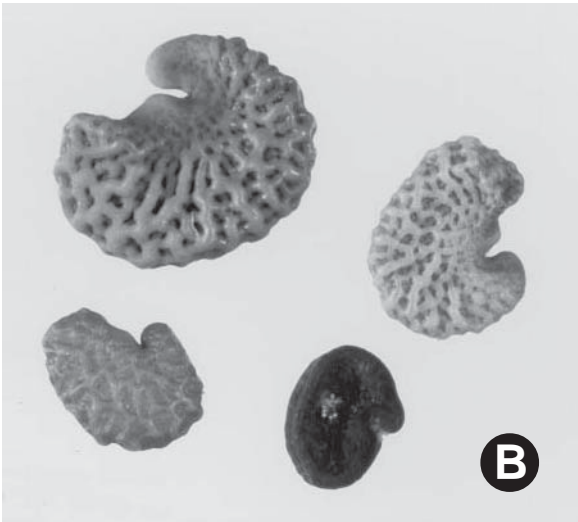
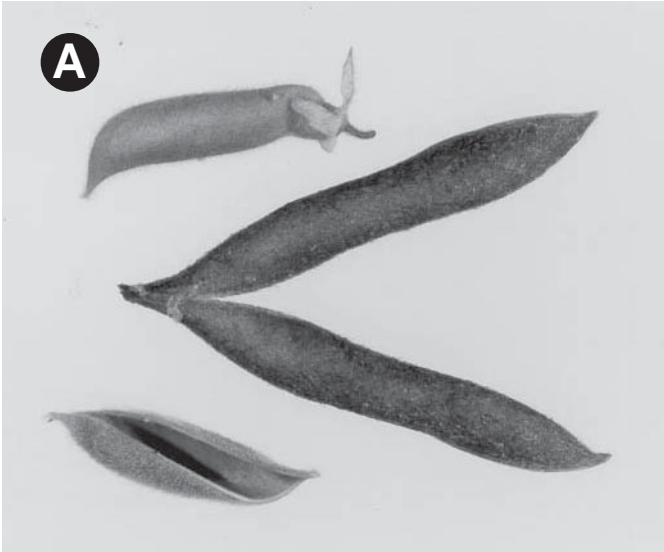
Seed $2-3.75 \times 1.5-3 \times 0.8-1$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; with deep or shallow hilar sinus; without umbo on seed faces. Testa

not adhering to endocarp; dull; not modified by a bloom; clear; monochrome (though intertices may be darker than ridges); light to dark reddish brown or tan; glabrous; not smooth; with elevated features; reticulate; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially or fully concealed; concealed by radicle lobe or wing; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; within rim. Hilum rim color of testa. Lens discernible or not discernible; less than 0.5 mm in length; with margins curved; more or less circular; not in groove of raphe; confluent with hilum; mounded; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thick; pluglike and resembling tip of radicle; covering entire embryo; adnate to testa or embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; green, brown (greenish), or tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip straight, curved, or hooked; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Australia.

Isotropis: *I. wheeleri* G. Bentham (C-E), *I.* spp. (A-B). A, Fruits with and without calyx (closed and dehisced) and valves ($\times 2.8$); B, seeds ($\times 9.7$); C-D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).

D



Genus: *Jacksonia* R. Brown ex J.E. Smith

Phylogenetic Number: 24.08.

Tribe: Mirbelieae.

Species Studied—Species in Genus: 10 spp.—ca. 50 spp.

Fruit a legume; unilocular; $0.5-1 \times 0.3-4.5 \times 0.25-0.35$ cm; with persistent or deciduous calyx; with calyx shorter than or equal in length to fruit; without orifice formed by curving of fruit or fruit segments; straight or curved; not plicate; not twisted; symmetrical or asymmetrical; oblong, obovate, or ovate; when asymmetrical with 1 straight and 1 curved suture or both sutures nearly straight; widest near middle or D-shaped; not inflated; terete or compressed; without or with beak; straight; with solid beak the same color and texture as fruit; long tapered at apex; apex aligned or oblique with longitudinal axis of fruit; short tapered or long tapered at base; base aligned or oblique with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate to nonstipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive. Replum invisible. Epicarp dull; monochrome; reddish brown or tan (reddish); pubescent and indurate; with 1 type of pubescence; puberulent or tomentose; with pubescence gray or golden; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; smooth or not smooth; with elevated features; veined or not veined; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp glossy; monochrome; reddish brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1 or 2; length parallel with fruit length; overlapping and touching or neither overlapping nor touching; in 1 series. Funiculus measured; 0.7 mm long; of 1 length only; filiform; curved. Aril present or absent; dry; tongue-aril; reddish brown or white.

Seed $2-3.5 \times 1-2.5 \times 0.5-1.5$ mm; not overgrown; not angular or angular; asymmetrical; oblong or reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus;

without umbo on seed faces. Cuticle wrinkled or not wrinkled. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled and streaked; reddish brown; with black overlay; glabrous; not smooth; with elevated features; wrinkled; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by radicle lobe or wing; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; recessed; not within corona, halo, or rim. Lens discernible; less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; adjacent to hilum; 0.3 mm from hilum; mounded; same color as testa; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to testa or embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing or not concealing radicle; entire or split over radicle; without or with lobes; with lobes not touching; with the interface division terminating at base of radicle; without margins recessed; greenish tan or green; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear or bulbous; lobe tip hooked; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Australia.

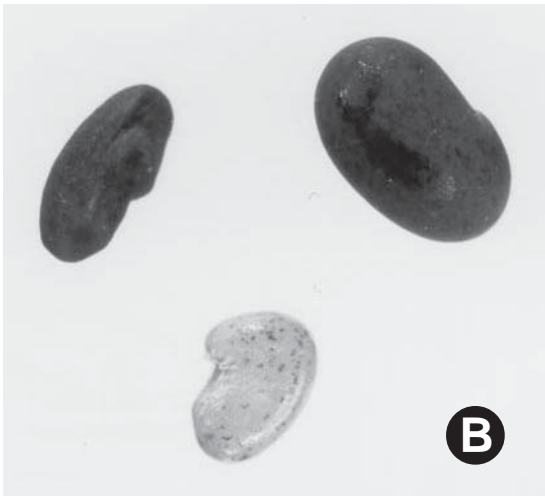
Notes: Crisp (1984) presented notes on *Jacksonia*.

Jacksonia: *J. ramosissima* G. Benth (C-E), *J. spp.* (A-B). A, Fruits with calyx and valve ($\times 3.5$); B, seeds ($\times 10$); C-D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).

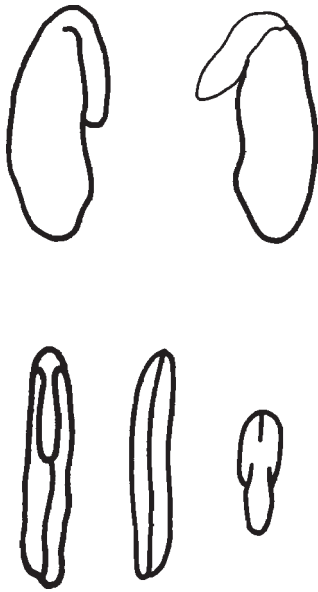
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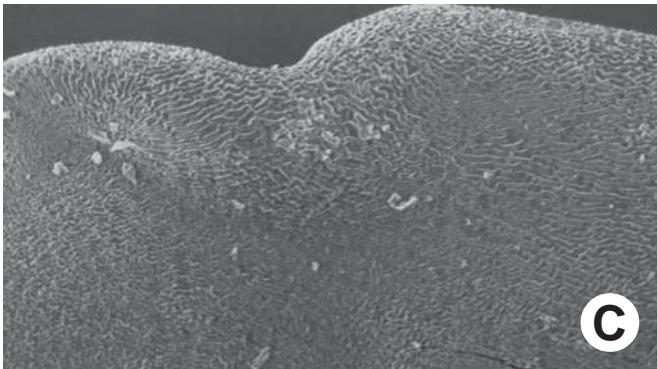
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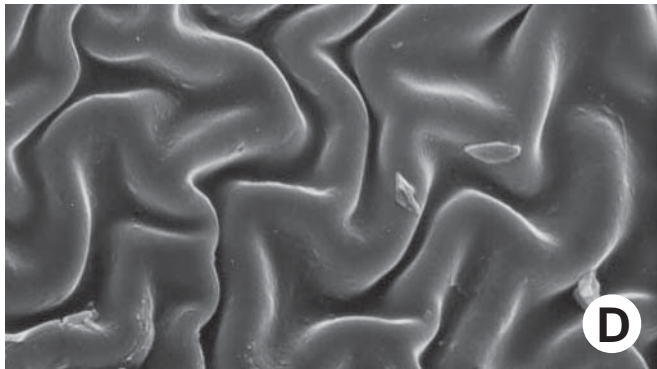
B



E



C



D

Genus: *Oxylobium* H.C. Andrews

Phylogenetic Number: 24.09.

Tribe: Mirbelieae.

Species Studied—Species in Genus: 13 spp.—ca. 15 spp.

Fruit a legume; unilocular; $0.5\text{--}2 \times 0.3\text{--}0.8 \times 0.2\text{--}0.5$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved; not plicate; not twisted; asymmetrical or symmetrical; ovate or C-shaped; when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; widest near middle or D-shaped; not inflated; compressed; without or with beak; straight; with solid beak the same color and texture as fruit; tapered or short tapered at apex; apex aligned or oblique with longitudinal axis of fruit; short tapered at base; base aligned or oblique with longitudinal axis of fruit; with the apex and base uniform in texture; ligneous; seed chambers externally invisible or visible (faintly). Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down (or apically only); passive. Replum invisible. Epicarp dull; monochrome; greenish brown, green, or black; pubescent and indurate; with hairs erect or appressed; with 1 type of pubescence; villous; with pubescence gray or golden; with pubescence uniformly distributed; with simple hairs; stiff or pliable; with hair bases plain; glandular; with glandular setae (short); without spines; not smooth; with elevated features; reticulately veined; not tuberculate; exfoliating in part, exfoliating, or not exfoliating; without cracks. Mesocarp thin; surface not veined; 1- or 2-layered; without balsamic vesicles; without or with fibers; solid; with fibers over solid layer; subligneous. Endocarp glossy; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 2–10; length parallel with or oblique to fruit length; neither overlapping nor touching or overlapping and touching; in 1 series. Funiculus measured; $0.7\text{--}0.8$ mm long; of 1 length only; filiform; curved, S-curved, or straight. Aril dry; tongue-aril; reddish brown, tan (to reddish tan), or red.

Seed $1\text{--}2.7 \times 1.2\text{--}2 \times 1.2\text{--}1.5$ mm; not overgrown; not angular or angular; asymmetrical; oblong, ovate, reniform, mitaform, triangular, or irregular; compressed; with surface smooth; with or without visible

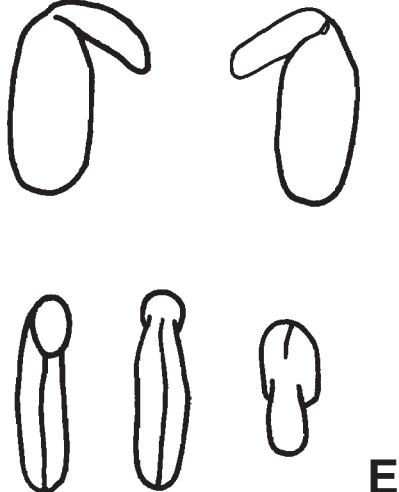
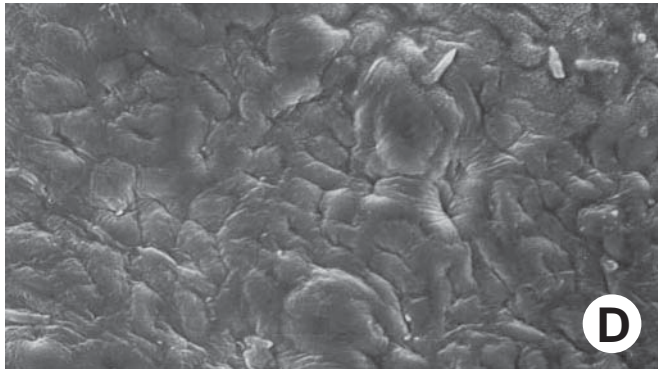
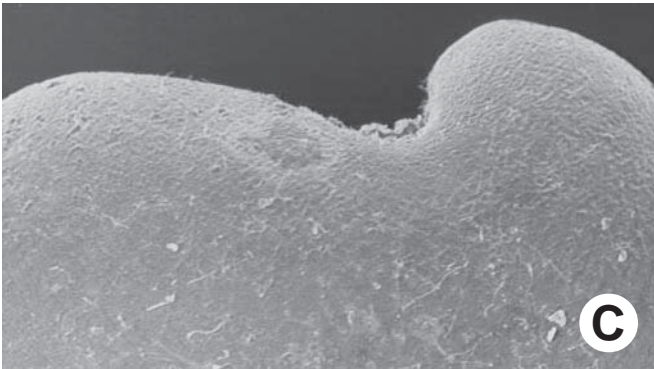
radicle and cotyledon lobes; without or with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; brown to dark to light reddish brown or black; with brown (reddish), tan (reddish), or black overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.5 mm long; with curved outline; elliptic or oval; between cotyledon and radicle lobe; recessed; not within corona, halo, or rim or within halo. Hilum halo color darker or lighter than testa. Lens not discernible or discernible (faintly); less than 0.5 mm or equal to or greater than 0.5 mm in length; up to 0.5 mm long; with margins curved; circular or elliptic; not in groove of raphe; adjacent to hilum; 0.3–0.5 mm from hilum; mounded; same or similar color as testa; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan to reddish tan or green; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Australia.

Notes: Crisp and Weston (1987) noted that “in its strictest sense, *Oxylobium* may include only *O. cordifolium* [H.C. Andrews] and *O. pultenaea*” A.-P. de Candolle. Lebler (1977) described the fruits and seeds of five species of *Oxylobium*, also known as shaggy-peas. The plants are poisonous to livestock.

Oxylobium: *O. robustum* J. Thompson (C–E), *O. spp.* (A–B). A, Fruits (dehiscid or closed) with or without calyx ($\times 2.5$); B, seeds ($\times 7$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 12$).

6



Genus: *Chorizema* J.J.H. de Labillardière

Phylogenetic Number: 24.10.

Tribe: Mirbelieae.

Species Studied—Species in Genus: 21 spp.—25 spp.

Fruit a legume; unilocular; $0.4\text{--}1.7 \times 0.3\text{--}0.8$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; ovate, obovate, or elliptic; when asymmetrical with 1 straight and 1 curved suture; widest near middle or D-shaped; not inflated; terete or compressed; with beak; straight, declined, or hooked; with solid beak the same color and texture as fruit; short tapered or tapered at apex; apex aligned or oblique with longitudinal axis of fruit; long tapered, tapered, or short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible or visible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit stipitate to substipitate to nonstipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down (to somewhat down); passive. Replum invisible. Epicarp dull; monochrome; brown; glabrous or pubescent and indurate; with hairs appressed; with 1 type of pubescence; with pubescence golden; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; subligneous. Endocarp glossy; monochrome; reddish brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds (number unknown, see Notes) length parallel with fruit length; in 1 series. Funiculus measured; 0.6 mm long; of 1 length only; filiform; curved. Aril dry; well developed rim-aril; reddish brown.

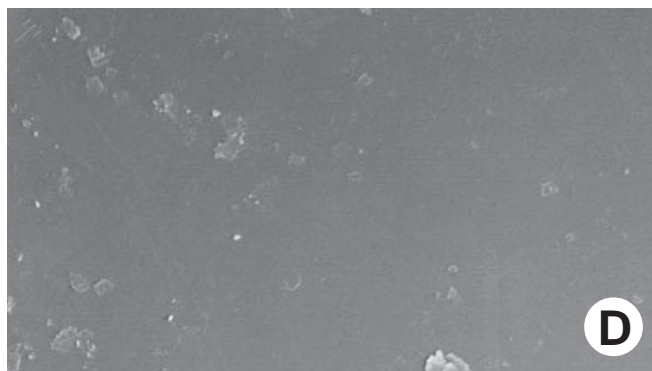
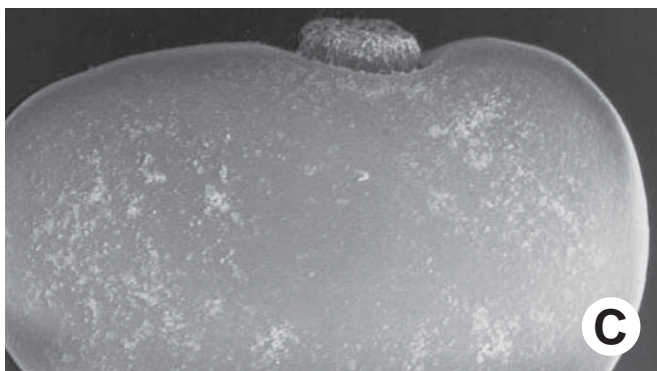
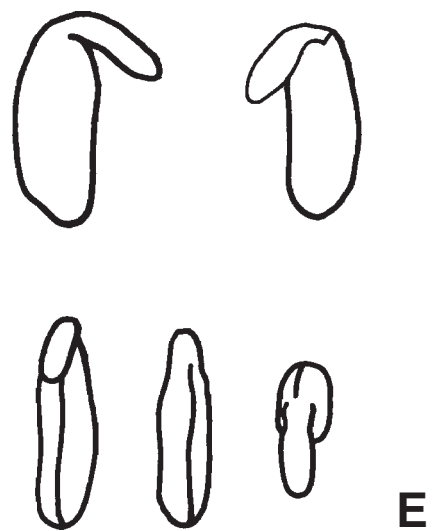
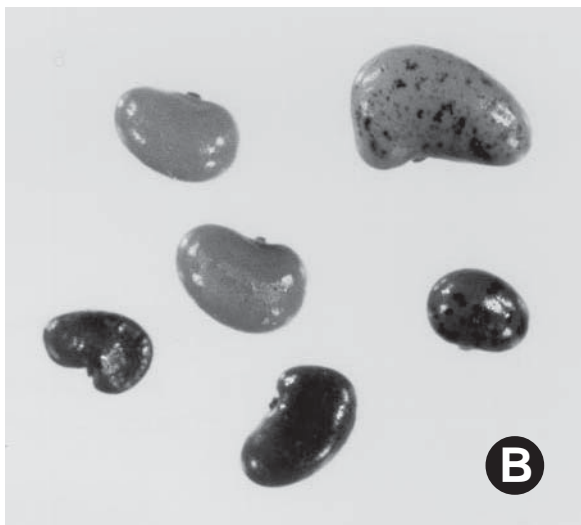
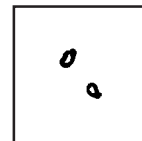
Seed $1.5\text{--}3.5 \times 1\text{--}2 \times 1\text{--}1.3$ mm; not overgrown; not angular; asymmetrical; D-shaped, oblong, or reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom;

colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; brown to greenish to reddish brown, tan, or black; with black overlay; glabrous; smooth or not smooth; with elevated features; reticulate; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially or fully (nearly) concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; up to 0.5 mm long; with curved outline; oval; marginal according to radicle tip or between cotyledon and radicle lobe; recessed; within rim. Hilum rim color of testa. Lens discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; 0.5 mm long; with margins straight; linear; not in groove of raphe; adjacent to hilum; 0.3 mm from hilum; flush; similar color as testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo or testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; yellow or orange; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Western Australia.

Notes: Taylor and Crisp (1992) revised *Chorizema*, and our species count agrees with theirs. All fruiting material available to us was dehiscent, therefore we were unable to determine the number of seeds per fruit. Taylor and Crisp did not report the number of seeds per fruit, but they did report that the ovaries had 8–30 ovules and that *C. retrorsum* J.M. Taylor & M.D. Crisp had as many as 35 ovules per ovary.

Chorizema: *C. ilicifolium* J.J.H. de Labillardière (C–E), *C.* spp. (A–B). A, Fruits (dehiscent) with and without calyx ($\times 5.3$); B, seeds ($\times 9.2$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



Genus: *Mirbelia* J.E. Smith

Phylogenetic Number: 24.11.

Tribe: Mirbelieae.

Species Studied—Species in Genus: 8 spp.—15–30 spp.

Fruit a legume; unilocular; $0.8\text{--}2 \times 0.3\text{--}1 \times 0.25\text{--}0.5$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical; ovate or didymous; not inflated; compressed; with beak; straight; with solid beak the same color and texture as fruit; short tapered or rounded at apex; apex aligned with longitudinal axis of fruit; short tapered or rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible or visible. Fruit margin not constricted or constricted; constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down or basal and up; passive. Replum invisible. Epicarp dull; monochrome; black, brown (reddish), or tan; glabrous or pubescent and indurate; with hairs erect or appressed; with 1 type of pubescence; puberulent; with pubescence golden; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; not veined or veined; reticulately veined and transversely veined relative to fruit length; not tuberculate; wrinkled and shagreen; not exfoliating or exfoliating; without cracks. Mesocarp thin; surface not veined; 1- or 2-layered; without balsamic vesicles; with fibers present or without fibers; solid; with fibers over solid layer; coriaceous. Endocarp dull or glossy; monochrome; reddish tan; smooth; with hairs restricted to sutures (some with hairs especially along funicular suture); nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 2; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; up to 2 mm long; of 1 length only; flattened; straight or curved. Aril dry; rim-aril; reddish brown, red, or black.

Seed $1.5\text{--}3 \times 1\text{--}2.2 \times 0.5\text{--}1.2$ mm; not overgrown; not angular or angular; asymmetrical; mitaform, oblong, reniform, rhombic, D-shaped, or irregular; compressed or mounded on 1 side and straight on other side (shape of valve with intruded lower suture); with surface

smooth; with or without visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull or glossy; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; light reddish to dark reddish brown or black; with purple overlay; glabrous; smooth or not smooth; with elevated features; wrinkled and shagreen; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible or partially concealed; concealed by funicular remnant, radicle lobe, or wing; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform or larger than punctiform; up to 0.5 mm long; with curved or angular outline; circular or triangular; marginal according to radicle tip or between cotyledon and radicle lobe; recessed; not within corona, halo, or rim or within halo. Hilum halo color (reddish-brown) lighter than testa or of testa. Lens not discernible or discernible (on light-colored seeds); less than 0.5 mm or equal to or greater than 0.5 mm in length; up to 0.5 mm long; with margins straight or curved; linear or irregular; not in groove of raphe; adjacent to or confluent with hilum; 0.2 mm from hilum; flush; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to testa or embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing or not concealing radicle; entire or split over radicle; without or with lobes; with lobes not touching; with the interface division terminating at base of radicle; without margins recessed; tan, brown (reddish), or yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip curved; deflexed and parallel to cotyledon width; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

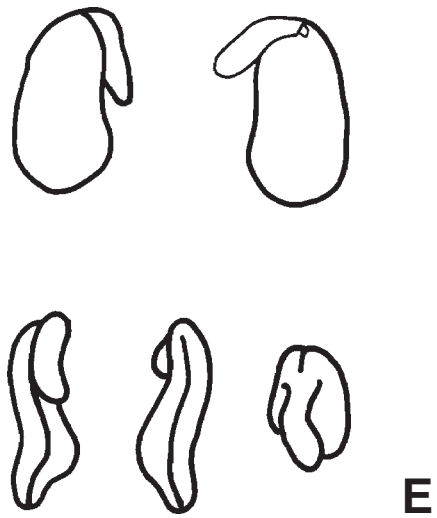
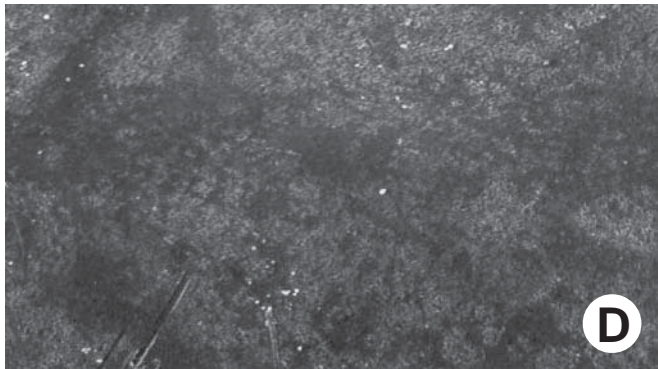
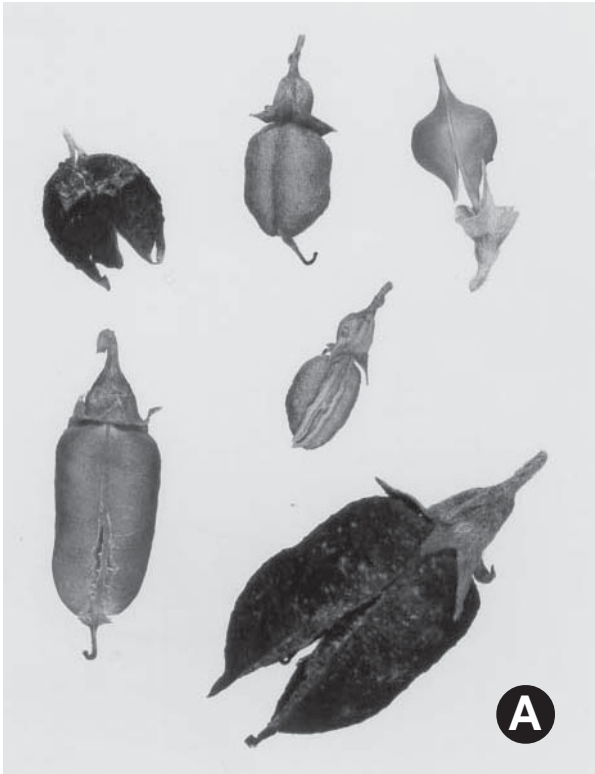
Distribution: Australia.

Notes: Crisp and Weston (1987) noted that its circumscription needs further study, especially in relation to *Chorizema* (24.10) and elements of *Oxylobium* (24.09). They (Crisp and Weston 1995) have carried out further cladistic studies and resurrected *Podolobium* R. Brown (24.14) with six species that were accepted by Wiecek (1991) as the first six species of *Oxylobium*. Pending

further evaluation by the botanical community, we have left those species in *Oxylobium*. The fruit has a spurious septum intruding from the lower suture.

Mirbelia: *M. grandiflora* W. Aiton (C–E), *M. spp.* (A–B). A, Fruits with calyx (closed and dehisced) ($\times 3.2$); B, seeds ($\times 10.6$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).

6



Genus: *Callistachys* É.P. Ventenat

Phylogenetic Number: 24.12.

Tribe: Mirbelieae.

Species Studied—Species in Genus: 1 sp.— 1 or 2 spp.

Fruit a legume; unilocular; $1.5-2 \times 0.5-0.6 \times 0.4-0.45$ cm; with persistent or deciduous (rarely) calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; oblong; when asymmetrical with both sutures nearly straight; not inflated; terete; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base oblique with longitudinal axis of fruit; with the apex and base uniform in texture; ligneous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive. Replum invisible. Epicarp dull; monochrome; dark reddish brown; pubescent and indurate; with 1 type of pubescence; villous; with pubescence golden; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; obliquely veined relative to fruit length; not tuberculate; ribbed; exfoliating (especially with age over and around ribs); without cracks. Mesocarp thick; surface uniformly veined; 2-layered; without balsamic vesicles; without fibers; with veins over solid layer; ligneous. Endocarp dull; monochrome; tan; scurfy or smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 7; length transverse to fruit length; overlapping or touching; in 1 series. Funiculus measured; 7–15 mm long; of 1 length only; flattened; curved. Aril dry; rim-aril; tan.

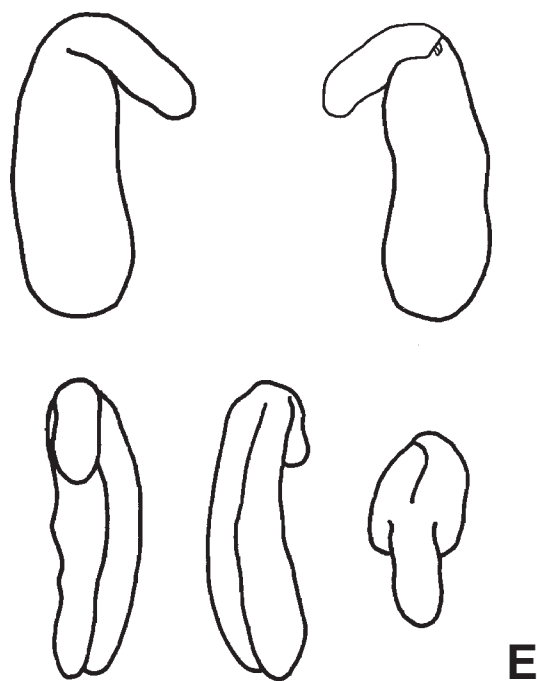
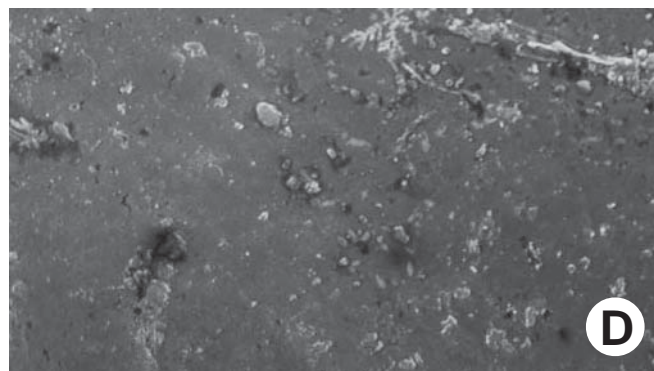
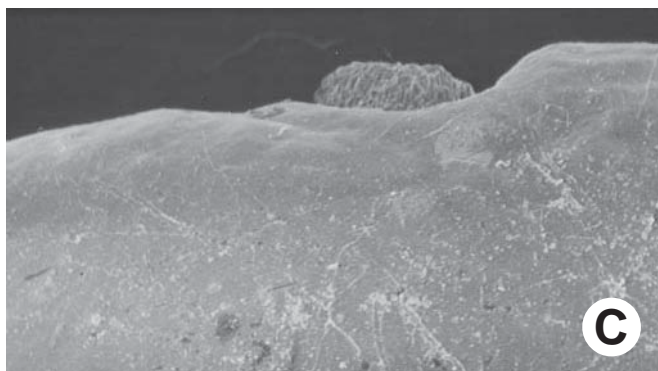
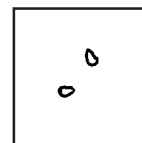
Seed $2-2.5 \times 1.2-1.5 \times 1-1.2$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; mottled and streaked; with frequent mottles; with frequent streaks; dark reddish brown; with brown (darker reddish) overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe

not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.4 mm long; with curved outline; circular; between cotyledon and radicle lobe; recessed; within halo. Hilum halo color lighter than testa. Lens not discernible or discernible (faintly); less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; adjacent to hilum; 0.3–0.4 mm from hilum; mounded or flush; similar color as testa; darker than testa; darker reddish brown; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Southwestern Australia.

Notes: *Callistachys*, a segregate of *Oxylobium* (24.09), was recognized by Crisp and Weston (1987) but not by Polhill (1981m).

Callistachys: *C. lanceolata* É.P. Ventenat (A–E). A, Fruits with calyx ($\times 2.9$); B, seeds ($\times 9.7$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 20$).



Genus: *Gastrolobium* R. Brown

Phylogenetic Number: 24.13.

Tribe: Mirbelieae.

Species Studied—Species in Genus: 10 spp.—ca. 50 spp.

Fruit a legume; unilocular; $0.7\text{--}2 \times 0.3\text{--}0.7 \times 0.2\text{--}0.65$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical or asymmetrical; ovate or circular; when asymmetrical with 1 straight and 1 curved suture; widest near middle or D-shaped; not inflated; terete; without beak; rounded at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned or oblique with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous or ligneous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit stipitate to substipitate; with the stipe up to 9 mm long. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive. Replum invisible. Epicarp dull; monochrome or multicolored; mottled; reddish brown; with purple overlay; glabrous, pubescent and indurate, or glabrate; with hairs erect or appressed; with 1 type of pubescence; villous; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; tan; smooth or scurfy; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seed 1; length parallel with fruit length. Funiculus measured; up to 2 mm long; thick; straight or curved (near apex). Aril present or absent; fleshy (to somewhat dry, but better developed than rim-aril); topknotlike or marginal hilar; covering 1/2 to nearly all of seed; reddish tan or cream.

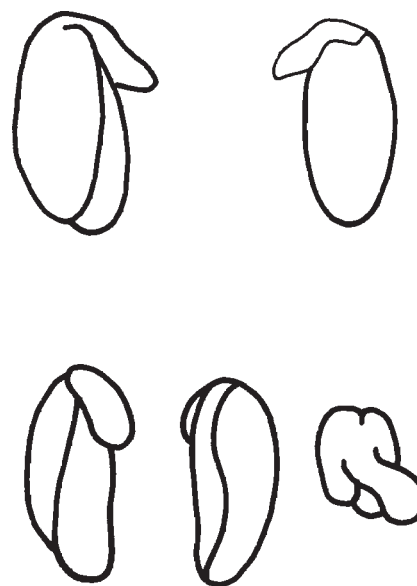
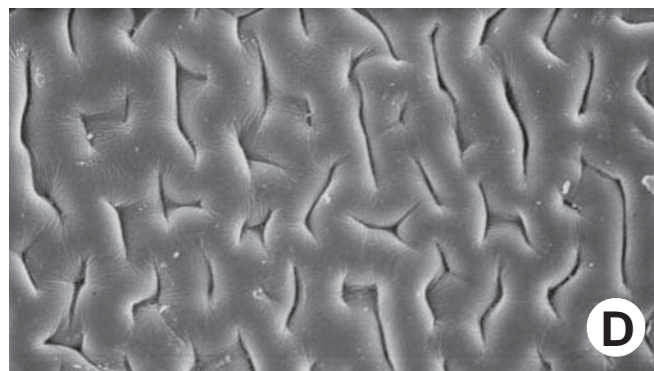
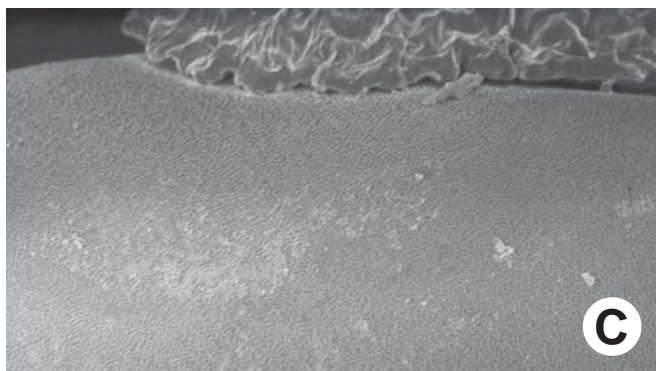
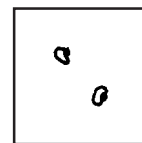
Seed $1.7\text{--}5 \times 1.3\text{--}3 \times 1\text{--}2.3$ mm; not overgrown; angular or not angular; asymmetrical or symmetrical; mitaform, oblong, reniform, or circular; compressed; with surface smooth; with or without visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome or mottled;

with frequent mottles; reddish brown or black; with purple overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 1 mm long; with curved outline; oval; marginal according to radicle tip; recessed; within rim. Hilum rim color darker than testa. Lens discernible; equal to or greater than 0.5 mm in length; up to 1 mm long; with margins straight or curved; circular or oblong; not in groove of raphe; confluent with or adjacent to hilum; up to 0.2 mm from hilum; mounded or flush; similar color as testa; darker than testa; brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; tan or brown (reddish); inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Australia.

Notes: Crisp and Weston (1987) included the *Oxylobium parviflorum* J. Lindley group in *Gastrolobium*.

Gastrolobium: *G. bilobum* R. Brown (C–E), *G.* spp. (A–B). A, Fruits (dehiscid and closed) with and without calyx ($\times 2.9$); B, seeds ($\times 6$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



Genus: *Nemcia* K. Domin

Phylogenetic Number: 24.15.

Tribe: Mirbelieae.

Species Studied—Species in Genus: 9 spp.—28 spp.

Fruit a legume; unilocular; $0.8\text{--}1.5 \times 0.3\text{--}0.5 \times 0.2\text{--}0.4$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; ovate or oblong; when asymmetrical with 1 straight and 1 curved suture, both sutures unequally curved, or both sutures parallelly curved; widest near middle or D-shaped; not inflated; terete; with or without beak; straight or declined; with solid beak the same color and texture as fruit; short tapered at apex; apex aligned with longitudinal axis of fruit; tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate or nonstipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down (at least 1/2 way); passive. Replum invisible. Epicarp dull; monochrome; dark to light reddish brown; pubescent and indurate; with 1 type of pubescence; villous; with pubescence golden or gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp glossy; monochrome; pale tan; smooth or reticulate; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seed 1; length parallel with fruit length. Funiculus measured; 1 mm long; thick; curved. Aril fleshy or dry; when fleshy topknotlike; covering less than 1/2 of seed; when dry rim-aril; reddish brown.

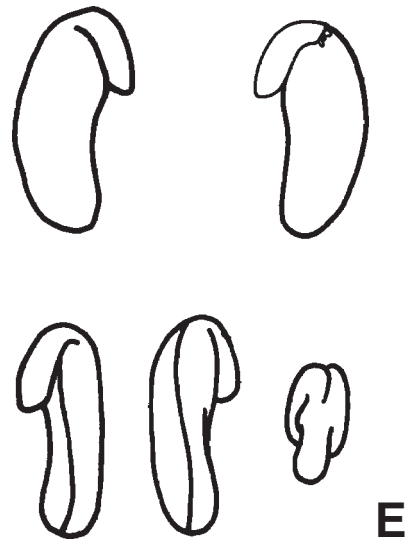
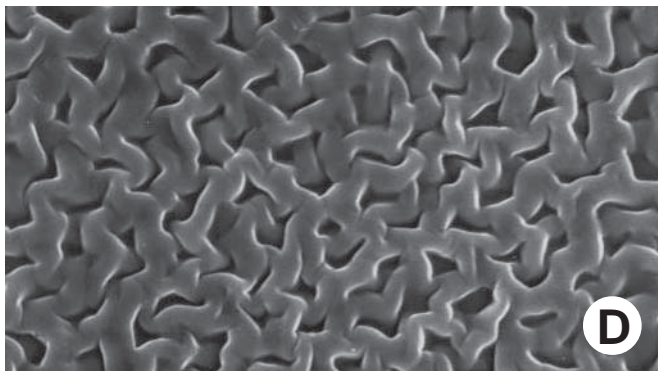
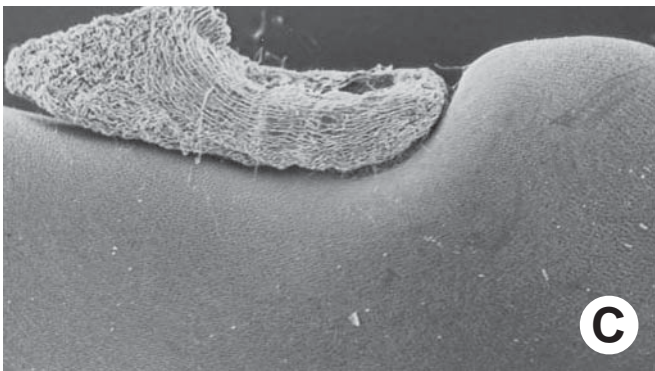
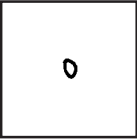
Seed $2.3\text{--}3 \times 1.5\text{--}1.8 \times 1\text{--}1.5$ mm; not overgrown; not angular; asymmetrical; oblong, reniform, or D-shaped; compressed; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; reddish brown; with

brown overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.7 mm long; with straight outline; oblong; marginal according to radicle tip; recessed; not within corona, halo, or rim. Lens discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; 0.5 mm long; with margins straight or curved; oblong; not in groove of raphe; confluent with hilum; barely mounded; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa or embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; reddish tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear or bulbous; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Southwestern Australia.

Notes: Crisp and Weston (1987) emended the generic circumscription to include series *Axillares* of *Gastrolobium* (24.13).

Nemcia: *N. dilatata* (G. Benth) M.D. Crisp (*C–E*), *N.* spp. (*A–B*). *A*, Fruits (dehiscent and closed) with and without calyx ($\times 4.8$); *B*, seeds ($\times 10.1$); *C–D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 10$).



Genus: *Brachysema* R. Brown

Phylogenetic Number: 24.16.

Tribe: Mirbelieae.

Species Studied—Species in Genus: 7 spp.—8 spp.

Fruit a legume; unilocular; 1–2.5 × 0.5–1 × 0.5–0.6 cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical; oblong; not inflated; terete; without beak; tapered to short tapered at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; ligneous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate to nonstipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive. Replum invisible. Epicarp dull; monochrome or multicolored; mottled (faintly in some species); reddish brown or tan; with gray overlay; pubescent and indurate; with 1 type of pubescence; tomentose; with pubescence gray; with pubescence uniformly distributed (or restricted to sutures); with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; shagreen or wrinkled; exfoliating in part; with or without cracks; cracking transverse to fruit length. Mesocarp thick; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; ligneous. Endocarp dull; monochrome; reddish tan; transversely wrinkled; nonseptate; ligneous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 7; length parallel with fruit length; overlapping and touching; in 1 series. Funiculus measured; 1 mm long; of 1 length only; thick; straight or curved (slightly). Aril fleshy; cupshaped; covering less than 1/2 of seed; reddish brown or tan.

Seed 2–3.1 × 1.5–2 × 1–1.5 mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; black or brown (reddish); glabrous; smooth or not smooth; with recessed features; punctate; coriaceous. Fracture lines

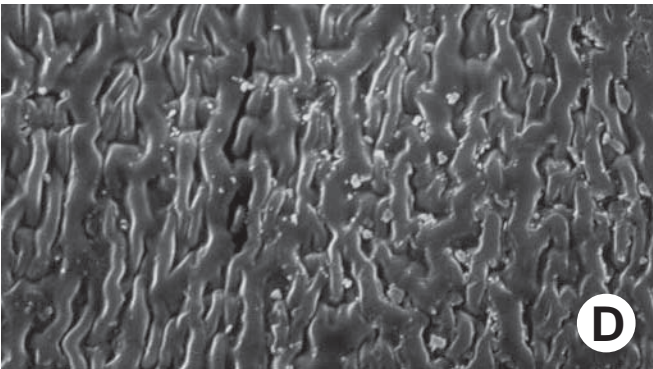
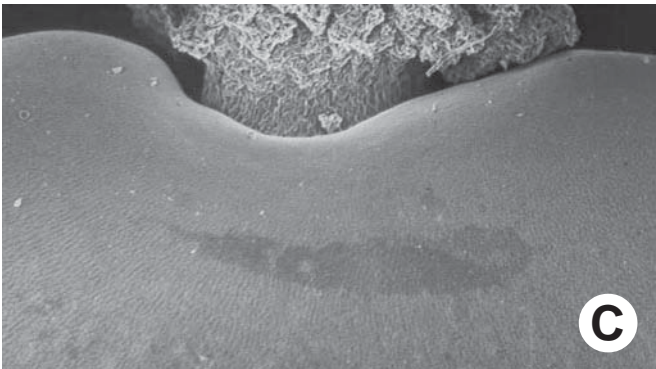
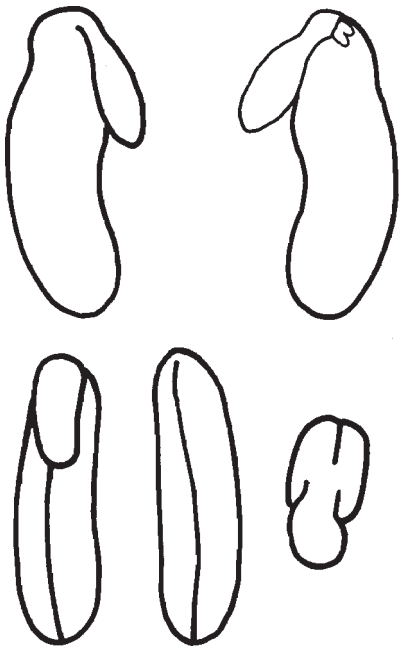
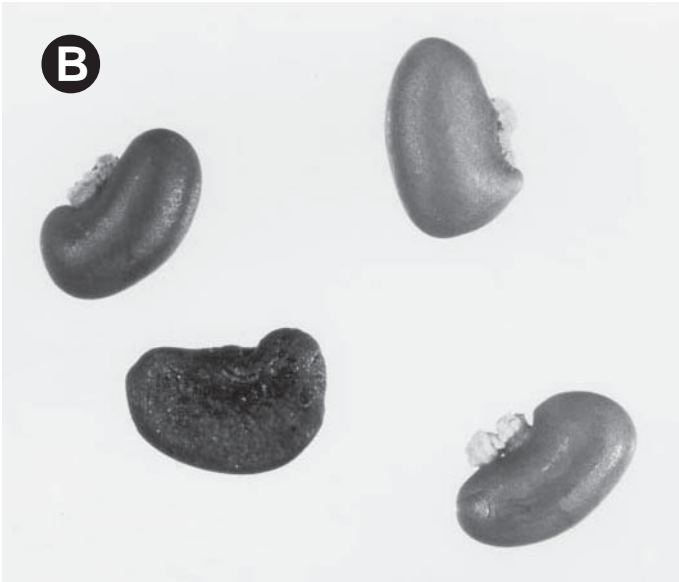
absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 1 mm long; with curved outline; oval; between cotyledon and radicle lobe; recessed; not within corona, halo, or rim or within halo. Hilum halo nearly color of testa. Lens discernible or not discernible; less than 0.5 mm to equal to or greater than 0.5 mm in length; up to 0.7 mm long; with margins curved; key-hole shaped; not in groove of raphe; confluent with hilum; flush; dissimilar color from testa; darker than testa; dark reddish brown; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; yellow or tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear or bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary or moderately developed; glabrous.

Distribution: Australia.

Notes: *Brachysema* is “under revision by M.D. Crisp” (Crisp and Weston 1987), but Crisp and Weston (1987) did not recognize *Cupulanthus* J. Hutchinson (old phylogenetic number 25.03). *Cupulanthus bracteolus* (F.H.J. von Mueller) J. Hutchinson now is *B. bracteolus* F.H.J. von Mueller.

Brachysema: *B. lanceolata* C.D.F. Meissner (C–E), *B.* spp. (A–B). A, Fruits (dehiscent and closed) with and without calyx (× 2.1); B, seeds (× 9.6); C–D, testa (× 50, × 1000); E, embryos (× 13.3).

0



Genus: *Latrobea* C.D.F. Meissner

Phylogenetic Number: 24.18.

Tribe: Mirbelieae.

Species Studied—Species in Genus: 2 spp.—7 spp.

Fruit a legume; unilocular; $0.7-1 \times 0.2-0.55 \times 0.15-0.2$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; ovate or falcate; when asymmetrical with both sutures parallelly curved; not inflated; compressed; without or with beak; straight; with solid beak the same color and texture as fruit; tapered or short tapered at apex; apex aligned or oblique with longitudinal axis of fruit; tapered or rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive. Replum invisible. Epicarp dull; monochrome or multicolored; mottled; reddish brown, tan (to greenish tan), purple, or green; with purple overlay; pubescent and indurate; with hairs erect or appressed; with 1 type of pubescence; villous; with pubescence golden or gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; vitreous (fractured); coriaceous. Endocarp dull; monochrome or mottled (somewhat because of darker mesocarp layer); grayish brown or gray; with brown (reddish) overlay; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1 or 2; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 0.5 mm long; of 1 length only; filiform; straight. Aril fleshy; cupshaped; covering less than 1/2 of seed; tan.

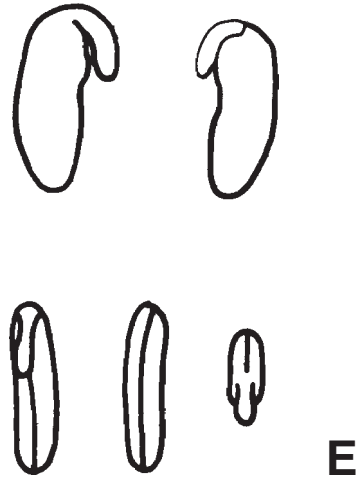
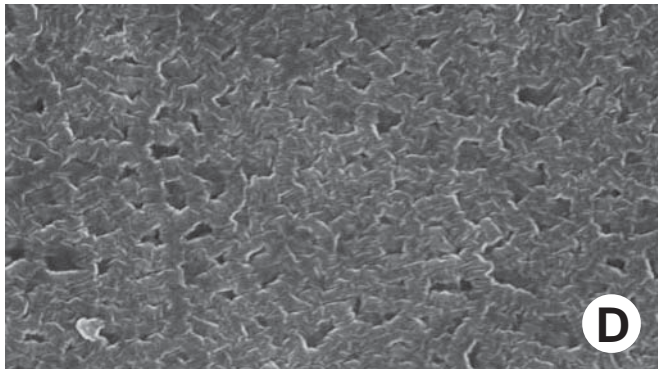
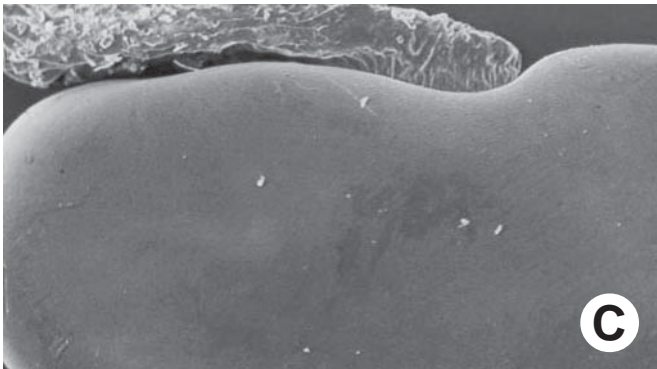
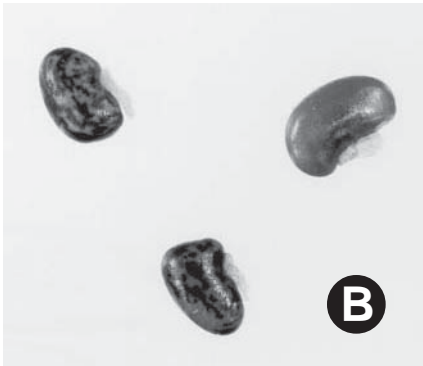
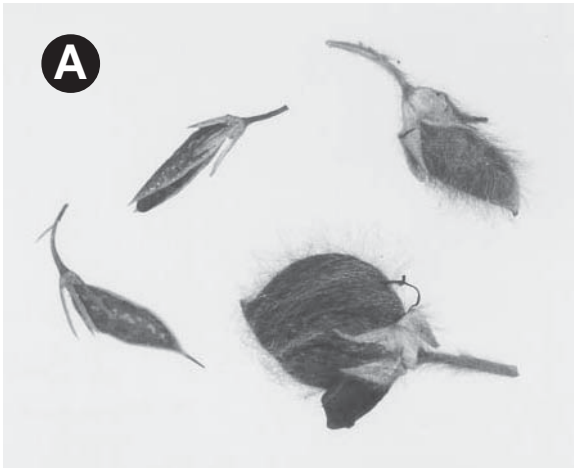
Seed $2 \times 1.2 \times 0.8$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by

a bloom; colored; monochrome; dark reddish brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; somewhat recessed; within rim. Hilum rim color of testa. Lens discernible; less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; adjacent to hilum; 0.5 mm from hilum; mounded; same color as testa; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; reddish brown; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Southwestern Australia.

Latrobea: *L. tenella* G. Bentham (C–E), *L. spp.* (A–B). A, Fruits with calyx ($\times 2.8$); B, seeds ($\times 10$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).

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Genus: *Phyllota* (A.-P. de Candolle) G. Bentham

Phylogenetic Number: 24.19.

Tribe: Mirbelieae.

Species Studied—Species in Genus: 4 spp.—10 spp.

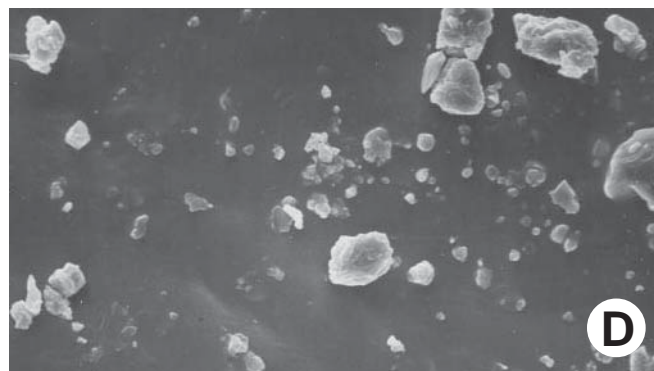
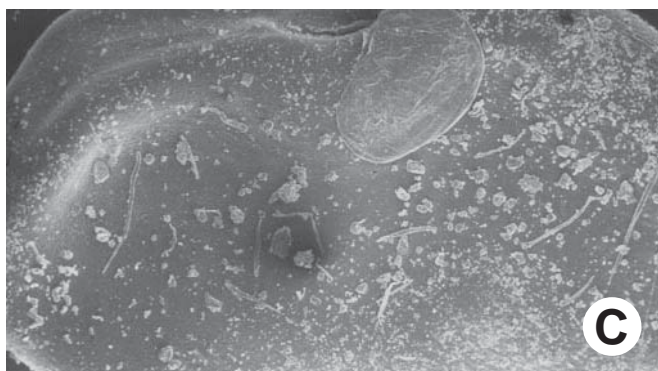
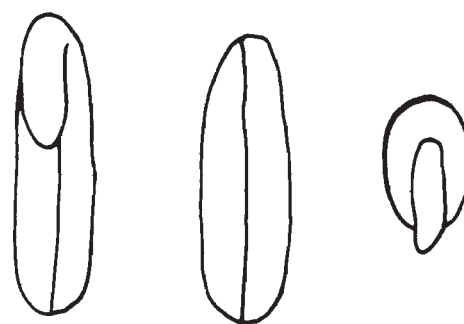
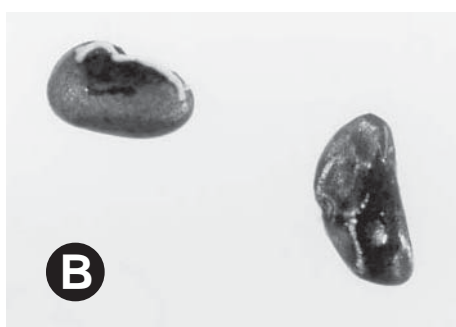
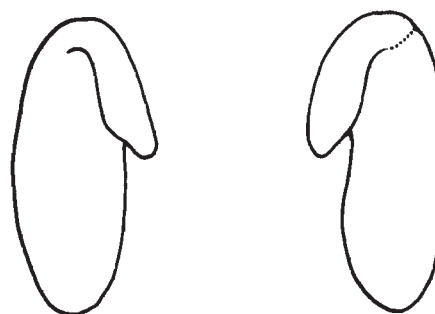
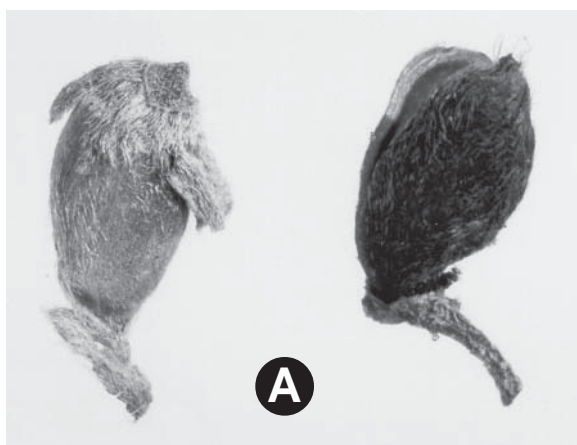
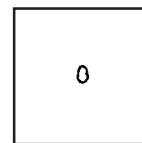
Fruit a legume; unilocular; $0.45\text{--}0.5 \times 0.25\text{--}0.3 \times 0.15\text{--}0.2$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; obovate or ovate; when asymmetrical with both sutures parallelly curved; not inflated; compressed; without beak; short tapered at apex; apex aligned or oblique with longitudinal axis of fruit (slightly); rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; ligneous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive or active; with valves enrolling. Replum invisible. Epicarp dull; monochrome; reddish brown or tan; pubescent and indurate; with hairs appressed or erect; with 1 type of pubescence; tomentose; with pubescence golden or gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; not veined or veined; reticulately veined; not tuberculate; shagreen; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp glossy; monochrome; reddish brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1 or 2; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; flattened; straight. Aril absent.

Seed $2.3\text{--}4 \times 1.5\text{--}2 \times 1.2\text{--}1.5$ mm; not overgrown; not angular or angular; asymmetrical; reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Cuticle inflated; inflated around hilum. Testa not adhering to endocarp; dull; not modified by a bloom; colored; mottled and streaked; with frequent mottles; with frequent streaks; reddish brown; with black overlay; glabrous; smooth; coria-

ceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.5 mm long; with curved outline; elliptic; between cotyledon and radicle lobe; recessed; within halo. Hilum halo color darker than testa. Lens discernible; equal to or greater than 0.5 mm in length; 0.8–1 mm long; with margins straight or curved; oblong or linear; not in groove of raphe; confluent with hilum; mounded; dissimilar color from testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; green; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Australia.

Phyllota: *P. pleurandroides* F.H.J. von Mueller (A–E). A, Fruits with calyx ($\times 8.7$); B, seeds ($\times 9.5$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 20$).



Genus: *Euchilopsis* F.H.J. von Mueller

Phylogenetic Number: 24.20.

Tribe: Mirbelieae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; unilocular; $0.9-1 \times 0.5-0.6 \times 0.35-0.45$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; ovate; when asymmetrical with both sutures parallelly curved; not inflated; terete; without beak; rounded at apex; apex aligned or oblique (slightly) with longitudinal axis of fruit; short tapered or rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; ligneous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate; with the stipe 2.5–3 mm long. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive. Replum invisible. Epicarp dull; monochrome; reddish brown; pubescent but soon deciduous; with 1 type of pubescence; villous; with pubescence pale golden; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with recessed features; not veined; not tuberculate; pitted; not exfoliating; without cracks. Mesocarp thin; surface not veined; 2-layered; without balsamic vesicles; without fibers; with vitreous layer over solid layer (vitreous layer beadlike); ligneous (or subligneous). Endocarp glossy; monochrome; reddish brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1 or 2; length parallel with fruit length; neither overlapping nor touching or overlapping and touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick or triangular; straight. Aril absent.

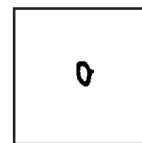
Seed $4 \times 2.3 \times 1$ mm; not overgrown; not angular; asymmetrical; D-shaped or rectangular; compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible.

Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.5 mm long; with straight outline; oblong; between cotyledon and radicle lobe; flush; within rim, corona, and halo. Hilum corona color (brown) darker than testa. Hilum halo color (reddish-brown) lighter than testa. Hilum rim color of testa. Lens discernible; equal to or greater than 0.5 mm in length; 1 mm long; with margins straight; linear; not in groove of raphe; confluent with hilum; flush; dissimilar color from testa; darker than testa; darker reddish brown; not within corona, halo, or rim. Endosperm thin; restricted to region of embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; green; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

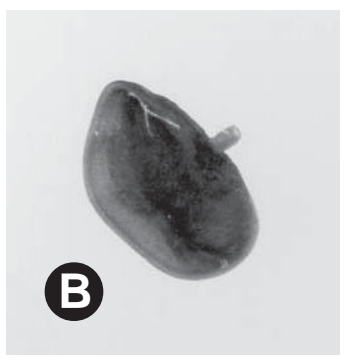
Distribution: Southwestern Australia.

Notes: Unfortunately, we were able to study only three fruit samples, each with minimal material, and only one seed.

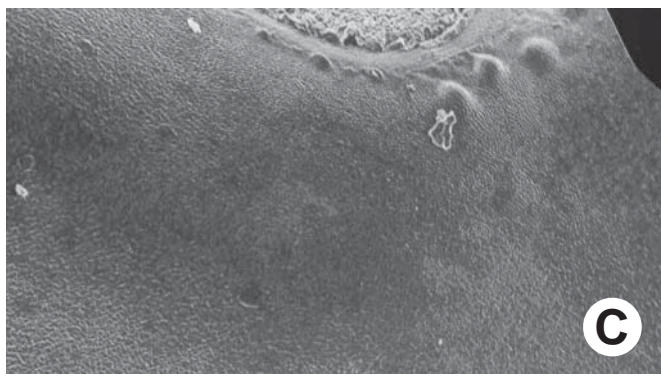
Euchilopsis: E. linearis (G. Bentham) F.H.J. von Mueller (A–E). A, Fruits and valve ($\times 5.7$); B, seed ($\times 10$); C–D, testa ($\times 50$, $\times 1000$).



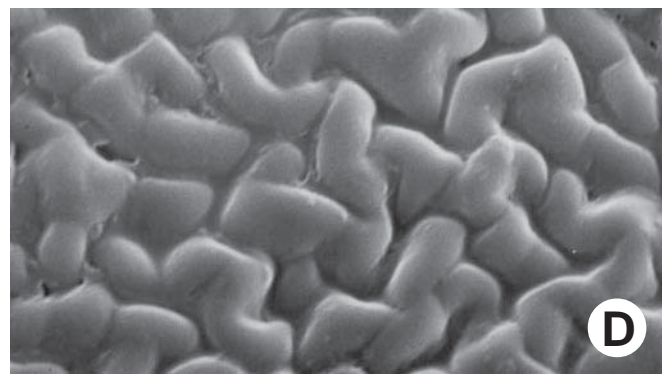
A



B



C



D

Genus: *Aotus* J.E. Smith

Phylogenetic Number: 24.21.

Tribe: Mirbelieae.

Species Studied—Species in Genus: 8 spp.—16–18 spp.

Fruit a legume; unilocular; $0.5\text{--}0.6 \times 0.4\text{--}0.45 \times 0.3\text{--}0.45$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical or asymmetrical; more or less circular; when asymmetrical with both sutures parallelly curved; not inflated; terete; without beak; rounded at apex; apex oblique or aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; ligneous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; embellished. Fruit wings absent. Fruit stipitate or substipitate; with the stipe up to 15 mm long. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive. Replum invisible. Epicarp dull; monochrome; dark reddish brown; pubescent and indurate; with 1 type of pubescence; villous; with pubescence golden or gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; glandular; with glandular dots; without spines; not smooth; with elevated features; not veined; not tuberculate; shagreen and subvesicular; not exfoliating; without cracks. Mesocarp thick; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; ligneous. Endocarp glossy; monochrome or mottled; dark reddish brown; with mottling (dark); with brown (reddish) overlay; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1 or 2; length parallel with fruit length; neither overlapping nor touching or overlapping and touching; in 1 series. Funiculus measured or less than 0.5 mm long; up to 0.5 mm long; of 1 length only; thick; straight. Aril present or absent; dry; rim-aril; white.

Seed $2.2\text{--}3 \times 1.7\text{--}3 \times 1\text{--}2$ mm; not overgrown; not angular or angular (somewhat); asymmetrical; D-shaped or oblong (more or less); compressed; with surface smooth; with visible radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes the same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to

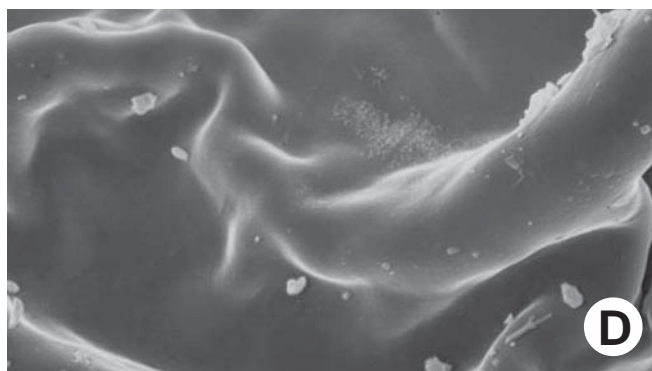
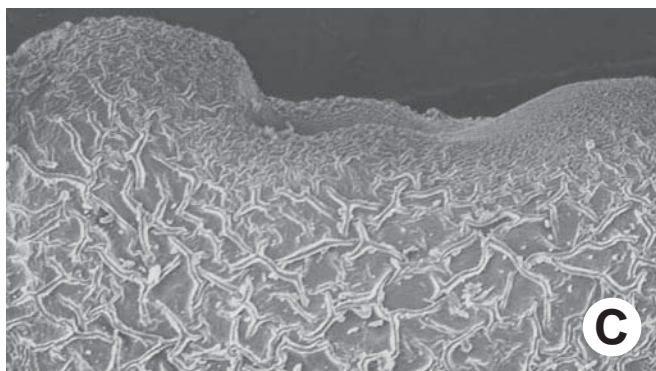
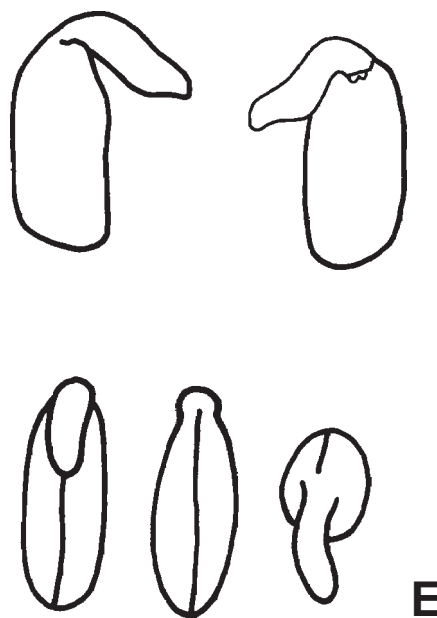
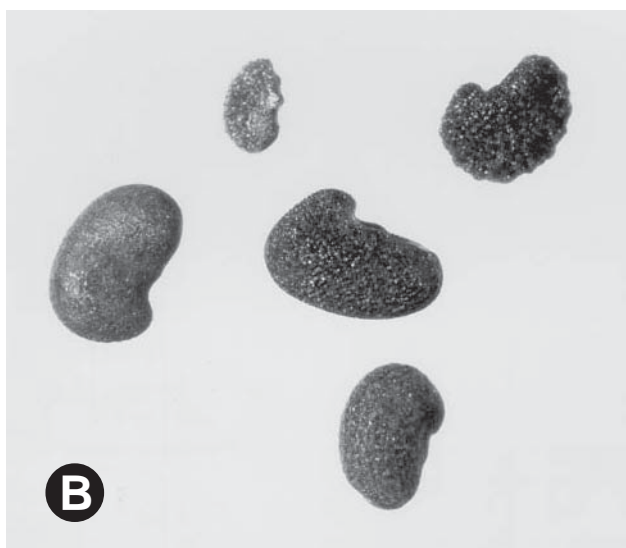
endocarp; dull; not modified by a bloom; colored; monochrome (cuticle may be raised, causing silver patches); dark to light reddish brown or black; glabrous; not smooth; with elevated features; reticulate or reticulate and shagreen; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible or partially concealed; concealed by funicular remnant, radicle lobe, or wing; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform to larger than punctiform; up to 0.5 mm long; with curved outline; elliptic; marginal according to radicle tip or between cotyledon and radicle lobe; recessed; not within corona, halo, or rim or within halo. Hilum halo color lighter than testa. Lens discernible or not discernible; less than 0.5 mm long or equal to or greater than 0.5 mm; up to 0.5 mm long; with margins straight or curved; triangular or more or less circular; not in groove of raphe; confluent with hilum; flush; dissimilar color from testa; darker than testa; black (ish); not within corona, halo, or rim. Endosperm thick (reflecting testa reticulation); covering entire embryo; adnate to testa or embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; green or tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight or hooked; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Australia.

Notes: The thick cuticle on the testa exfoliates during soaking of the seed.

Aotus: *A. ericoides* (É.P. Ventenat) G. Don (*C–E*), *A.* spp. (*A–B*). *A*, Fruits (closed and dehisced) with calyx ($\times 3.5$); *B*, seeds ($\times 9.8$); *C–D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 10$).

0°



Genus: *Urodon* P.K.N.S. Turczaninow

Phylogenetic Number: 24.22.

Tribe: Mirbelieae.

Species Studied—Species in Genus: 1 sp.—1–3 spp.

Fruit a legume; unilocular; $0.6\text{--}0.7 \times 0.3\text{--}0.35 \times 0.14\text{--}0.16$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; when asymmetrical with 1 straight and 1 curved suture; widest near middle or D-shaped; not inflated; compressed; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base oblique with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscent; splitting along suture. Dehiscence of valves along 1 suture; apical and down; active; with valves revolute. Replum invisible. Epicarp dull; monochrome; dark reddish brown; pubescent and indurate; with hairs appressed; with 1 type of pubescence; with pubescence gray; with pubescence uniformly distributed; with simple hairs; stiff; with hair bases plain; eglandular; without spines; with elevated features; faintly, transversely veined relative to fruit length; not tuberculate; not exfoliating; without cracks. Mesocarp absent. Endocarp dull; monochrome; grayish brown or gray; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 1 or 2; length parallel with fruit length; neither overlapping nor touching or overlapping and touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; flattened; straight. Aril fleshy; topknotlike; fimbriate; covering less than 1/2 of seed; reddish brown.

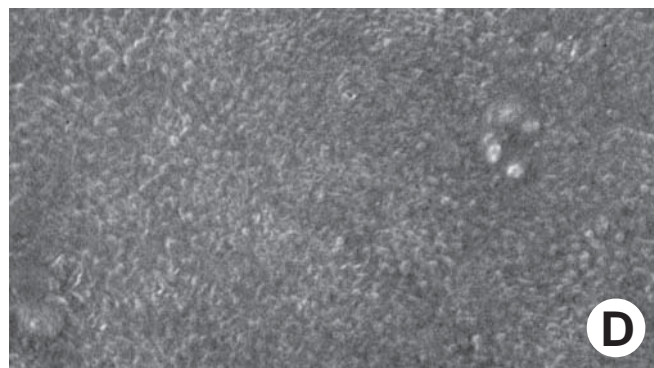
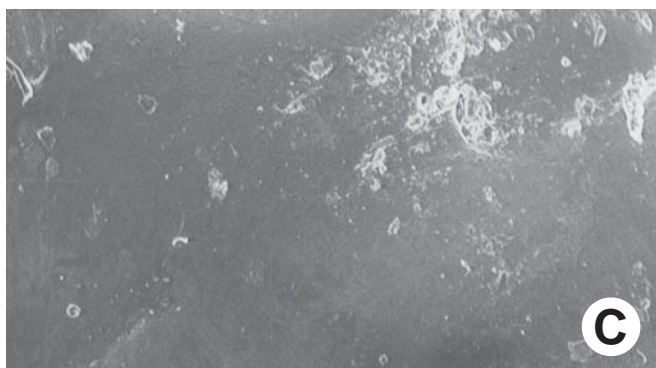
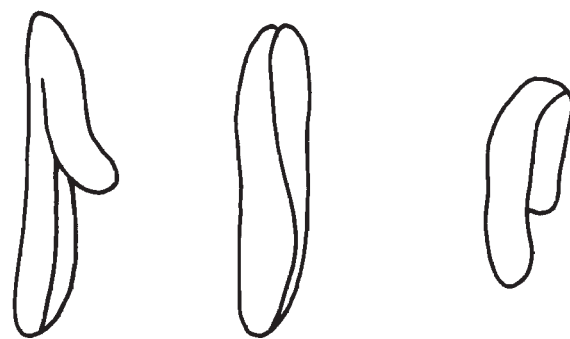
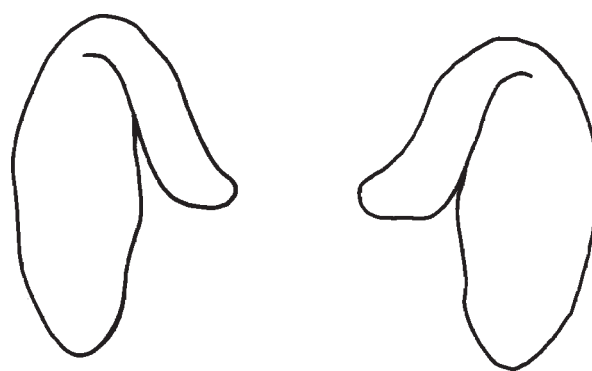
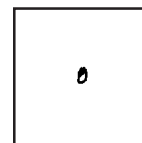
Seed $2.7 \times 1.6 \times 0.8$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome; dark reddish brown; glabrous; smooth or not smooth (occasionally); with recessed features; occasionally pitted with small separate pits; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the

rest of the hilum; larger than punctiform; 0.5 mm long; with curved outline; elliptic; subapical to radicle tip; recessed; not within corona, halo, or rim or within rim (slight). Hilum rim color of testa. Lens discernible; less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; adjacent to hilum; 0.3 mm from hilum; mounded; dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Southwestern Australia.

Notes: Crisp and Weston (1987) resurrected *Urodon*. This genus has three described species, but they were uncertain whether these species were truly separate or were instead one variable species.

Urodon: *U. capitatus* P.K.N.S. Turczaninow (A–E). A, Fruits with calyx (closed and dehiscent) ($\times 6$); B, seeds ($\times 13$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 20$).



Genus: *Pultenaea* J.E. Smith

Phylogenetic Number: 24.23.

Tribe: Mirbelieae.

Species Studied—Species in Genus: 14 spp.—ca. 150 spp.

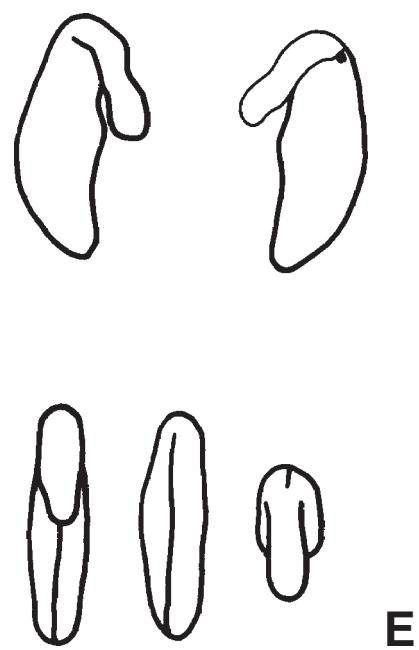
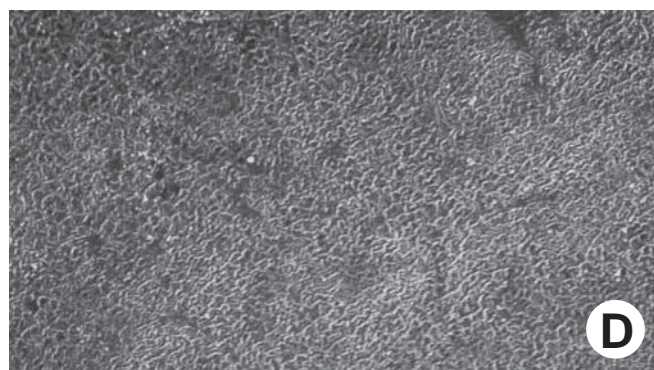
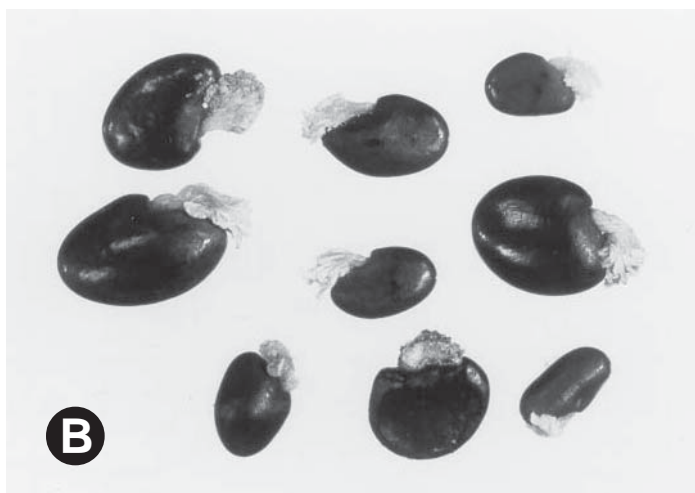
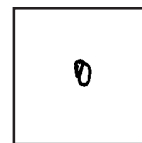
Fruit a legume; unilocular; $0.4\text{--}0.7 \times 0.3\text{--}0.35 \times 0.2$ cm; with persistent calyx; with calyx shorter or longer than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; ovate; when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; widest near middle or D-shaped; not inflated; compressed or terete; without or with beak; straight or hooked; with solid beak the same color and texture as fruit; short tapered or rounded at apex; apex aligned or oblique with longitudinal axis of fruit; rounded or truncate at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate or nonstipitate. Fruit with all layers dehiscent; splitting along suture. Dehiscence of valves along 1 suture; apical and down; passive. Replum invisible. Epicarp dull; monochrome; reddish brown or black; glabrous or pubescent but soon deciduous; with hairs appressed or erect; with 1 type of pubescence; villous; with pubescence golden or gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; minutely warty; exfoliating in part or exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; reddish brown or black; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1 or 2; length parallel with fruit length; overlapping or overlapping and touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; flattened; straight. Aril fleshy; topknotlike or cupshaped; entire or fimbriate; covering less than 1/2 of seed; tan to reddish tan.

Seed $1.5\text{--}4 \times 0.6\text{--}2 \times 0.7\text{--}1.3$ mm; not overgrown; not angular; asymmetrical; oblong, mitaform, or reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to

endocarp; glossy or dull; not modified by a bloom; colored; mottled and streaked or monochrome; with frequent mottles; with frequent streaks; reddish brown; with black overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim present. Wings absent. Raphe not visible. Hilum partially concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; $0.5\text{--}0.6$ mm long; with curved outline; elliptic; between cotyledon and radicle lobe; recessed; within rim. Hilum rim color lighter than testa. Lens not discernible or discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; $0.3\text{--}0.5$ mm long; with margins curved; circular; not in groove of raphe; confluent with hilum; flush; dissimilar color from testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; reddish brown, tan, or yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear or bulbous; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Australia.

Pultenaea: *P. obcordata* (R. Brown) G. Bentham (*C–E*), *P.* spp. (*A–B*). *A*, Fruits within calyx (closed and dehiscent) ($\times 3.3$); *B*, seeds ($\times 6.7$); *C–D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 10$).



Genus: *Almaleea* M.D. Crisp & P.H. Weston

Phylogenetic Number: 24.24.

Tribe: Mirbelieae.

Species Studied—Species in Genus: 5 spp.—5 spp.

Fruit a legume; unilocular; $0.3\text{--}0.6 \times 0.2\text{--}0.4 \times 0.2\text{--}0.3$ cm; with persistent calyx; with calyx shorter than or equal in length to fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; ovate; when asymmetrical with both sutures parallelly curved; not inflated; terete; without beak; rounded or short tapered at apex; apex oblique or aligned with longitudinal axis of fruit; short tapered or rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures or 1 suture; apical and down (about 1/2 way down); passive. Replum invisible. Epicarp dull; monochrome; dark reddish brown; pubescent and indurate; with 1 type of pubescence; villous; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain or swollen; eglandular; without spines; not smooth; with elevated or recessed features; reticulately veined; not tuberculate; tuberculate (base of hairs); punctate (when hair bases absent); not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp glossy; monochrome; grayish or reddish tan or gray; smooth; nonseptate; chartaceous; exfoliating in part; remaining fused to mesocarp and epicarp; entire. Seeds 1 or 2; length parallel with fruit length; overlapping, touching, or neither overlapping nor touching; in 1 or 2 or more series. Funiculus measured; $0.3\text{--}0.8$ mm long; of 1 length only; thick; straight. Aril fleshy; cupshaped; covering less than 1/2 of seed; tan.

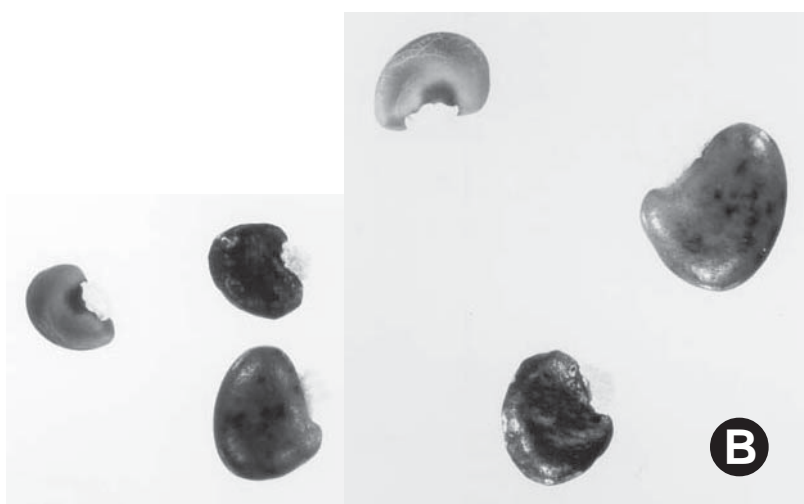
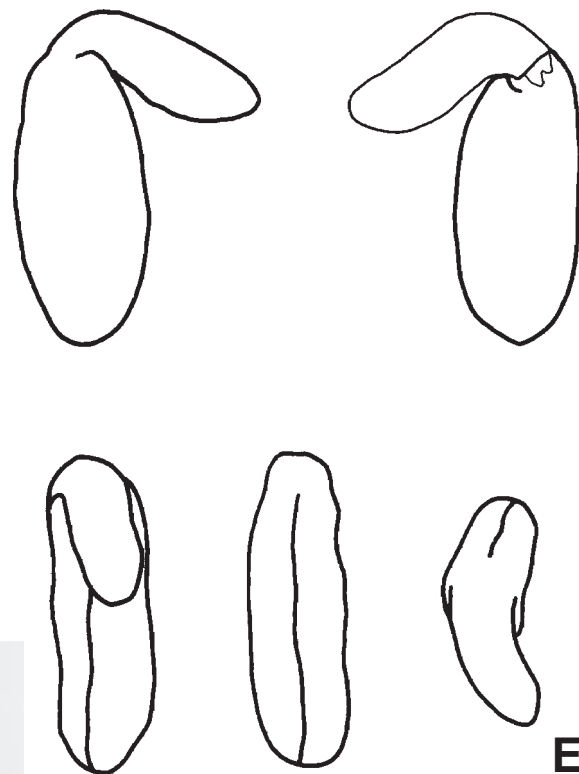
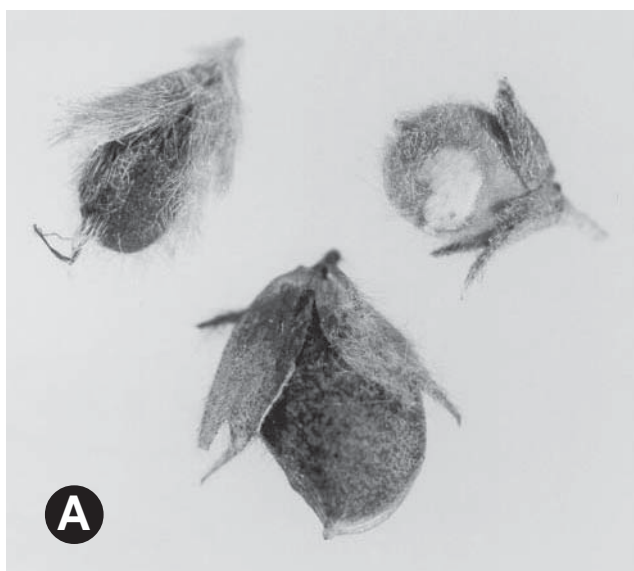
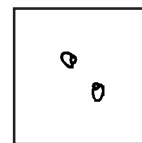
Seed $1\text{--}2.7 \times 1\text{--}2 \times 0.6\text{--}1.2$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with surface smooth; with visible radicle and cotyledon lobes; with or without external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom;

colored; mottled or monochrome; with frequent mottles; reddish brown; with brown (reddish) overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.5 mm long; with straight outline; oblong; between cotyledon and radicle lobe; recessed; not within corona, halo, or rim or within halo. Hilum halo color lighter than testa. Lens discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; 0.5 mm long; with margins curved; more or less circular; not in groove of raphe; confluent with hilum; flush; similar color as testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; yellow or tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Southeastern Australia.

Notes: *Almaleea* includes species formerly placed in *Pultenaea* (24.23) and *Dillwynia* (24.25) (Crisp and Weston 1991). Crisp and Weston noted that *Almaleea* was closely related to *Eutaxia* (24.26) and *Dillwynia* (24.25).

Almaleea: *A. subumbellata* (W.D. Hooker) M.D. Crisp & P.E. Weston (C–E), *A. spp.* (A–B). A, Fruits with calyx ($\times 7.1$); B, seeds ($\times 9.5$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 15$).



Genus: *Dillwynia* J.E. Smith

Phylogenetic Number: 24.25.

Tribe: Mirbelieae.

Species Studied—Species in Genus: 5 spp.—ca. 20 spp.

Fruit a legume; unilocular; $0.4\text{--}0.7 \times 0.25\text{--}0.45 \times 0.3\text{--}0.4$ cm; with persistent or deciduous calyx; with calyx slightly shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; circular, elliptic, or ovate; when asymmetrical with both sutures parallelly curved; not inflated; terete; without or with beak; declined; with solid beak the same color and texture as fruit; rounded at apex; apex oblique with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; ligneous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive. Replum invisible. Epicarp dull; monochrome; reddish brown; pubescent but soon deciduous; with hairs erect or appressed; with 1 type of pubescence; villous; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; not veined or veined (rarely); reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; subligneous. Endocarp glossy; monochrome; reddish brown or purple; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1 or 2; length parallel with fruit length; neither overlapping nor touching or overlapping and touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril fleshy; topknotlike; covering less than 1/2 of seed; reddish tan or yellow.

Seed $2.5\text{--}3.5 \times 2\text{--}2.5 \times 1.3\text{--}1.7$ mm; not overgrown; not angular or angular; asymmetrical; reniform, mitaform, or triangular; compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom;

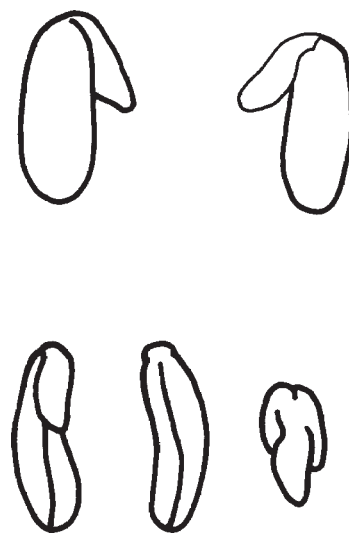
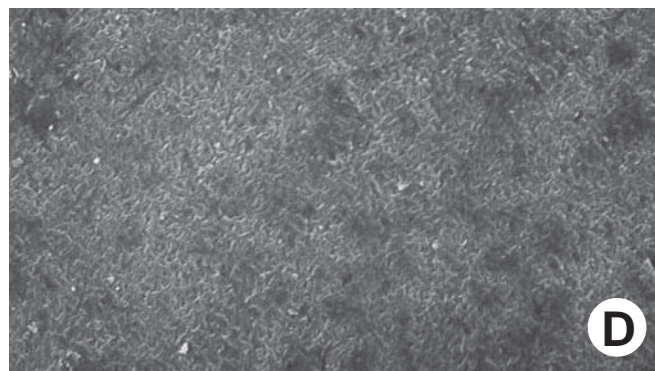
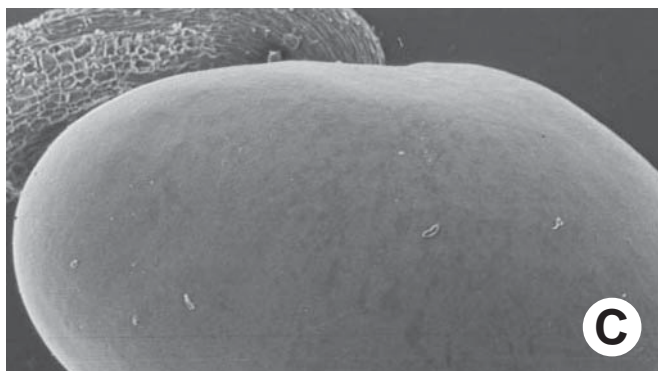
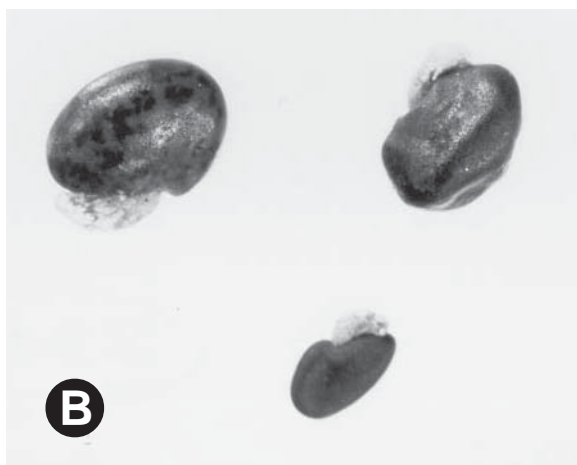
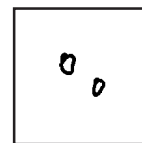
colored; streaked; with frequent streaks; dark brown or black; with brown (lighter) or purple overlay; glabrous; smooth or not smooth; with recessed features; punctate; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum fully concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.5–0.6 mm long; with curved outline; circular; marginal according to radicle tip or between cotyledon and radicle lobe; recessed; within halo. Hilum halo color lighter than testa. Lens discernible; equal to or greater than 0.5 mm in length; 0.6 mm long; with margins straight or curved; oblong; not in groove of raphe; confluent with hilum (at least halo); barely mounded; similar color as testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to testa or embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; yellow or brown (reddish); inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 to 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Australia.

Notes: Two species of *Dillwynia*, known as parrot-pea, are Australian wildflowers and were discussed by Lebler (1976).

Dillwynia: *D. floribunda* J. Smith (C–E), *D.* spp. (A–B).

A, Fruits with or without calyx (closed and dehiscent) ($\times 4.7$); B, seeds ($\times 9.4$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



E

Genus: *Eutaxia* R. Brown

Phylogenetic Number: 24.26.

Tribe: Mirbelieae.

Species Studied—Species in Genus: 4 spp.—10 spp.

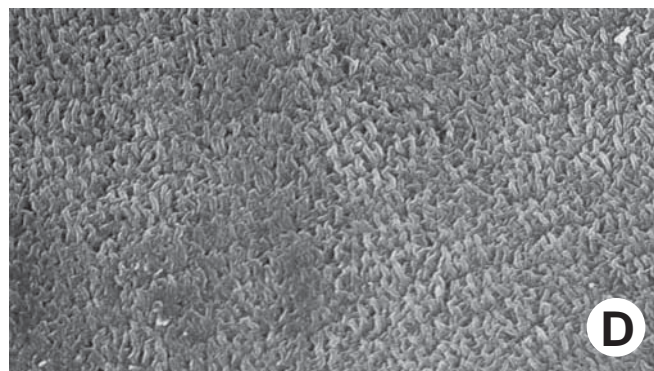
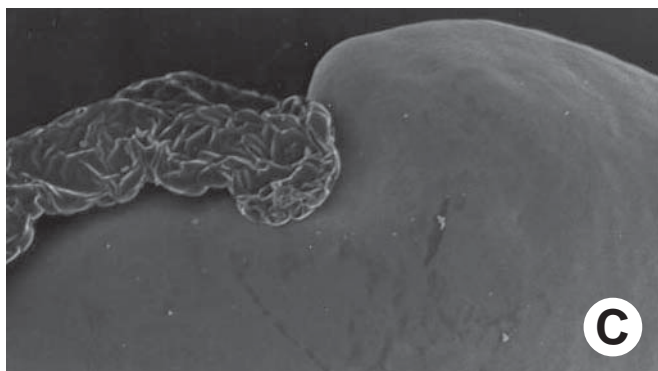
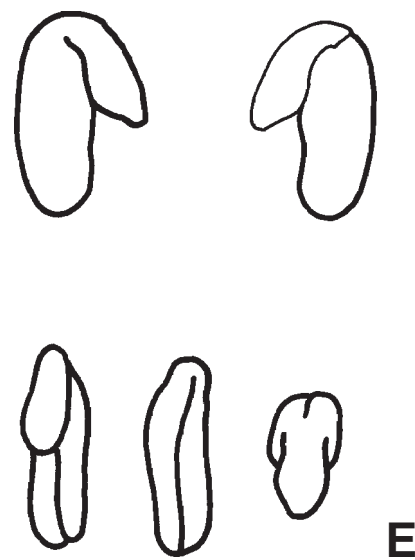
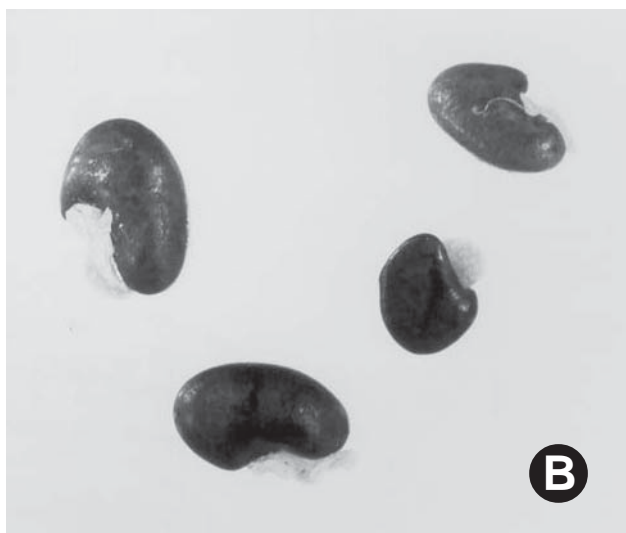
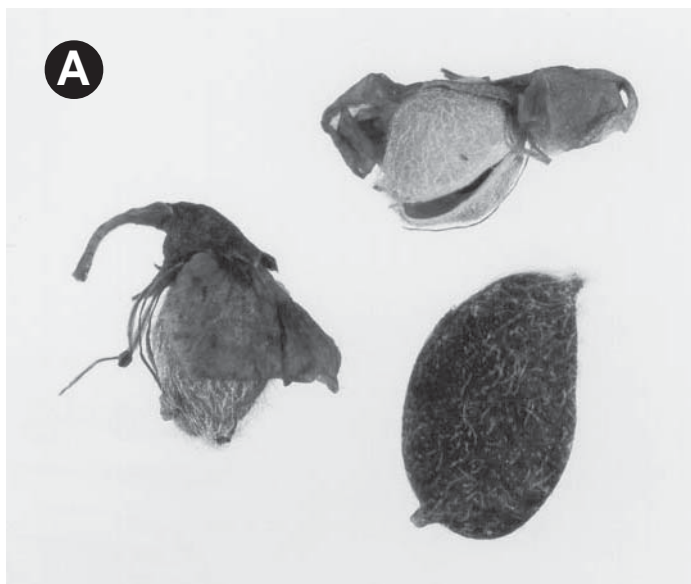
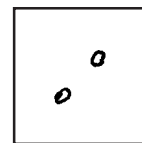
Fruit a legume; unilocular; $0.4\text{--}0.6 \times 0.25\text{--}0.3 \times 0.1\text{--}0.25$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical or asymmetrical; ovate; when asymmetrical with 1 straight and 1 curved suture; widest near middle or D-shaped; not inflated; compressed or flattened; without or with beak; hooked; with solid beak the same color and texture as fruit; rounded at apex; apex aligned or oblique with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive. Replum invisible. Epicarp dull; monochrome; reddish to dark reddish brown; pubescent and indurate; with 1 type of pubescence; puberulent; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; reddish tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1 or 2; length parallel with fruit length; neither overlapping nor touching or overlapping and touching; in 1 series. Funiculus measured; 0.5–1 mm long; of 1 length only; filiform or thick; straight. Aril fleshy; topknotlike; covering less than 1/2 of seed; yellow.

Seed $2.2\text{--}2.7 \times 1.5\text{--}2 \times 1\text{--}1.5$ mm; not overgrown; not angular or angular (somewhat); asymmetrical; mitaform; compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; brown to

reddish brown; with brown (dark reddish) or tan overlay; glabrous; smooth or not smooth; with elevated features; reticulate; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by aril and radicle lobe or wing; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; within rim. Hilum rim color lighter (reddish) than testa. Lens discernible; less than 0.5 mm in length; with margins straight or curved; somewhat wedge-shaped; elliptic; not in groove of raphe; confluent with hilum; mounded; similar color as testa; darker than testa; brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Southern Australia.

Eutaxia: *E. microphylla* (R. Brown) J.M. Black (*C–E*), *E.* spp. (*A–B*). *A*, Fruits with or without calyx (closed and dehiscent) ($\times 6.5$); *B*, seeds ($\times 9.2$); *C–D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 10$).



Podalyriace (25.01–25.09)

Genus: *Xiphotheca* C.F. Ecklon & J.M. Zeyher

Phylogenetic Number: 25.01.

Tribe: Podalyriace.

Subtribe: Xiphothecinae.

Species Studied—Species in Genus: 1 sp.—9 spp.

Fruit a legume; unilocular; 1.5–3.8 × 0.6–0.9 × 0.3–0.4 cm; with persistent calyx or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (rarely); not plicate; not twisted; asymmetrical or symmetrical (rarely); obliquely obovate, obliquely ovate, or oblong (rarely); when asymmetrical with both sutures unequally or parallelly (rarely) curved; not inflated or inflated (rarely); compressed; with beak (1–5 mm long); straight; with solid beak the same color and texture as fruit; tapered to long tapered at apex; apex aligned or oblique (slightly) with longitudinal axis of fruit; tapered or long tapered at base; base oblique or aligned with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous; seed chambers externally invisible or visible; with the raised seed chambers not torulose. Fruit margin not constricted or constricted; slightly constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures (assumed); active (assumed); with valves twisting (slightly). Replum invisible. Epicarp dull; monochrome; brown to tan; with surface texture uniform; pubescent and indurate or glabrous (rarely); with hairs erect; with 1 type of pubescence; tomentose, villous (densely), velutinous, or hirsute; with pubescence brown; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; straight; straight at apex; eglandular; without spines; smooth; not veined; not tuberculate; not exfoliating; without cracks. Mesocarp trace; surface not veined; 1-layered; without balsamic vesicles; without fibers; without reniform canals; solid. Endocarp glossy; opaque; monochrome; tan; smooth; without adhering pieces of testa; nonseptate; taceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–6; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 0.4–0.8 mm long; of 1 length only; flattened; straight. Aril fleshy; cupshaped

(with a narrow opening on the micropylar side) or horseshoe shaped (with the opening towards the micropyle); entire; covering less than 1/2 of seed; orangish tan or white.

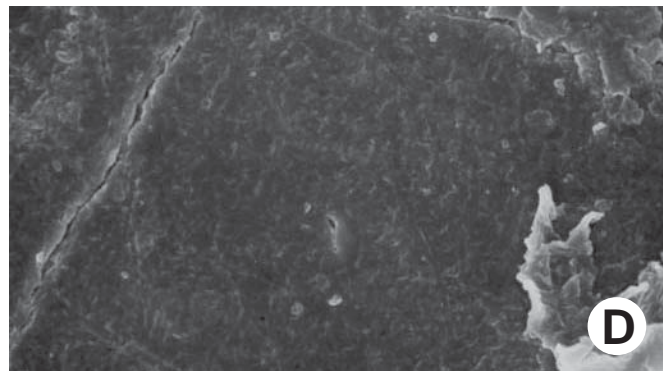
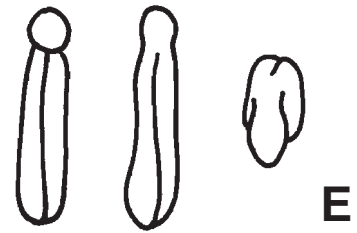
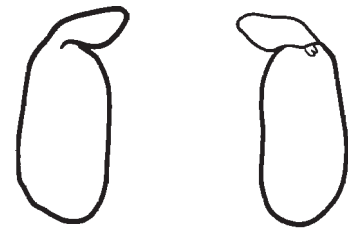
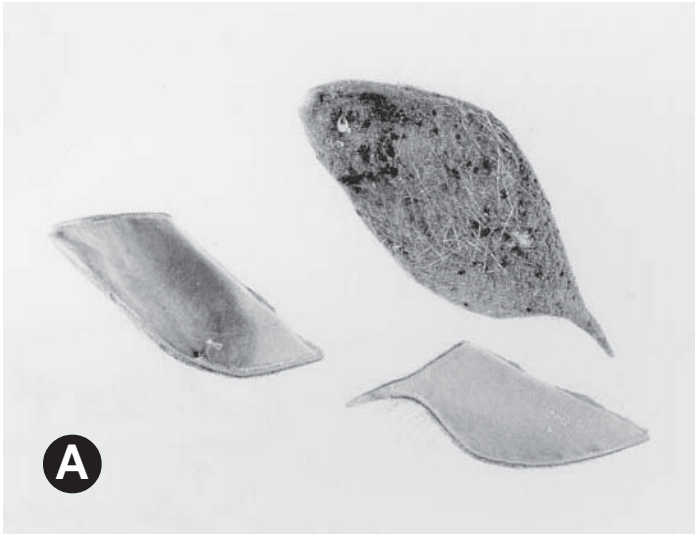
Seed 3.5–4.5 × 2.5–3.5 × ca. 2 mm; not overgrown; not angular; asymmetrical; reniform (oblong) or oblong; compressed; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces; without medial ridge on each face. Testa without pieces of adhering epicarp; not adhering to endocarp; free from endocarp; glossy; not modified by a bloom; colored; mottled or monochrome (rarely); with frequent mottles; greenish tan to tan or brown; with brown (darker) overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe from hilum through lens and terminating before base of seed; not bifurcating; color of or darker than testa; brown; flush. Hilum partially concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.5–1 mm long; with curved outline; elliptic; apical according to radicle tip but marginal according to seed length; recessed; within rim or not within corona, halo, or rim. Hilum rim color darker than testa. Lens discernible; equal to or greater than 0.5 mm in length; 1.2–1.5 mm long; with margins straight; oblong; not in groove of raphe; confluent with hilum; mounded; similar color as or dissimilar color from testa; darker than testa; brown; not within corona, halo, or rim. Endosperm thick; not pluglike and not resembling tip of radicle; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis oblique; perpendicular to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon width; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: South Africa (Cape Province).

Notes: Wyk and Schutte (1995) considered Lipariace and Podalyriace to each be monophyletic and Sophoreae (2) to be their sister group. Using Crotalariae (27) as the outgroup, Schutte and Wyk (1998a,b) found that the

genera of Liparieae and Podalyrieae coalesced into two closely related clades. *Liparia* (25.04) was in the *Podalyria* (25.06) clade. This supported earlier suggestions (Polhill 1976, 1981o; Wyk and Schutte 1995) that Liparieae and Podalyrieae should be merged. Schutte and Wyk (1998a,b) merged the two tribes as Podalyrieae, recognized the two clades as subtribes, Xiphothecinae and Podalyriinae, and erected a monotypic tribe for *Hypocalyptus* (26.01), Hypocalypteae (26). The generic enumeration and number of species in each genus follows Schutte and Wyk (1998a). Schutte and Wyk (1993) recently reinstated *Xiphotheca*, a segregate genus of *Priestleya* A.-P. de Candolle, and Schutte (1997) revised the genus.

Xiphotheca: *X. fruticosa* (C. Linnaeus) A.L. Schutte & B.-E. van Wyk (A–E). A, Fruits ($\times 4.2$); B, seeds ($\times 3.3$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 5$).



Genus: *Amphithalea* C.F. Ecklon & C.L.P. Zeyher

Phylogenetic Number: 25.02

Tribe: Podalyriaceae.

Subtribe: Xiphothecinae.

Species Studied—Species in Genus: 4 spp.—21 spp.

Fruit a legume; unilocular; 0.7–0.8 × 0.3–0.4 × 0.2 cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; oblong to ovate; when asymmetrical with 1 straight and 1 curved suture, both sutures unequally curved, or both sutures parallelly curved; widest near middle or D-shaped; not inflated; compressed; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered or rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate or nonstipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive or active (barely); with valves enrolling (somewhat). Replum invisible. Epicarp dull; monochrome; greenish to dirty or reddish brown (concealed by long straight dense hairs) or gray (because of hairs); pubescent and indurate; with 1 type of pubescence; villous (*A. ericifolia* (C. Linnaeus) C.F. Ecklon & J.M. Zeyher); with pubescence gray or golden; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; smooth; not veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; tan; spongy; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–4 (several); length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick or triangular; straight. Aril fleshy; cupshaped (with tongue-like extension); covering less than 1/2 of seed; reddish brown.

Seed 2.7–3 × 1.5–1.7 × 0.7–1.1 mm; not overgrown; not angular; asymmetrical; reniform (oblong) or oblong; compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between

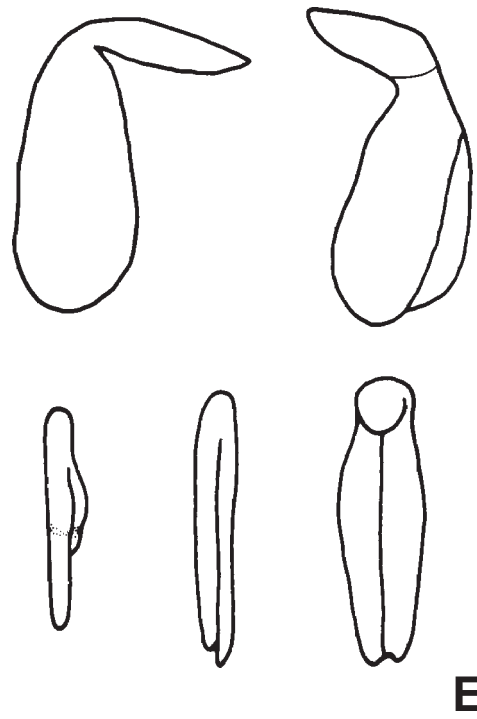
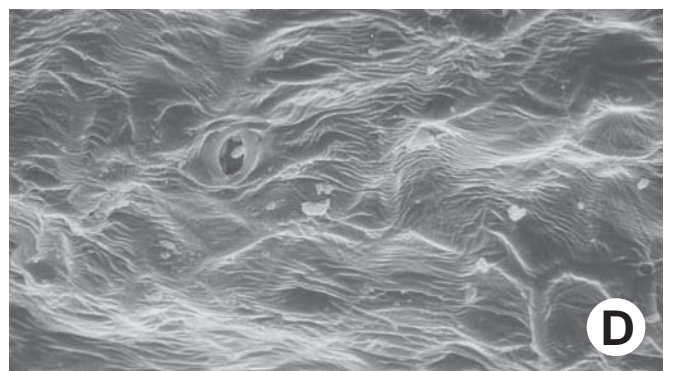
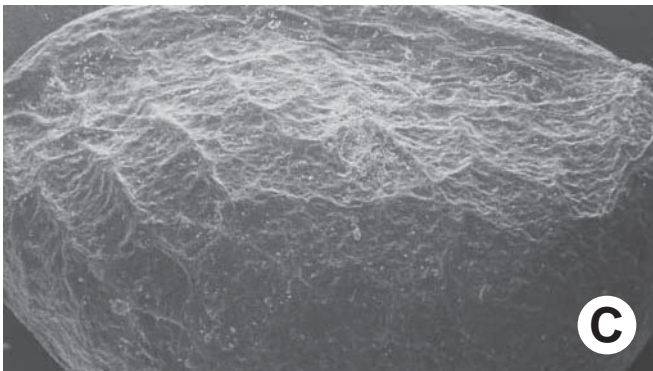
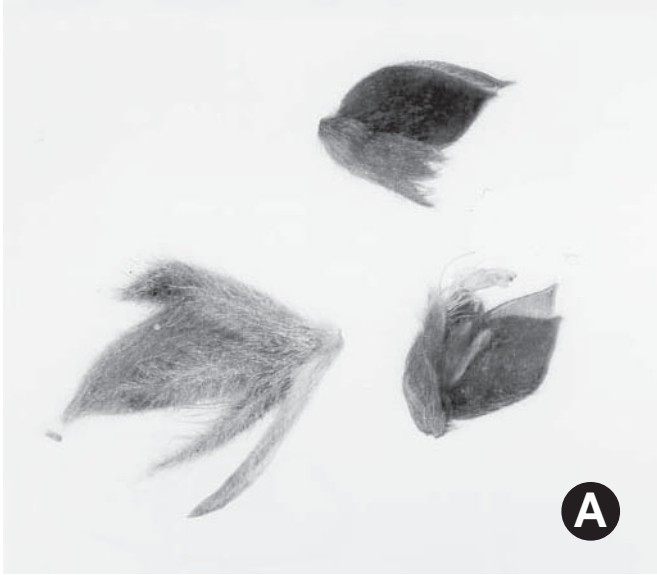
radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible (perhaps concealed by aril). Hilum visible; with faboid split; with the lips of the faboid split the same color (nearly so) as the rest of the hilum; larger than punctiform; 0.5 mm long; with curved outline; circular; between cotyledon and radicle lobe; recessed; within rim or halo. Hilum halo color lighter than testa. Hilum rim color darker than testa. Lens not discernible (perhaps concealed by aril). Endosperm absent. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon width; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: South Africa (southern Cape Province).

Notes: Polhill (1981p) noted that *Amphithalea* may be combined with *Coelidium* (26.04). Schutte (1998) carried out a cladistic analysis using morphological and alkaloid characters of *Amphithalea* and *Coelidium* with *Liparia* (26.01) and *Xiphotheca* (26.03) as outgroups. She concluded that the two genera are synonymous, and transferred the *Coelidium* species to *Amphithalea*.

Amphithalea: *A. cuneifolia* C.F. Ecklon & C.L.P. Zeyher (B–E), A. spp. (A). A, Fruits (× 3.3); B, seed (× 10); C–D, testa (× 50, × 1000); E, embryos (× 20).

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Genus: *Coelidium* (B.C. Vogel) G.W. Walpers

Phylogenetic Number: 25.03.

Tribe: Podalyrieae.

Subtribe: Xiphothecinae.

Species Studied—Species in Genus: 5 spp.—21 spp.

Fruit a legume; unilocular; $0.3\text{--}1.5 \times 0.2\text{--}0.7 \times 0.2$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; ovate or dolabriform; when asymmetrical with both sutures nearly straight; not inflated; compressed; with beak; straight; with solid beak the same color and texture as fruit; rounded at apex; apex aligned with longitudinal axis of fruit; rounded at base; base oblique with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate or nonstipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive. Replum invisible. Epicarp dull; monochrome; brown; pubescent and indurate; with 1 type of pubescence; tomentose, villous, or sericeous; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; not veined; not tuberculate; faintly wrinkled; not exfoliating; without cracks. Mesocarp thin; surface uniformly veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1 or 2; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick or triangular; straight. Aril fleshy; cupshaped (with tonguelike extension); covering less than 1/2 of seed; reddish brown.

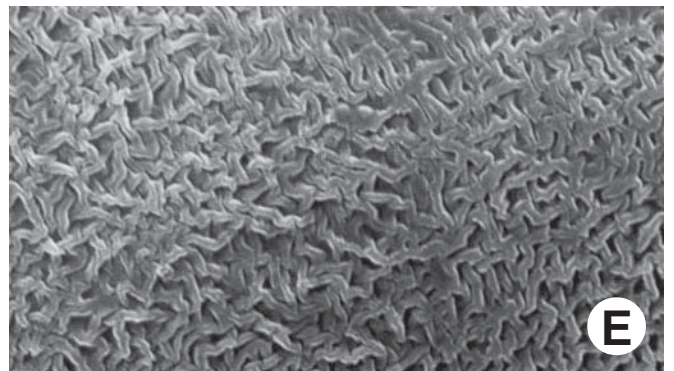
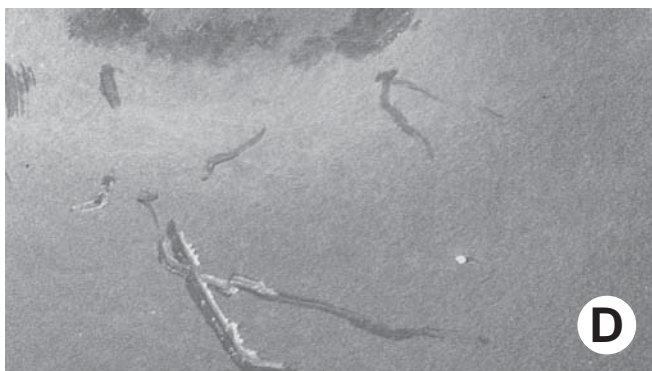
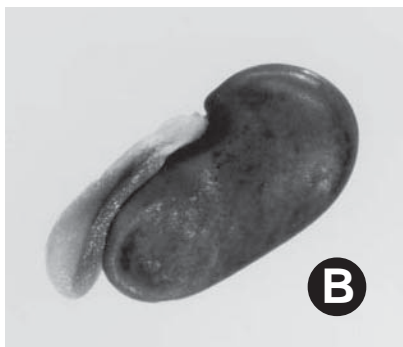
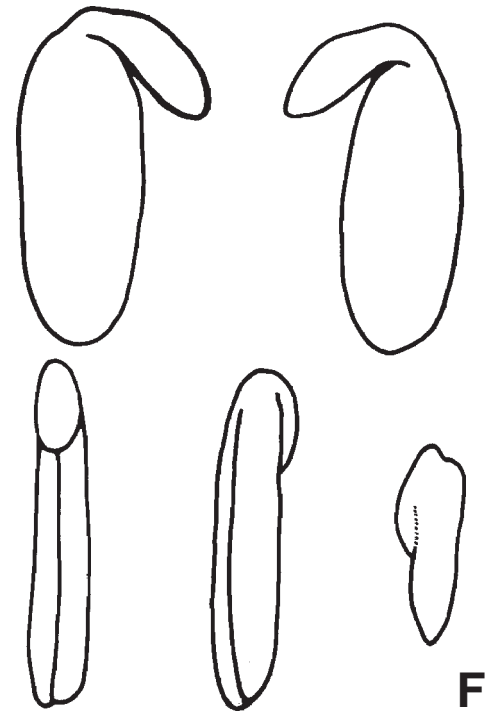
Seed $1.5\text{--}5.5 \times 0.9\text{--}3 \times 0.5\text{--}1.2$ mm; not overgrown; not angular; asymmetrical; oblong; compressed; with surface smooth; with (slightly) or without visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; streaked and mottled; with frequent mottles; with

frequent streaks; brown; with black overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible (perhaps concealed by aril). Hilum visible; with faboid split; with the lips of the faboid split lighter colored than the rest of the hilum and therefore conspicuous; larger than punctiform; 0.5 mm long; with curved outline; elliptic; between cotyledon and radicle lobe; recessed; within rim or halo. Hilum halo color lighter than testa. Hilum rim color darker than testa. Lens discernible (but concealed under aril); not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; green; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; oblique to cotyledons; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: South Africa (southern Cape Province).

Notes: Polhill (1981p) noted that this genus is "doubtfully distinct from *Amphithalea*" (26.05). Granby (1980) monographed the genus, recognizing 19 species (7 new), but Polhill recognized only ca. 15 species. Schutte (1998) carried out a cladistic analysis using morphological and alkaloid characters of *Amphithalea* and *Coelidium* with *Liparia* (26.01) and *Xiphotheca* (26.03) as outgroups. She concluded that the two genera are synonymous, and transferred the *Coelidium* species to *Amphithalea*. According to Granby, fruits of several species were unknown.

Coelidium: *C. muraltioides* G. Benth (C), *C. pageae* H.M.L. Bolus (B, D–F), *C.* spp. (A). A, Fruits ($\times 5$); B–C, seed ($\times 7$, $\times 12.5$); D–E, testa ($\times 50$, $\times 1000$); F, embryos ($\times 7$).



Genus: *Liparia* C. Linnaeus

Phylogenetic Number: 25.04.

Tribe: Podalyrieae.

Subtribe: Podalyriinae.

Species Studied—Species in Genus: 8 spp.—20 spp.

Fruit a legume; unilocular; $1.5\text{--}3.5 \times 0.5\text{--}1$ cm; with deciduous or persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; oblong (obliquely ovate); when asymmetrical with both sutures parallelly curved or 1 straight and 1 curved suture; widest near middle or D-shaped; not inflated; compressed; with or without beak; declined or straight; with solid beak the same color and texture as fruit; short tapered at apex; apex slightly oblique or aligned with longitudinal axis of fruit; rounded or short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active or passive; with valves twisting. Replum invisible. Epicarp dull; black or brown (dark); pubescent and indurate or pubescent but soon deciduous; with 1 type of pubescence; villous; with pubescence golden or gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; with elevated features; veined or not veined; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–5; length parallel with or transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 1–2 mm long; of 1 length only; triangular or thick; straight. Aril fleshy; cupshaped (but not a complete circle); covering less than 1/2 of seed; reddish brown to brown or yellow (pale).

Seed $3.5\text{--}5.6 \times 1.5\text{--}4 \times 1.5\text{--}1.8$ mm; not overgrown; not angular; asymmetrical; reniform (oblong) or oblong; compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between

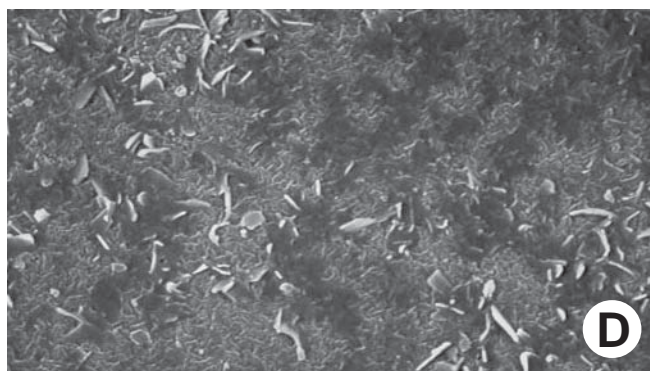
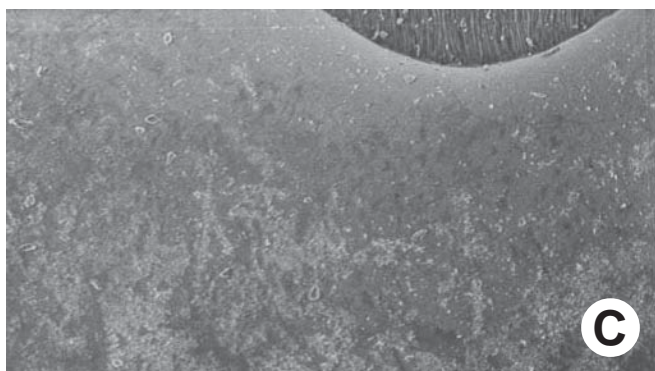
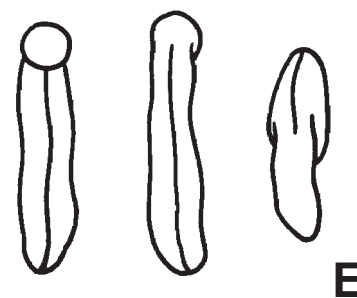
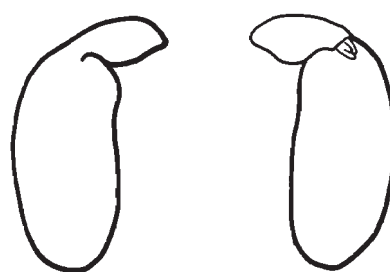
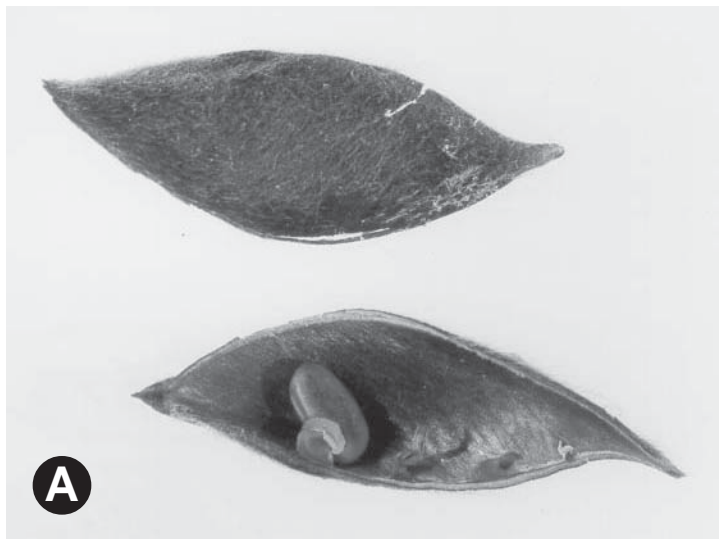
radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome, streaked (mainly), or mottled; with frequent mottles; with frequent streaks; dark or reddish brown or tan; with black or purple overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe from hilum through lens to base of seed and terminating or from hilum to lens (at base of seed); not bifurcating; darker than testa; reddish to blackish brown; flush. Hilum partially concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 1 mm long; with curved outline; circular or elliptic; between cotyledon and radicle lobe; recessed; not within corona, halo, or rim or within halo. Hilum halo color darker than testa. Lens discernible; equal to or greater than or less than 0.5 mm in length; 0.5–1 mm long; with margins curved; roughly elliptic; not in groove of raphe; adjacent to hilum; 1.2–2 mm from hilum; mounded; similar color as or dissimilar color from testa; darker than testa; reddish to blackish brown; not within corona, halo, or rim. Endosperm present (with or without 3 layers: white, cloudy, translucent (thin)); thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan or green; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; with a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon width; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed or well developed; glabrous.

Distribution: South Africa (Cape Province).

Notes: Bos (1967) monographed *Liparia*, s.s. Our treatment follows the reappraisal of *Liparia* and *Priestleya* A.-P. de Candolle (26.02) by Schutte and Wyk (1994), who placed *Priestleya* into synonymy under *Liparia*. Wyk and Schutte (1995) carried out cladistic analyses of tribes Crotalarieae (27), Liparieae, and Podalyrieae (25) and their genera, and presented *Priestleya* as a good genus distinct from *Liparia*. Wyk (personal communication, 1997; see also Schutte and Wyk 1998a) in-

formed us that "*Priestleya* is definitely included in
Liparia."

Liparia: L. splendens (N.L. Burman) J.J. Bos & H.C.D. de Wit (A–E). A, Valves ($\times 3.4$); B, seeds ($\times 4.8$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 5$).



Genus: *Cyclopia* E.P. Ventenat

Phylogenetic Number: 25.05.

Tribe: Podalyriaceae.

Subtribe: Podalyriinae.

Species Studied—Species in Genus: 6 spp.—23 spp.

Fruit a legume; unilocular; $2-3.5 \times 0.7-1.5 \times 0.3-0.4$ (estimated) cm; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; oblong; when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; widest near middle or D-shaped; not inflated; compressed; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned to oblique with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; assumed apical and down; passive. Replum invisible. Epicarp dull; monochrome; brownish black or brown (reddish); glabrous; eglandular; without spines; not smooth; with elevated features; faintly reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; reddish brown; cobwebby (around funicular area) or smooth; nonseptate; coriaceous; not exfoliating; remaining fused to mesocarp and epicarp. Seeds 2–11; length parallel with or transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; up to 1 mm long; of 1 length only; thick; straight. Aril fleshy; annular; covering less than 1/2 of seed; tan.

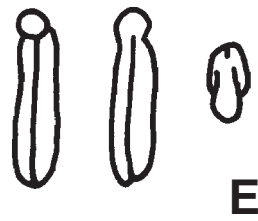
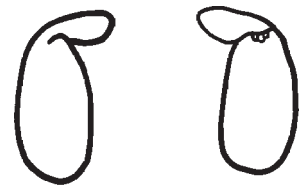
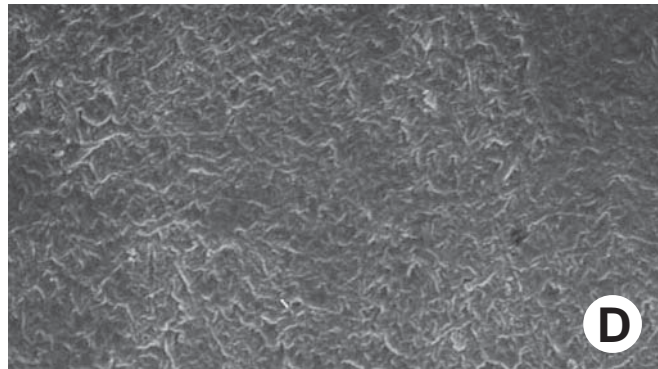
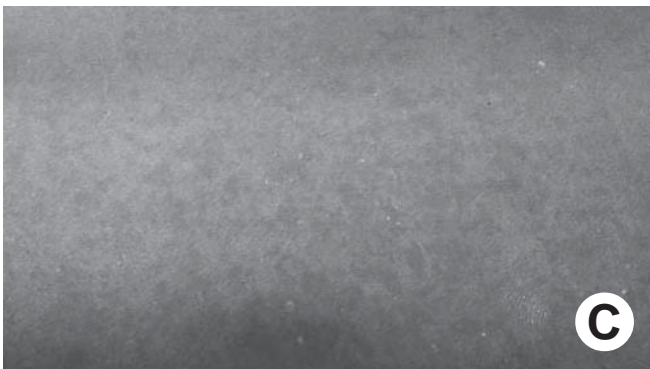
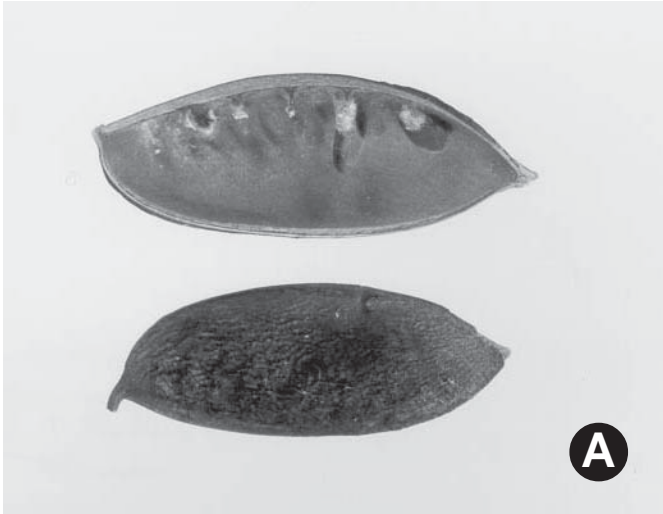
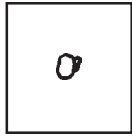
Seed $3.5-4 \times 2-2.5 \times 1.5-1.7$ mm; not overgrown; not angular; asymmetrical; nearly oblong; compressed; without or with (barely) visible radicle and cotyledon lobes; with umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; greenish brown or tan; glabrous; smooth; coria-

ceous. Fracture lines absent. Rim absent. Raphe from hilum through lens to base of seed and terminating; not bifurcating; lighter than testa; flush. Hilum partially concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 1–1.2 mm long; with curved outline; circular or elliptic; between cotyledon and radicle lobe; recessed; not within corona, halo, or rim. Lens discernible or not discernible; less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; adjacent to hilum; mounded or flush; similar color as or dissimilar color from testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; green; inner face flat; glabrous around base of radicle. Embryonic axis oblique; perpendicular to length of seed. Radicle bulbous; lobe tip curved; deflexed and parallel to cotyledon width; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

Distribution: South Africa (Cape).

Notes: Kies (1951) monographed *Cyclopia* and noted that most species are used as a type of tea and “lately ‘bush-tea’ has become a marketable commodity.”

Cyclopia: *C. galioides* (B. Bergius) A.-P. de Candolle (A, C–E), *C. spp.* (B). A, Valves ($\times 3$); B, seeds ($\times 6$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 5$).



Genus: *Podalyria* C.L. von Willdenow

Phylogenetic Number: 25.06.

Tribe: Podalyrieae.

Subtribe: Podalyriinae.

Species Studied—Species in Genus: 7 spp.—19 spp.

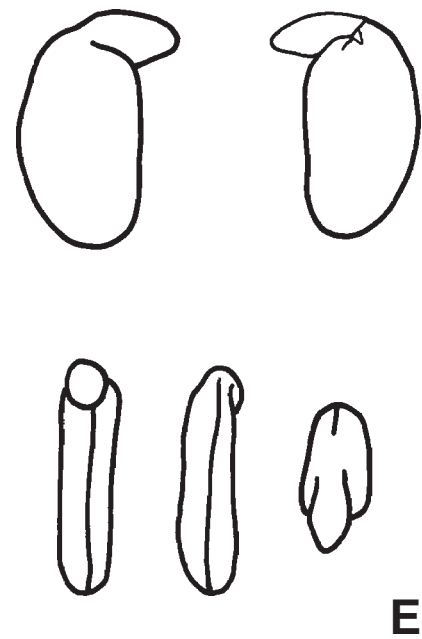
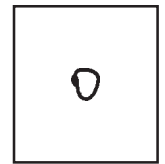
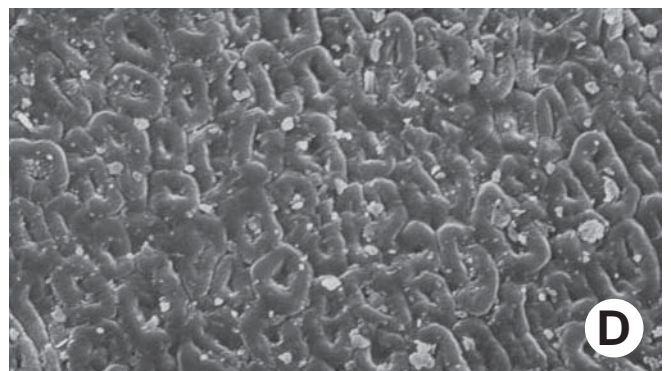
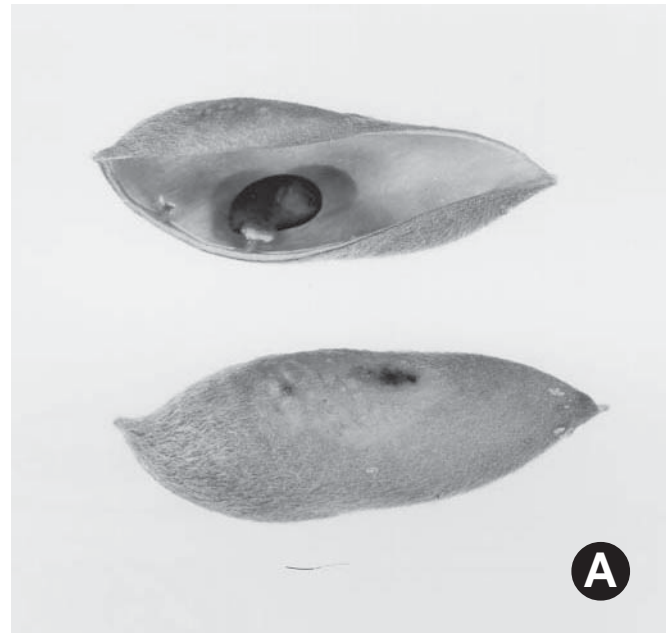
Fruit a legume; unilocular; $2.5-3 \times 1.2-1.3 \times 0.3-0.4$ (estimated) cm; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; when asymmetrical with 1 straight and 1 curved suture; widest near middle or D-shaped; not inflated; compressed; without beak; rounded at apex; apex aligned with longitudinal axis of fruit; tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; assumed apical and down; passive. Replum invisible. Epicarp dull; monochrome; green or brown (greenish); pubescent and indurate; with 1 type of pubescence; tomentose; with pubescence golden; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with recessed features; not veined; not tuberculate; minutely pitted; not exfoliating; without cracks. Mesocarp thin; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; tan; smooth; nonseptate; coriaceous; not exfoliating; remaining fused to mesocarp and epicarp. Seeds 8; length oblique to fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 0.5 mm long; of 1 length only; thick; straight. Aril fleshy; annular; covering less than 1/2 of seed; cream, tan, or white.

Seed $4.5-5 \times 3-4 \times 2.5-3$ mm; not overgrown; not angular; asymmetrical; oblong; compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome, mottled, or streaked; with frequent mottles; with frequent streaks; reddish, blackish, greenish, or dark brown, green, or tan; with black overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings

absent. Raphe from hilum through lens to base of seed and terminating; lighter than testa; flush. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 2 mm long; with straight outline; oblong; marginal according to radicle tip or between cotyledon and radicle lobe; recessed; within corona (when aril removed) or not within corona, halo, or rim. Hilum corona color darker than testa. Lens not discernible or discernible; less than 0.5 mm or equal to or greater than 0.5 mm in length; up to 0.5 mm long; with margins straight or curved; irregular; not in groove of raphe; adjacent to hilum; 1 mm from hilum; mounded; similar color as testa; lighter or darker than testa; brownish red; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; green; inner face flat; glabrous around base of radicle. Embryonic axis oblique; oblique to length of seed. Radicle bulbous; oblique to cotyledons; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

Distribution: South Africa (Cape region into Natal).

Podalyria: *P. sericea* (H.C. Andrews) R. Brown (*A*, *C-E*), *P. spp.* (*B*). *A*, Valves ($\times 3$); *B*, seeds ($\times 7$); *C-D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 5$).



Genus: *Virgilia* J.L.M. Poiret

Phylogenetic Number: 25.08.

Tribe: Podalyrieae.

Subtribe: Podalyriinae.

Species Studied—Species in Genus: 2 spp.—2 spp.

Fruit a legume; unilocular; $1.5-7 \times 0.7-1.5 \times 0.1-0.2$ cm; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; slightly curved; not plicate; not twisted; asymmetrical or symmetrical; linear to oblong; when asymmetrical with both sutures nearly straight; not inflated; flattened; without beak; rounded at apex; apex oblique with longitudinal axis of fruit; tapered at base; base oblique (slightly) with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous or ligneous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin slightly constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit substipitate to nonstipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along 1 suture or both sutures; assumed apical and down; passive. Replum invisible. Epicarp dull; monochrome; brown; pubescent and indurate (widely scattered); with 1 type of pubescence; pilose; with pubescence golden; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; transversely veined relative to fruit length; not tuberculate; not exfoliating; with cracks; cracking transverse to fruit length. Mesocarp apparently absent. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp. Seeds 4–6; length oblique to fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only. Aril fleshy; annular; covering less than 1/2 of seed; tan or white.

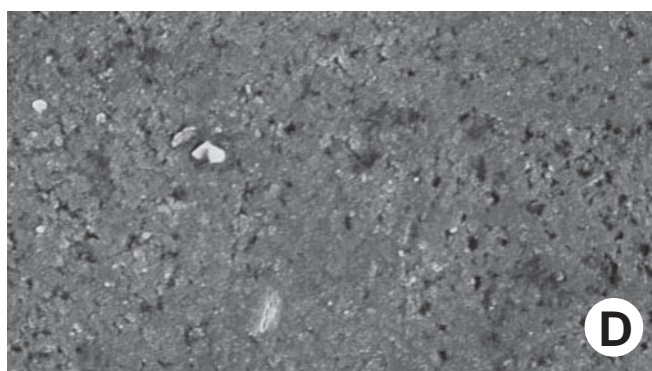
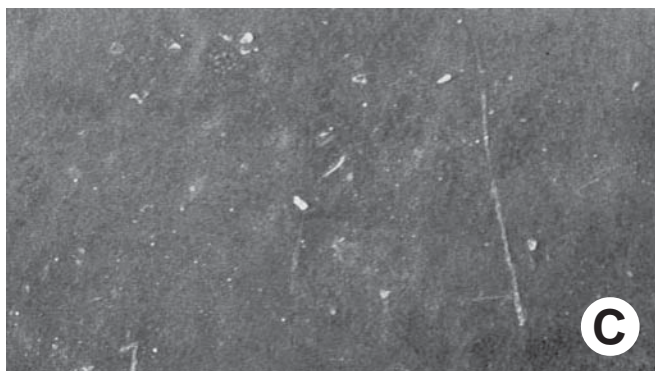
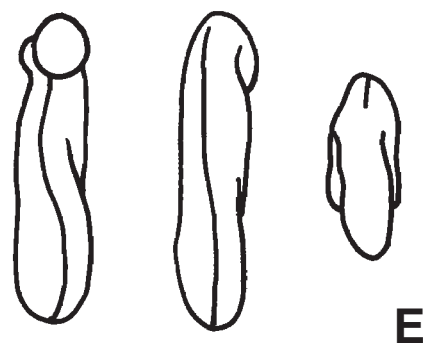
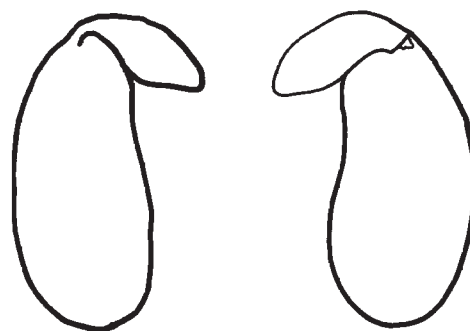
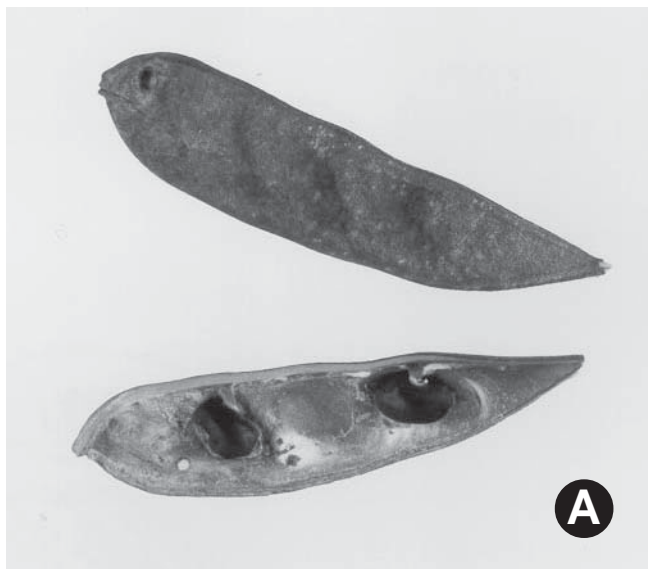
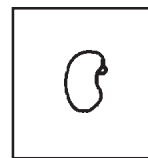
Seed $5-9 \times 3-6 \times 2.5-3.5$ mm; not overgrown; angular or not angular; symmetrical or asymmetrical; sub circular to oblong to reniform; compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; glossy to dull; not modified by a bloom; colored; monochrome; black, brown, or yellow (-brown); glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe from hilum to lens; not bifurcating; color of

testa; flush. Hilum partially or fully concealed; concealed by aril or aril remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 1.3–1.5 mm long; with curved outline; elliptic; marginal according to radicle tip; recessed; not within corona, halo, or rim. Lens discernible or not discernible (at most a discolored darker and flush area); equal to or greater than 0.5 mm in length; 0.8 mm long; with margins curved; elliptic; not in groove of raphe; adjacent to hilum; 1.5 mm from hilum; flush; similar color as testa; darker than testa; gray (ish); not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; green (ish); inner face flat; glabrous around base of radicle. Embryonic axis oblique; oblique to length of seed. Radicle linear; oblique to cotyledons; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

Distribution: South Africa (southern Cape Province).

Notes: Wyk (1986) monographed *Virgilia*.

Virgilia: *V. oroboides* (B. Bergius) T.M. Salter (*A, C–E*), *V. spp.* (*B*). *A*, Valves ($\times 2$); *B*, seeds ($\times 4.5$); *C–D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 5$).



Genus: *Calpurnia* E.H.F. Meyer

Phylogenetic Number: 25.09.

Tribe: Podalyrieae.

Subtribe: Podalyriinae.

Species Studied—Species in Genus: 4–5 spp.—7 spp.

Fruit a legume; unilocular; $2.2\text{--}13 \times 0.5\text{--}1.9 \times 1\text{--}3$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; asymmetrical or symmetrical; linear or falcate (slightly); when asymmetrical with both sutures parallelly curved; not inflated; flattened; with beak; straight or hooked; with solid beak the same color and texture as fruit; tapered or rounded at apex; apex aligned or oblique with longitudinal axis of fruit; long tapered or tapered at base; base aligned or oblique with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous to coriaceous (sub); seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; embellished; with wing. Fruit wing 1; $0.2\text{--}2.5$ mm wide; sutural; on 1 suture. Fruit stipitate or substipitate; with the stipe $4\text{--}15$ mm long. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome or multicolored; mottled; greenish tan; with brown overlay; glabrous or pubescent and indurate; with 1 type of pubescence; sparsely strigose; with pubescence golden; with pubescence uniformly distributed; with simple hairs; stiff; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; sometimes dotted; not exfoliating; without cracks. Mesocarp present or absent; thin; surface not veined; 1-layered; without balsamic vesicles; solid; chartaceous. Endocarp glossy; monochrome; golden tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; remaining fused to epicarp; entire. Seeds 2–10; length oblique or transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; $1.5\text{--}2.5$ mm long; of 1 length only; filiform; curved. Aril dry; rim-aril; entire; cream or tan.

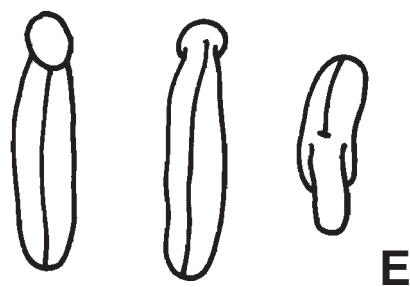
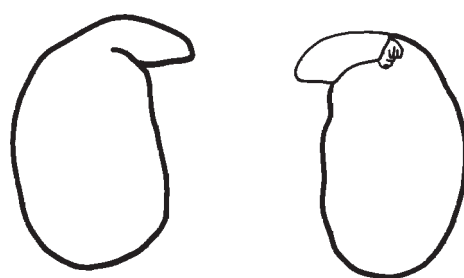
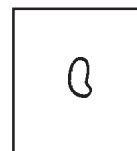
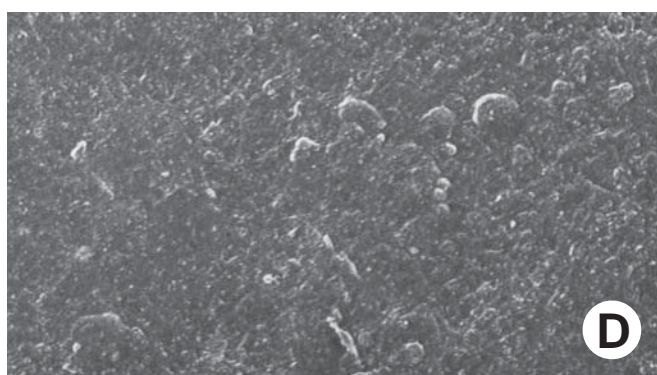
Seed $4\text{--}10.5 \times 2.5\text{--}6.5 \times 1.5\text{--}3.5$ mm; not overgrown; not angular; asymmetrical; elliptic to ovate to irregular; terete or compressed; with surface smooth; without

visible radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy to dull; not modified by a bloom; colored or clear; monochrome or mottled; with infrequent mottles; brown or tan; with brown (darker) overlay; glabrous; smooth; chartaceous. Fracture lines absent. Rim absent. Wings absent. Raphe visible or not visible; from hilum through lens to base of seed and terminating; not bifurcating; darker than testa; brown; flush. Hilum partially concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; $0.4\text{--}0.6$ mm long; with curved outline; circular to elliptic; subapical to radicle tip or apical according to radicle tip but marginal according to seed length; recessed; within rim. Hilum rim color of testa. Lens discernible; equal to or greater than 0.5 mm in length; $0.5\text{--}0.8$ mm long; with margins straight; diamond-shaped; not in groove of raphe; adjacent to or confluent with hilum; 1 mm from hilum; mounded; similar color as testa; lighter or darker than testa; brown; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to testa or embryo. Cotyledons not smooth; apically sulcate; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; notched at radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis right angled; parallel to length of seed; without a joint evident between the radicle and the cotyledons. Radicle differentiated from cotyledon; linear; lobe tip curved; oblique to cotyledons or with 90 -degree turn; centered between cotyledons; less than $1/2$ length of cotyledons. Plumule moderately developed; glabrous.

Distribution: South Africa (eastern Cape) and southern India.

Notes: Brummitt (1967) treated *Calpurnia aurea* and suggested that the genus has six or seven species. Yakovlev (1971) recognized nine species in the genus.

Calpurnia: *C. aurea* (W. Aiton) G. Bentham (C–E), *C. spp.* (A–B). A, Fruits ($\times 1.1$); B, seeds ($\times 6.3$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 5$).



Hypocalypteae (26.01)

Genus: *Hypocalyptus* C.P. Thunberg

Phylogenetic Number: 26.01.

Tribe: Hypocalypteae.

Species Studied—Species in Genus: 3 spp.—3 spp.

Fruit a legume; unilocular; $0.2\text{--}6.5 \times 0.4\text{--}1.4 \times 0.25$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight to curved (slightly); not plicate; not twisted; symmetrical or asymmetrical; linear, oblong, or obovate; when asymmetrical with both sutures nearly straight; not inflated or inflated; compressed or terete; with beak; short tapered at apex; apex aligned with longitudinal axis of fruit; tapered at base; base oblique with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous or chartaceous; seed chambers externally visible; with the raised seed chambers torulose. Fruit margin constricted or not constricted; slightly constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; medial and up and down; passive. Replum invisible. Epicarp dull; reddish or blackish brown or brown, black, or yellow (pale); glabrous; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–6; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; triangular; straight. Aril fleshy; cupshaped; covering less than 1/2 of seed; white.

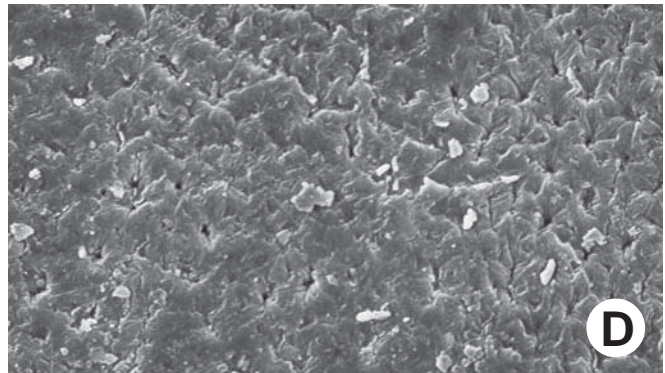
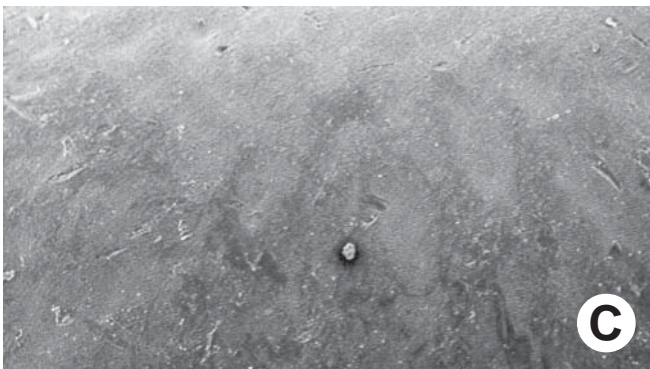
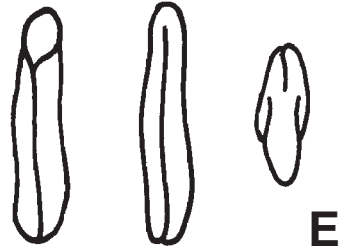
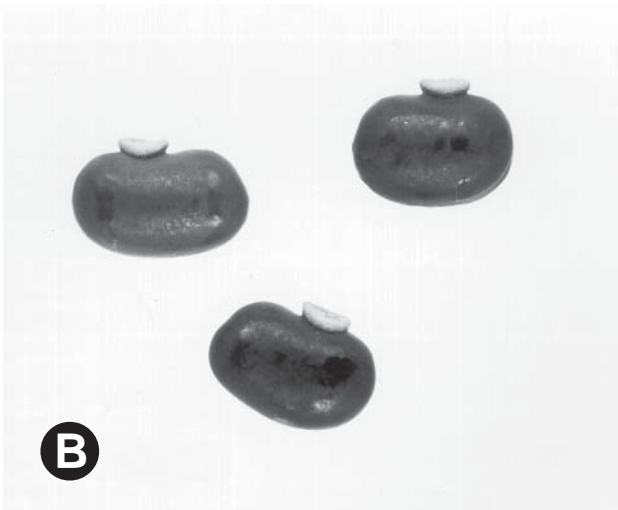
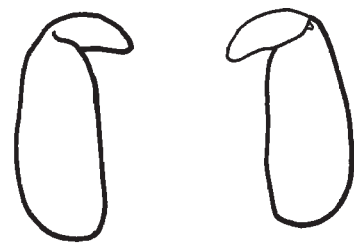
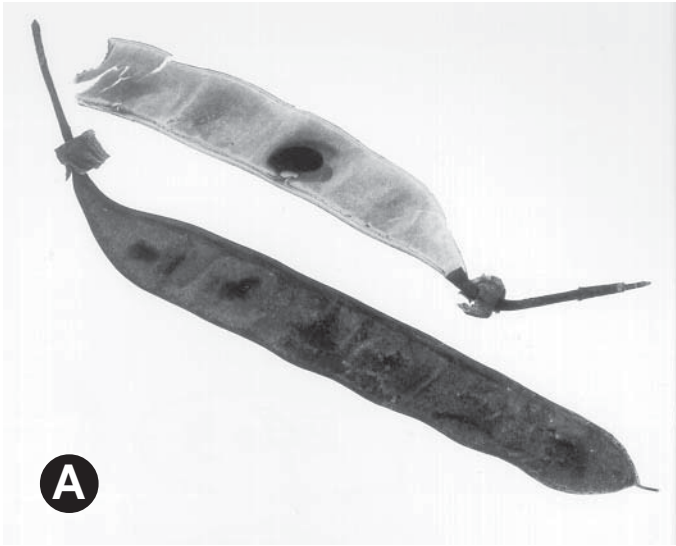
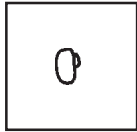
Seed $3.4\text{--}8 \times 2\text{--}3 \times 1.3\text{--}3$ mm; not overgrown; not angular; asymmetrical; reniform (oblong) or ovate; compressed; with surface smooth; with (faintly) or without visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull and glossy or dull; not modified by a bloom; colored; monochrome or mottled to streaked; with frequent mottles; with frequent streaks; black to brown (dark); with black (brownish)

overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Raphe visible or not visible; from hilum through lens to base of seed and terminating; not bifurcating; darker than testa; reddish brown or black; flush. Hilum partially concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 1 mm long; with straight outline; oblong; between cotyledon and radicle lobe or marginal according to radicle tip; recessed; not within corona, halo, or rim. Lens discernible or not discernible; less than 0.5 mm in length; with margins curved; circular (outline difficult to see); not in groove of raphe; adjacent to hilum; 1 mm from hilum; mounded; dissimilar color from testa; darker than testa; reddish brown or black; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon width; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary glabrous.

Distribution: South Africa (southern Cape Province).

Notes: Schutte and Wyk (1998a,b) carried out extensive cladistic analyses of the tribes Liparieae and Podalyrieae and related genera. They concluded that all genera of Liparieae, except *Hypocalyptus*, should be transferred to Podalyrieae and that a monotypic tribe should be created for *Hypocalyptus*. Dahlgren (1972) monographed *Hypocalyptus* and correctly noted the fruit variation. *Hypocalyptus coluteoides* (J.B.A.P. de M. de Lamarck) R.M.T. Dahlgren has an inflated legume like *Colutea* (16.05), while the other two species have linear to obovate legumes that are not inflated

Hypocalyptus: *H. sophoroides* (P.J. Bergius) H.E. Baillon (A–E). A, Fruits and valve ($\times 1.7$); B, seeds ($\times 5.5$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 5$).



Crotalarieae (27.01–27.11)

Genus: *Pearsonia* R.A. Dummer

Phylogenetic Number: 27.01.

Tribe: Crotalarieae.

Species Studied—Species in Genus: 7 spp.—12 spp.

Fruit a legume; unilocular; $0.5\text{--}3.8 \times 0.35\text{--}0.8 \times 0.7\text{--}0.8$ cm; with persistent calyx; with calyx equal in length to or shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; asymmetrical or symmetrical; elliptic or oblong (lanceolate); when asymmetrical with both sutures nearly straight; not inflated; compressed; without beak; tapered at apex; apex aligned with longitudinal axis of fruit; tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscing (assumed); splitting along sutures. Dehiscence of valves along both sutures; apical and down; assumed active; with valves twisting (assumed). Replum invisible. Epicarp dull; monochrome; brown (because of numerous golden hairs); pubescent and indurate; with 1 type of pubescence; pilose, tomentose, villous, or sericeous; with pubescence golden; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; veined or not veined; reticulately veined; not tuberculate; shagreen (may not be best answer); not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–15; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent.

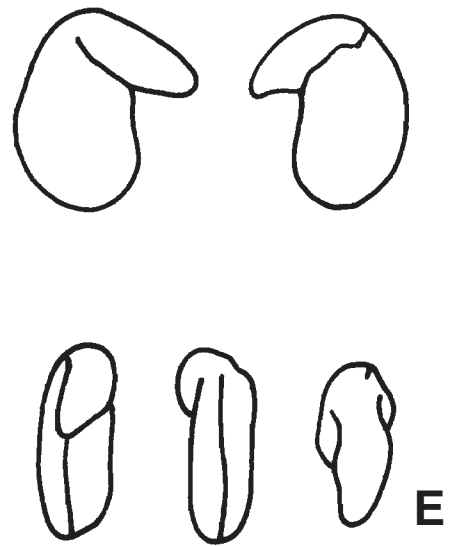
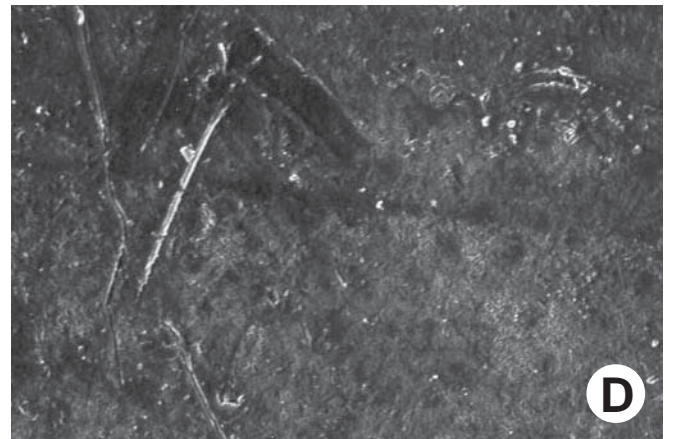
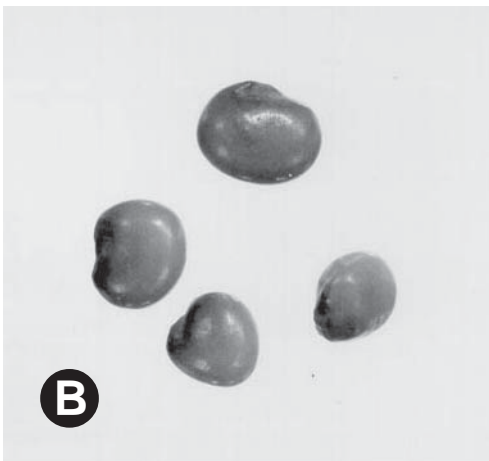
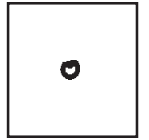
Seed $2\text{--}2.5 \times 1.7\text{--}2 \times 1.4\text{--}1.5$ mm; not overgrown; not angular; asymmetrical; obliquely cordate or reniform; compressed; with or without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome; brown or tan; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible or fully

concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; flush; within rim. Hilum rim color of or lighter than testa. Lens discernible; equal to or greater than 0.5 mm in length; 0.5–0.7 mm long; with margins straight or curved; linear or oblong; not in groove of raphe; adjacent to hilum; 0.1 mm from hilum; mounded; dissimilar color from testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle bulbous; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Africa (south of the equator) and Madagascar (1 sp.).

Notes: Polhill (1981q) broadly defined the tribe Crotalarieae with two generic groups. The first group, which does not have a two-lipped calyx, formed a tight cluster around *Lebeckia* (27.10) in southern Africa. The second group, which has a two-lipped calyx, had more scattered distributions and uncertain affinities. Wyk (1991) followed Polhill (1981q) and transferred *Argyrobium* (30.03) from Genisteae (30) to the second group. Crotalarieae and related tribes are rich in alkaloids, which have been extensively studied in the last decade (Hussain et al. 1988; Wyk and Verdoorn 1989a,b,c, 1990, 1991a,b; Wyk et al. 1989, 1993; Verdoorn and Wyk 1990, 1991). Using chemical and morphological data, Polhill (1994a,b) and Wyk and Schutte (1995) restricted Crotalarieae to the genera without a two-lipped calyx and transferred those with a two-lipped calyx to Genisteae, *Anarthrophyllum* (30.06), *Argyrobium* (30.03), *Dichilus* (30.02), *Melolobium* (30.01), and *Sellocharis* (30.07), except *Lebeckia*. They also more or less inverted the generic order within the first group according to Wyk and Schutte's cladistic analysis for the genera of Crotalarieae in the narrow sense. Polhill (1974) monographed *Pearsonia*.

Pearsonia: *P. cajanifolia* (C.E.O. Kuntze) R.M. Polhill (C–E), *P.* spp. (A–B). A, Fruit ($\times 2.8$); B, seeds ($\times 8$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



Genus: *Rothia* C.H. Persoon

Phylogenetic Number: 27.02.

Tribe: Crotalariaeae.

Species Studied—Species in Genus: 2 spp.—2 spp.

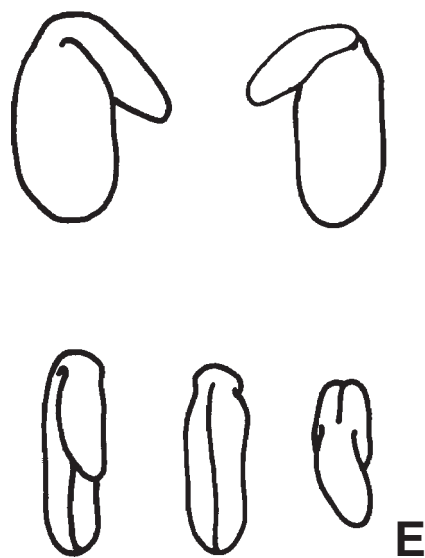
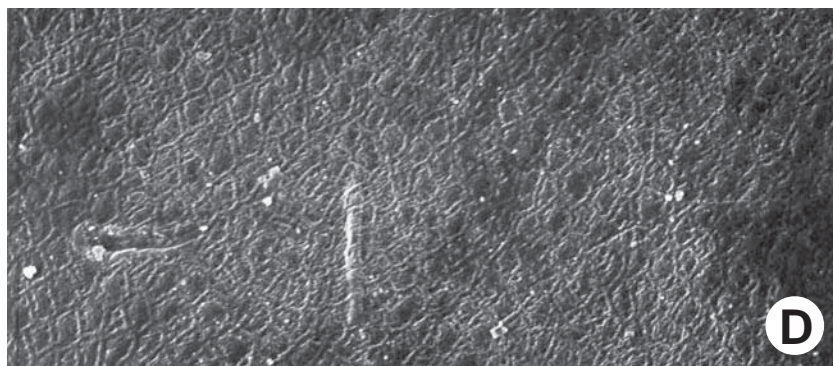
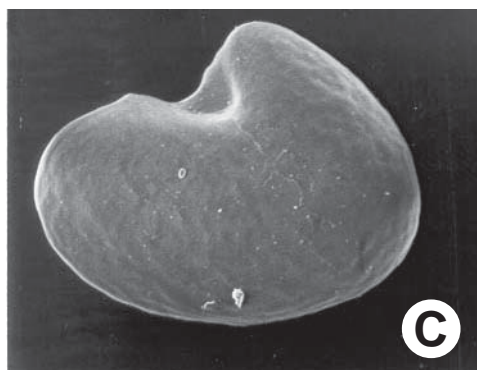
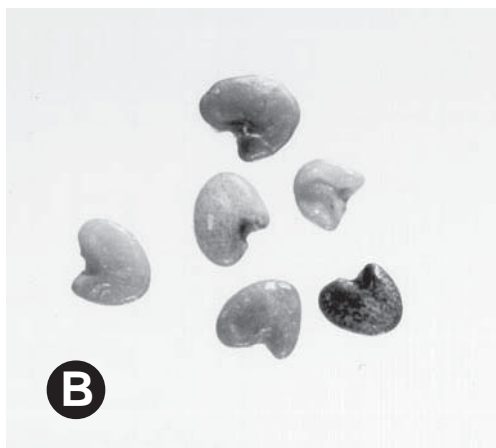
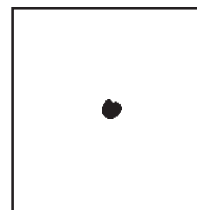
Fruit a legume; unilocular; $3.5\text{--}4.5 \times 0.15\text{--}0.2 \times 0.15\text{--}0.17$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical; linear; not inflated; flattened; without beak; tapered at apex; apex aligned with longitudinal axis of fruit; tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscing; splitting along suture. Dehiscence of valves along 1 suture; apical and down; active; with valves enrolling (when mature gaping along adaxial suture). Replum invisible. Epicarp dull; monochrome; reddish brown; pubescent and indurate; with hairs appressed; with 1 type of pubescence; with pubescence golden; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp absent. Endocarp glossy; monochrome; brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to epicarp; entire. Seeds 30–40 (estimated); length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; up to 1 mm long; of 1 length only; filiform; contorted. Aril absent.

Seed $1\text{--}1.4 \times 0.8\text{--}1 \times 0.6\text{--}0.7$ mm; not overgrown; not angular; asymmetrical; mitaform; compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; conspicuously to faintly mottled or monochrome; with frequent mottles; brown, green, or tan; with purple or tan overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform (may be the smallest in the subfamily); between cotyledon and radicle lobe; recessed; within rim (with or without a black patch around rim). Hilum rim color of testa. Lens discernible (as large as hilar area (including rim)); less than 0.5 mm in length; with margins curved; circular;

not in groove of raphe; confluent (or nearly so) with hilum; mounded; dissimilar color from testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan or yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear; deflexed and parallel to cotyledon length; not centered between cotyledons (radicle outside 1 cotyledon and inside other, therefore junctions for each cotyledon different); less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Africa (1 sp.) and Baluchistan to Australia (1 sp.).

Rothia: *R. indica* (C. Linnaeus) G.C. Druce (*C–E*), *R. spp.* (*A–B*). *A*, Fruits ($\times 2.5$); *B*, seeds ($\times 11$); *C–D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 18$).



Genus: *Robynsiophyton* R. Wilczek

Phylogenetic Number: 27.03.

Tribe: Crotalariaeae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; unilocular; $0.6-1 \times 0.3-0.45 \times 0.1-0.15$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical; oblong (ovate), lanceolate (linear), or linear; not inflated; compressed to flattened; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscing; splitting along suture. Dehiscence of valves along apparently 1 suture; assumed apical and down; passive. Replum invisible. Epicarp dull; monochrome; brown; pubescent and indurate; with 1 type of pubescence; pilose or tomentose; with pubescence golden; with simple hairs; pliable; with hair bases plain; without spines; apparently smooth; not veined; not tuberculate; not exfoliating; without cracks. Mesocarp absent or present; thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; chartaceous. Endocarp dull; monochrome; brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp or to epicarp; entire. Seeds 4–8; length parallel with or transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 1.5–1.7 mm long; of 1 length only; filiform; straight. Aril absent.

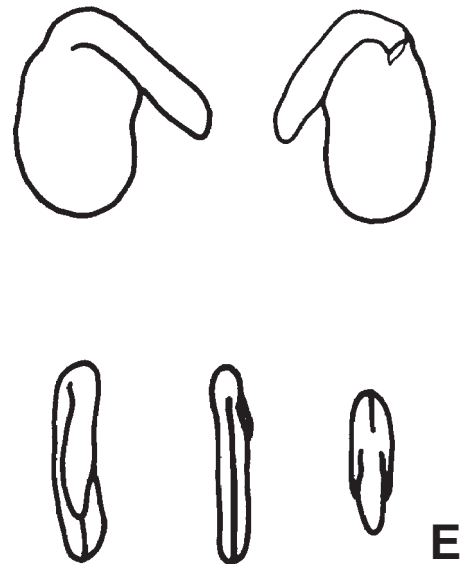
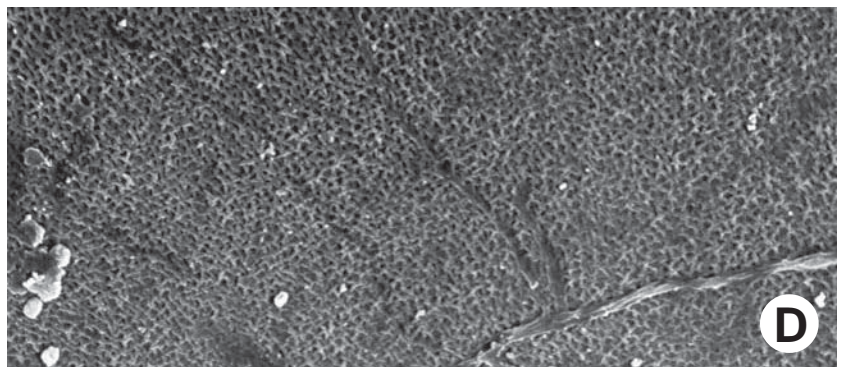
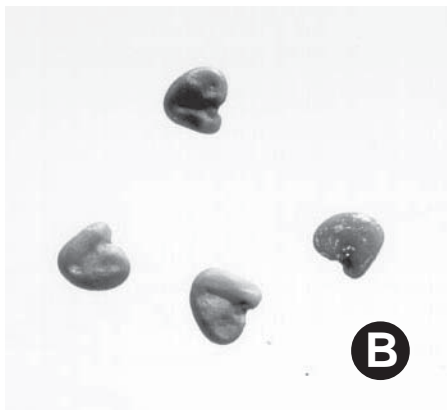
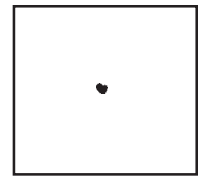
Seed $1-1.2 \times 1-1.2 \times 0.4-0.5$ mm; not overgrown; not angular; asymmetrical; mitaform; compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; greenish brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; recessed; within rim. Hilum rim color of testa. Lens discernible; less than 0.5 mm in length; with margins straight; wedge-shaped; not in groove of raphe; adjacent to hilum; mounded; same color as testa; not

within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule moderately developed; glabrous.

Distribution: South-central Africa.

Notes: Our observations are based on only one sample augmented by data from the literature.

Robynsiophyton: *R. vanderystii* R. Wilczek (A–E). A, Fruits ($\times 5.1$); B, seeds ($\times 12.5$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 20$).



Genus: *Spartidium* A.N. Pomel

Phylogenetic Number: 27.04.

Tribe: Crotalariaeae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; unilocular; $3\text{--}4.3 \times 0.8\text{--}1 \times 0.08\text{--}0.17$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted or twisted; symmetrical or asymmetrical; oblong; when asymmetrical with 1 straight and 1 curved suture or both sutures nearly straight; widest near middle or D-shaped; not inflated; flattened; without beak; rounded at apex; apex aligned or oblique with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally visible; with the raised seed chambers torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit assumed indehiscent. Replum invisible or visible (valve could irregularly separate from sutures). Epicarp semiglossy; monochrome; reddish brown; glabrous; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; chartaceous. Endocarp dull; monochrome; tan; smooth and scurfy (smooth around seeds and scurfy between seeds); nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 2–6; length transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 4 mm long; of 1 length only; filiform; hooked. Aril absent.

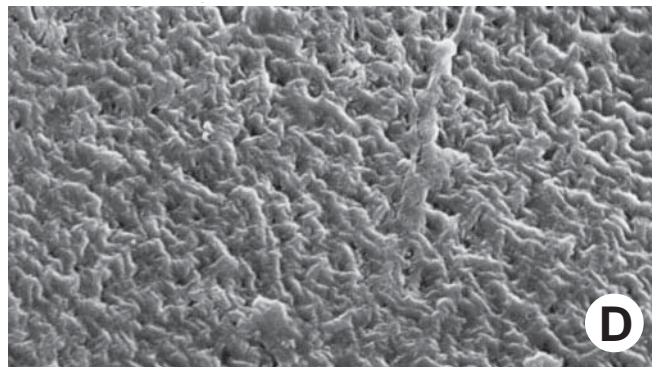
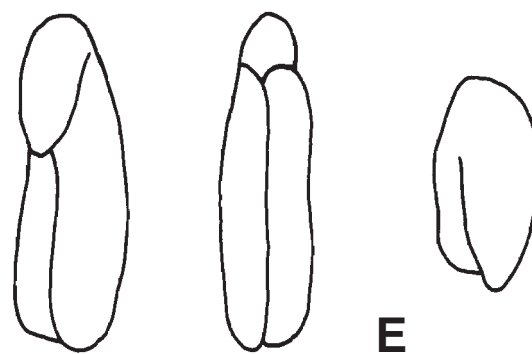
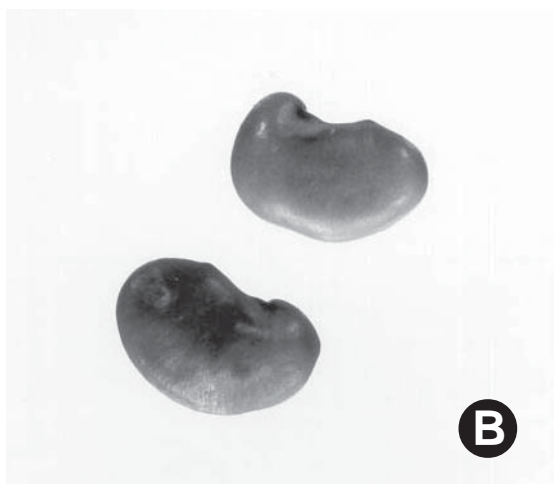
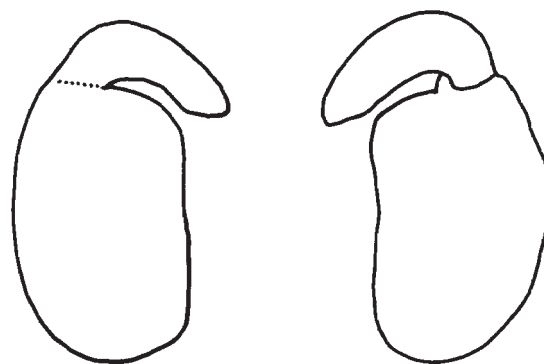
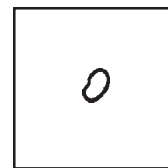
Seed $3.5\text{--}4 \times 2\text{--}2.5 \times 1.5\text{--}1.8$ mm; not overgrown; not angular or angular (somewhat); asymmetrical; oblong or reniform; terete; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown or tan (to reddish); glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible or fully concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe;

recessed; within rim. Hilum rim color of testa. Lens discernible; equal to or greater than 0.5 mm in length; 1.4–1.8 mm long; with margins straight or curved; oblong; not in groove of raphe; confluent with hilum; mounded; dissimilar color from testa; darker than testa; brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; without margins recessed; reddish tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: North Africa (Libya to Algeria and probably Morocco).

Notes: Polhill (1981q) noted that this genus is “virtually indistinguishable from *Lebeckia*” (27.10). However, alkaloid data support keeping *Spartidium* separate from *Lebeckia* (Wyk et al. 1989).

Spartidium: *S. saharae* (E.S.-C. Cosson & E. Reboul) A.N. Pomel (A–E). A, Fruit ($\times 1.7$); B, seeds ($\times 8.4$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 4.6$).



Genus: *Rafnia* C.P. Thunberg

Phylogenetic Number: 27.05.

Tribe: Crotalariaeae.

Species Studied—Species in Genus: 9 spp.—ca. 23 spp.

Fruit a legume; unilocular; $1.5-3 \times 0.5-0.8 \times 0.2-0.3$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; lanceolate (linear), linear, or oblong (narrowly to broadly); when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; widest at base or near apex; not inflated; compressed; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; embellished to plain. Fruit wing present or absent; 1; 1–2 mm wide; sutural (along upper suture and usually best developed near calyx); on 1 suture. Fruit stipitate to substipitate to nonstipitate; with the stipe up to 10 mm long. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves enrolling or twisting. Replum invisible. Epicarp dull; monochrome; black or brown (dirty); glabrous; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; lenticular (tannish); not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; nearly spongy or solid; coriaceous. Endocarp dull or glossy; monochrome; brown (to reddish); reticulate or hairy (appressed and silver); nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seed 1 (assumed); assumed length parallel with fruit length. Funiculus less than 0.5 mm long; thick; straight. Aril absent.

Seed $3.7-4 \times 2.2-2.5 \times 0.8-2$ mm; not overgrown; not angular; asymmetrical; reniform; compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; reddish brown or tan; with black (grayish) overlay; glabrous; smooth or not smooth; with elevated features; wrinkled; coriaceous. Fracture lines absent.

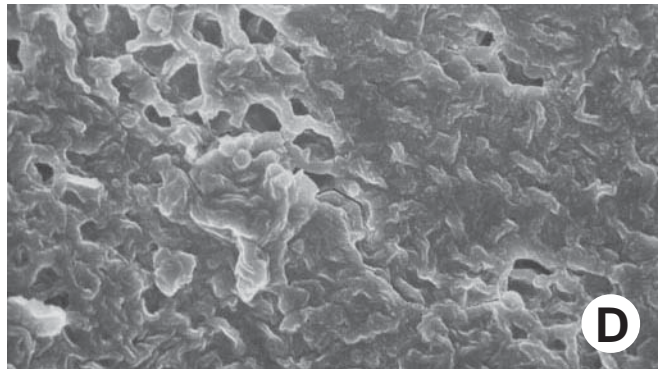
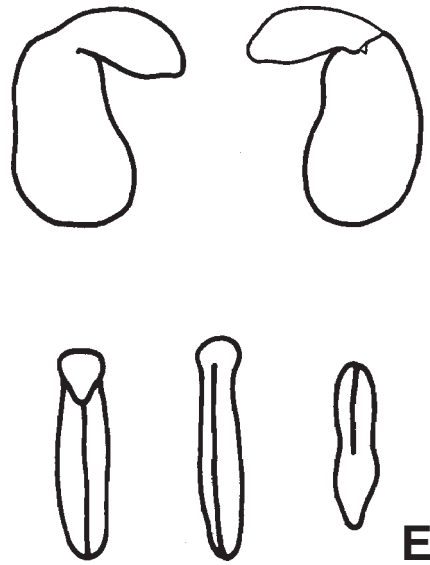
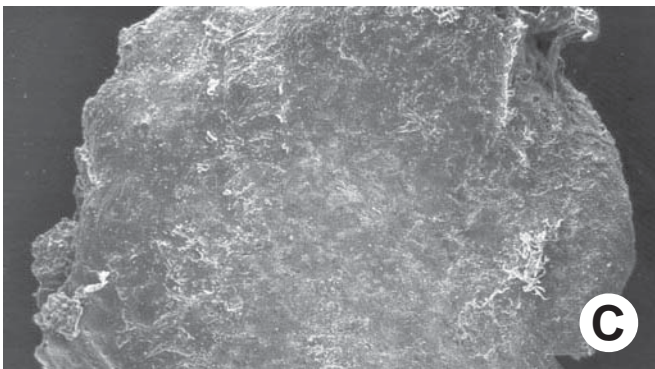
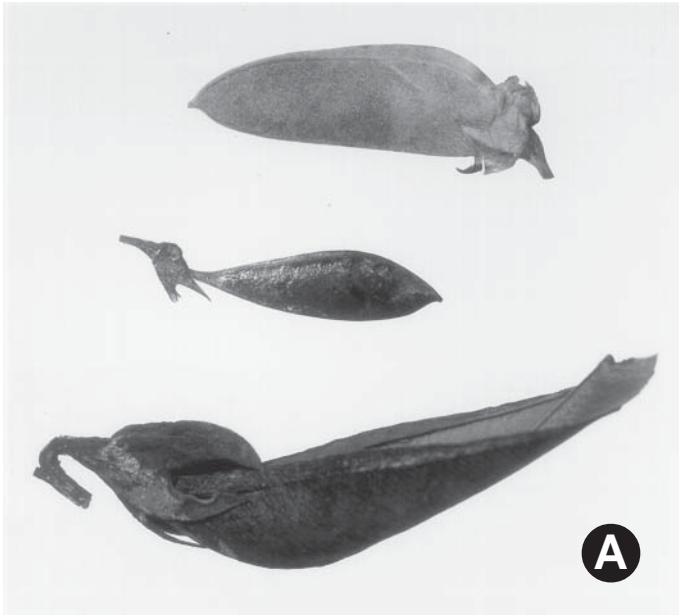
Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.5–0.7 mm long; with straight outline; oblong; between cotyledon and radicle lobe; recessed; within rim. Hilum rim color darker (slightly to black) than testa. Lens discernible; equal to or greater than 0.5 mm in length; 0.5–1 mm long; with margins straight or curved; narrowly oblong; not in groove of raphe; adjacent to hilum; mounded; dissimilar color from testa; darker than testa; black or brown (dark to reddish to greenish); not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; brownish red; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle bulbous; deflexed and parallel to cotyledon width; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: South Africa (southwestern Cape Province to Natal).

Notes: Number of species and distribution taken from Wyk (1991) and Wyk and Schutte (1995).

Rafnia: *R. amplexicaulis* (C. Linnaeus) C.P. Thunberg (*C–E*), *R.* spp. (*A–B*). *A*, Fruits ($\times 2$); *B*, seeds ($\times 6$); *C–D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 6$).

3



Genus: *Aspalathus* C. Linnaeus

Phylogenetic Number: 27.06.

Tribe: Crotalariaeae.

Species Studied—Species in Genus: 24 spp.—ca. 278 spp.

Fruit a legume or nutlet (a few spp.); unilocular; $0.4\text{--}3 \times 0.2\text{--}6.3 \times 0.2\text{--}0.3$ cm; with persistent calyx or deciduous calyx; with calyx longer or shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight to curved (slightly); not plicate; not twisted; asymmetrical or symmetrical; linear, obovate, ovate (and rhombic), rhombic (sub), lanceolate, falcate, or rectangular; when asymmetrical with 1 straight and 1 curved suture, both sutures parallelly curved, or both sutures unequally curved; widest near middle or D-shaped; slightly inflated or not inflated; compressed or terete; without beak; long tapered to tapered to short tapered to rounded at apex; apex aligned to oblique with longitudinal axis of fruit; tapered to short tapered to rounded (nearly) at base; base aligned to oblique with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous or ligneous; seed chambers externally visible or invisible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit stipitate to substipitate to nonstipitate; with the stipe up to 7 mm long. Fruit with all layers dehiscent (calyx may retard dehiscence for ovate pods shorter than calyx); splitting along sutures. Dehiscence of valves along 1 suture (for ovate fruits) or both sutures; apical and down or basal and up (for ovate fruits); active or passive; with valves twisting. Replum invisible. Epicarp dull; monochrome; black, brown (reddish), or tan; glabrous, glabrate, or pubescent and indurate; with 1 type of pubescence; villous, tomentose, or sericeous; with pubescence gray or golden; with pubescence uniformly distributed or apical pubescence different from basal pubescence; with apical 1/4 tomentose and basal 3/4 glabrous; with simple hairs; pliable; with hair bases plain; eglandular; without spines; smooth or not smooth; with elevated features; reticulately veined; not tuberculate; rugose; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid coriaceous to ligneous (including subligneous). Endocarp dull; monochrome; brown or tan; smooth; subseptate to nonseptate; with septa thicker than paper, firm; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–18

(many); length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent.

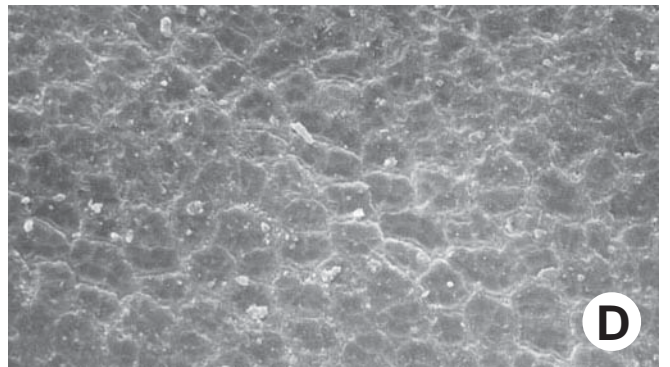
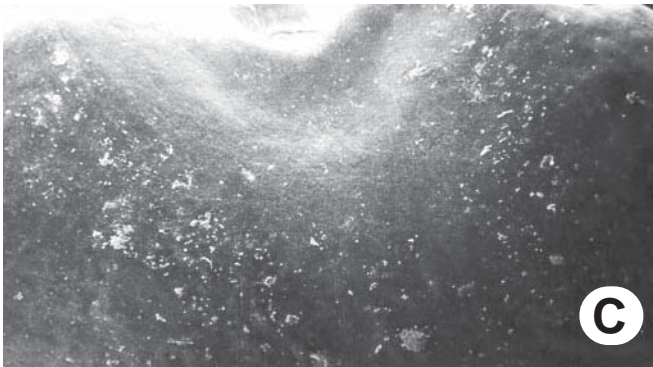
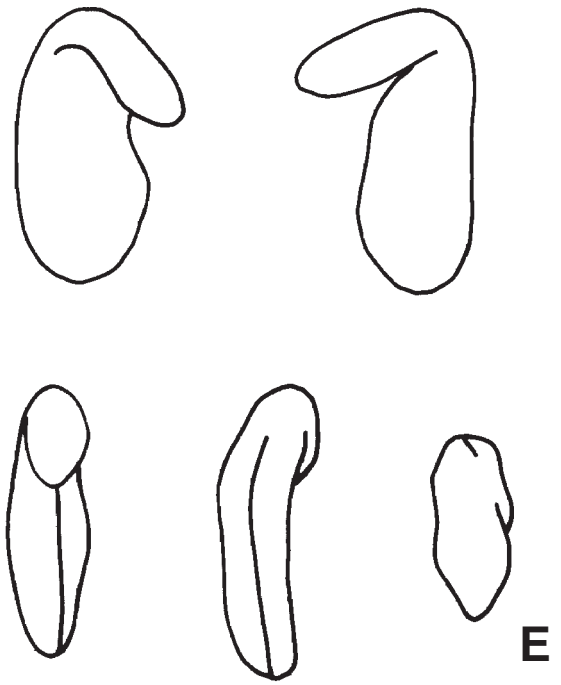
Seed $2\text{--}3.5 \times 1.5\text{--}3 \times 1\text{--}2$ mm; not overgrown; not angular to angular; asymmetrical; mitaform, quadrangular, rhombic (sub), or circular (sub); compressed to terete; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull or glossy; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; black, brown (to yellowish or reddish), tan, or white; with black or gray overlay (green, brown, purple or dark); glabrous; smooth or not smooth; with elevated features; warty; coriaceous. Fracture lines absent. Rim absent. Raphe not visible. Hilum visible or partially concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; marginal according to radicle tip or between cotyledon and radicle lobe; recessed; within rim, corona, and halo or not within corona, halo, or rim. Hilum corona color darker than testa. Hilum halo color lighter or darker than testa. Hilum rim color of testa. Lens discernible or not discernible; equal to or greater than 0.5 mm in length; 0.7 mm long; with margins straight or curved; oblong (with or without lighter colored medial line); not in groove of raphe; adjacent to hilum; to 0.5 mm from hilum; slightly mounded; similar color as testa; darker than testa; black or brown (reddish); within halo and corona. Lens corona color darker than testa. Lens halo color lighter than testa. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length not centered between cotyledons (radicle outside 1 cotyledon and inside other, therefore junctions for each cotyledon different); less than 1/2 length of cotyledons to 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: South Africa (southwestern Cape Province to Natal).

Notes: Dahlgren (1960, 1963a,b, 1965, 1968) monographed *Aspalathus* in a series of papers. His fruit and seed data were used to enlarge our limited database. In discussing the legume morphology, Dahlgren (1963b, pp. 98–105) noted that there is no typical *Aspalathus* legume, though the short, more or less triangular and compressed legume is most common. His figure 15 is a useful compilation of legume shapes and hair types and patterns. Legumes usually dehisce either actively or passively on the plant. Some species have legumes that remain closed and fall to the ground while closed, acting as a “nutlet”; for example, *A. bodkinii* H. Bolus and probably *A. argyrella* P. MacOwan, *A. comptonii* R.M.T. Dahlgren, and *A. villosa* C.P. Thunberg. The number of species and distribution used here were taken from Wyk (1991) and Wyk and Schutte (1995).

Aspalathus: *A. linearis* (N.L. Burman) R.M.T. Dahlgren
(C-E), *A. spp.* (A-B). A, Fruits ($\times 2.1$); B, seeds ($\times 8.4$); C-D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 12$).

8



Genus: *Crotalaria* C. Linnaeus

Phylogenetic Number: 27.07.

Tribe: Crotalariaeae.

Species Studied—Species in Genus: Ca. 200 spp.—ca. 600 spp.

Fruit a legume; unilocular; 0.3–12 × 0.3–1.7 × 1–2 cm; with deciduous or persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; asymmetrical or symmetrical; oblong, elliptic (clavate, oblong, or circular), linear (and linear-oblong), or circular; when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; widest near middle or D-shaped; inflated (some species markedly inflated); terete or compressed (especially species in subgenus *Priotropis* (R. Wight & G.A.W. Arnott) C.D.F. Meisner); without or with beak; straight; with solid beak the same color and texture as fruit; rounded to short tapered at apex; apex aligned or oblique with longitudinal axis of fruit; rounded at base; base aligned or oblique with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous or coriaceous; seed chambers externally invisible. Fruit margin not constricted; with or without sulcus; plain. Fruit wings absent. Fruit stipitate to substipitate to nonstipitate; with the stipe 0–30 mm long. Fruit with all layers dehiscent or indehiscent (for a few species); splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves enrolling or twisting. Replum invisible. Epicarp dull; monochrome; brown to tan; glabrous or pubescent and indurate; with 1 type of pubescence; puberulent, tomentose, villous, sericeous, or peltate; with pubescence brown (and including purple and blackish-brown); with pubescence uniformly distributed or apical pubescence different from basal pubescence; with apical 1/4 tomentose and basal 3/4 glabrous; with simple hairs; pliable; with hair bases plain; eglandular; without spines; smooth or not smooth; with elevated features; not veined; not tuberculate; shagreen; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous to ligneous (sub). Endocarp dull; monochrome; brown or tan; smooth or hairy; with hairs restricted to sutures, in longitudinal rows, or scattered over endocarp; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 10–80; length parallel with fruit length;

neither overlapping nor touching; in 1 series. Funiculus measured; up to 3 mm long; of 1 length only; filiform or thick; S-curved or curved. Aril absent or present (rarely); dry; rim-aril (in section *Chrysocalycinae* (G. Bentham) E.G. Baker subsection *Stipulosae* (E.G. Baker) F.A. Bisby & R.M. Polhill); covering less than 1/2 of seed; brown or tan.

Seed 1–8 × 1–6 × 0.75–3 mm; not overgrown; not angular to angular; asymmetrical; reniform (and obliquely reniform), mitaform, cordate (obliquely), or circular (sub); compressed or flattened; with visible radicle and cotyledon lobes; with deep, with shallow, or without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; usually glossy or dull; not modified by a bloom; colored; monochrome, mottled and streaked, or bichrome (primarily dark reddish-black with a white patch over radicle tip and with or without white patch at junction of radicle and cotyledon lobes or a continuous white patch to radicle tip to radicle cotyledon junction, *C. spectabilis* A.W. Roth); with frequent mottles; with frequent streaks; brown (in combination with most other colors), tan, yellow, orange, red, black, cream, gray, green, or purple; with black or brown (greenish, yellowish, reddish) overlay; glabrous; smooth or not smooth; with elevated or recessed features; rugose (faces and/or margins), shagreen, warty, wrinkled, or papillate; punctate (minutely punctate in *C. stolzii* (E.G. Baker) R.M. Polhill); coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible, partially concealed, or fully concealed; concealed by radicle lobe (partially or completely concealed), funiculus, or wing; with or without faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform or punctiform; up to 6 mm long; with curved outline; elliptic; between cotyledon and radicle lobe; recessed; within rim and halo or rim or not within corona, halo, or rim. Hilum halo color lighter than testa. Hilum rim color darker than testa. Lens discernible (not bearing elevated features that rest of testa may bear and often with a light-colored longitudinal medial line); equal to or greater than 0.5 mm in length; 0.5–1.5 mm long; with margins straight or curved; rectangular, wedge-shaped, oblong, or circular; not in groove of raphe; adjacent to hilum; 1–7 mm from hilum; mounded; similar color as or dissimilar color from testa; lighter or darker than testa; tan; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded;

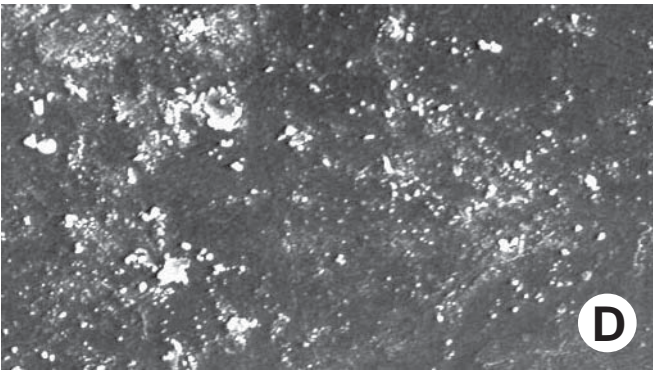
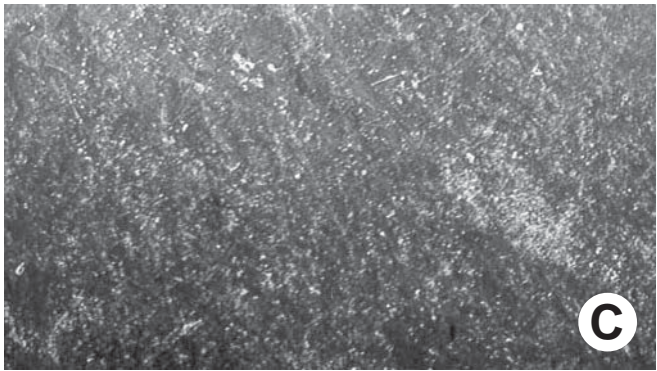
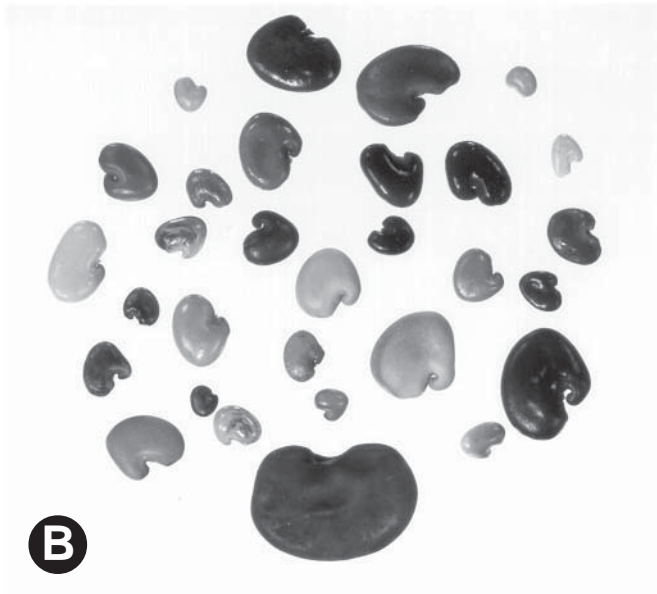
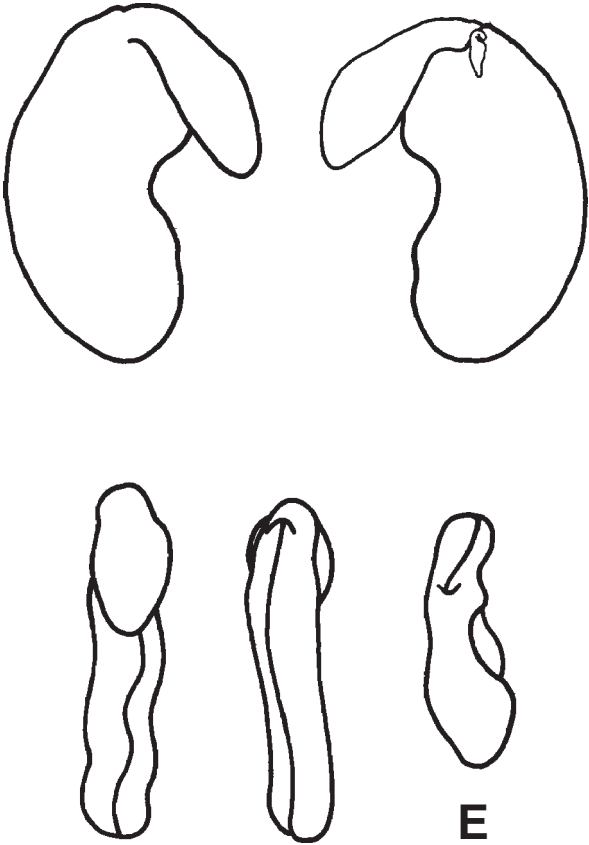
margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow or tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear or bulbous; lobe tip straight, curved, or hooked; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 or 1/2 to nearly length of cotyledons. Plumule rudimentary, or moderately developed; glabrous.

Distribution: Pansubtropical and pantropical with three-quarters of the species in eastern and southern Africa.

Notes: Polhill (1982) monographed the species of this genus in Africa and Madagascar, where three-quarters of the species are endemic. To balance his excellent contribution, we also consulted the following three monographs from the New World and one from Thailand: North America, Windler (1974); Colombia, Bernal (1986); Venezuela, Matos (1978); and Thailand, Niyomdham (1978). Miller (1967) studied the seed morphology and anatomy of "40 species probably endemic to the New World, 21 species from the Old World, and four pantropicals." Because of synonymy problems, seeds of only 47 different species are keyed and illustrated. Miller's key seed characters are: hilum open vs. hilum occluded by radicle, seeds small vs. medium, funicular remnant distinct vs. absent, and glossy vs. not glossy. His term "boss" is synonymous with our term "lens." Windler (1973) noted that like other legume genera, *Crotalaria* pods have an active ballistic dehiscence. The two valves separate along the "center part of the adaxial suture," and an "explosive inward and upward movement of the lower suture causes the dispersal of the seeds. The valves continue to curl in the same direction, frequently trapping a few seeds in each of the curled valves." Windler reported that in the laboratory seeds were thrown up to 5 meters. He also noted that movement by water and animals accounted for most seed dispersal. Niyomdham (1978) observed that species of *Crotalaria* can be divided into two seed groups: Reniform group and cordate (with unequal lobes) or mitiform group. The seeds of *Crotalaria* exhibit an impressive array of monochrome colors, including, but not limited to, brown (light to dark and in combination with red, gray, yellow, orange, or orange-red), tan, black, orange, red, and yellow. Mottled seeds also occur.

Crotalaria: *C. juncea* C. Linnaeus (*C-E*), *C. spp.* (*A-B*). *A*, Fruits ($\times 1.6$); *B*, seeds ($\times 2.3$); *C-D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 5$).

3



Genus: *Bolusia* G. Bentham

Phylogenetic Number: 27.08.

Tribe: Crotalariaeae.

Species Studied—Species in Genus: 3 spp.—5 spp.

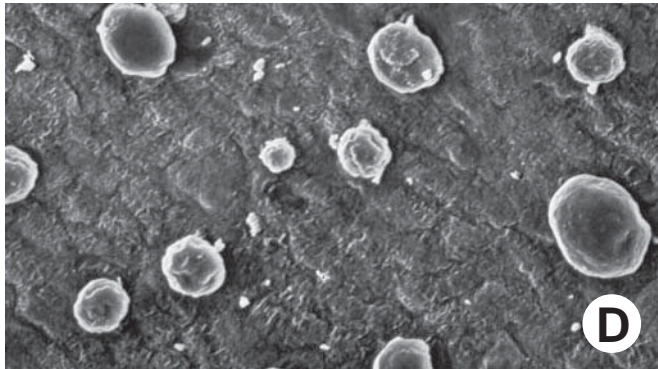
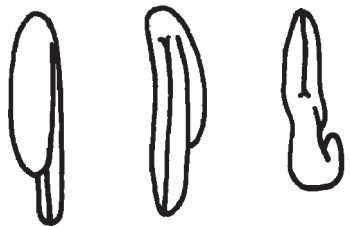
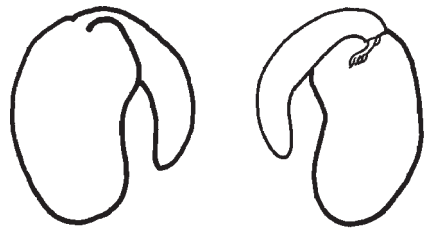
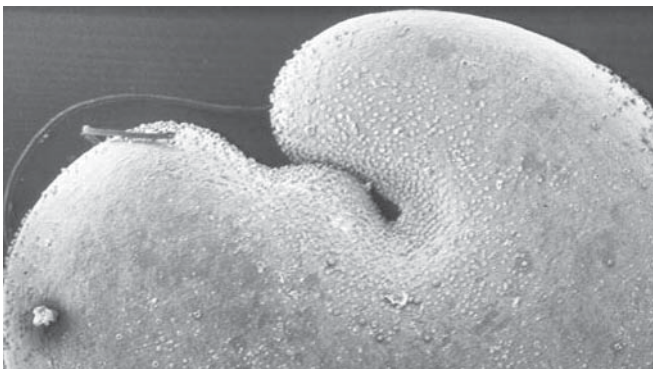
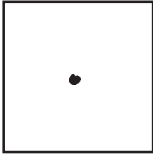
Fruit a legume; unilocular; $2.5-4 \times 0.5-1 \times 0.5-0.6$ cm; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; oblong (fusiform or clavate); when asymmetrical with both sutures nearly straight; inflated (like most *Crotalaria* (27.07) spp.); compressed; without beak; short tapered to rounded at apex; apex aligned with longitudinal axis of fruit; short tapered to rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; ligneous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves enrolling or twisting. Replum invisible. Epicarp dull; monochrome; tan; glabrous; eglandular; without spines; not smooth; with elevated features; faintly reticulately veined; not tuberculate; faintly wrinkled; not exfoliating; without or with cracks (with age); cracking oblique to fruit length. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; subligneous. Endocarp glossy; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 5–8 (estimated); length parallel with or transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 1–1.5 mm long; of 1 length only; filiform; hooked. Aril absent.

Seed $2.5-4 \times 2.5-3 \times 1$ mm; not overgrown; not angular; asymmetrical; circular (but with deep hilar sinus); compressed; with visible radicle and cotyledon lobes; with shallow hilar sinus; with umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; streaked and mottled or monochrome (when immature); with frequent mottles; with frequent streaks; tan; with brown (ish gray) overlay; glabrous; not smooth; with elevated features; tuberculate (with tiny white tubercles especially along margin of seed); coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum fully concealed; concealed by radicle lobe (hilum in deep sinus) or wing; without faboid split; punctiform; between

cotyledon and radicle lobe (in deep hilar sinus); flush; not within corona, halo, or rim. Lens discernible; less than 0.5 mm in length; with margins straight or curved; apparently oblong; not in groove of raphe; adjacent to hilum; 0.2 mm from hilum; mounded (well developed and blocking hilar sinus); same color as testa; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing (barely covering part of radicle near base) or not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; with 1 or both margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear; lobe tip hooked; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Africa (south of the equator).

Bolusia: *B. rhodesiana* A.G. Corbishley (C–E), *B.* spp. (A–B). A, Fruit and valve ($\times 2.1$); B, seeds ($\times 5.2$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 9$).



Genus: *Lotononis* (A.-P. de Candolle) C.F. Ecklon & J.M. Zeyher

Phylogenetic Number: 27.09.

Tribe: Crotalariaeae.

Species Studied—Species in Genus: 16 spp.—ca. 150 spp.

Fruit a legume; unilocular; $0.2\text{--}1.7 \times 0.15\text{--}0.9 \times 0.1$ cm; with persistent calyx; with calyx longer or shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved; not plicate or plicate (rarely); not twisted; asymmetrical or symmetrical; oblong, falcate, circular, linear, or ovate; when asymmetrical with both sutures nearly straight or parallelly curved; not inflated; flattened; without beak; tapered to short tapered at apex; apex oblique with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without (lower suture flush) or with sulcus (lower suture deeply sulcate); plain or embellished. Fruit wing present or absent; 1; 2 mm wide; sutural; on 1 suture. Fruit stipitate to substipitate to nonstipitate; with the stipe up to 10 mm long. Fruit with all layers dehiscent (to tardily dehiscent) or indehiscent; splitting along sutures. Dehiscence of valves along both sutures; assumed apical and down; active; with valves twisting. Replum invisible. Epicarp dull; monochrome; dark brown to black; pubescent and indurate or pubescent but soon deciduous; with 1 type of pubescence; pilose, villous, or sericeous; with pubescence golden or gray; with simple hairs; pliable; with hair bases plain; without spines; smooth or not smooth; with elevated features; reticulately veined; not tuberculate; distinctly to inconspicuously verrucose-rugose or warty (along upper suture); not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; reddish brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–30; length parallel with fruit length; neither overlapping nor touching or touching; in 1 series. Funiculus measured; up to 2.5 mm long; of 2 different lengths (are some of 1 length?); filiform; straight. Aril absent.

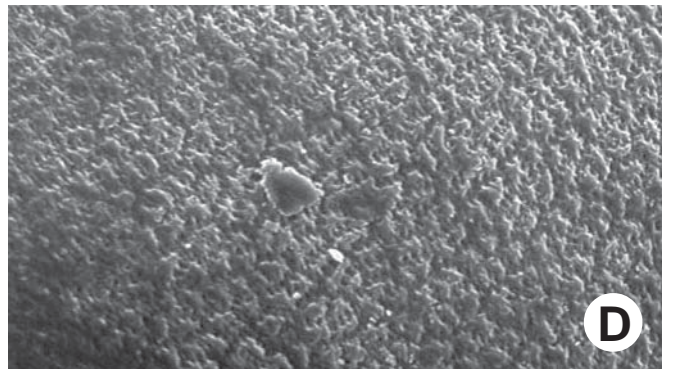
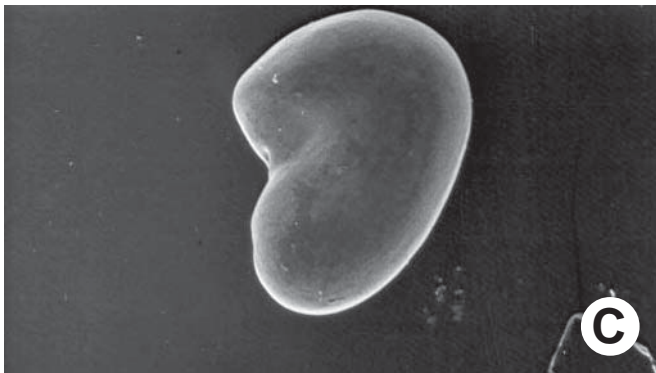
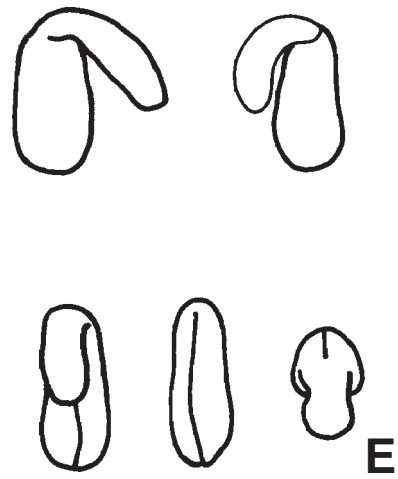
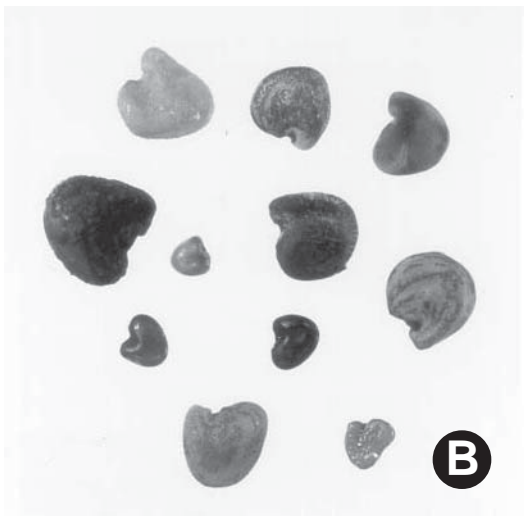
Seed $1\text{--}3 \times 1\text{--}2.8 \times 0.5\text{--}0.7$ mm; not overgrown; not angular; asymmetrical; mitaform, reniform, or cordate (obliquely); compressed; with visible radicle and

cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome, bichrome (especially yellows and purples or brown with black tubercles), or mottled and streaked; with frequent mottles; with frequent streaks; red (dish to yellowish), yellow (to greenish), or purple (to tannish); with black or purple overlay; glabrous; smooth or not smooth; with elevated features; tuberculate (minute and densely to sparsely); coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; recessed; within rim. Hilum rim color of or darker than testa. Lens discernible; less than 0.5 mm in length; with margins curved; more or less circular; not in groove of raphe; adjacent to hilum; 0.1–0.4 mm from hilum; mounded; same color as, similar color as, or dissimilar color from testa; lighter or darker than testa; brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle bulbous; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Southern Africa (ca. 93 percent of species) to Mediterranean region and India.

Notes: *Buchenroedera* C.F. Ecklon & J.M. Zeyher has been merged with *Lotononis*, following Gunn et al. (1992). Polhill (1981q) noted that the 20 species of *Buchenroedera* might be “perhaps better included in *Lotononis*.” The seeds of *Lotononis* are remarkably similar in shape, size, and color to seeds of *Trifolium* (21.06). Number of species and distribution follow Wyk (1991) and Wyk and Schutte (1995).

Lotononis: *L. bainesii* J.G. Baker (C–E), *L.* spp. (A–B). A, Fruits and valves ($\times 2.8$); B, seeds ($\times 8.7$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 15$).



Genus: *Lebeckia* C.P. Thunberg

Phylogenetic Number: 27.10.

Tribe: Crotalariaeae.

Species Studied—Species in Genus: 14 spp.—ca. 35 spp.

Fruit a legume; unilocular; $1.2\text{--}6 \times 0.2\text{--}1.3 \times 0.25$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight to curved; not plicate; not twisted; asymmetrical or symmetrical; linear, oblong, or elliptic (oblong); when asymmetrical with both sutures parallelly to unequally curved; not inflated to inflated; flattened to terete; without beak; short tapered to rounded at apex; apex aligned with longitudinal axis of fruit; tapered to rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; membranous to coriaceous; seed chambers externally visible; with the raised seed chambers torulose or not torulose. Fruit margin not constricted; without sulcus; plain or embellished. Fruit wing present or absent; 1; 1–2 mm wide; sutural; on 1 suture. Fruit stipitate to substipitate; with the stipe up to 30 mm long. Fruit with all layers dehiscing or indehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible. Epicarp dull; monochrome; reddish brown or tan; glabrous or pubescent and indurate; with hairs appressed; with 1 type of pubescence; with pubescence gray; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; tan; smooth and cobwebby (smooth below seeds and cobwebby between seeds and in areas without seeds); septate or nonseptate; with septa thin (tissue paper-like), flexible; with septa eglandular; coriaceous to chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–8; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent.

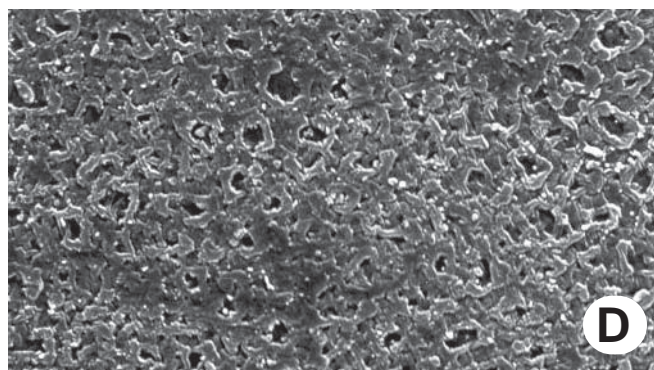
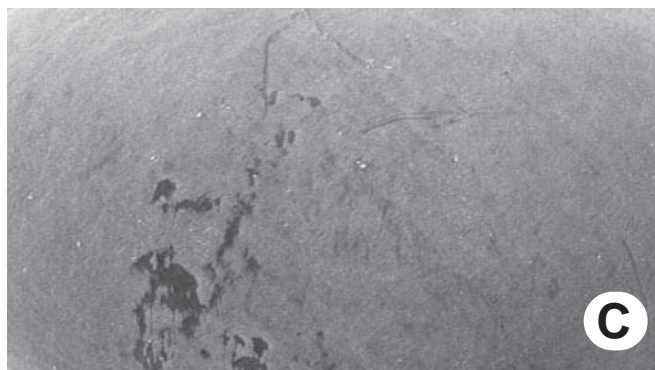
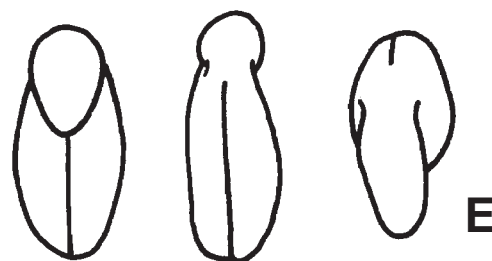
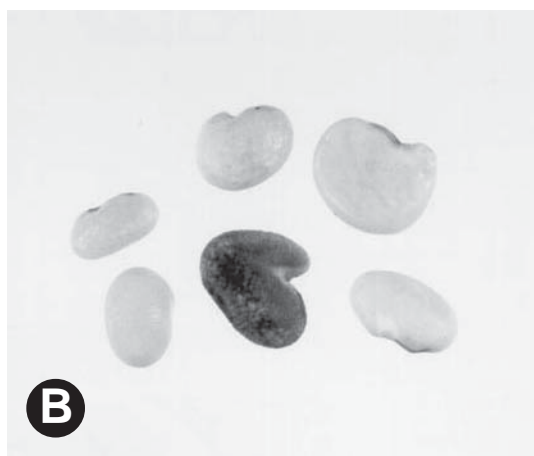
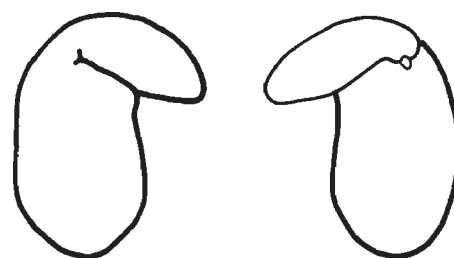
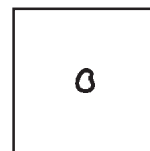
Seed $3\text{--}4 \times 1.7\text{--}2.2 \times 1.2\text{--}1.5$ mm; not overgrown; not angular to angular; asymmetrical; obliquely cordate, oblong (reniform), rectangular, or reniform; compressed; with visible (barely) radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering

to endocarp; dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; tan; with brown (dark reddish to purplish) overlay; glabrous; smooth or not smooth; with elevated features; faintly warty; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; recessed; within rim, halo, and corona or within rim. Hilum corona color darker than testa. Hilum halo color of testa. Hilum rim color of or darker than testa. Lens discernible; equal to or greater than 0.5 mm in length; 0.7–1 mm long; with margins straight or curved; wedge-shaped (elongated and ending or not in circular area) or circular (above elongated wedge-shape); not in groove of raphe; adjacent to hilum; mounded; dissimilar color from testa; darker than testa; reddish to orangish to dark brown; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle bulbous; deflexed and parallel to cotyledon width to deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary or moderately developed; glabrous.

Distribution: Namibia, Botswana, and South Africa (Cape Province).

Notes: Polhill (1981q) noted that *Lebeckia* is “virtually indistinguishable” from *Spartidium* (27.04). Number of species and distribution taken from Wyk (1991) and Wyk and Schutte (1995).

Lebeckia: *L. capensis* (C. Linnaeus) G.C. Druce (C–E), *L.* spp. (A–B). A, Fruits and valves ($\times 1.6$); B, seeds ($\times 4.6$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 9$).



Genus: *Wiborgia* C.P. Thunberg

Phylogenetic Number: 27.11.

Tribe: Crotalariaeae.

Species Studied—Species in Genus: 10 spp.—10 spp.

Fruit a legume or nutlet; unilocular; $0.7\text{--}3.2 \times 0.4\text{--}1.8 \times 0.15\text{--}0.5$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; circular, elliptic, oblong, or ovate; when asymmetrical with both sutures parallelly curved or nearly straight; not inflated or inflated (*W. humilis* (C.P. Thunberg) R. Dahlgren); flattened, compressed, or terete (because crested); without beak; short tapered or rounded at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned or oblique with longitudinal axis of fruit; with the apex and base uniform in texture; fragile, thinner than chartaceous like *Trifolium* (21.06); seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; embellished. Fruit wing 1; $0.5\text{--}5$ mm wide (broadest in *W. monoptera* E.H.F. Meyer and *W. sericea* C.P. Thunberg); samaroid or sutural; on 1 suture or both sutures. Fruit stipitate or substipitate; with the stipe 5 mm long. Fruit indehiscent. Replum invisible. Epicarp dull or glossy; monochrome (though wings may be a different shade); black or brown (to black-brown and with or without patches of brown); with surface texture uniform or not uniform, with patches of different texture not restricted to the base and apex; glabrous; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thick; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; subligneous or coriaceous. Endocarp glossy; monochrome; brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–3; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; up to 1 mm long; of 1 length only; filiform; curved. Aril absent.

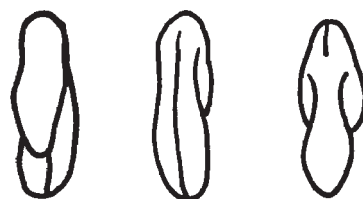
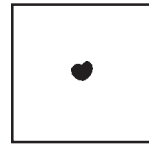
Seed $3\text{--}4 \times 2.5\text{--}2.8 \times 1.5\text{--}1.8$ mm; not overgrown; not angular to angular (somewhat); asymmetrical; ovate or rectangular; compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored or clear; monochrome; salmon brown or orange

(light); glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible, fully concealed, or partially concealed; concealed by funicular remnant or wing; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; recessed; within rim. Hilum rim color of or darker than testa (green). Lens discernible; equal to or greater than 0.5 mm in length; $0.8\text{--}1.5$ mm long; with margins straight or curved; oblong (with narrow extension or full body reaching to hilum); not in groove of raphe; adjacent to hilum; mounded; dissimilar color from testa; darker than testa; brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow or tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle bulbous; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

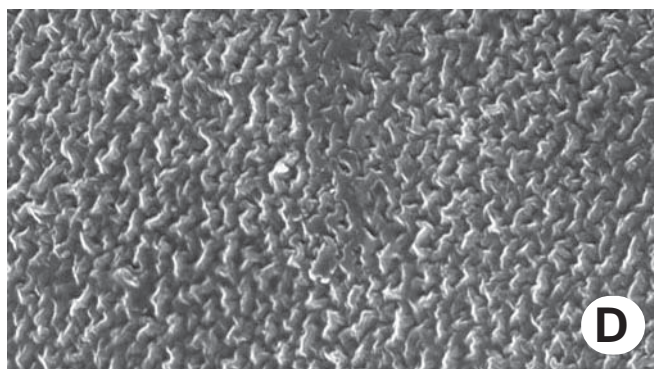
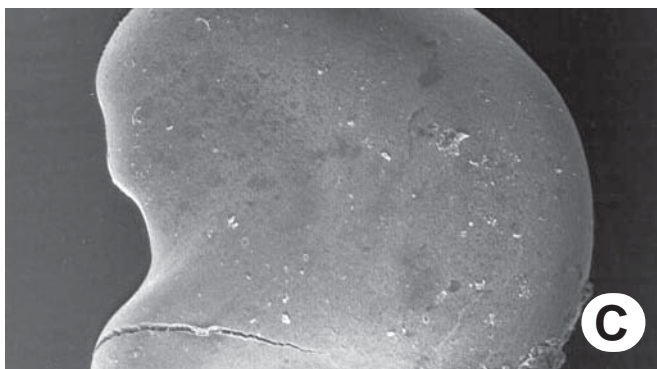
Distribution: South Africa (southern and southwestern Cape Province).

Notes: Dahlgren (1975) monographed the genus and illustrated fruits of the species. He noted that fruit characters are important in “distinguishing *Wiborgia* from the similar species of *Lebeckia*” (27.10). Fruits of most species are typical samaras. However, the fruit of *W. humilis* (C.P. Thunberg) R. Dahlgren is a stipitate nutlet with no dorsal wing, and the fruits of *W. leptoptera* R. Dahlgren and *W. obcordata* (B. Bergius) C.P. Thunberg have a distinct upper ridge reminiscent of the wing in other species. The wing tissue may or may not be reticulate, but the fruit tissue over the seed chamber is always reticulate.

Wiborgia: *W. mucronata* (C. Linnaeus) A.P. Druce (C–E), *W. spp.* (A–B). A, Fruits ($\times 2.1$); B, seeds ($\times 5.3$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 7$).



E



Euchrestea (28.01)

Genus: *Euchrestea* J.J. Bennett

Phylogenetic Number: 28.01.

Tribe: Euchrestea.

Species Studied—Species in Genus: 2 spp.—4 spp.

Fruit a legume; unilocular; $1.2\text{--}2.2 \times 0.8\text{--}1 \times 0.5\text{--}0.6$ cm; with deciduous corolla; with deciduous calyx without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical; oblong; not inflated; compressed; without beak; rounded at apex; apex aligned with longitudinal axis of fruit; rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; fleshy (when fresh), drupaceous, or leathery (when dry); seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit stipitate to substipitate; with the stipe 3–12 mm long. Fruit indehiscent. Replum invisible. Epicarp dull or glossy; monochrome; violet-black; glabrous; eglandular; without spines; smooth or not smooth; with elevated features; not veined; not tuberculate; wrinkled; not exfoliating; without cracks. Mesocarp thin; 1-layered; without balsamic vesicles; without fibers; spongy; coriaceous. Endocarp dull; monochrome; tan; cobwebby or spongy; nonseptate; not exfoliating; remaining fused to epicarp; entire. Seed 1; length parallel with fruit length. Funiculus less than 0.5 mm long; of 1 length only; straight. Aril absent.

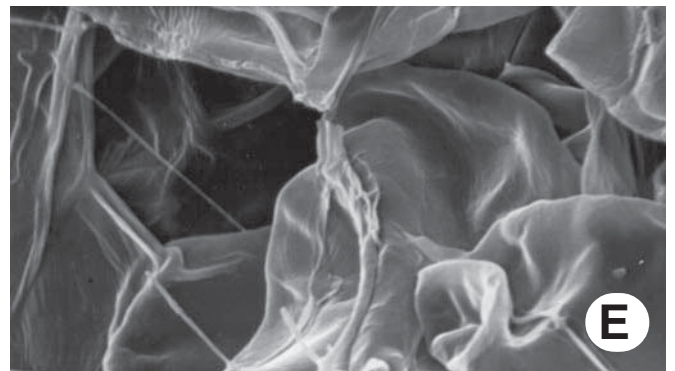
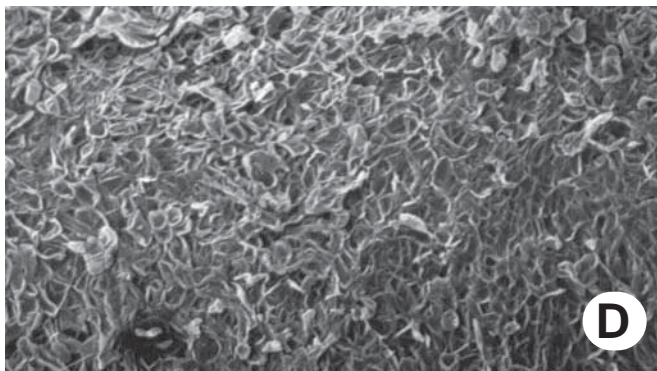
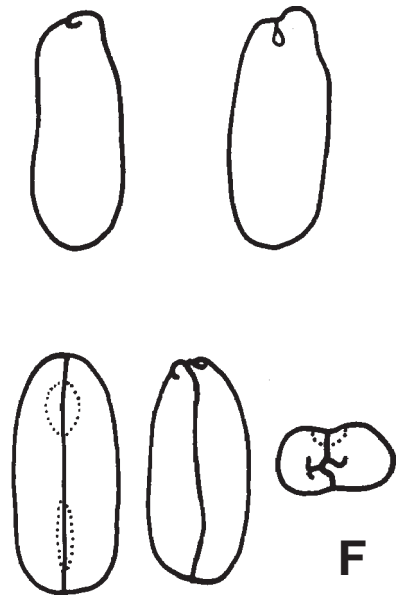
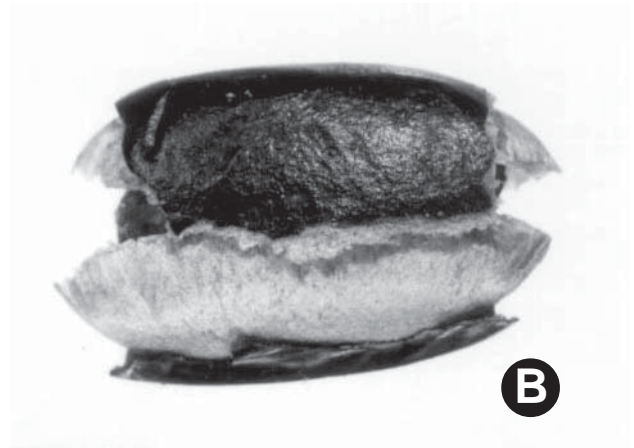
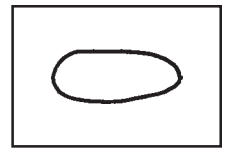
Seed $12\text{--}20 \times 6\text{--}8 \times 3\text{--}4$ mm; not overgrown; not angular; symmetrical; oblong; compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; tan; glabrous; smooth; chartaceous. Pleurogram absent. Fracture lines absent. Rim absent. Raphe from hilum to near base of seed and terminating; not bifurcating; darker than testa; black; raised. Hilum visible; without faboid split; punctiform; subapical to radicle tip; flush; not within corona, halo, or rim. Endosperm absent. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; completely concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; red. Cotyledons inner face flat; glabrous around base of radicle;

embryonic axis right angled. Embryonic axis perpendicular to length of seed; radicle linear; radicle with 90 degree turn. Radicle centered between cotyledons; less than one half length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Northeastern India to southern Japan to Philippines and Malay Islands.

Notes: Ohashi (1978) reported on the taxonomy and distribution of *E. japonica* (J.D. Hooker) E.A. von Regel and concluded that *E. trifoliolata* E.D. Merrill is a synonym. Therefore, the number of species is four, not five. The testa is fragile and difficult to completely separate from the endocarp. The cotyledons are free of the testa and rattle when seeds are shaken. Apparently seeds germinate while still in the moist fruit. Our seed measurements are based on interior fruit measurements because the testae were too fragile to measure.

Euchrestea: *E. horsfieldii* (J.B.L.T. Lescherault de la Tour) J.J. Bennett (*D–F*), *E. spp.* (*A–C*). *A*, Fruits ($\times 2.1$); *B*, open fruit ($\times 3.7$); *C*, seeds ($\times 3.7$); *D–E*, testa ($\times 50$, $\times 1000$); *F*, embryos ($\times 2$).



Thermopsidae (29.01–29.06)

Genus: *Ammopiptanthus* S.F. Cheng

Phylogenetic Number: 29.01.

Tribe: Thermopsidae.

Species Studied—Species in Genus: 2 spp.—2 spp.

Fruit a legume; unilocular; $4-8 \times 1.5-2 \times 0.1-0.25$ cm; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; asymmetrical or symmetrical; oblong; when asymmetrical with both sutures nearly straight; not inflated; flattened; without or with beak; straight or declined; with solid beak the same color and texture as fruit; short tapered at apex; apex aligned or oblique with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous; seed chambers externally visible. Fruit margin not constricted or constricted; slightly constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit stipitate; with the stipe up to 8 mm long. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive. Replum invisible. Epicarp dull; monochrome; tan; glabrous; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp quite thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; chartaceous. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 2–5; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent (but indurate funiculus present).

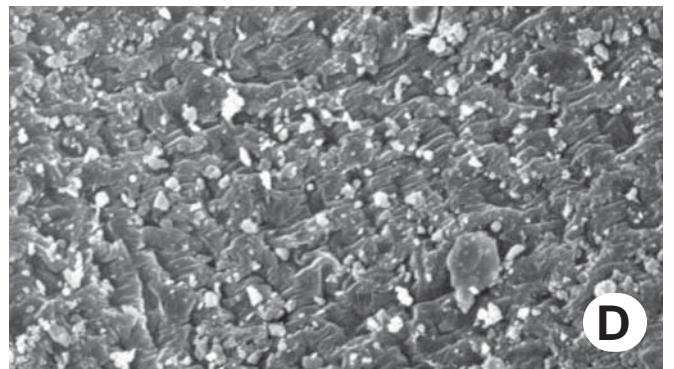
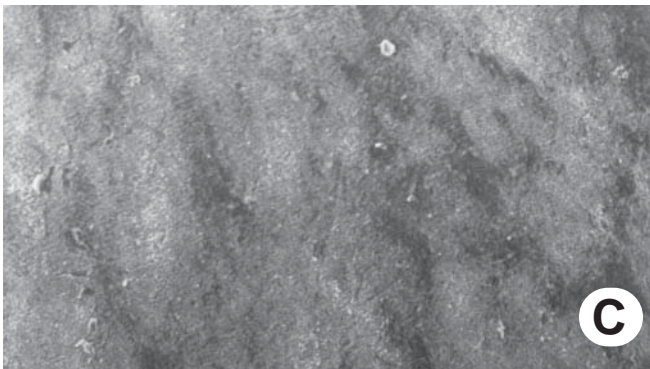
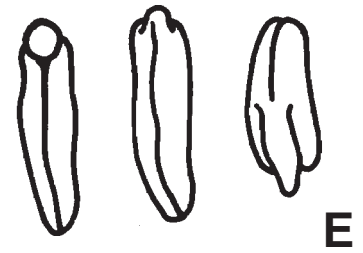
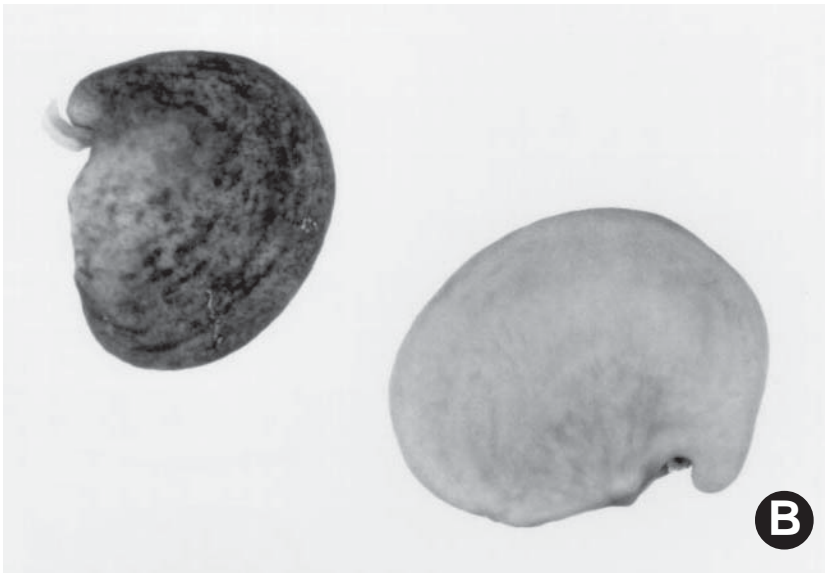
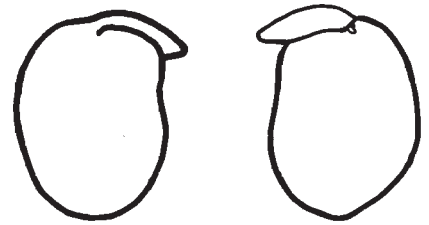
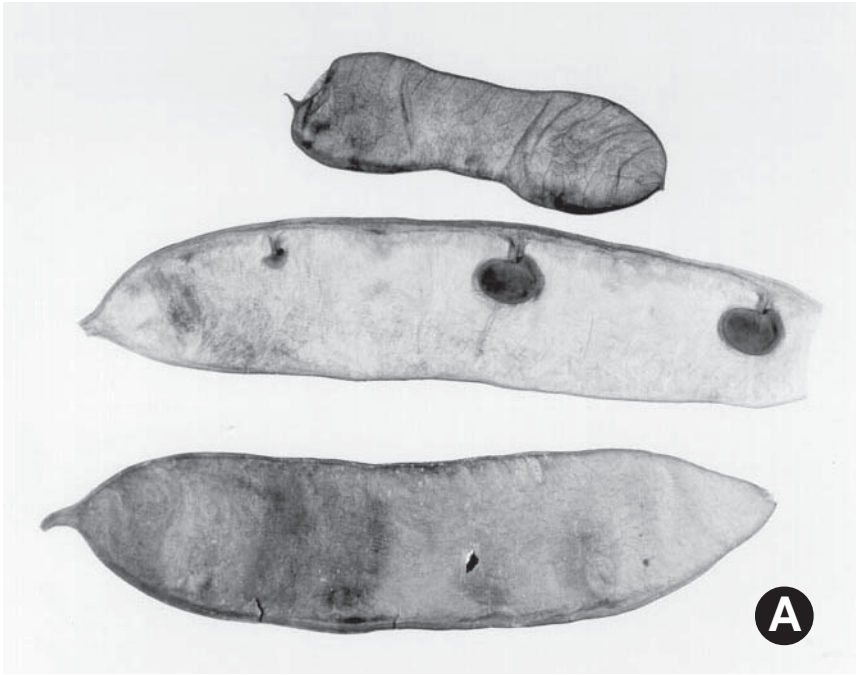
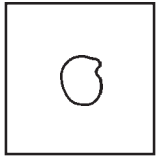
Seed $5-8 \times 5-7 \times 1.5-1.6$ mm; not overgrown; not angular; asymmetrical; reniform (rounded); compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; modified by a bloom; colored; mottled to streaked or monochrome; with frequent mottles; with frequent streaks; brown, tan (greenish), or yellow; with black overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe from hilum through lens and terminating before base of seed; not bifurcating; darker than testa; black; slightly raised.

Hilum partially or fully concealed; concealed by funicular remnant, funiculus, or wing; with or without faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.6 mm long; with curved outline; elliptic; between cotyledon and radicle lobe; flush; not within corona, halo, or rim. Lens discernible; equal to or greater than or less than 0.5 mm in length; 0.5 mm long; with margins curved; circular; not in groove of raphe; adjacent to hilum; 0.5 mm from hilum; barely rounded; dissimilar color from testa; darker than testa; brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; partially concealing radicle; notched at radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear; lobe tip curved; deflexed and parallel to cotyledon width; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Russia to Mongolia (Inner and Outer) and China.

Notes: Yuan and Peng (1990) reevaluated the 6 genera and 47 species in the tribe, and their data confirms the information reported by Turner (1981). Turner recognized 46 species and 6 genera in the tribe. Cheng (1959) monographed the genus and illustrated the fruits and seeds of both species. Turner (1981) noted “one or possibly two species,” and Yuan and Peng (1990) recognized two species, the number which we used.

Ammopiptanthus: *A. mongolicus* (C.J. Maximowicz) S.-H. Cheng (C–E), *A.* spp. (A–B). A, Fruits ($\times 1.2$); B, seeds ($\times 7.3$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 3$).



Genus: *Piptanthus* R. Sweet

Phylogenetic Number: 29.02.

Tribe: Thermopsidae.

Species Studied—Species in Genus: 2 spp.—2–3 spp.

Fruit a legume; unilocular; $7-9 \times 1-1.3 \times 0.18-0.2$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight to curved (to slightly curved); not plicate; not twisted; asymmetrical or symmetrical; linear; when asymmetrical with both sutures nearly straight; not inflated; flattened; without beak; tapered or short tapered at apex; apex aligned or oblique with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible. Fruit margin constricted or not constricted; constricted along both margins (not regularly); without sulcus; plain. Fruit wings absent. Fruit stipitate or substipitate; with the stipe 5–20 mm long. Fruit with all layers dehiscent or indehiscent; splitting along sutures. Dehiscence of valves passive. Replum invisible. Epicarp dull; monochrome; brown or tan (and brown over seeds); pubescent and indurate; with hairs appressed or erect; with 1 type of pubescence; tomentose; with pubescence golden (*P. tomentosa* A.R. Franchet) or gray (*P. nepalensis*); with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp quite thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; chartaceous. Endocarp dull; monochrome; dark brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; separating into 1-seeded winged segments. Seeds 2–10; length transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 3 mm long; of 1 length only; thick; straight. Aril absent.

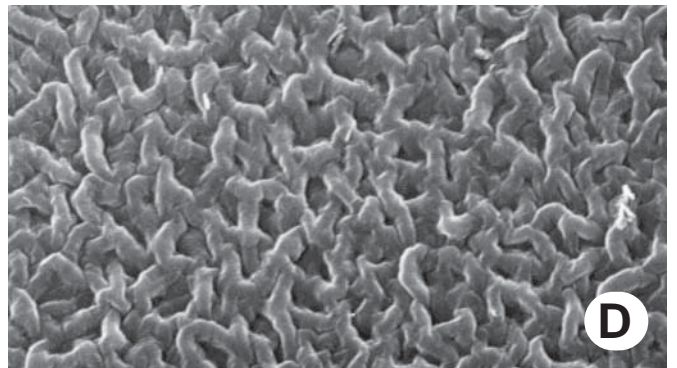
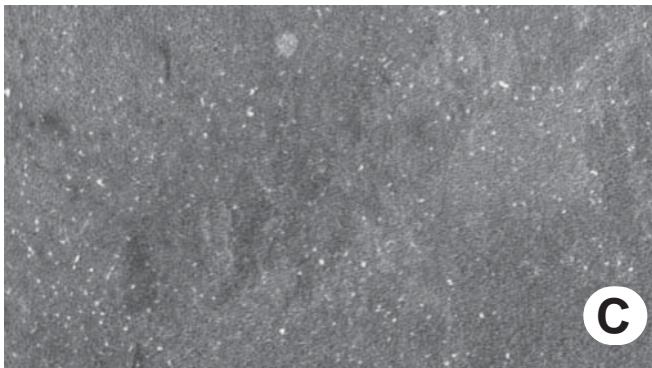
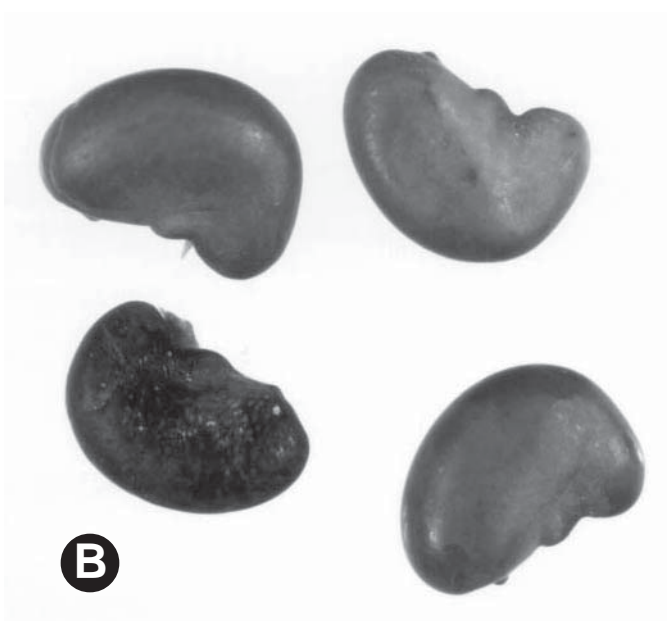
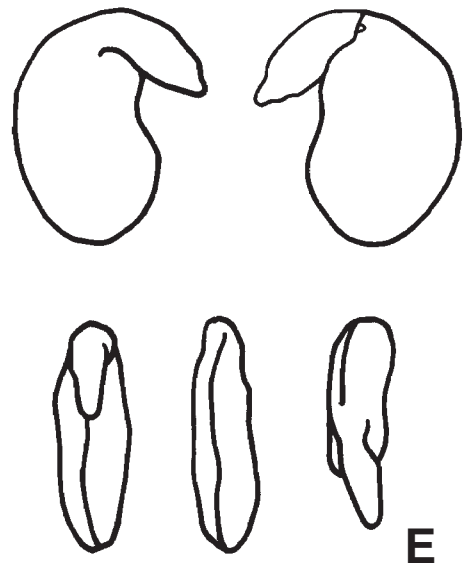
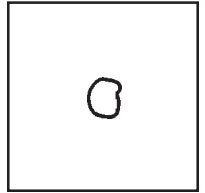
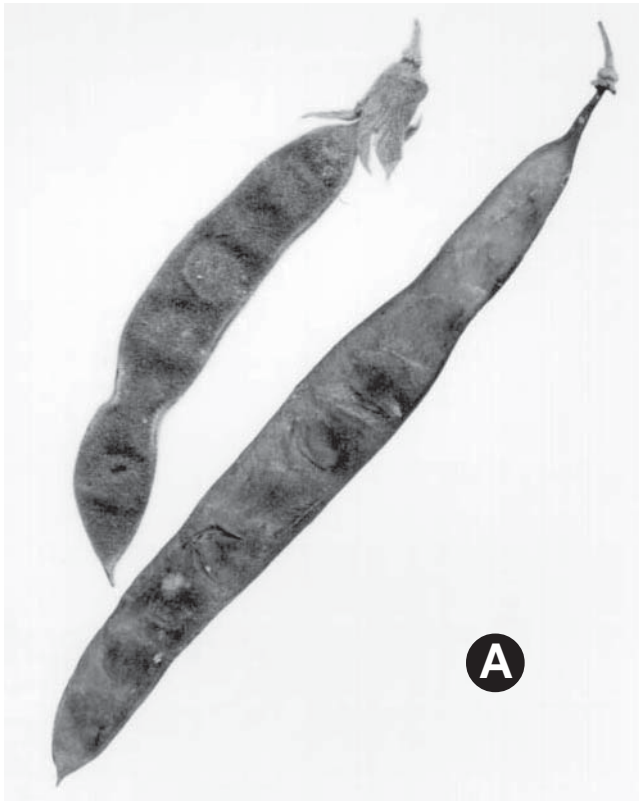
Seed $5-7 \times 4.3-5 \times 1.5-3.5$ mm; not overgrown; not angular; asymmetrical; oblong (with radicle lobe); compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; greenish or reddish brown or tan (reddish); with reddish brown or green

overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe from hilum through lens and terminating before base of seed; not bifurcating; darker than testa; brown; flush. Hilum partially concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform or punctiform; 0.3–0.7 mm long; with curved outline; circular; between cotyledon and radicle lobe; recessed; within rim. Hilum rim color of or darker than testa. Lens discernible; less than or equal to or greater than 0.5 mm in length; 0.5–1 mm long; with margins curved; circular; not in groove of raphe; adjacent to hilum; 1.3–1.5 mm from hilum; mounded; dissimilar color from testa; darker than testa; dark brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa (and a sheath around radicle). Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle bulbous; deflexed and parallel to cotyledon length or width; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

Distribution: India, Nepal, and China.

Notes: Turner (1980), who monographed the genus, recognized two species, but later, he noted the species number as two or three (Turner 1981). We noticed that the area under the hilum is thick and spongy.

Piptanthus: *P. nepalensis* (W.J. Hooker) D. Don (B–E), *P.* spp. (A). A, Fruits ($\times 1.3$); B, seeds ($\times 5.7$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 6$).



Genus: *Anagyris* C. Linnaeus

Phylogenetic Number: 29.03.

Tribe: Thermopsideae.

Species Studied—Species in Genus: 2 spp.—1 or 2 spp.

Fruit a legume; unilocular; up to 13×1.5 – 2×0.3 – 1.3 cm; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; symmetrical; broadly linear; not inflated; flattened or compressed; without or with beak; straight; with solid beak the same color and texture as fruit; tapered or rounded at apex; apex aligned with longitudinal axis of fruit (or nearly so); long tapered or rounded at base; base aligned with longitudinal axis of fruit (or nearly so); with the apex and base uniform in texture; coriaceous or ligneous (when dry); seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit stipitate; with the stipe up to 10 mm long. Fruit indehiscent. Replum invisible. Epicarp dull; monochrome; brown; glabrous; eglandular; without spines; smooth; not veined; not tuberculate; not exfoliating; without cracks. Mesocarp thick or thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; spongy or solid; coriaceous or ligneous. Endocarp dull; monochrome; brown; smooth; septate; with septa thin (tissue paper-like), flexible; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 5; length transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; straight. Aril absent.

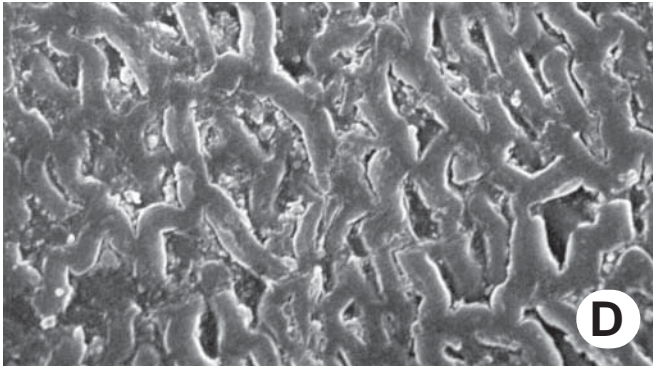
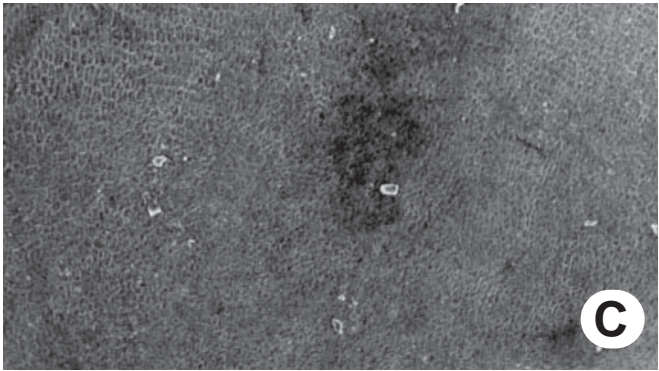
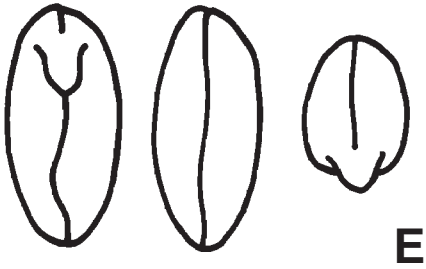
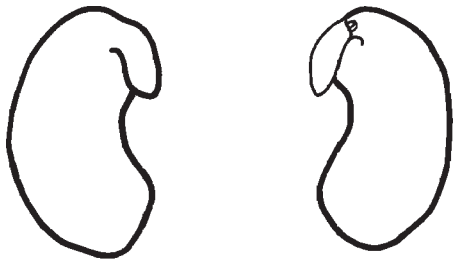
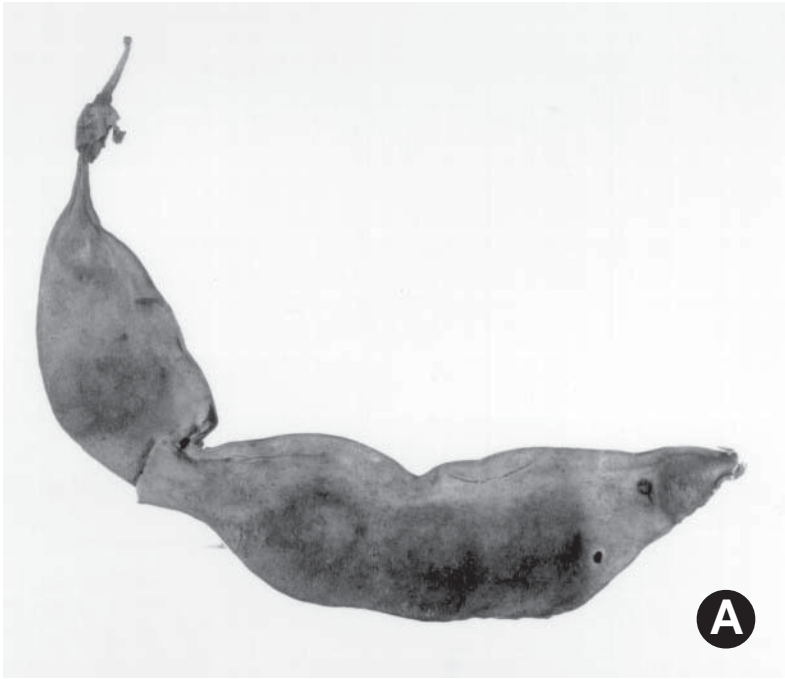
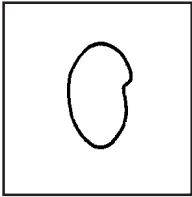
Seed 10 – 15×7 – 10×5 – 6.7 mm; not overgrown; not angular; asymmetrical; elliptic to oblong; compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome; dark to light brown or tan; glabrous; smooth; osseous. Fracture lines absent. Rim absent. Wings absent. Raphe from hilum through lens and terminating before base of seed; not bifurcating; darker than testa; dark reddish brown; flush. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 2 mm long; with curved or straight outline; elliptic or oblong; marginal according to radicle tip; recessed; within rim. Hilum rim color of testa. Lens discernible; equal to or greater than 0.5

mm in length; 1 mm long; with margins curved; circular; not in groove of raphe; adjacent to hilum; 2 mm from hilum; barely mounded; dissimilar color from testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; with 1 or both margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear; lobe tip curved; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Mediterranean Europe, Asia Minor, northern Africa, and Canary Islands.

Notes: We are still unsure whether one or two species exist in *Anagyris*. The other possible species (besides *A. foetida*) is *A. latifolia* P.M.A. Broussonet ex C.L. von Willdenow (Hansen and Sundling 1993).

Anagyris: *A. foetida* C. Linnaeus (A–E). A, Fruits ($\times 1.1$); B, seeds ($\times 2.5$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 2$).



Genus: *Thermopsis* R. Brown

Phylogenetic Number: 29.04.

Tribe: Thermopsideae.

Species Studied—Species in Genus: 17 spp.—23 spp.

Fruit a legume or loment (or a loment segment, or at least lomentaceous); unilocular; $3-10 \times 0.8-1 \times 0.15-0.3$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight, curved (or slightly curved), or 0.5-coiled; not plicate; not twisted; asymmetrical or symmetrical; linear, oblong, ovate, or elliptic; when asymmetrical with both sutures parallelly curved or nearly straight; not inflated or inflated (*T. inflata* J. Cambessedes); flattened or compressed; without beak; short tapered or rounded at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned or right angled with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate or nonstipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive. Replum invisible. Loment indehiscent. Loment segments widest across seed area; rectangular. Epicarp dull; monochrome; brown; glabrous or pubescent and indurate; with hairs erect or appressed; with 1 type of pubescence; puberulent or villous; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; brown; smooth; nonseptate or septate; with septa thicker than paper, firm; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 2–11; length transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight or hooked. Aril dry; when dry rim-aril, or partial rim-aril; lacinate, or entire; covering less than 1/2 of seed; without tongue (or flap-like) on lips of 2-lipped rim-aril; white.

Seed $3.2-6 \times 2-4 \times 1.5-2.8$ mm; not overgrown; not angular; asymmetrical; reniform (or nearly so); compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull or glossy; not modified or modified by a bloom; colored; monochrome or bichrome; greenish or reddish black, black, brown (yellow, orange, or brown), purple, or orange; glabrous; not smooth or smooth; with elevated features; blistered cuticle (exudate); coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible or visible; from hilum through lens and terminating before base of seed; not bifurcating; color of or darker than testa; brown; raised. Hilum partially concealed; concealed by funicular remnant or wing; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; recessed; within rim. Hilum rim color of testa. Lens discernible or not discernible; less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; adjacent to hilum; 0.5 mm from hilum; mounded; same color or similar color as testa; darker than testa; black or brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa or embryo. Cotyledons smooth; both outer faces convex; both the same thickness; 1 longer than other; not folded; margin entire 180 degrees from base of radicle; similar at apex; completely concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon width; not centered between cotyledons (radicle outside 1 cotyledon and inside other, therefore junctions for each cotyledon different); less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

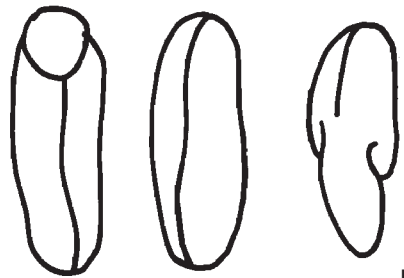
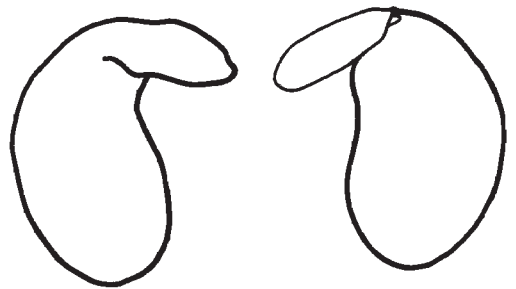
Distribution: North America (10 spp.) and Asia (13 spp.).

Notes: Larisey (1940b), Isley (1981), and Chen et al. (1994) monographed the North American species, and Barneby (1989) treated the species for the intermountain region of the western United States. Larisey and Chen et al. used narrow species concepts, and recognized 10 species in North America—the number we used for our species count. Isley and Barneby employed much broader species concepts. Isley accepted only four species in North America, and Barneby just three. Most species have a dehiscent legume, but a few species have lomentaceous fruits and these should be studied. Species producing the latter include *T. divaricarpa* A.

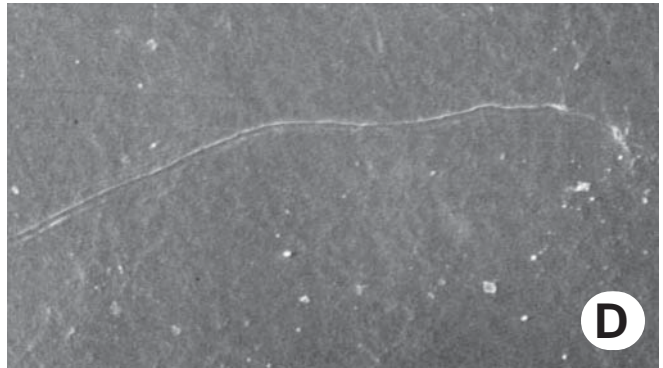
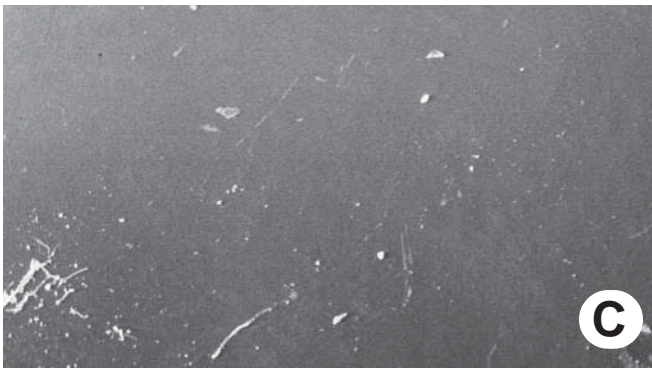
Nelson, *T. gracilis* T.J. Howell, and *T. rhombifolia* (T. Nuttall ex F.T. Pursh) J. Richardson.

Thermopsis: *T. lupinoides* (C. Linnaeus) J.H.F. Link (*C–E*),
T. spp. (*A–B*). *A*, Fruits ($\times 1.4$); *B*, seeds ($\times 6.6$); *C–D*,
testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 8$).

3



E



Genus: *Baptisia* É.P. Ventenat

Phylogenetic Number: 29.05.

Tribe: Thermopsidae.

Species Studied—Species in Genus: 7 spp.—17 spp.

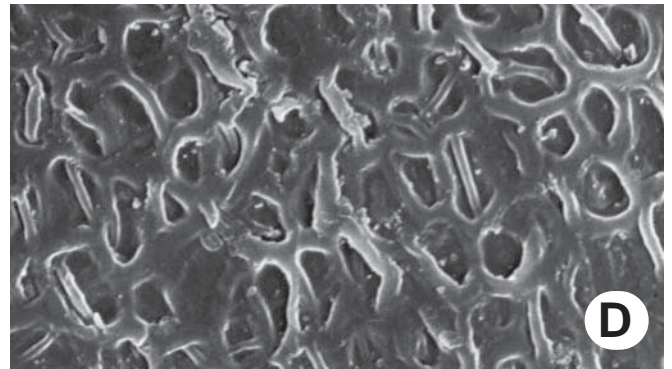
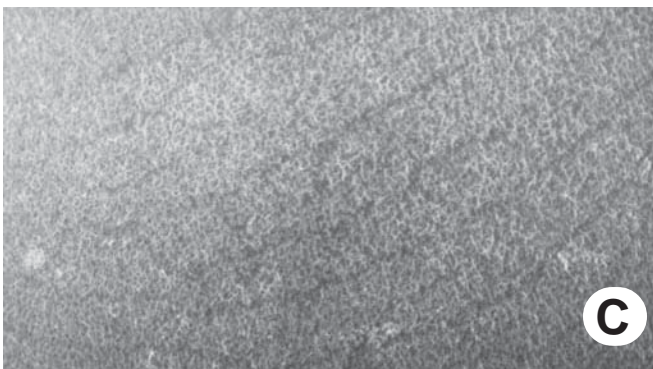
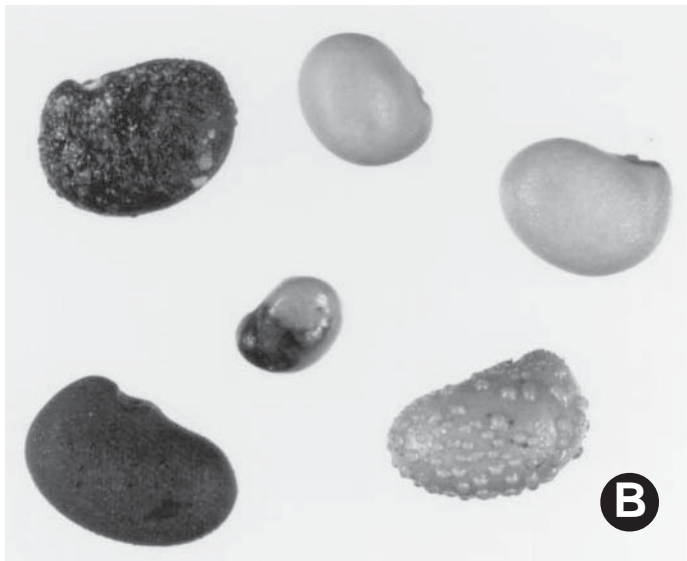
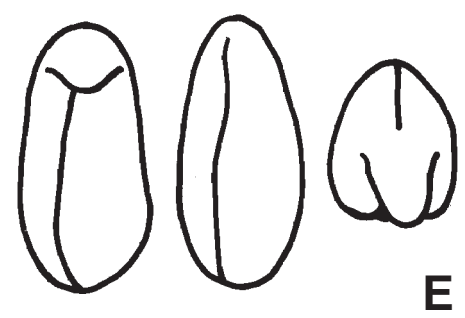
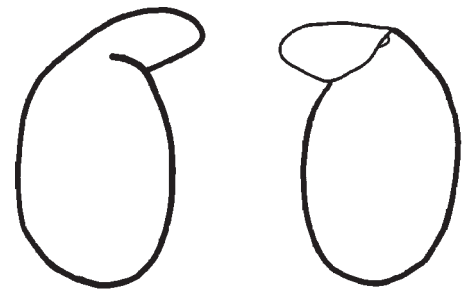
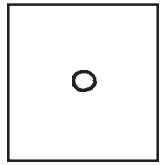
Fruit a legume; unilocular; $1-7 \times 0.2-2.5 \times 0.7-2$ cm; with persistent or deciduous calyx; with calyx shorter than or equal in length to fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; symmetrical or asymmetrical; oblong, ovate, circular, or elliptic; when asymmetrical with both sutures parallelly curved or 1 straight and 1 curved suture; widest near middle or D-shaped; usually inflated or not inflated; terete; without or with beak; straight; with solid beak the same color and texture as fruit; rounded or long tapered at apex; apex aligned or oblique with longitudinal axis of fruit; long tapered or rounded at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; ligneous, coriaceous, or membranous (*B. megacarpa* A.W. Chapman ex J. Torrey & A. Gray); seed chambers externally invisible. Fruit margin not constricted; without or with sulcus; plain. Fruit wings absent. Fruit stipitate or substipitate; with the stipe 4–13 mm long. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive. Replum invisible. Epicarp dull or semiglossy; monochrome; dark to yellowish to reddish to purplish brown or black (brownish); glabrous or pubescent and indurate; with hairs appressed (sub) or erect; with 1 type of pubescence; villous; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; smooth or not smooth; with elevated features; reticulately veined; not tuberculate; wrinkled or rugose; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; subligneous, coriaceous, or chartaceous. Endocarp dull; monochrome; dark to light brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 20–30 (estimated); length transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 3.5 mm long; of 1 length only; thick; straight. Aril absent or present (really funicular remnant); dry; rim-aril; brown.

Seed $2.5-4.5 \times 2-3 \times 1.6-2$ mm; not overgrown; not angular; asymmetrical; D-shaped (with inconspicuous radicle lobe); compressed; with visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull or glossy; modified by a bloom; colored; monochrome; yellowish to dark brown, tan, or white; glabrous; smooth or not smooth; with elevated features; tuberculate (glandular exudates) or blistered cuticle (*B. megacarpa* A.W. Chapman ex J. Torrey & A. Gray); coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe from lens to base of seed and terminating (near base); not bifurcating; darker than testa; black; slightly recessed or flush. Hilum partially concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform or larger than punctiform; 0.3–0.4 mm long; with curved outline; circular; between cotyledon and radicle lobe; recessed; within rim or halo (occasionally and faintly). Hilum halo color darker than testa. Hilum rim color of testa. Lens discernible or not discernible; less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; adjacent to hilum; 2 mm from hilum; flush; dissimilar color from testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow or tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear; lobe tip curved; deflexed and parallel to cotyledon width; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Eastern Canada, United States, and Mexico.

Notes: Larisey (1940a) and Isley (1981) monographed *Baptisia*. Occasionally, three cotyledons are found in the seed.

Baptisia: *B. alba* (C. Linnaeus) É.P. Ventenat (C–E), *B.* spp. (A–B). A, Fruits ($\times 1.2$); B, seeds ($\times 7.2$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 12$).



Genus: *Pickeringia* T. Nuttall ex J. Torrey & A. Gray

Phylogenetic Number: 29.06.

Tribe: Thermopsidae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; unilocular; $2-5 \times 0.4-0.5 \times 0.2$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; slightly curved; not plicate; not twisted; symmetrical; linear; not inflated; compressed; with beak; straight; with solid beak the same color and texture as fruit; long tapered at apex; apex aligned or oblique with longitudinal axis of fruit; long tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible or invisible; with the raised seed chambers not torulose. Fruit margin constricted along both margins (by abortion of ovules); without sulcus; plain. Fruit wings absent. Fruit stipitate; with the stipe 5–6 mm long. Fruit with all layers dehiscent; splitting along suture. Dehiscence of valves along 1 suture; assumed apical and down; passive. Replum invisible. Epicarp dull; monochrome; light brown; pubescent and indurate; with hairs appressed; with 1 type of pubescence; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp present (other mesocarp characters are assumed); thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; chartaceous. Endocarp dull; monochrome; tan; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–10; length parallel with fruit length; neither overlapping nor touching or touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent.

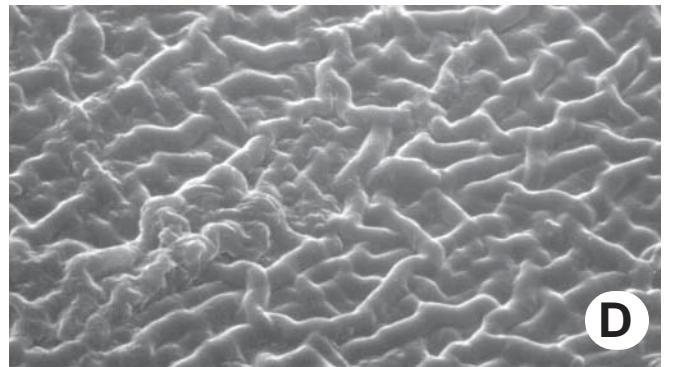
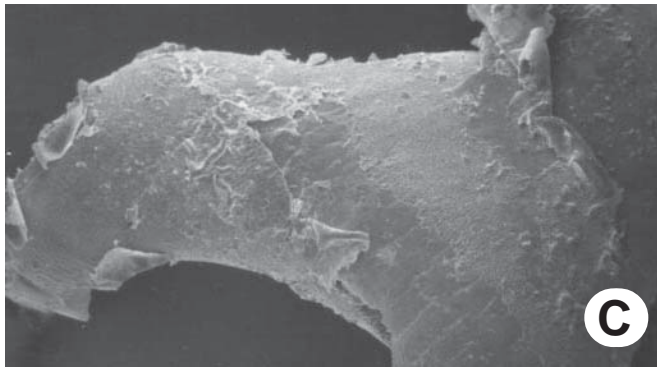
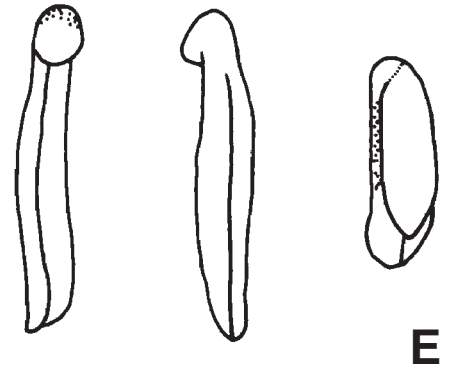
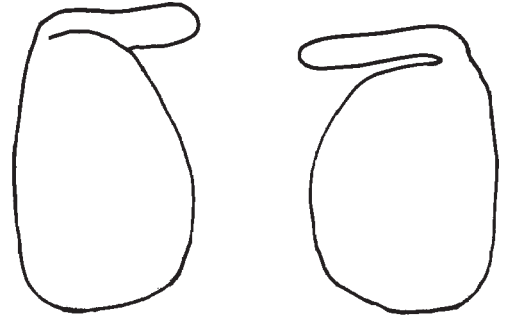
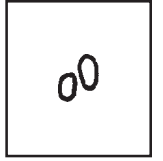
Seed $3-4.2 \times 2-2.5 \times 1-1.5$ mm; not overgrown; not angular; asymmetrical; rectangular or reniform; compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; modified by a bloom; colored; monochrome; brownish black; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe from hilum through lens and terminating before base of seed; not bifurcating; color of testa;

raised. Hilum partially or fully concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; marginal according to radicle tip; recessed; within rim. Hilum rim color of testa. Lens discernible; less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; adjacent to hilum; 0.5 mm from hilum; mounded; same color as testa; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; parallel to length of seed; without a joint evident between the radicle and the cotyledons. Radicle differentiated from cotyledon; linear; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: United States (north-central California) to Mexico (northern Baja California).

Notes: Isley (1981) revised the genus. *Pickeringia montana* rarely sets fruits and seeds, hence the lack of material for our plate. Some authors, including Isley but not Rudd (1968), recognized var. *tomentosa*, which sets more fruits and seeds. Variety *tomentosa* cannot be separated from var. *montana* by the use of morphological characters.

Pickeringia: *P. montana* T. Nuttall (A), *P. montana* T. Nuttall var. *tomentosa* (L.R. Abrams) I.M. Johnston (C–E), *P. spp.* (B). A, Fruit ($\times 3.7$); B, seeds ($\times 11.3$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



Genisteae (30.01–30.25)

Genus: *Melolobium* C.F. Ecklon & J.M. Zeyher

Phylogenetic Number: 30.01.

Tribe: Genisteae.

Species Studied—Species in Genus: 8 spp.—ca. 20 spp.

Fruit a legume; unilocular; $0.8\text{--}2 \times 0.3\text{--}0.5 \times 0.08\text{--}0.2$ cm; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight or curved; not plicate; not twisted; asymmetrical or symmetrical; linear or oblong (narrowly) to ovate; when asymmetrical with both sutures nearly straight; not inflated; compressed; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers torulose. Fruit margin slightly constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves slightly twisting. Replum invisible. Epicarp dull; monochrome or multicolored; mottled; brown or tan; with brown (reddish) overlay; with mottling over seed chambers; pubescent and indurate; with 1 type of pubescence; tomentose; with pubescence golden or gray; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; not veined; not tuberculate; warty; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; reddish brown; smooth; subseptate; with septa thin (tissue paper-like), flexible; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–8; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; flattened; straight. Aril present (so tiny that it can be missed) or absent; dry; tiny tongue-aril; white.

Seed $2\text{--}2.5 \times 2\text{--}2.5 \times 1.5$ mm; not overgrown; not angular; asymmetrical; ovate to circular (sub); compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled; with frequent mottles; reddish to dark reddish brown; glabrous; smooth; coriaceous. Fracture lines

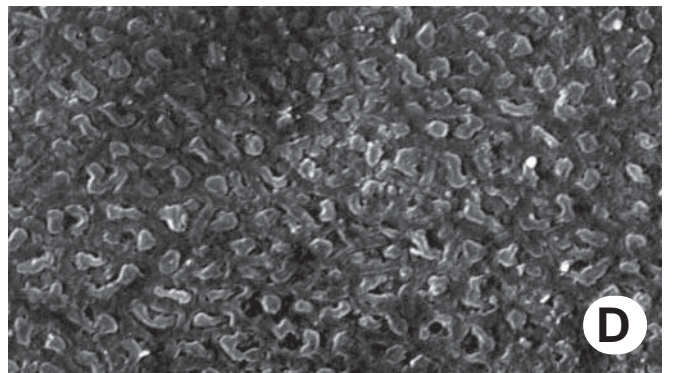
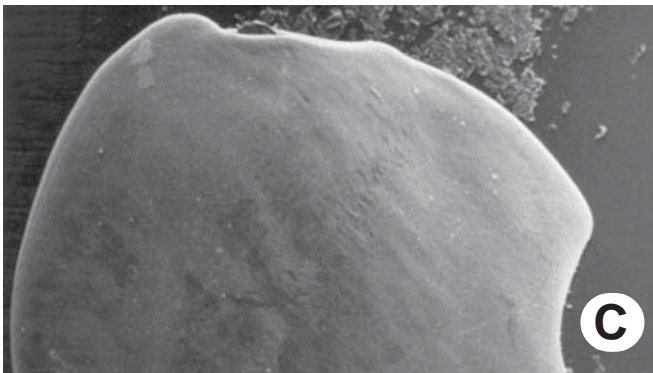
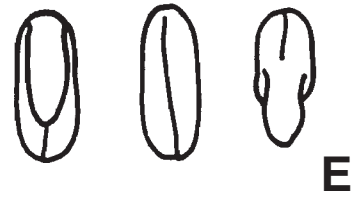
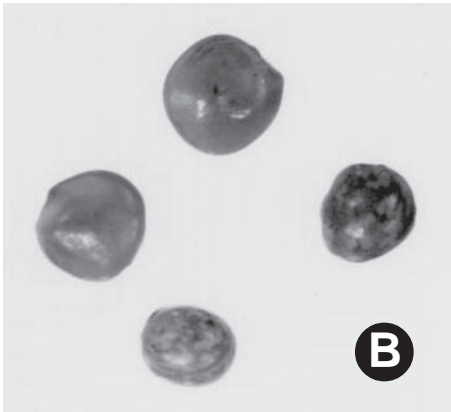
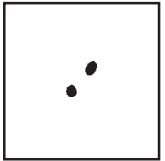
absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; recessed; within rim. Hilum rim color of, lighter than, or darker than testa. Lens discernible; less than 0.5 mm in length; with margins straight or curved; irregular; irregular or key-hole shaped; not in groove of raphe; adjacent to hilum; up to 0.2 mm from hilum; mounded; dissimilar color from testa; darker than testa; black (at least center); not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow or green; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Southern Africa.

Notes: Traditionally this tribe has been called Genisteae.

Reveal (1997) reported that the name Cytiseae was published before the name Genisteae. In accordance with the International Code of Botanical Nomenclature (Greuter et al. 1994), the oldest name for a taxon must be used, so Reveal suggested that this tribe should be called Cytiseae. In 1999, however, Reveal (1999) reversed himself, so this tribe remains the Genisteae. Bisby (1981) summarized the tribe Genisteae, following the excellent study by Polhill (1976). Bisby correctly noted that “many species have been moved from one genus to another several times and the *Cytisus-Genista* complex has gained a reputation as a critical group.” He continued with an in-depth analysis of the tribe. Using chemical and morphological characters, Polhill (1994a,b) and Wyk and Schutte (1995) transferred the following five genera from Crotalariaeae (27) to Genisteae: *Anarthrophyllum* (30.06), *Argyrolobium* (30.03), *Dichilus* (30.02), *Melolobium*, and *Sellocharis* (30.07). Cristofolini (1997) carried out a cladistic study of the tribe’s biogeography and discussed its early evolutionary history. Polhill (1981q) and Wyk (1991) had *Melobium* in Crotalariaeae but later transferred it to the beginning of the Genisteae (Polhill 1994a,b, Wyk and Schutte 1995).

Melolobium: *M. decumbens* (E.H.F. Meyer) J. Burtt Davy
(C-E), *M. spp.* (A-B). A, Fruits ($\times 2.2$); B, seeds
($\times 7.5$); C-D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



Genus: *Dichilus* A.-P. de Candolle

Phylogenetic Number: 30.02.

Tribe: Genisteae.

Species Studied—Species in Genus: 5 spp.—5 spp.

Fruit a legume; unilocular; $0.25\text{--}0.55 \times 0.4 \times 0.14\text{--}0.15$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight to curved (slightly); not plicate; not twisted; asymmetrical or symmetrical; oblong to linear (or narrowly so) or oblong (narrowly); when asymmetrical with both sutures nearly straight; not inflated; compressed; without beak; short tapered at apex; apex oblique with longitudinal axis of fruit; tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin slightly constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible. Epicarp dull; monochrome; brown; glabrous, pubescent and indurate, or pubescent but soon deciduous; with 1 type of pubescence; puberulent (especially along sutures); with pubescence gray; with simple hairs; pliable; with hair bases plain; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; brown; spongy; septate; with septa thin (tissue paper-like), flexible; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 2–9; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent.

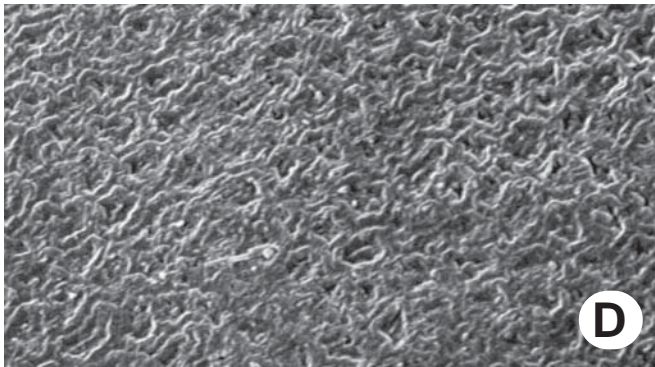
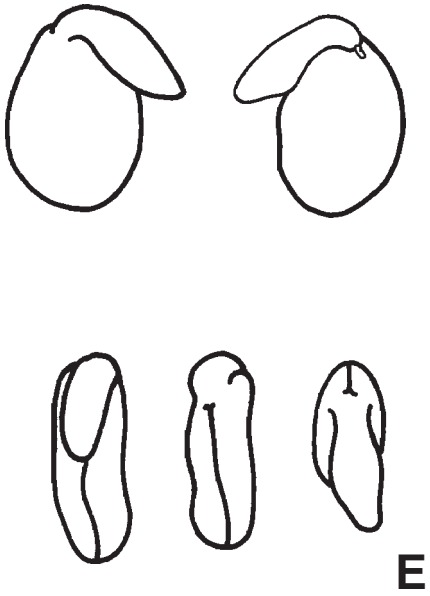
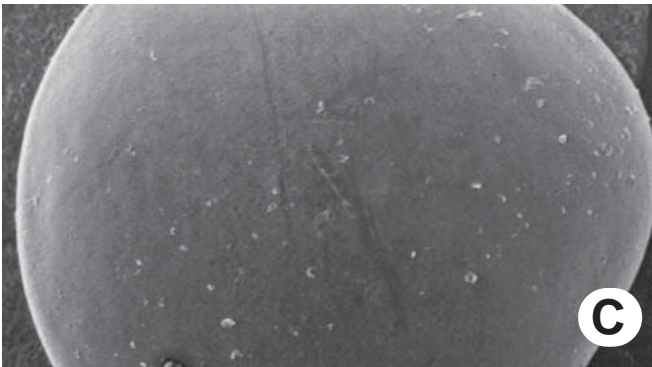
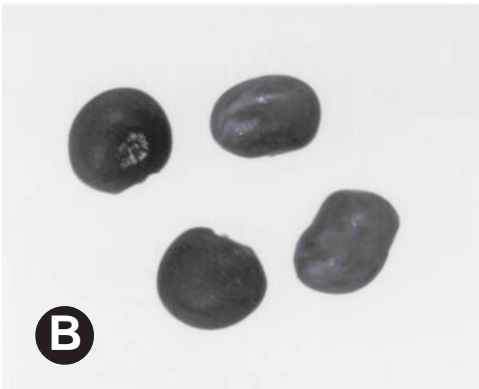
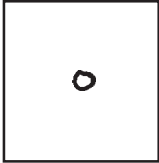
Seed $2.5\text{--}3 \times 2\text{--}2.8 \times 1.5\text{--}1.7$ mm; not overgrown; not angular; asymmetrical; circular or oblong; compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent or infrequent mottles; with frequent or infrequent streaks; black, brown (pale yellow to brown), green (dark to olive), or orange; with black (restricted to black seeds), brown,

green (restricted to green seeds), or yellow (restricted to green seeds) overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by funicular remnant; without faboid split; larger than punctiform; 0.5 mm long; with curved outline; circular; marginal according to radicle tip or between cotyledon and radicle lobe; flush; within rim or not within corona, halo, or rim. Hilum rim color lighter than testa. Lens discernible; equal to or greater than 0.5 mm in length; 0.6–0.9 mm long; with margins straight or curved; wedge-shaped (to hourglass-shaped and surrounded by tan circular patch, when circular tan with reddish-brown and hourglass-shaped to wedge-shaped interior) or circular; not in groove of raphe; adjacent to hilum; 0.1 mm from hilum; mounded; dissimilar color from testa; lighter than testa; tan and brown (reddish); not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons not smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; completely concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle bulbous; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule rudimentary or moderately developed; glabrous.

Distribution: Southern Africa.

Notes: Schutte and Wyk (1988) monographed the genus and illustrated its seeds and fruits. They also analyzed the taxonomic relationships of the species (Schutte and Wyk 1990). Polhill (1981*q*) and Wyk (1991) placed this genus in Crotalariaeae but later transferred it to the beginning of the Genisteae (30) (Polhill 1994*a,b*, Wyk and Schutte 1995).

Dichilus: *D. lebeckioides* A.-P. de Candolle (*C–E*), *D.* spp. (*A–B*). *A*, Fruits ($\times 1.8$); *B*, seeds ($\times 6.8$); *C–D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 8$).



Genus: *Argyrolobium* C.F. Ecklon & J.M. Zeyher

Phylogenetic Number: 30.03.

Tribe: Genisteae.

Species Studied—Species in Genus: 19 spp.—ca. 70 spp.

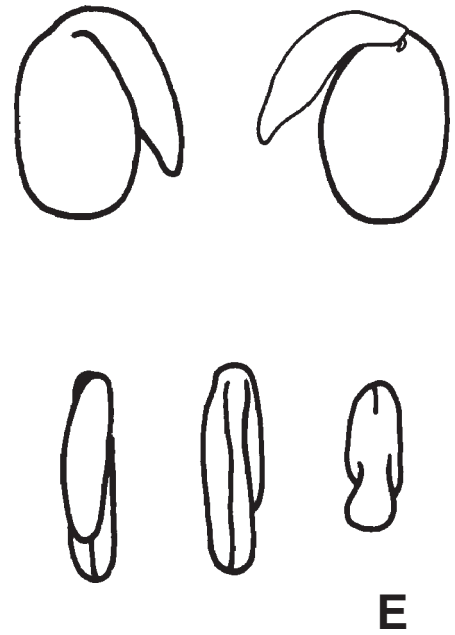
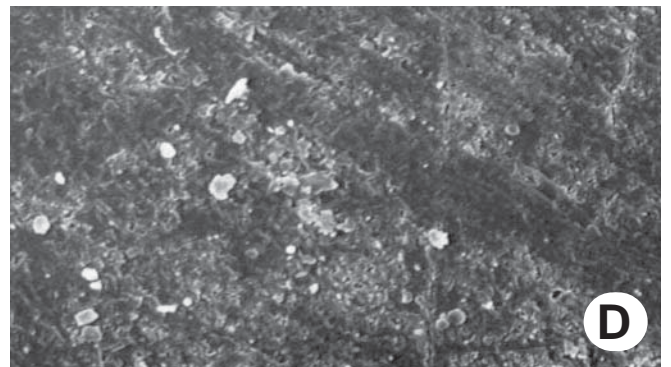
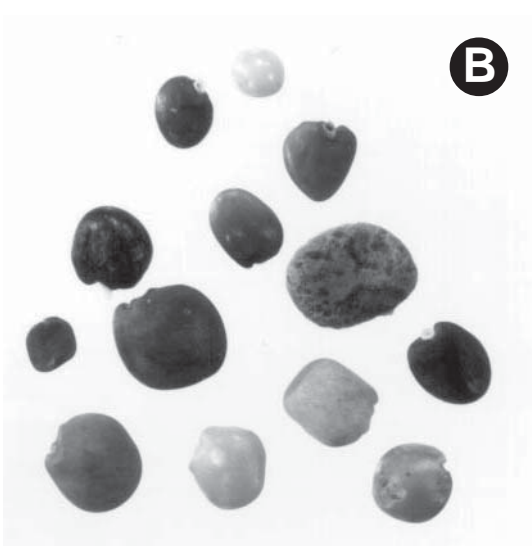
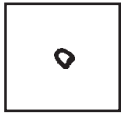
Fruit a legume; unilocular; $0.6\text{--}8.5 \times 0.3\text{--}0.6 \times 0.13\text{--}0.25$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (or slightly curved); not plicate; not twisted; asymmetrical or symmetrical; linear, oblong, ovate, lanceolate, or C-shaped; when asymmetrical with both sutures nearly straight or parallelly curved; not inflated; compressed or flattened; with or without beak; with solid beak the same color and texture as fruit; tapered or short tapered at apex; apex aligned or right-angled with longitudinal axis of fruit; short tapered at base; base aligned or oblique with longitudinal axis of fruit; with the apex and base uniform in texture; membranous or coriaceous; seed chambers externally visible; with the raised seed chambers torulose or not torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible. Epicarp dull; monochrome; brown or tan; pubescent and indurate or glabrous; with hairs erect or appressed; with 1 or 2 types of pubescence; pilose, villous, or sericeous; with pubescence gray or golden; with gray hairs on valves and golden hairs on sutures; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; smooth or not smooth; with elevated features; not veined; not tuberculate; faintly wrinkled; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; brown or tan; smooth and scurfy; nonseptate (with slight to well developed scurfy lines between seeds) or subseptate (because of regular intrusion of fruit); with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–14; length oblique to fruit length; neither overlapping nor touching; in 1 series. Funiculus measured or less than 0.5 mm long; up to 1.5 mm long; of 1 length only; flattened or thick; straight or curved. Aril dry; rim-aril or tongue-aril; tan, white, or black.

Seed $1.4\text{--}4 \times 1.2\text{--}2.8 \times 1\text{--}1.3$ mm; not overgrown; not angular or angular; asymmetrical; oblong, ovate, quadrangular, reniform, triangular, circular, or mitaform; compressed or terete; with surface smooth; with or without visible radicle and cotyledon lobes; with or without external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent or infrequent mottles; with frequent streaks; reddish to greenish brown, tan (to greenish), green, olive, yellow, or black; with brown (dark), purple (definite marks to “clouds”), or black overlay; glabrous; smooth or not smooth; with elevated features; reticulate or wrinkled; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform or larger than punctiform; up to 0.5 mm long; with curved outline; circular; between cotyledon and radicle lobe, apical at apex of radicle tip, subapical to radicle tip, or marginal according to radicle tip; recessed; within rim. Hilum rim color of or lighter than testa. Lens discernible or not discernible; less than or equal to or greater than 0.5 mm in length; up to 0.5 mm long; with margins straight or curved; triangular or oblong; circular or oblong; not in groove of raphe; adjacent to hilum; 0.2–0.5 mm from hilum; flush or mounded; dissimilar color from or similar color as testa; darker or lighter than testa; brown or tan; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons not smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; tan, yellow, or white; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly or equaling length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Mediterranean region to India, highlands tropical Africa, South Africa, and Madagascar (1 sp.).

Notes: Polhill (1968) monographed the taxa of tropical Africa, Chaudhary (1997) revised the Indian taxa, and Edwards (1997) revised the species of series *Racemosae* sensu W.H. Harvey (Harvey 1962). Wyk and Schutte (1990) compared *Argyrobium* with several *Crotalariaeae* genera of South Africa and concluded that *Argyrobium* should be part of *Crotalariaeae*, but they never made the change. Polhill noted that the endocarp often breaks down to form internal partitions.

Argyrolobium: *A. biebersteinii* P.W. Ball (C–E), *A. spp.* (A–B). A, Fruits (closed and dehisced) ($\times 1.2$); B, seeds ($\times 4.7$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



Genus: *Polhillia* C.H. Stirton

Phylogenetic Number: 30.04.

Tribe: Genisteae.

Species Studied—Species in Genus: 3 spp.—7 spp.

Fruit a legume; unilocular; $1.5\text{--}4 \times 0.3\text{--}0.6 \times 0.2\text{--}0.3$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate or plicate; not twisted; asymmetrical or symmetrical; nearly oblong or linear; when asymmetrical with both sutures nearly straight; not inflated; flattened; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered at base; with the apex and base uniform in texture; chartaceous or ligneous (according to Stirton (1986b)); seed chambers externally visible; with the raised seed chambers torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit indehiscent. Replum invisible. Epicarp dull; dark brown to black (but appearing gray because of hairs); pubescent and indurate; with 1 type of pubescence; villous; with pubescence gray; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; not veined; not tuberculate; shagreen; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; grayish brown; smooth; nonseptate (but fruit impressed between seeds); chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 4–8; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; triangular or thick; straight or curved (slightly). Aril dry; rim-aril; reddish brown.

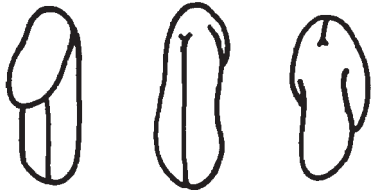
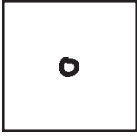
Seed $2.3\text{--}3 \times 2.3\text{--}3 \times 2\text{--}2.2$ mm; not overgrown; not angular; asymmetrical; obliquely cordate or mitaform; compressed; with visible radicle and cotyledon lobes; with umbo (nearly) on seed faces; with umbo on both faces of seed. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome (if green may be blotchy purple but not mottled and streaked greenish to dark brown or tan); glabrous; smooth or not smooth; with elevated features; wrinkled (based on seed and not testa characters); coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum fully concealed; concealed by aril; with faboid

split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; recessed; within rim. Hilum rim color darker than testa. Lens discernible; equal to or greater than 0.5 mm in length; 0.7 mm long; with margins straight; wedge-shaped; not in groove of raphe; adjacent to hilum; mounded; dissimilar color from testa; lighter than or darker than testa; black or tan; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed. Radicle linear; deflexed and parallel to cotyledon length; centered between cotyledons; $1/2$ to nearly length of cotyledons. Plumule moderately developed; glabrous.

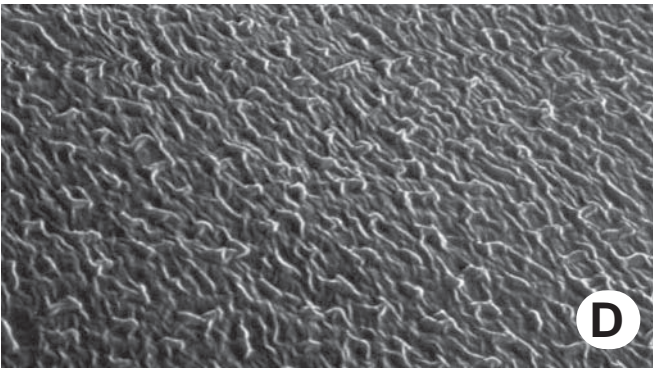
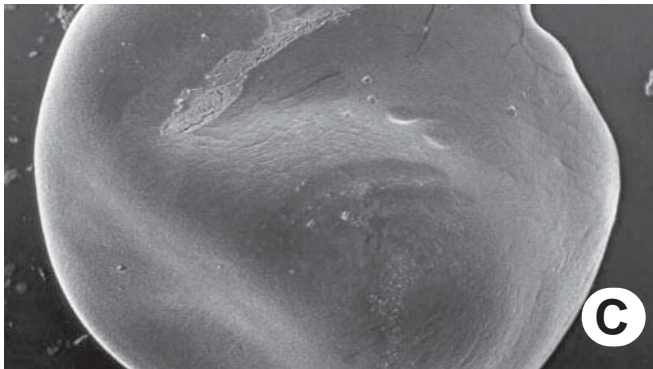
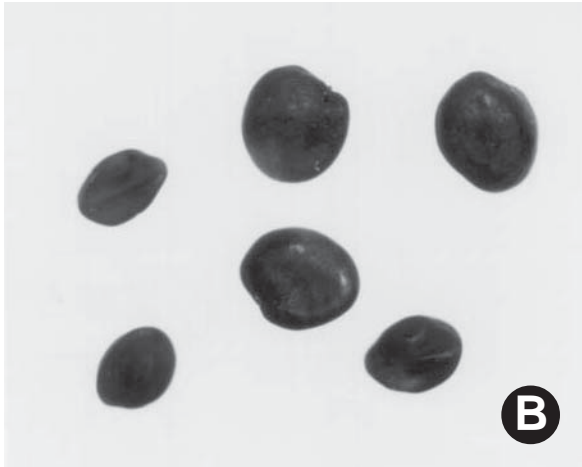
Distribution: South Africa (southwestern Cape Province).

Notes: When he founded the genus, Stirton (1986b) noted that *Polhillia* “has a natural affinity with *Melolobium* and *Dichilus*,” (30.01) and (30.02) respectively. Polhill (1981p) and Wyk (1991) placed this genus in Crotalariaeae but later transferred it to the beginning of the Genisteae (30) (Polhill 1994a,b, Wyk and Schutte 1995). Its number of species and distribution were taken from Wyk (1991) and Wyk and Schutte (1995).

Polhillia: *P. pallens* C.H. Stirton (C–E), *P* spp. (A–B). A, Fruits ($\times 2.2$); B, seeds ($\times 7$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



E



Genus: *Adenocarpus* A.-P. de Candolle

Phylogenetic Number: 30.05.

Tribe: Genisteae.

Species Studied—Species in Genus: 12 spp.—15 spp.

Fruit a legume; unilocular; $1.5-6 \times 0.4-1 \times 0.03-0.1$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; slightly curved or straight; not plicate; not twisted; asymmetrical or symmetrical; oblong, linear, or C-shaped; when asymmetrical with both sutures parallelly curved or nearly straight; not inflated; compressed or flattened; without or with beak; with solid beak the same color and texture as fruit; short tapered or rounded at apex; apex aligned or oblique with longitudinal axis of fruit; short tapered or rounded at base; base aligned or oblique with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting (loosely). Replum invisible. Epicarp glossy or dull; monochrome (though conspicuous glandular tuberculae may be darker colored); brown to light or dark reddish brown; glabrous or pubescent and indurate; with hairs erect or appressed; with 1 type of pubescence; puberulent, villous, or sericeous; with pubescence gray or golden; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; glandular; with glandular papillae (long to short); without spines; not smooth; with elevated features; reticulately veined; not tuberculate; papillose; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; brown; smooth; nonseptate (but may be slightly scurfy between seeds); chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–8; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; up to 1 mm long; of 1 length only; thick; straight or curved. Aril dry; rim-aril or tongue-aril (somewhat); tan.

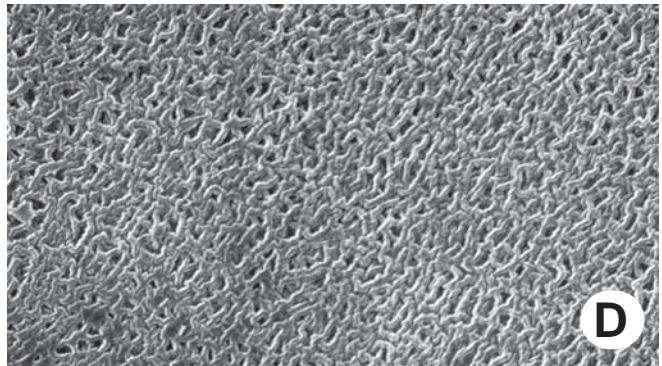
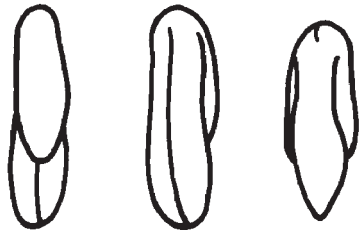
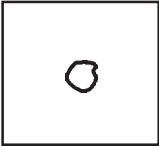
Seed $2-5.5 \times 2-5.5 \times 1.2-2.5$ mm; not overgrown; not angular; asymmetrical; quadrangular, mitaform, oblong, ovate, circular (more or less), rectangular, or reniform;

compressed or terete; with surface smooth; with or without visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome or mottled and streaked; with frequent mottles; with frequent streaks; reddish to greenish brown, green, olive, or black; with purple or black overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than or punctiform; 0.3–0.4 mm long; with curved outline; circular; between cotyledon and radicle lobe, apical at apex of radicle tip, or subapical to radicle tip; recessed; within rim. Hilum rim color of testa. Lens discernible; equal to or greater than 0.5 mm in length; up to 1 mm long; with margins straight or curved; triangular; circular; not in groove of raphe; confluent with or adjacent to hilum; up to 0.4 mm from hilum; mounded or flush; similar color as or dissimilar color from testa; darker than testa; black; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; white or yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous or linear; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; equaling length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Mediterranean region, Canary Islands, highest mountains of tropical Africa, and Syria.

Notes: Gibbs (1967) monographed the genus, and Luaces (1972) reported on the seed germination and chromosome counts of the Iberian species. Greinwald et al. (1992) reported on the taxonomic significance of alkaloids in *Adenocarpus*, and Veen et al. (1992) reported on the alkaloids of *A. hispanicus* (J.P.A.P.M. de Lamarck) A.-P. de Candolle.

Adenocarpus: *A. decorticans* P.E. Boissier (C–E), *A.* spp. (A–B). A, Fruits (closed and dehiscent) ($\times 1.4$); B, seeds ($\times 4.7$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 6$).



Genus: *Anarthrophyllum* G. Bentham

Phylogenetic Number: 30.06.

Tribe: Genisteae.

Species Studied—Species in Genus: 13 spp.—15 spp.

Fruit a legume; unilocular; $0.7\text{--}4 \times 0.4\text{--}0.9 \times 0.2\text{--}0.8$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; asymmetrical or symmetrical; lanceolate, linear, oblong, ovate, or rhombic; when asymmetrical with both sutures parallelly to unequally curved; not inflated; compressed; without or with beak; with solid beak the same color and texture as fruit; tapered or short tapered at apex; apex oblique with longitudinal axis of fruit; long tapered or tapered at base; base oblique with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous or coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate or nonstipitate. Fruit with all layers dehiscing; splitting along suture. Dehiscence of valves along 1 suture; apical and down; active; with valves twisting. Replum invisible. Epicarp dull; monochrome; brown; pubescent and indurate or glabrous to glabrate; with 1 type of pubescence; tomentose or villous; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–8; length transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 1.5 mm long; of 1 length only; thick; straight. Aril absent.

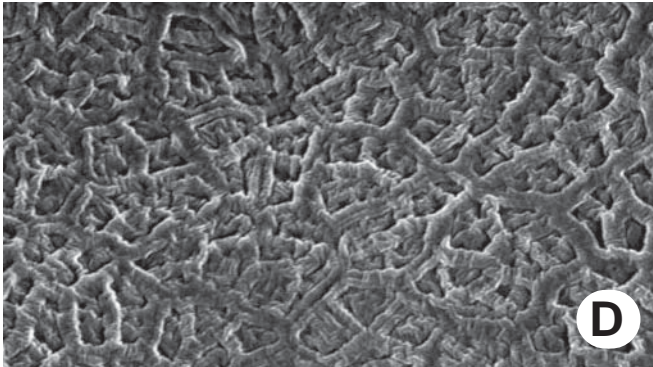
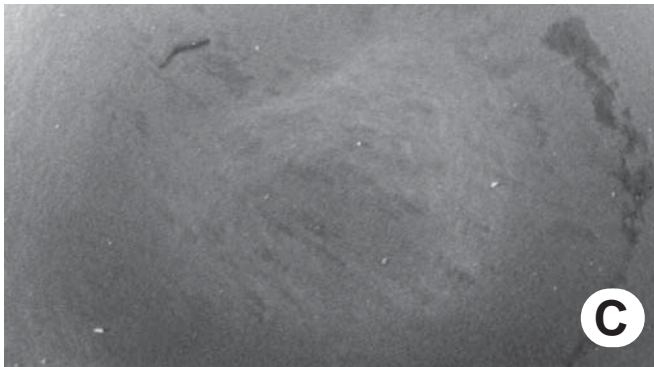
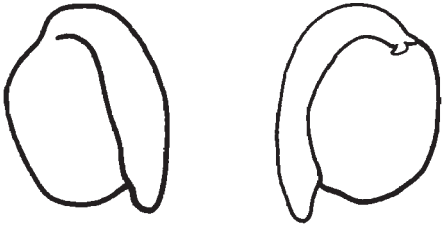
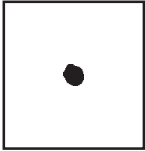
Seed $2.5\text{--}5 \times 1.5\text{--}4 \times 1.5\text{--}1.7$ mm; not overgrown; not angular; symmetrical (except for hilum); circular, oblong, or ovate; compressed; without visible radicle and cotyledon lobes; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; reddish brown to brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum

partially concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; apical according to radicle tip but marginal according to seed length; recessed; not within corona, halo, or rim. Lens discernible; equal to or greater than 0.5 mm in length; 0.9 mm long; with margins straight; wedge-shaped; not in groove of raphe; adjacent to hilum; 0.1 mm from hilum; flush; similar color as testa; darker than testa; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; entire over radicle; without lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis parallel (radicle length parallel to cotyledon length); parallel to length of seed. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; exceeding length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Chile and Argentina (Andes).

Notes: Soraru (1974) monographed the genus and illustrated the external characters of its fruits and seeds. Polhill (1981q) and Soraru both noted that *Anarthrophyllum* seeds often bulge on the side opposite the hilum (or radicle tip). This bulge is a normal legume seed with its axis parallel to the hilum length shorter than the axis at right angles to the hilum length, that is, the seeds are wider than they are long. Polhill continued that *Anarthrophyllum* is a “very remarkable genus of uncertain affinities, apart from its probable relationship with *Sellocharis*” (30.07). Polhill (1981q) and Wyk (1991) had this genus in Crotalariaeae but later transferred it to the beginning of the Genisteae (30) (Polhill 1994a,b, Wyk and Schutte 1995).

Anarthrophyllum: *A. rigidum* (J. Gilles ex W.J. Hooker & G.A.W. Arnott) G.H.E.W. Hieronymus (C–E), *A.* spp. (A–B). A, Fruits and valve ($\times 1.9$); B, seeds ($\times 4.8$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 8$).



Genus: *Lupinus* C. Linnaeus

Phylogenetic Number: 30.08.

Tribe: Genisteae.

Species Studied—Species in Genus: 75 spp.—200 spp.

Fruit a legume; unilocular; $2-9 \times 0.3-2 \times 0.18-0.8$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; oblong or ovate; when asymmetrical with both sutures nearly straight; not inflated; compressed, terete, or flattened; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; long tapered or short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous, membranous, chartaceous, or ligneous; seed chambers externally visible or invisible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate or nonstipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible. Epicarp dull or glossy; monochrome or multicolored; mottled; brown to dark reddish brown; with black overlay; pubescent and indurate, glabrous, or pubescent but soon deciduous; with 1 type of pubescence; tomentose, villous, or puberulent; with pubescence golden or gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous, ligneous (sub), or chartaceous. Endocarp dull or glossy; monochrome; brown or tan; spongy; septate, subseptate, or nonseptate; with septa thicker than paper, firm; with septa eglandular; chartaceous; not exfoliating or exfoliating in part; remaining fused to mesocarp and epicarp; entire. Seeds 1–15; length parallel with or transverse to fruit length; neither overlapping nor touching or touching; in 2 or more series. Funiculus less than 0.5 mm long; of 1 length only; thick or triangular; straight or curved. Aril absent or present; dry; rim-aril; white.

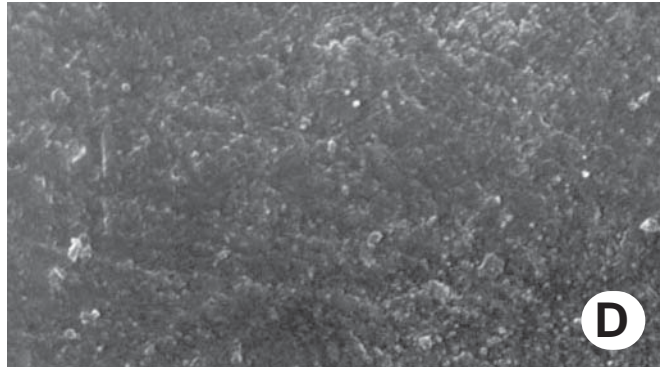
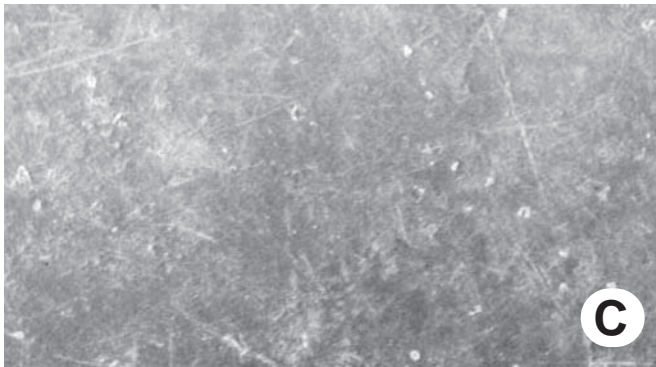
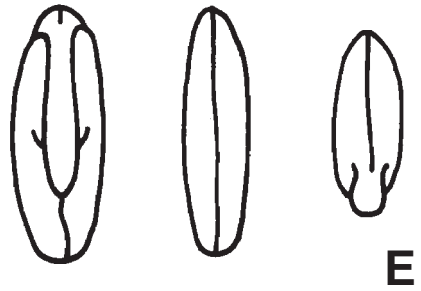
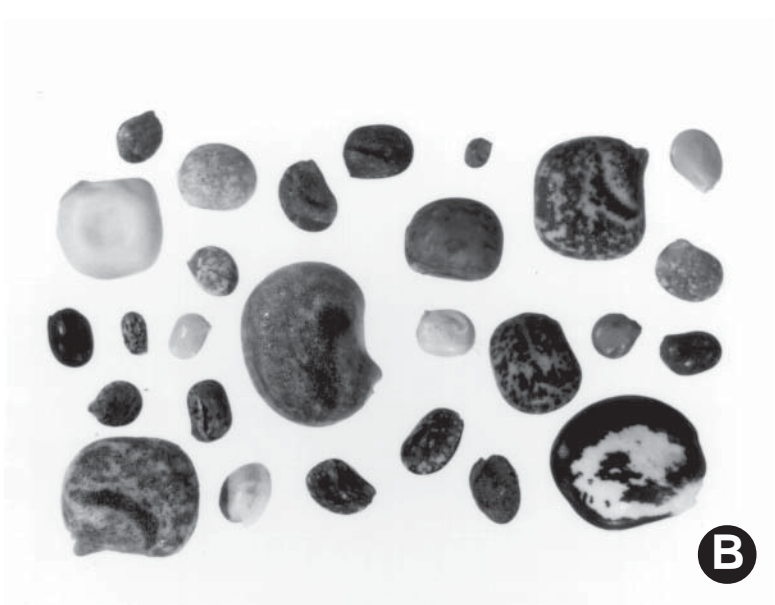
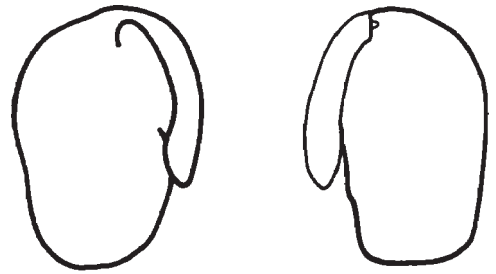
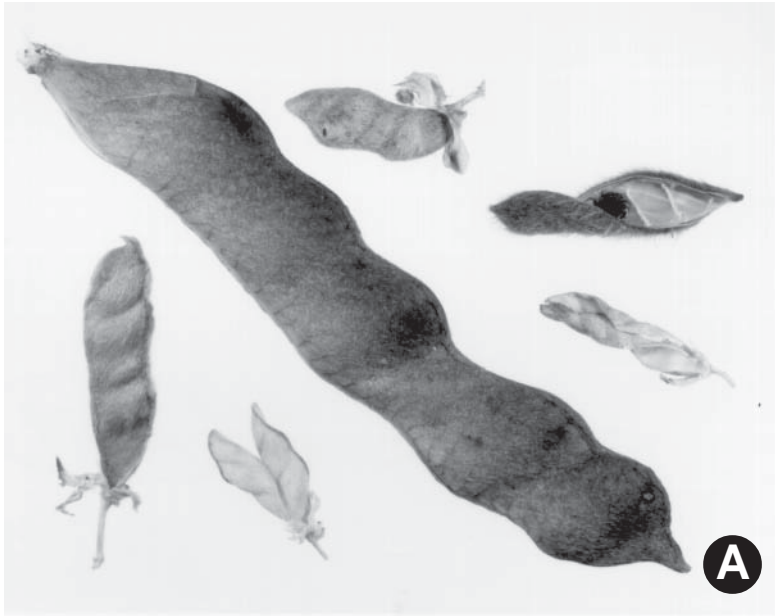
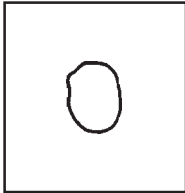
Seed $1.5-9 \times 1.5-8 \times 1-5$ mm; not overgrown; not angular or angular; asymmetrical; ovate, circular, oblong, or

quadrangular; compressed; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull or glossy; not modified by a bloom; colored or clear; monochrome, mottled and streaked, or bichrome (ivory and reddish-brown); with frequent mottles; with frequent streaks; dark reddish brown, cream, tan, white, gray (to bluish), pink, or blue; with brown, gray (to bluish), red, or black overlay; glabrous; smooth or not smooth; with elevated or recessed features; wrinkled, shagreen, or rugose; concave; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible or visible; from hilum to lens or through lens and terminating before base of seed; not bifurcating; color of or darker than testa; reddish brown; recessed. Hilum visible or partially concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same color as or lighter than the rest of the hilum and therefore conspicuous; larger than punctiform; up to 2 mm long; with angular, curved, or straight outline; circular, oval, wedge-shaped, triangular (more or less), or oblong; subapical or marginal according to radicle tip; recessed; not within corona, halo, or rim or within rim or halo. Hilum halo color of or lighter than testa. Hilum rim color of testa. Lens discernible or not discernible; equal to or greater than 0.5 mm in length; up to 3 mm long; with margins curved; circular (often with linear center) or elliptic; not in or in groove of raphe; adjacent to hilum; up to 3 mm from hilum; mounded; dissimilar color from testa; lighter or darker than testa; reddish tan or black; not within corona, halo, or rim or within rim (its own). Lens rim color of testa. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with lobes not touching; with the interface division terminating at base of radicle or in radicle tissue; without margins recessed; tan; inner face flat or wrinkled; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear or triangular; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2, 1/2 to nearly, or equaling length of cotyledons. Plumule rudimentary, moderately developed, or well developed; glabrous.

Distribution: New World, Mediterranean region, tropical highlands of Africa, and naturalized elsewhere.

Notes: Cristofolini and Chiapella (1977) studied the water-soluble seed proteins of 45 species of *Lupinus*. Phillips (1955) monographed the perennial lupine species of North America, and Dunn and Gillett (1966) monographed the taxa in Canada. Heyn and Herrnstadt (1977) studied the testae of Old World species. Lawson (1982) edited an overview of the agronomic value, liability, and problems in growing *Lupinus* species in Australia. Summerfield and Roberts (1985b) also reported on the economic value of the genus. Plitmann (1981) traced the evolutionary history of the Old World lupines.

Lupinus: *L. tauris* G. Bentham (*C-E*), *L. spp.* (*A-B*). *A*,
Fruits (closed and dehisced) ($\times 1.1$); *B*, seeds ($\times 1.8$);
C-D, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 2$).



Genus: *Laburnum* P.C. Fabricius

Phylogenetic Number: 30.09.

Tribe: Genisteae.

Species Studied—Species in Genus: 2 spp.—2 spp.

Fruit a legume; unilocular; $2-6 \times 0.7-1 \times 0.15-0.4$ cm; with deciduous or persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (or slightly curved); not plicate; not twisted; symmetrical or asymmetrical; linear or oblong (narrowly); when asymmetrical with both sutures nearly straight; not inflated; flattened or compressed; without beak; long tapered, tapered, or short tapered at apex; apex aligned or oblique (slightly) with longitudinal axis of fruit; long tapered or tapered at base; base aligned or oblique (slightly) with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous, membranous, or ligneous; seed chambers externally visible; with the raised seed chambers not torulose or torulose. Fruit margin not constricted or constricted; slightly constricted (hardly) along both margins; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscing (tardily); splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive. Replum invisible. Epicarp dull; monochrome; dark to reddish brown or tan; glabrous or pubescent and indurate; with hairs erect or appressed; with 1 type of pubescence; puberulent; with pubescence golden; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; longitudinally veined relative to fruit length; not tuberculate; longitudinally and irregularly wrinkled; exfoliating in part or not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; subligneous or coriaceous. Endocarp dull; monochrome; reddish brown or tan; smooth; nonseptate or subseptate (because of intrusion of fruit); with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–8; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; up to 1.5 mm long; of 1 length only; thick; curved. Aril absent.

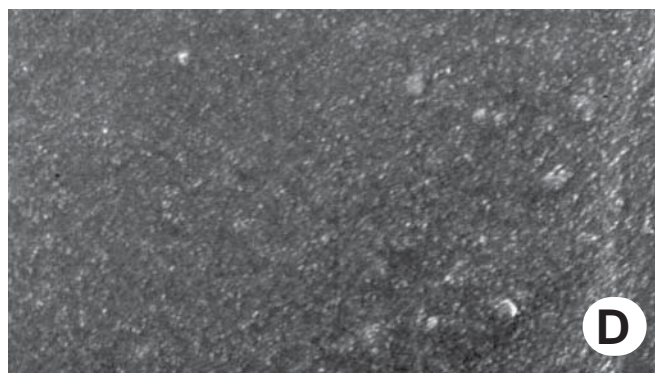
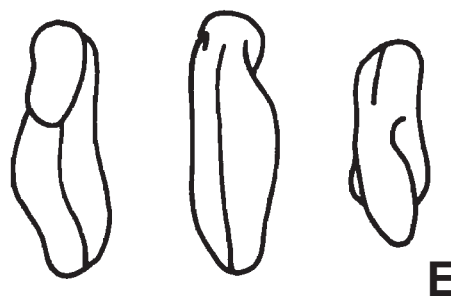
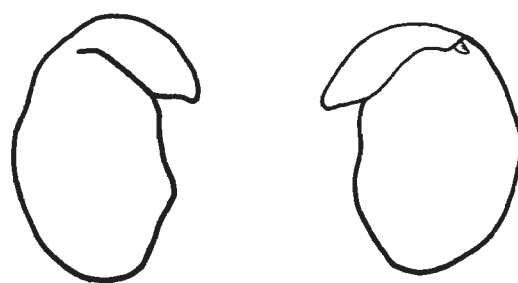
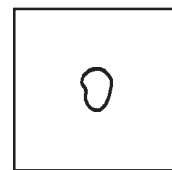
Seed $4-5 \times 3.5-4 \times 2.5-2.8$ mm; not overgrown; not angular or angular (somewhat); asymmetrical; oblong, reniform, triangular (more or less), or mitaform; compressed; with surface smooth; with visible radicle

and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull or glossy (somewhat); not modified by a bloom; colored; monochrome; dark to bright reddish brown or orange; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; up to 0.5 mm long; with curved outline; circular; between cotyledon and radicle lobe; recessed; within rim. Hilum rim color of testa. Lens discernible; equal to or greater than 0.5 mm in length; 0.5–1 mm long; with margins straight or curved; wedge-shaped or elliptic; not in groove of raphe; adjacent to or confluent with hilum; 0.2 mm from hilum; barely mounded; similar color as testa; reddish brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; with both folded (barely) or not folded; not sufficiently folded for inner face to touch itself; portions of inner folded face unequal; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; red; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Southern Europe.

Notes: Forrester (1979) stated that an average of about 3,000 children per summer are poisoned by fruits, seeds, and flowers of *Laburnum* in England.

Laburnum: *L. anagyroides* F.C. Medikus (C–E), *L. spp.* (A–B). A, Fruits (closed and dehiscent) ($\times 1.4$); B, seeds ($\times 4.8$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 5$).



Genus: *Hesperolaburnum* R.C.J.E. Maire

Phylogenetic Number: 30.10.

Tribe: Genisteae.

Species Studied—Species in Genus: 1 sp.—1 sp.

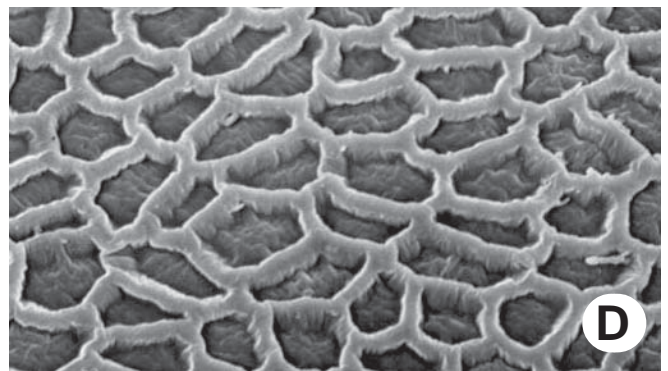
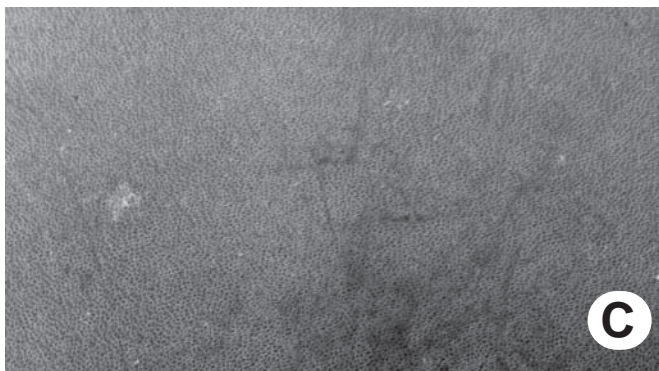
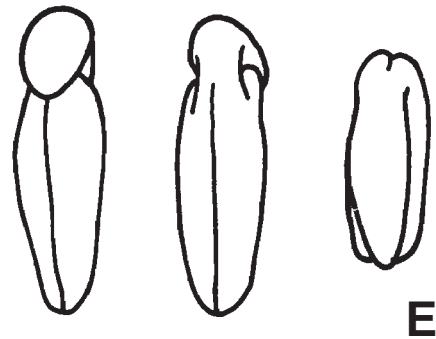
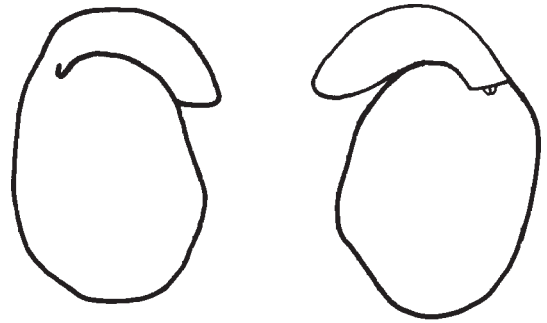
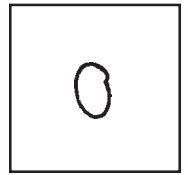
Fruit a legume; unilocular; $4 \times 1 \times 0.5$ cm; with deciduous or persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; oblong; when asymmetrical with 1 straight and 1 curved suture, both sutures unequally curved, or both sutures parallelly curved; widest near middle or D-shaped; not inflated; compressed; without beak; short tapered at apex; apex oblique with longitudinal axis of fruit; tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin slightly constricted only on 1 margin; without sulcus; embellished. Fruit wings absent. Fruit substipitate or nonstipitate. Fruit with all layers dehiscent (to tardily so); splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive. Replum invisible. Epicarp glossy; monochrome; dark reddish brown; glabrous; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; warty (tan); not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; pale brown; scurfy; septate; with septa thin (tissue paper-like), flexible; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–3; length transverse to, oblique to, or parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; flattened; curved. Aril absent.

Seed $5.5\text{--}6 \times 4.5\text{--}5 \times 3\text{--}3.3$ mm; not overgrown; not angular; asymmetrical; ovate; compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; dark reddish brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum fully concealed; concealed by funicular remnant; with faboid split; with the lips of the faboid split the same

color as the rest of the hilum; punctiform; apical at apex of radicle tip or between cotyledon and radicle lobe; recessed; within rim. Hilum rim color somewhat darker than testa. Lens discernible; equal to or greater than 0.5 mm in length; up to 1 mm long; with margins straight or curved; oblong; not in groove of raphe; confluent with hilum (hilar rim extends out to lens); mounded; similar color as testa; lighter than testa; reddish brown; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat or concave (or one concave and other convex); glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Morocco (Anti-Atlas mountains).

Hesperolaburnum: *H. platycarpum* (R.C.J.E. Maire) R.C.J.E. Maire (A–E). A, Valves showing endocarp and epicarp ($\times 1.7$); B, seeds ($\times 4.3$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 5$).



Genus: *Podocytisus* P.E. Boissier & T.H.H. von Heldreich

Phylogenetic Number: 30.11.

Tribe: Genisteae.

Species Studied—Species in Genus: 1 sp.—1 sp.

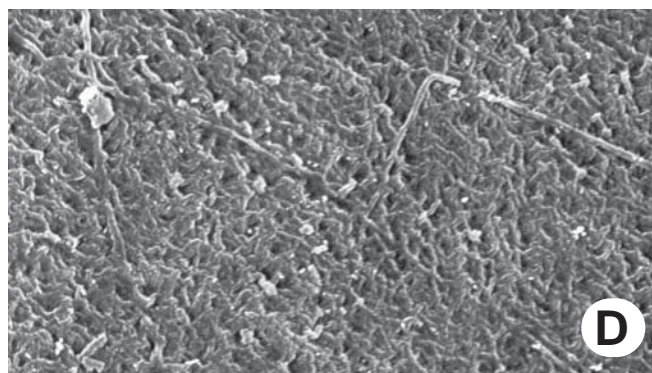
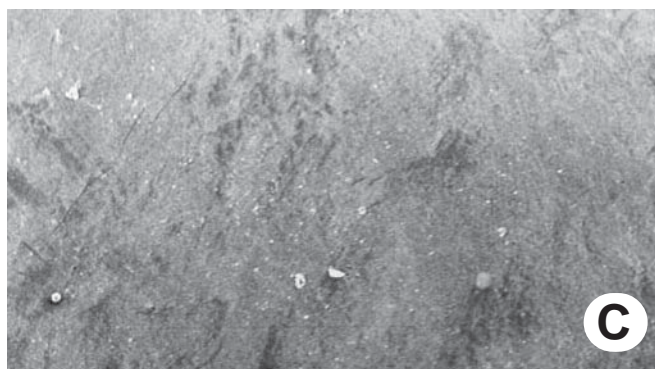
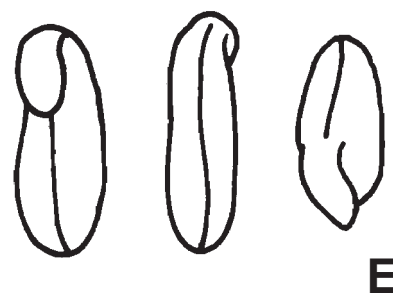
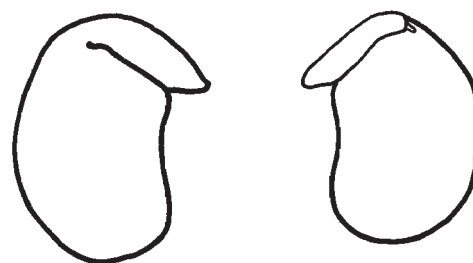
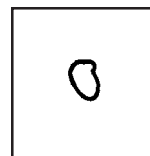
Fruit a legume; unilocular; $2.5\text{--}4.5 \times 1\text{--}2 \times 0.03\text{--}0.05$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; curved; not plicate; not twisted; asymmetrical; oblong; when asymmetrical with both sutures nearly straight; not inflated; flattened; without beak; rounded at apex; apex oblique with longitudinal axis of fruit; rounded or short tapered at base; base oblique with longitudinal axis of fruit; with the apex and base uniform in texture; membranous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin not constricted or constricted; slightly constricted (and irregularly) only on 1 margin; without sulcus; embellished. Fruit wing 1; 1.5 mm wide; sutural; on both valves; on 1 suture. Fruit substipitate. Fruit indehiscent or with all layers dehiscent (tardily); splitting along suture. Dehiscence of valves along 1 suture; probably medial and up and down; passive. Replum invisible. Epicarp dull; monochrome or multicolored; bichrome (irregularly, no pattern) or mottled and streaked (neither true mottling nor true streaking); brown (greenish with irregular dark-brown to purple patches), green, purple, or tan (greenish); with brown (dark brown to dark purple) overlay; glabrous; eglandular; without spines; not smooth; with elevated features; reticulately veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; chartaceous (or thinner). Endocarp dull or glossy (without “cobwebs”); monochrome; tan; cobwebby; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 2–6; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; up to 3 mm long (most of length fused with valve and 1 branched); of 1 length only; flattened; curved. Aril absent.

Seed $4.5\text{--}5 \times 4\text{--}4.5 \times 2\text{--}2.8$ mm; not overgrown; not angular or angular (somewhat); asymmetrical; oblong, circular, or reniform (more or less); compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on

seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome; dark reddish brown or mixture of dark and darker reddish brown; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.7 mm long; with straight outline; oblong; between cotyledon and radicle lobe; slightly flush; not within corona, halo, or rim or within rim (faint). Hilum rim color of testa. Lens discernible; less than or equal to or greater than 0.5 mm in length; 0.5 mm long; with margins curved; circular (with linear center); not in groove of raphe; confluent with or adjacent to hilum; up to 0.2 mm from hilum; flush; dissimilar color from testa; lighter than testa; reddish tan; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Balkans and Turkey (Anatolia).

Podocytisus: *P. caramanicus* P.E. Boissier & T.H.H. von Heldreich (A–E). A, Fruits ($\times 1.7$); B, seeds ($\times 4.2$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 5$).



Genus: *Cytisophyllum* O.F. Lang

Phylogenetic Number: 30.12.

Tribe: Genisteae.

Species Studied—Species in Genus: 1 sp.—1 sp.

Fruit a legume; unilocular; $2.5-4 \times 1$ cm; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical or asymmetrical; linear to oblong; when asymmetrical with both sutures nearly straight; not inflated; compressed; with the apex and base uniform in texture; coriaceous. Fruit margin without sulcus; plain. Fruit wings absent. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible. Epicarp glossy; monochrome; glabrous; eglandular; without spines; smooth; not veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; reddish tan; smooth and scurfy; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seed 3-6 (Pignatti 1982); neither overlapping nor touching; in 1 series. Funiculus of 1 length only. Aril fleshy; topknotlike or cupshaped; covering less than 1/2 of seed; yellow.

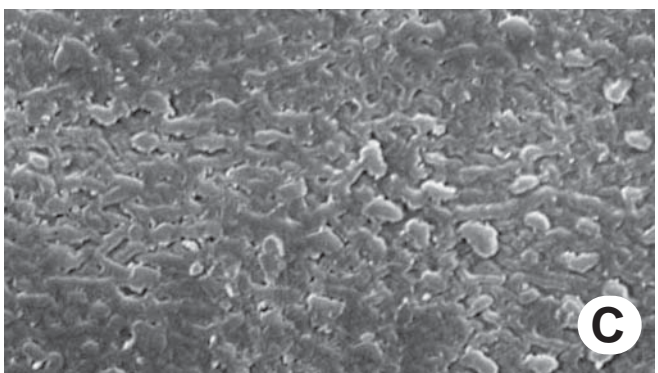
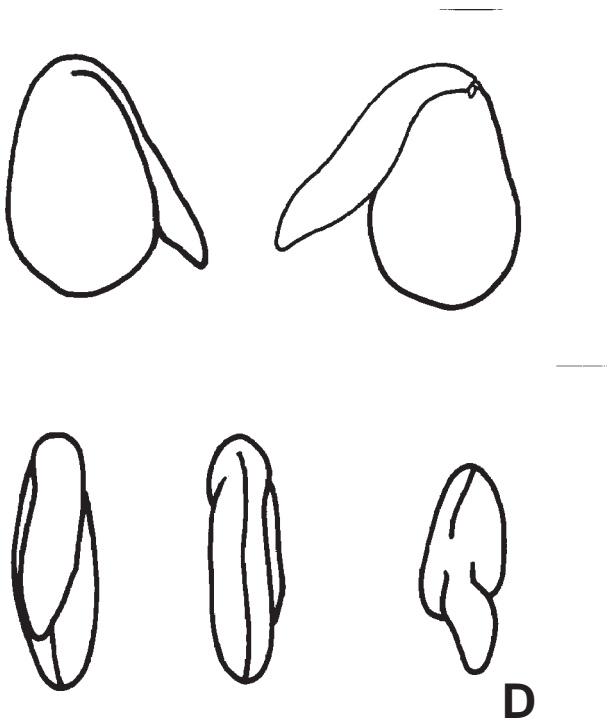
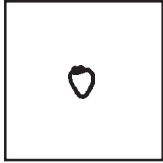
Seed $4-5 \times 3-4 \times 1.2-1.7$ mm; not overgrown; angular or not angular; asymmetrical; oblong, ovate, circular (more or less), triangular, or irregular (somewhat); compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome; dark reddish to greenish brown or black; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.6 mm long; with curved outline; elliptic; apical at apex of radicle tip and between cotyledon and radicle lobe; recessed; within rim (inconspicuous). Hilum rim color of testa. Lens discernible; less than 0.5 mm in length; with margins curved; circular; not in groove of raphe; confluent with hilum; flush; dissimilar color from testa; lighter than testa; tan; not within corona, halo, or rim. Endosperm thick; covering entire embryo;

adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; equaling length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Eastern Spain, southern France, and Italy.

Notes: No entire fruits were available for photographing.

Cytisophyllum: *C. sessilifolium* (C. Linnaeus) O.F. Lang (A–D). A, Seeds ($\times 4.4$); B–C, testa ($\times 50$, $\times 1000$); D, embryos ($\times 6$).



Genus: *Petteria* C.B. Presl

Phylogenetic Number: 30.13.

Tribe: Genisteae.

Species Studied—Species in Genus: 1 sp.—1 sp.

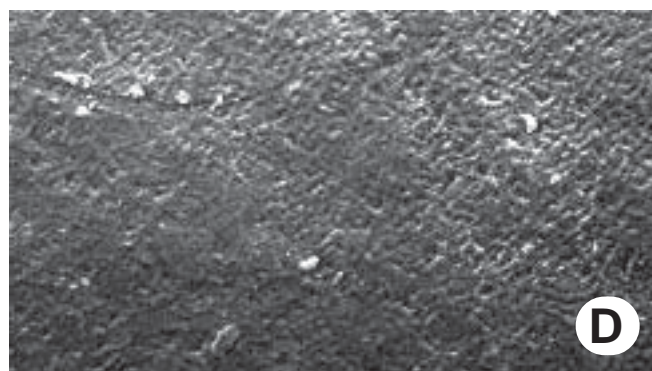
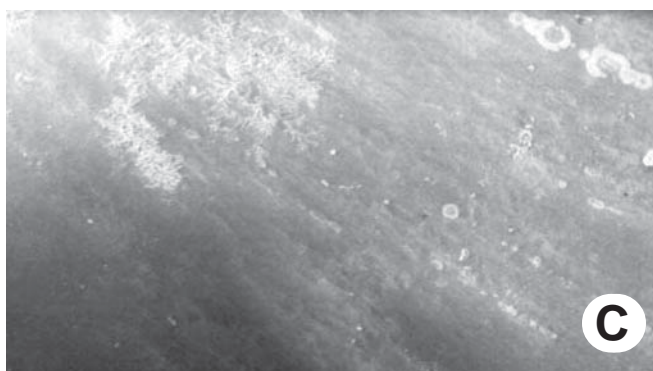
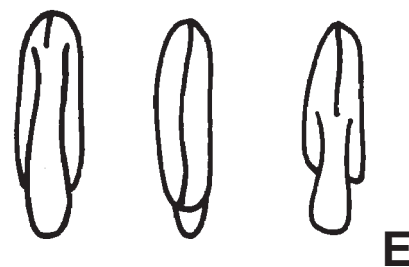
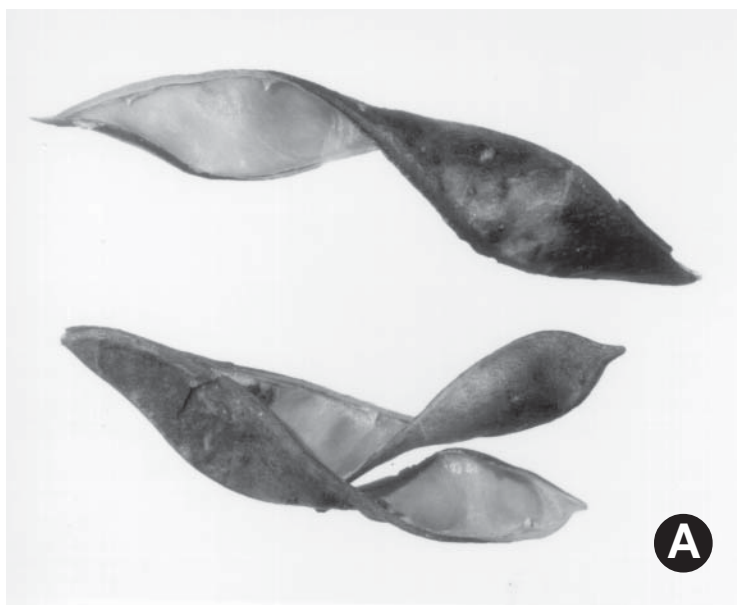
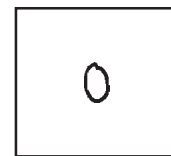
Fruit a legume; unilocular; $2.5\text{--}5 \times 0.5\text{--}1$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; symmetrical or asymmetrical; broadly linear or falcate; when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; not inflated; compressed; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible. Epicarp dull; monochrome; dark reddish brown; glabrous; eglandular; without spines; not smooth; with elevated features; not veined; not tuberculate; wrinkled or shagreen; not exfoliating or exfoliating in part; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; brown; spongy and scurfy (between seeds); nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 8; length parallel with or transverse to fruit length; neither overlapping nor touching or touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; flattened or triangular; straight. Aril dry; tongue-aril (nearly); tan.

Seed $4.5\text{--}5 \times 2.5\text{--}4.5 \times 1.6\text{--}2.2$ mm; not overgrown; not angular or angular; symmetrical; rectangular, oblong, rhombic, or triangular; compressed or terete; with surface smooth; with visible radicle and cotyledon lobes; without or with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome; orangish to greenish and reddish brown, tan (orangish), green, or orange; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent.

Wings absent. Raphe not visible. Hilum visible, partially concealed, or fully concealed; concealed by funiculus, funicular remnant, radicle lobe, or wing (somewhat); with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.5 mm long; with straight (more or less) outline; oblong; apical at apex of radicle tip; recessed; within rim (which involves radicle lobe and open on lens side). Hilum rim color of testa. Lens barely discernible; less than 0.5 mm in length; with margins straight; tiny wedge-shaped or rhombic (tiny); not in groove of raphe; adjacent to hilum; 0.5 mm from hilum; barely mounded; dissimilar color from testa; darker than testa; dark reddish brown; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly, equaling, or exceeding length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Balkans.

Petteria: *P. ramentacea* (F.W. Sieber) C.B. Presl (A–E). A, Fruit (dehisced) and valve ($\times 2$); B, seeds ($\times 3.7$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 5$).



Genus: *Argyrocytismus* (R.C.J.E. Maire) D.G. Frodin & V.H. Heywood ex C. Raynaud

Phylogenetic Number: 30.14.

Tribe: Genisteae.

Species Studied—Species in Genus: 1 sp.—1 sp.

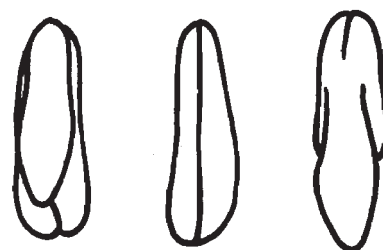
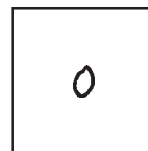
Fruit a legume; unilocular; 5.5×0.7 cm; without orifice formed by curving of fruit or fruit segments; slightly curved; not plicate; not twisted; asymmetrical or symmetrical; linear; when asymmetrical with both sutures nearly straight; not inflated; compressed; without beak; short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible or visible. Epicarp dull; monochrome; pubescent and indurate; with 1 type of pubescence; pilose; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; veined or not veined; reticulately veined (faintly near suture); not tuberculate; faintly wrinkled; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; tan; smooth; nonseptate (but fringe of scurfy, light-colored material along ridges between seeds); chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 8; length transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 0.5 mm long; of 1 length only; thick; straight. Aril dry; tongue-aril; white.

Seed $3.5-4 \times 3-3.5 \times 2-2.3$ mm; not overgrown; not angular; asymmetrical; oblong or rectangular; compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled and streaked (both faintly); dark reddish to greenish brown; with brown overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum

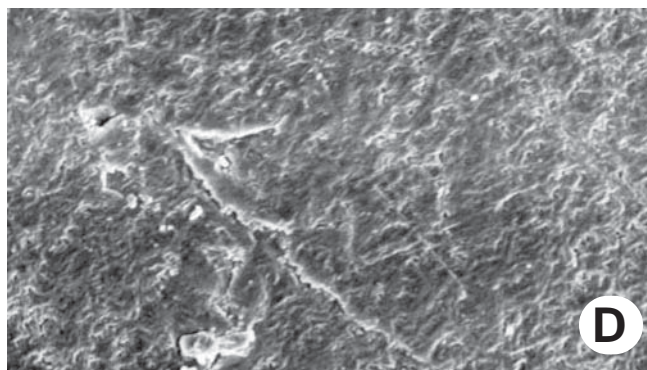
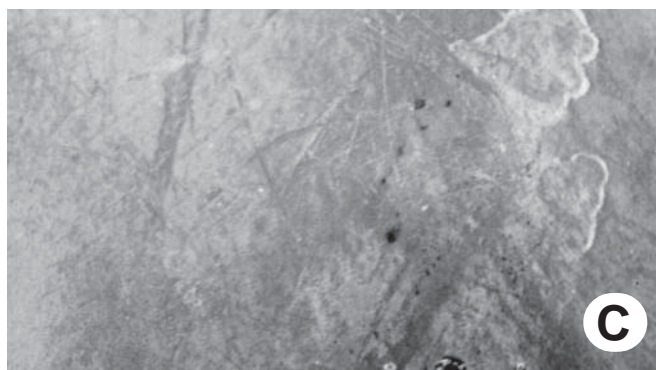
partially concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.4 mm long; with curved outline; oval; apical at apex of radicle tip and between cotyledon and radicle lobe; recessed; within rim. Hilum rim color darker than testa (slightly to black). Lens discernible; equal to or greater than 0.5 mm in length; 0.7–0.9 mm long; with margins straight; linear; not in groove of raphe; confluent with hilum; slightly mounded; dissimilar color from testa; lighter than testa; tan; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; not sufficiently folded for inner face to touch itself; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; equaling length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Africa (Atlas Mountains).

Argyrocytismus: *A. battandieri* (R.C.J.E. Maire) C. Raynaud (A–E). A, Valves ($\times 1.5$); B, seeds ($\times 4.5$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 6$).



E



Genus: *Cytisus* R.L. Desfontaines

Phylogenetic Number: 30.15.

Tribe: Genisteae.

Species Studied—Species in Genus: 13 spp.—35 spp.

Fruit a legume; unilocular; $1.2-7 \times 0.4-1.3 \times 0.1-0.3$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; asymmetrical or symmetrical; linear, oblong, or ovate; when asymmetrical with both sutures nearly straight; not inflated (more or less) or inflated; compressed or flattened; without beak; short tapered at apex; apex aligned or oblique with longitudinal axis of fruit; short tapered at base; base aligned or oblique with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous or coriaceous; seed chambers externally invisible or visible; with the raised seed chambers not torulose. Fruit margin not constricted or constricted; slightly constricted along both margins; without sulcus; plain. Fruit wings absent. Fruit nonstipitate or substipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible. Epicarp dull; monochrome; brown to dark reddish brown or black; pubescent and indurate, pubescent but soon deciduous, or glabrous; with hairs erect or appressed; with 1 or 2 types of pubescence; villous (to restricted to sutures), pilose, or tomentose; with pubescence gray, brown, or golden; with long and short gray plain-tipped hairs; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; not veined or veined; reticulately veined; not tuberculate; faintly wrinkled; not exfoliating or exfoliating in part; without or with cracks; cracking oblique to fruit length. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; brown to blackish brown or tan; smooth; subseptate or nonseptate; with septa composed of minute fringe of hairs; with septa eglandular; chartaceous; not exfoliating or exfoliating in part; remaining fused to mesocarp and epicarp; entire. Seeds 8–14; length transverse to, oblique to, or parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long or measured; up to 1 mm long; of 1 length only; triangular; straight or curved. Aril fleshy or dry; when

fleshy cupshaped; covering less than 1/2 of seed; when dry rim-aril; brown to reddish brown, tan (to reddish tan), or orange.

Seed $3-5 \times 2-4.2 \times 1.5-2.5$ mm; not overgrown; not angular; asymmetrical; oblong, ovate, rectangular, rhombic, circular, or D-shaped; compressed; with surface smooth; with or without visible radicle and cotyledon lobes; without or with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled and streaked; brown to blackish, reddish, or greenish brown, tan (to greenish or reddish tan), red, orange, olive, green, or black; with tan overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.5 mm long; with curved outline; circular; apical at apex of radicle tip and between cotyledon and radicle lobe, subapical to radicle tip, or marginal according to radicle tip; recessed; within rim. Hilum rim color of or darker than testa. Lens discernible; less or equal to or greater than 0.5 mm in length; 0.5 mm long; with margins straight or curved; oblong; not in groove of raphe; confluent with hilum; mounded; similar color as testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; yellow or tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous or linear; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; equaling, 1/2 to nearly, or exceeding length of cotyledons. Plumule rudimentary; glabrous.

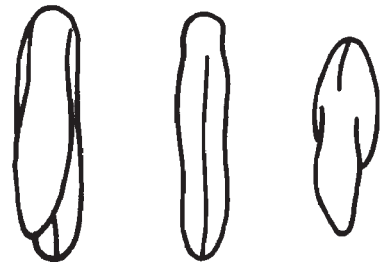
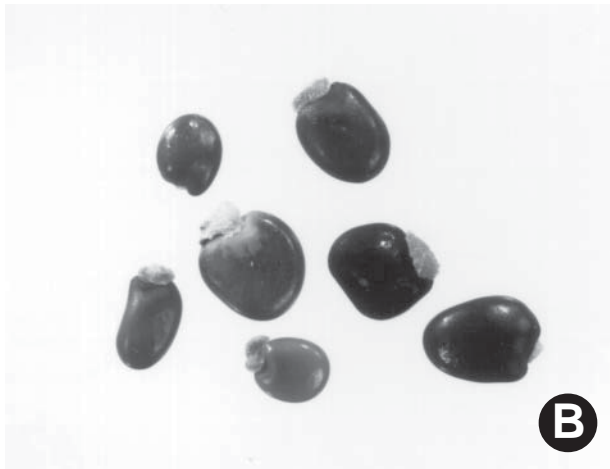
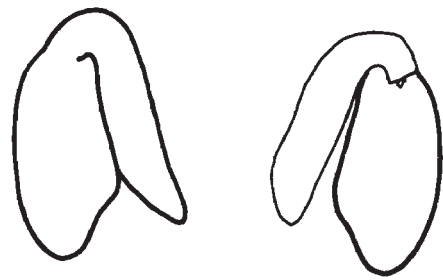
Distribution: Europe, North Africa, Canary Islands, and Asia.

Notes: Talavera and Gibbs (1997) added two species to *Cytisus*, and the species count includes them. Polhill (1994b) accepted *Lembotropis* A.H.R Grisebach

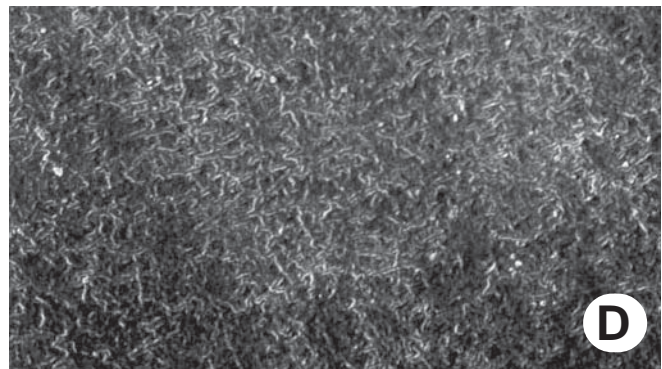
(30.16) as a genus, but we are maintaining it as a synonym of *Cytisus*.

Cytisus: *C. commutatus* (H.M. Willkomm) J.I. Briquet (*C–E*), *C. spp.* (*A–B*). *A*, Valves and fruit (dehisced) ($\times 1.4$); *B*, seeds ($\times 4$); *C–D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 11$).

0



E



Genus: *Chamaecytisus* J.H.F. Link

Phylogenetic Number: 30.15A.

Tribe: Genisteae.

Species Studied—Species in Genus: 11 spp.—30 spp.

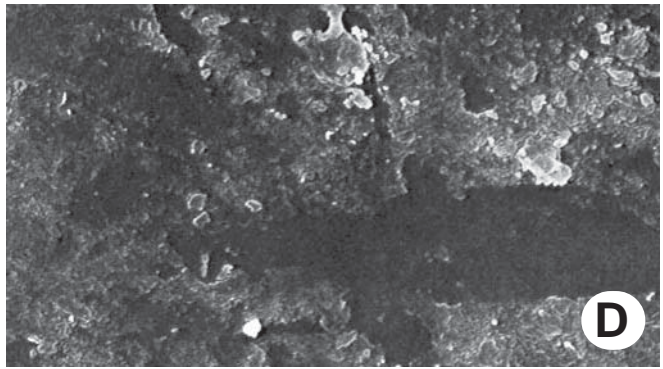
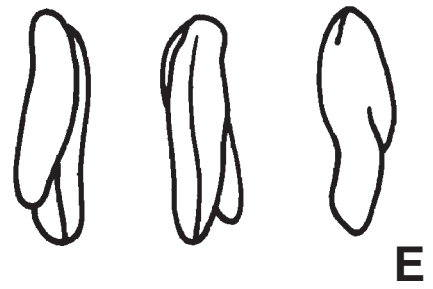
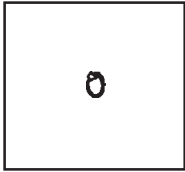
Fruit a legume; unilocular; $2-7 \times 0.5-1.1 \times 0.2-0.4$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; asymmetrical or symmetrical; oblong or falcate (barely); when asymmetrical with both sutures nearly straight; not inflated; flattened or compressed; without beak; tapered or short tapered at apex; apex aligned or oblique with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous or ligneous; seed chambers externally visible or invisible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate or nonstipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible. Epicarp dull; monochrome; brown to reddish brown; pubescent and indurate or pubescent but soon deciduous; with 1 type of pubescence; pilose or tomentose; with pubescence golden; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; smooth or not smooth; with elevated features; veined or not veined; reticulately veined; not tuberculate; faintly wrinkled or pustulate (minutely); not exfoliating, exfoliating, or exfoliating in part; with or without cracks; cracking oblique or transverse to fruit length. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; ligneous (or subligneous) or coriaceous. Endocarp dull; monochrome; reddish brown; smooth or scurfy; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 4–13; length transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; up to 1 mm long; of 1 length only; flattened or triangular; straight. Aril present or absent; fleshy; topknotlike or cupshaped; covering less than 1/2 of seed; reddish brown or tan (to reddish).

Seed $2.7-5 \times 2.2-3.5 \times 1.5-2.7$ mm; not overgrown; angular or not angular; asymmetrical; oblong, ovate,

circular (more or less), triangular (more or less), or cordate; compressed or terete; with surface smooth; with or without visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; with umbo on seed faces. Cuticle wrinkled. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome; brown to reddish or greenish brown, tan (to greenish tan), olive, or black; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum partially concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as or lighter colored than the rest of the hilum and therefore conspicuous; larger than punctiform; up to 1 mm long; with curved outline; circular or elliptic; apical at apex of radicle tip, subapical to radicle tip, or between cotyledon and radicle lobe; recessed; within rim or halo. Hilum halo color of testa (to duller). Hilum rim color of testa. Lens discernible or not discernible; less than or equal to or greater than 0.5 mm in length; up to 1 mm long; with margins straight or curved; circular (with light colored line), elliptic, or oblong; not in groove of raphe; confluent with hilum; mounded or flush; same color as or dissimilar color from testa; lighter than testa; reddish tan; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear or bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; equaling or exceeding length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Europe, Morocco, and Canary Islands.

Chamaecytisus: *C. austriacus* (C. Linnaeus) J.H.F. Link (*C-E*), *C. spp.* (*A-B*). *A*, Fruits (closed and dehisced) ($\times 1.3$); *B*, seeds ($\times 4.6$); *C-D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 8$).



Genus: *Calicotome* J.H.F. Link

Phylogenetic Number: 30.17.

Tribe: Genisteae.

Species Studied—Species in Genus: 2 spp.—2 spp.

Fruit a legume; unilocular; $3\text{--}5.5 \times 0.7\text{--}0.8 \times 0.27$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (slightly); not plicate; not twisted; asymmetrical or symmetrical; linear or oblong; when asymmetrical with both sutures nearly straight; not inflated; compressed; with beak; straight; with solid beak the same color and texture as fruit; tapered or short tapered at apex; apex aligned or oblique with longitudinal axis of fruit; tapered or short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; ligneous; seed chambers externally visible or invisible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain (though upper suture thickened and at most with 2 subwings) or embellished. Fruit wings absent or present; 2; 1 mm wide (at most); sutural; on 1 suture. Fruit nonstipitate or substipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible. Epicarp glossy; monochrome; dark reddish to slightly purplish brown; pubescent and indurate; with 1 type of pubescence; puberulent or villous; with pubescence golden or gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; not veined; not tuberculate; faintly wrinkled; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; subligneous. Endocarp dull; monochrome; brown to purplish brown or purple; smooth and scurfy; nonseptate (with well developed scurfy lines between seeds) or subseptate (because of regular intrusion of fruit); chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 2–8; length oblique to fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; filiform; straight. Aril present or absent; dry; rim-aril or tongue-aril; tan or white.

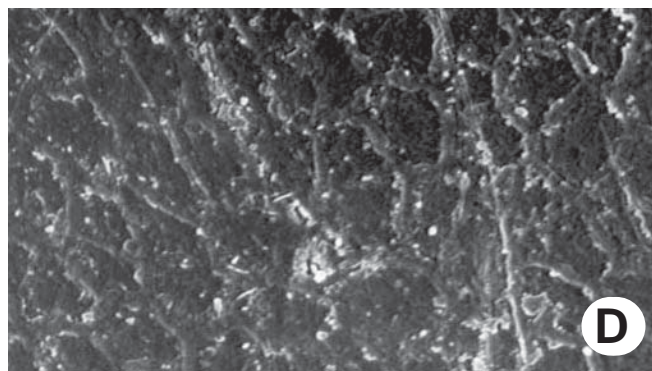
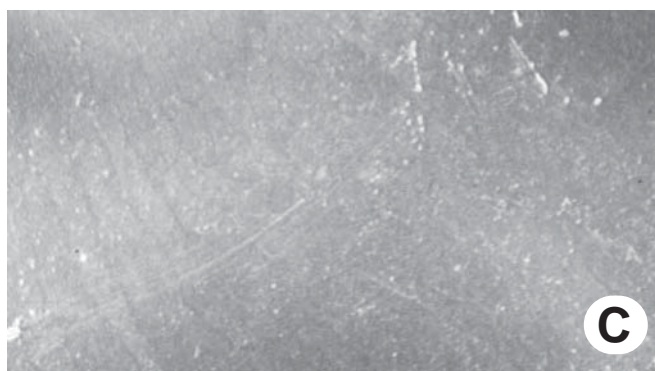
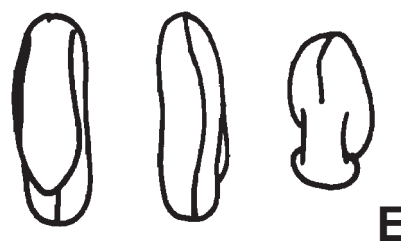
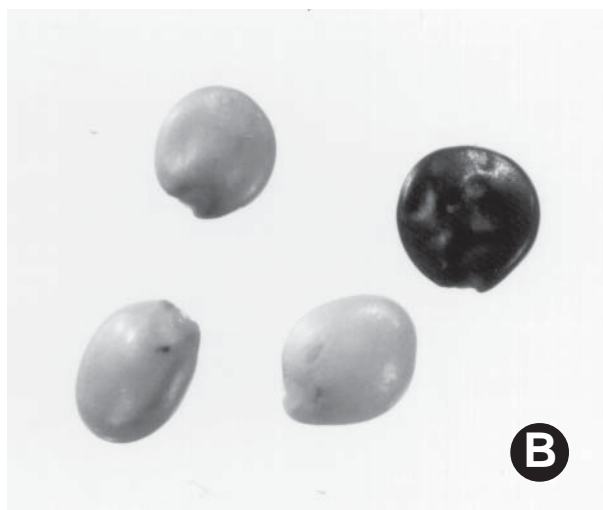
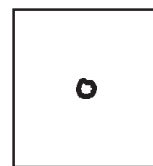
Seed $3\text{--}4.2 \times 2.6\text{--}3.3 \times 1\text{--}3$ mm; not overgrown; not angular or angular; asymmetrical; rectangular, oblong, elliptic, or circular; compressed or terete; with surface

smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome; brown to light brown to dark reddish brown, tan (to faintly greenish tan), or yellow; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform or larger than punctiform; 0.3 mm long; with curved outline; circular; apical at apex of radicle tip or between cotyledon and radicle lobe; recessed; within rim. Hilum rim color of testa. Lens discernible; equal to or greater than 0.5 mm in length; 0.7–0.8 mm long; with margins straight or curved; oblong or wedge-shaped; oblong; not in groove of raphe; confluent with hilum; mounded; similar color as testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; tan or yellow; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly or equaling length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Mediterranean region.

Notes: The correct spelling of the genus is *Calicotome*, not *Calycotome* (Gunn 1983, Gunn et al. 1992).

Calicotome: *C. spinosa* (C. Linnaeus) J.H.F. Link (*C–E*), *C.* spp. (*A–B*). *A*, Fruit and valves ($\times 1.5$); *B*, seeds ($\times 6.1$); *C–D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 8$).



Genus: *Erinacea* M. Adanson

Phylogenetic Number: 30.18.

Tribe: Genisteae.

Species Studied—Species in Genus: 1 sp.—1 sp.

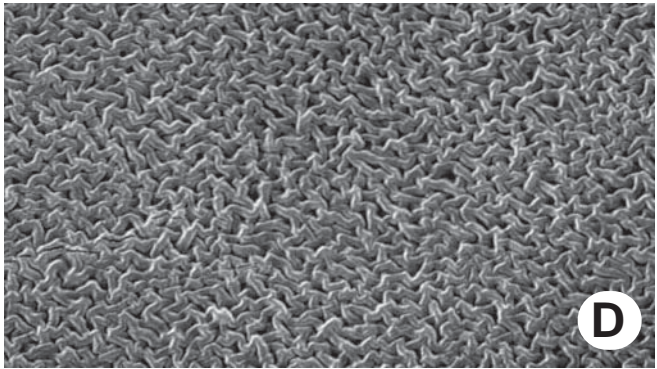
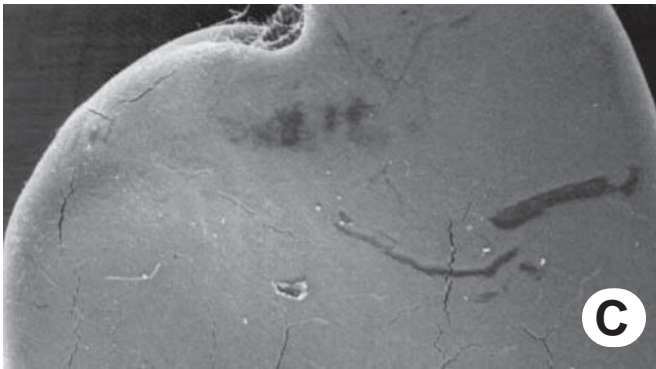
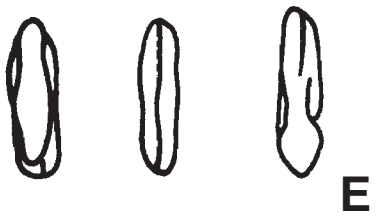
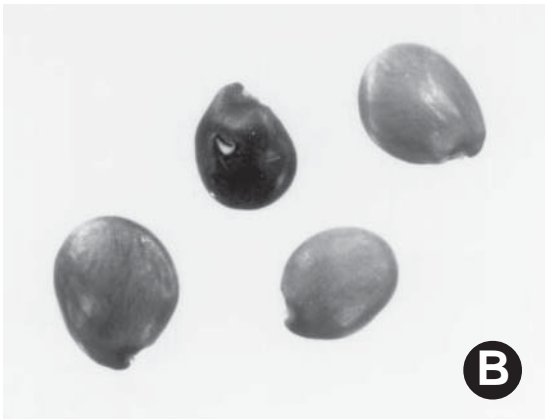
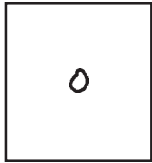
Fruit a legume; unilocular; $1.5\text{--}1.8 \times 0.4 \times 0.1$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; narrowly oblong; when asymmetrical with both sutures nearly straight; not inflated; compressed; with beak; straight; with solid beak the same color and texture as fruit; tapered at apex; apex aligned with longitudinal axis of fruit; tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; chartaceous; seed chambers externally visible; with the raised seed chambers torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves reflexing. Replum invisible. Epicarp dull; monochrome; reddish brown or black; pubescent and indurate; with hairs appressed or erect; with 1 type of pubescence; sericeous; with pubescence golden or gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; smooth; not veined; not tuberculate; not exfoliating or exfoliating in part; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; chartaceous. Endocarp dull; monochrome; reddish brown or gray; smooth and scurfy; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–3; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; triangular; straight. Aril dry; rim-aril; reddish tan or white.

Seed $3.7 \times 3 \times 1.5$ mm; not overgrown; not angular; asymmetrical; oblong or triangular; compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome; dark reddish to greenish brown or olive; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings

absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; subapical to radicle tip and between cotyledon and radicle lobe; recessed; within halo. Hilum halo color darker (greenish) than testa. Lens discernible; less than 0.5 mm in length; with margins straight or curved; oblong or linear; not in groove of raphe; confluent with hilum; flush; dissimilar color from testa; lighter than testa; tan; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; reddish brown; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; not centered between cotyledons (radicle outside 1 cotyledon and inside other, therefore junctions for each cotyledon different); equaling length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Southwestern Europe and northwestern Africa.

Erinacea: E. anthyllis J.H.F. Link (*A–E*). *A*, Fruit within calyx and corolla and valve ($\times 2.9$); *B*, seeds ($\times 6.2$); *C–D*, testa ($\times 50$, $\times 1000$); *E*, embryos (upper two show the outside of both cotyledon-radicle junctions) ($\times 10$).



Genus: *Spartium* C. Linnaeus

Phylogenetic Number: 30.19.

Tribe: Genisteae.

Species Studied—Species in Genus: 1 sp.—1 sp.

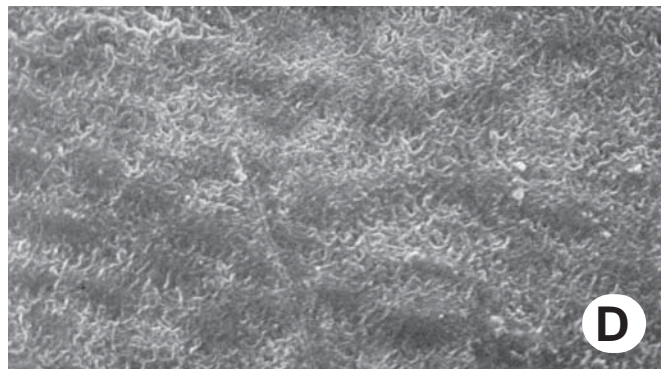
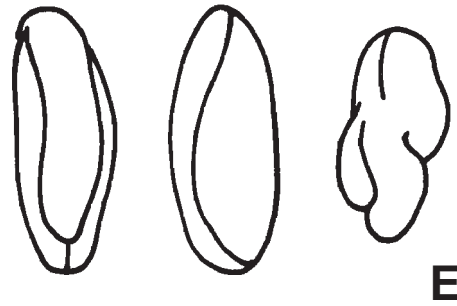
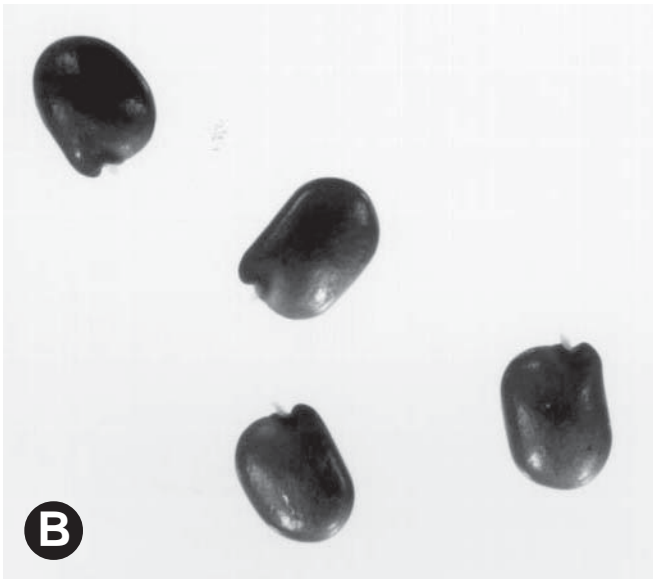
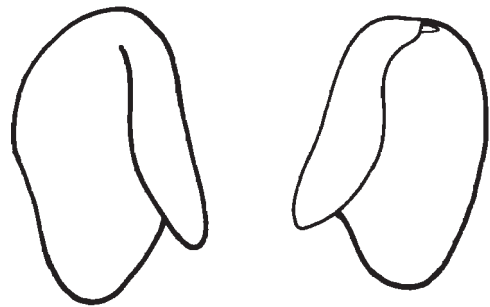
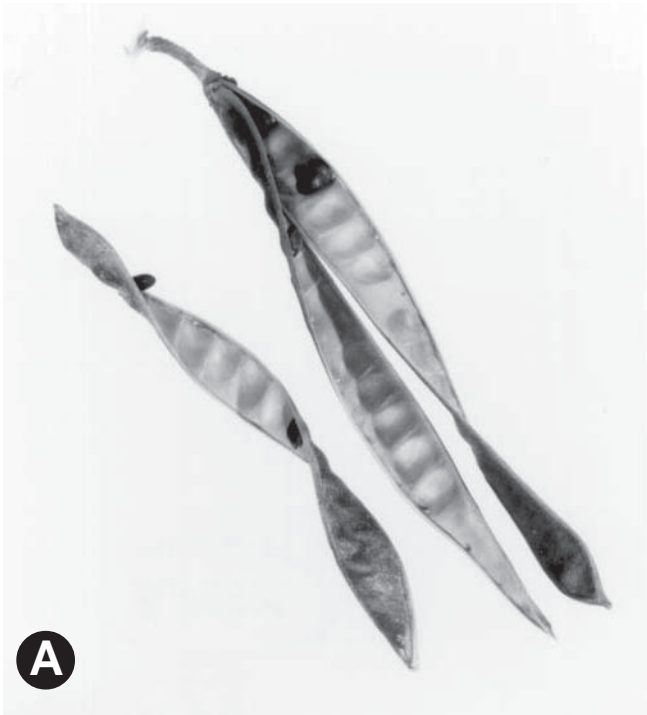
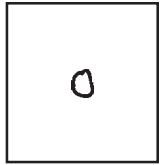
Fruit a legume; unilocular; $5-7 \times 0.5-0.8 \times 0.2-0.3$ cm; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical; linear; not inflated; flattened; without or with beak; with solid beak the same color and texture as fruit; short tapered at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain. Fruit nonstipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible. Epicarp glossy; monochrome; reddish brown; glabrous; eglandular; without spines; not smooth; with elevated features; not veined; not tuberculate; faintly wrinkled; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp glossy or dull; monochrome; reddish brown or tan (reddish); smooth and scurfy (somewhat between seeds); subseptate; with septa thin (tissue paper-like), flexible; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 10–16; length transverse to fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril dry; rim-aril or tongue-aril; cream or tan.

Seed $3.5-4 \times 2.5-3 \times 1.5-1.7$ mm; not overgrown; not angular or angular; asymmetrical; oblong, quadrangular, rectangular, circular, D-shaped, or irregular; compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome; dark to bright reddish brown or purple (almost dark); glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum;

punctiform; subapical to radicle tip to apical at apex of radicle tip; recessed; within rim. Hilum rim color of to darker than testa. Lens discernible; less than 0.5 mm in length; with margins straight or curved; circular or oblong; not in groove of raphe; confluent with hilum; mounded; similar color as or dissimilar color from testa; lighter or darker than testa; tan (reddish within dark reddish border) or black; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; pale tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Mediterranean region and widely cultivated.

Spartium: *S. junceum* C. Linnaeus (A–E). A, Dehisced fruit and valve ($\times 1.4$); B, seeds ($\times 6$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 8$).



Genus: *Gonocytisus* É. Spach

Phylogenetic Number: 30.20.

Tribe: Genisteae.

Species Studied—Species in Genus: 2 spp.—3 spp.

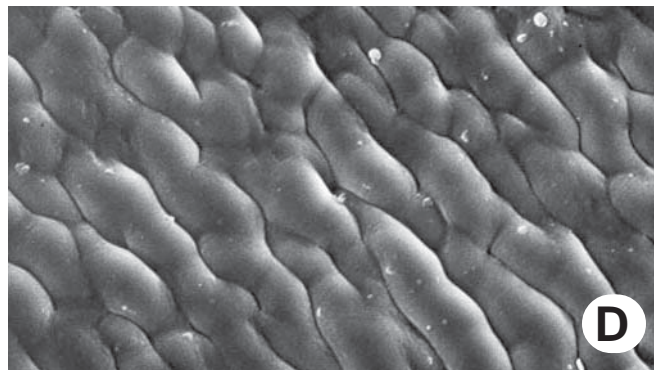
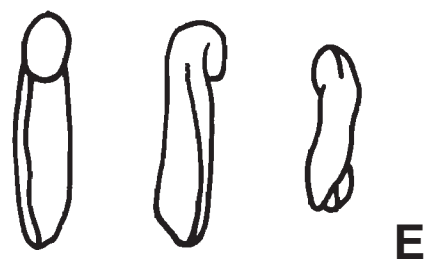
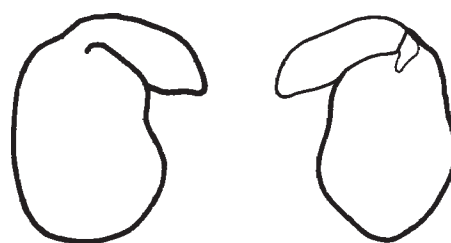
Fruit a legume; unilocular; $1.2\text{--}1.7 \times 0.45\text{--}0.6 \times 0.075\text{--}0.18$ cm; with persistent or deciduous calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; oblong or rhombic; when asymmetrical with both sutures nearly straight; not inflated; compressed; without beak; short tapered at apex; apex aligned or oblique (slightly) with longitudinal axis of fruit; short tapered at base; base aligned (slightly) or oblique with longitudinal axis of fruit; with the apex and base uniform in texture; ligneous; seed chambers externally visible; with the raised seed chambers not torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; passive. Replum invisible. Epicarp dull; monochrome; reddish brown; pubescent and indurate; with hairs appressed; with 1 type of pubescence; with pubescence gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; obliquely veined relative to fruit length; not tuberculate; faintly wrinkled; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; subligneous. Endocarp dull; monochrome; brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–2; length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; filiform or triangular; straight. Aril dry; rim-aril; tan.

Seed $2.5\text{--}4 \times 2\text{--}3 \times 1.7\text{--}2$ mm; not overgrown; not angular or angular; asymmetrical; oblong, reniform, or circular (more or less); compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome; dark reddish brown or black; glabrous; smooth; coriaceous. Fracture lines absent.

Rim present. Wings absent. Raphe not visible. Hilum partially or fully concealed; concealed by aril or funiculus; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; between cotyledon and radicle lobe; recessed; within rim or not within corona, halo, or rim. Hilum rim color of testa. Lens discernible; less than 0.5 mm in length; with margins straight or curved; more or less oblong or circular; not in groove of raphe; adjacent to hilum; 0.5 mm from hilum; flush or recessed; similar color as or dissimilar color from testa; lighter than testa; tan; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; reddish brown; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; with a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Eastern Mediterranean.

Gonocytisus: *G. angulatus* (C. Linnaeus) É. Spach (*C–E*), *G. spp.* (*A–B*). *A*, Fruits (closed and dehisced) ($\times 3.4$); *B*, seeds ($\times 5.7$); *C–D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 8$).



Genus: *Retama* C.S. Rafinesque-Schmaltz

Phylogenetic Number: 30.21.

Tribe: Genisteae.

Species Studied—Species in Genus: 4 spp.—4 spp.

Fruit a legume; unilocular; $0.7\text{--}2 \times 0.6\text{--}1 \times 0.45\text{--}1$ cm; with deciduous calyx; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical or symmetrical; ovate to elliptic or elliptic to ovate; when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; widest near middle or D-shaped; not inflated; terete; without or with beak; declined; with solid beak the same color and texture as fruit; rounded at apex; apex oblique with longitudinal axis of fruit; tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; ligneous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit nonstipitate. Fruit indehiscent (to finally incompletely dehiscent along vertical suture) or with all layers dehiscing; splitting along suture. Dehiscence of valves along 1 suture; probably apical and down; passive. Replum invisible. Epicarp glossy or dull; monochrome (though some with darker areas); brown to dark or dark reddish brown or tan; glabrous; eglandular; without spines; not smooth or smooth; with elevated features; not veined; not tuberculate; rugose or wrinkled; not exfoliating; without cracks. Mesocarp thick or thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid (tan) or vitreous (dark reddish-brown); ligneous (or subligneous). Endocarp dull or glossy; monochrome (to darker and lighter when underlain by dark mesocarp); brown or tan; spongy and cobwebby; subseptate or nonseptate; with septa thin (tissue paper-like), flexible or thicker than paper, firm; with septa eglandular; coriaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1(–2); length parallel with fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; straight. Aril absent.

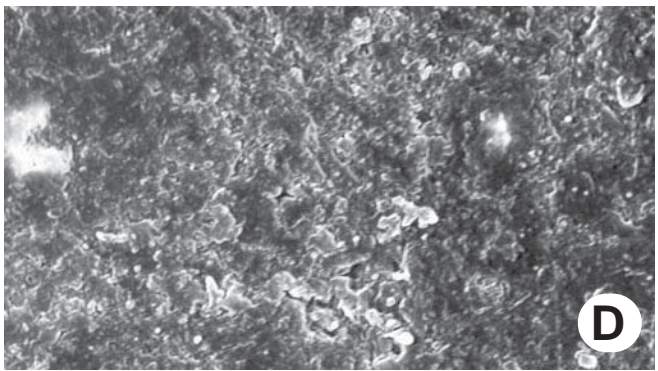
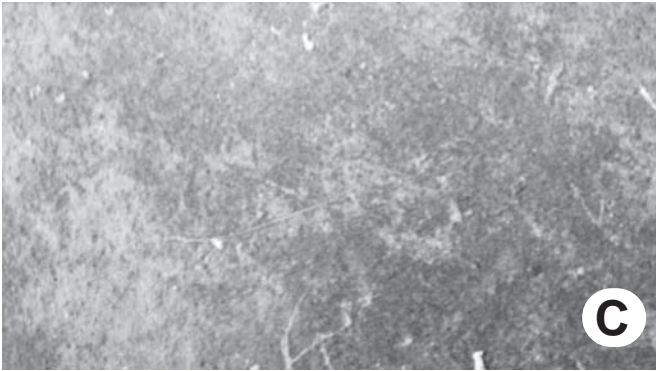
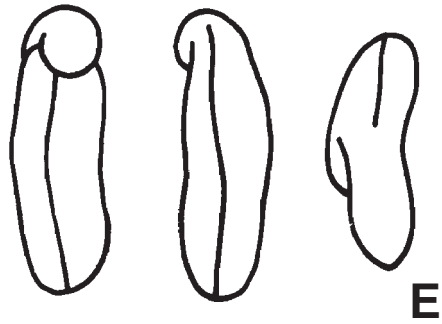
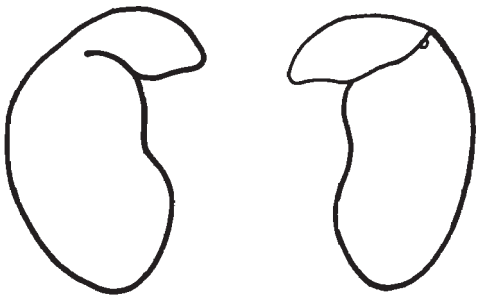
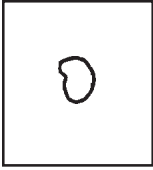
Seed $6\text{--}7.5 \times 4\text{--}5.5 \times 3\text{--}4.5$ mm; not overgrown; not angular or angular; asymmetrical or symmetrical; oblong, reniform, triangular (more or less), D-shaped, or irregular; compressed, terete, or mounded on 1 side and straight on other side; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering or

partially adhering to endocarp; dull; not modified by a bloom; colored; monochrome or mottled; with frequent or infrequent mottles; dark reddish to greenish brown, tan (to greenish or reddish tan), green (light to dark), or black; with black overlay; glabrous; smooth; osseous. Fracture lines absent. Rim present. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; up to 1 mm long; with straight outline; oblong; marginal according to radicle tip; recessed; within rim. Hilum rim color of or lighter than testa. Lens discernible or not discernible; equal to or greater than 0.5 mm in length; up to 2.5 mm long; with margins straight or curved; linear, oblong, wedge-shaped, or circular (with a small satellite); not in groove of raphe; confluent with or adjacent to hilum; up to 0.3 mm from hilum; flush or recessed; similar color as or dissimilar color from testa; lighter or darker than testa; reddish brown, tan, or black; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; deflexed and parallel to cotyledon length; centered between cotyledons; less than 1/2 length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Mediterranean region, northern Africa, Canary Islands, and Asia (Middle East).

Notes: This genus is presented under the name *Lygos* M. Adanson in Heywood (1968).

Retama: *R. sphaerocarpa* (C. Linnaeus) P.E. Boissier (*C–E*), *R. spp.* (*A–B*). *A*, Fruits ($\times 3.4$); *B*, seeds ($\times 4$); *C–D*, testa ($\times 50$, $\times 1000$); *E*, embryos ($\times 5$).



Genus: *Genista* C. Linnaeus

Phylogenetic Number: 30.22.

Tribe: Genisteae.

Species Studied—Species in Genus: 33 spp.—87 spp.

Fruit a legume; unilocular; $0.8\text{--}3 \times 0.35\text{--}0.4 \times 0.15\text{--}0.3$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight or curved (or slightly curved); not plicate; not twisted; asymmetrical or symmetrical; oblong, linear, ovate, rhombic, or falcate; when asymmetrical with both sutures parallelly curved; not inflated or inflated; compressed, flattened (rarely), or terete; without beak; tapered or short tapered at apex; apex aligned, oblique, or right-angled with longitudinal axis of fruit; tapered or short tapered at base; base aligned, oblique, or right angled with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally visible or invisible; with the raised seed chambers not torulose or torulose. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate or nonstipitate. Fruit with all layers dehiscing or indehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible. Epicarp glossy or dull; monochrome; dark to light reddish brown; glabrous or pubescent and indurate; with hairs erect or appressed; with 1 type of pubescence; tomentose or villous; with pubescence golden or gray; with pubescence uniformly distributed or with apical pubescence different from basal pubescence; with apical $1/3\text{--}1/2$ pubescent and basal $1/2\text{--}2/3$ glabrous (*G. cephalantha* É. Spach); with simple hairs; pliable; with hair bases plain; eglandular; without spines; not smooth; with elevated features; veined or not veined; obliquely veined relative to fruit length or reticulately veined; not tuberculate; wrinkled; exfoliating in part or not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; reddish brown; smooth and scurfy (around seeds); with hairs scattered over endocarp (minute except along sutures where much longer); subseptate or nonseptate; with septa thin (tissue paper-like), flexible; with septa eglandular; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–7; length transverse, oblique, or parallel with fruit length; neither

overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long or measured; up to 1.5 mm long; of 1 length only; filiform, thick, or triangular; straight, curved, S-curved, or hooked. Aril dry or fleshy; when fleshy topknotlike or cupshaped; covering less than $1/2$ of seed; when dry rim-aril or tongue-aril; reddish brown, tan, white, or red (nearly).

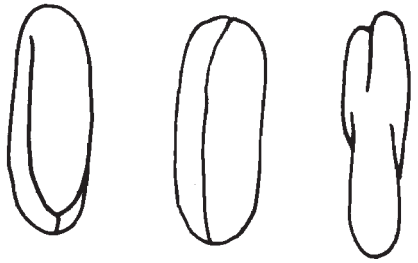
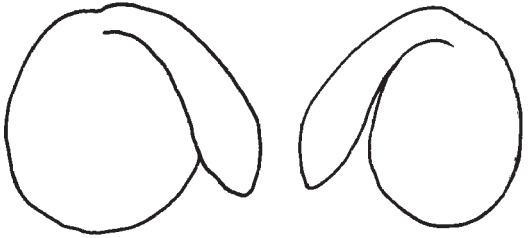
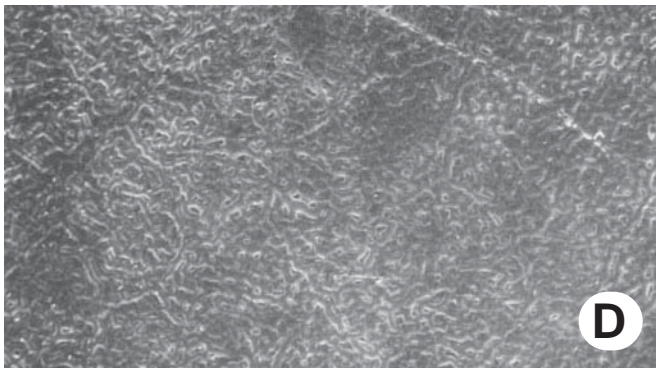
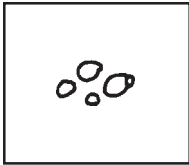
Seed $1.8\text{--}4.2 \times 1.5\text{--}3 \times 1\text{--}2$ mm; not overgrown; not angular or angular; asymmetrical; oblong, ovate, reniform, circular (more or less), D-shaped, irregular (somewhat), quadrangular, rhombic, or triangular; compressed or terete; with surface smooth; with or without visible radicle and cotyledon lobes; without or with external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome or mottled and streaked (sometimes both faint); with frequent mottles; with frequent streaks; brown to yellowish, greenish or reddish brown, yellow (to brownish to greenish yellow), green, olive, or black; with brown or black overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible or fully concealed (occasionally); concealed by funiculus or funicular remnant; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform or larger than punctiform; 0.3 mm long; with curved outline; circular; apical at apex of or subapical to radicle tip; recessed; within rim. Hilum rim color of testa. Lens discernible or not discernible; less than or equal to or greater than 0.5 mm in length; 0.5 mm long; with margins straight or curved; elliptic or oblong; not in groove of raphe; adjacent to or confluent with hilum; 0.1–0.2 mm from hilum; mounded or flush; similar color as testa; not within corona, halo, or rim. Endosperm thick or thin; covering entire embryo; adnate to embryo or testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; tan, yellow, or white; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle linear or bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; $1/2$

to nearly, equaling, or exceeding length of cotyledons.
Plumule rudimentary; glabrous.

Distribution: Europe, Canary Islands, northern Africa, and western Asia.

Notes: Gibbs (1966) revised the genus, and Gibbs and Dingwall (1971) revised its segregate *Teline* F.K. Medikus, now recombined with *Genista*.

Genista: *G. germanica* C. Linnaeus (*C–E*), *G. spp.* (*A–B*). *A*,
Fruits (dehisced) ($\times 1.5$); *B*, seeds ($\times 4$); *C–D*, testa
($\times 50$, $\times 1000$); *E*, embryos ($\times 10$).



E

Genus: *Echinopartum* (É. Spach) J.P. Fourreau

Phylogenetic Number: 30.23.

Tribe: Genisteae.

Species Studied—Species in Genus: 2 spp.—3 spp.

Fruit a legume; unilocular; $1-1.5 \times 0.3-0.5 \times 0.1-0.2$ cm; with persistent calyx; with calyx longer than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; oblong; when asymmetrical with 1 straight and 1 curved suture or both sutures parallelly curved; widest near middle or D-shaped; not inflated; compressed; with beak; straight; with solid beak the same color and texture as fruit; tapered at apex; apex aligned with longitudinal axis of fruit; tapered at base; base aligned with longitudinal axis of fruit; with the apex and base uniform in texture; liginous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; embellished. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves enrolling. Replum invisible. Epicarp dull; monochrome; brown; pubescent and indurate; with 1 type of pubescence; villous; with pubescence golden; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; smooth; not veined; not tuberculate; not exfoliating; without cracks. Mesocarp thick; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; sublignous. Endocarp glossy; monochrome; reddish tan; smooth and scurfy; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1 or 2; length oblique to fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; curved. Aril dry; rim-aril; black.

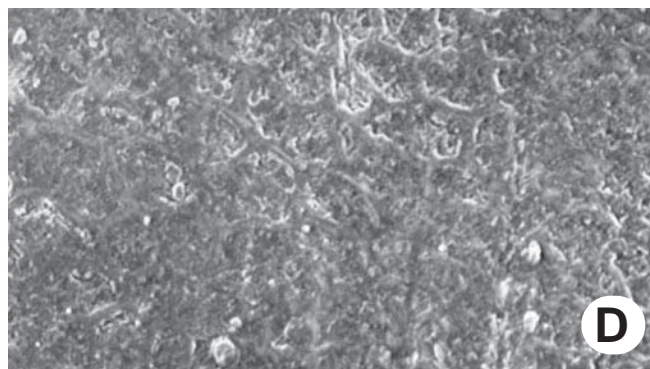
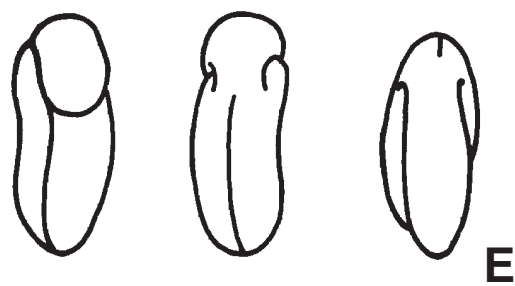
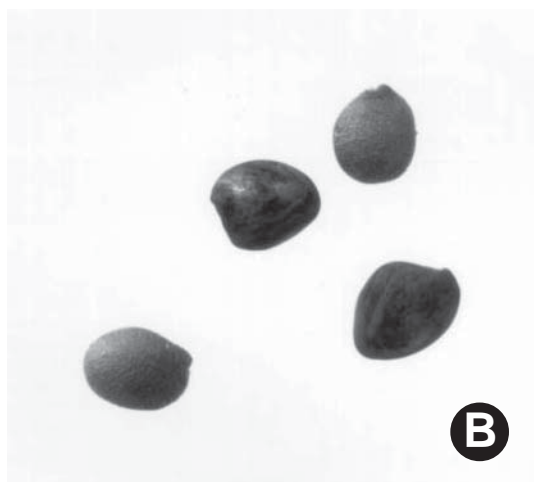
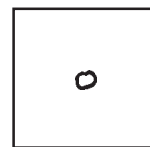
Seed $2.5-2.7 \times 2-2.5 \times 1.7-2$ mm; not overgrown; angular or not angular; asymmetrical; oblong, ovate, or D-shaped; compressed or terete; with surface smooth; without visible radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Cuticle wrinkled (*E. horridum* (J.L.M. Vahl) W.H.P. Rothmaler). Testa not adhering to endocarp; dull; not modified by a bloom; colored; mottled and streaked; with frequent mottles; with frequent streaks; dark reddish brown; with black overlay; glabrous; smooth or not smooth; with elevated features; wrinkled (because

of cuticle); coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform; apical at apex of radicle tip; slightly recessed; within rim. Hilum rim color of testa. Lens not discernible. Endosperm thick; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; reddish tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle somewhat linear; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; $1/2$ to nearly length of cotyledons. Plumule moderately developed; glabrous.

Distribution: Southwestern Europe.

Notes: We are following Gunn et al. (1992) for the author of this genus rather than Bisby (1981).

Echinopartum: *E. lusitanicum* (C. Linnaeus) W.H.P. Rothmaler (C-E), *E. spp.* (A-B). A, Fruits (dehiscid) ($\times 2.9$); B, seeds ($\times 6.6$); C-D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 12$).



Genus: *Stauracanthus* J.H.F. Link

Phylogenetic Number: 30.24.

Tribe: Genisteae.

Species Studied—Species in Genus: 2 spp.—2 spp.

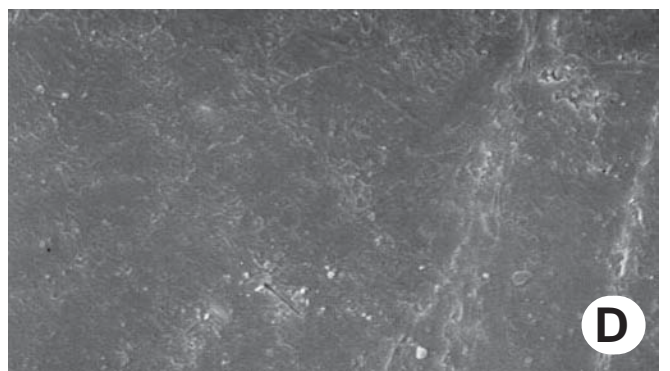
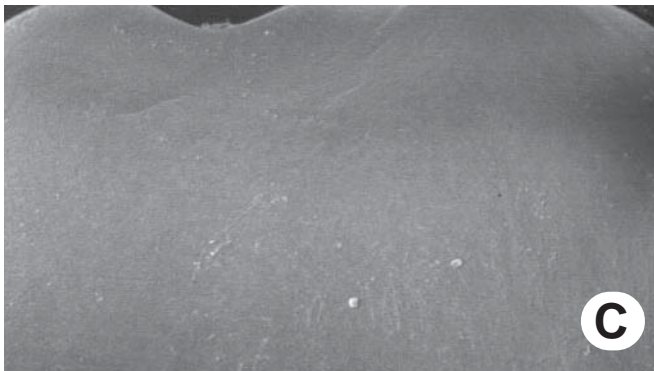
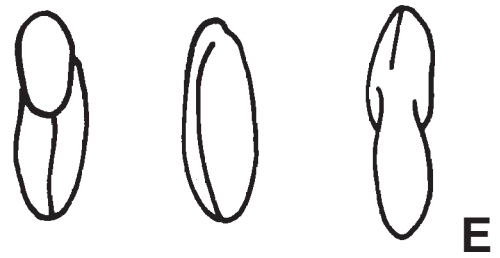
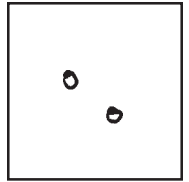
Fruit a legume; unilocular; $0.8\text{--}2.5 \times 0.5$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; asymmetrical; linear or oblong (to linear); when asymmetrical with 1 straight and 1 curved suture or both sutures nearly straight; widest near middle or D-shaped (somewhat); not inflated; compressed; without beak; rounded at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base oblique with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous; seed chambers externally invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit nonstipitate. Fruit with all layers dehiscing; splitting along sutures. Dehiscence of valves along both sutures; assumed apical and down; passive. Replum invisible. Epicarp dull; monochrome; reddish brown; glabrous or pubescent but soon deciduous; with hairs appressed; with 1 type of pubescence; with pubescence golden (barely golden, primarily colorless); with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; smooth; not veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous. Endocarp dull; monochrome; reddish brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 2–6; length oblique to fruit length; neither overlapping nor touching; in 1 series. Funiculus measured; 1 mm long; of 1 length only; flattened; curved. Aril present (but apparently easily knocked off); fleshy; topknotlike; covering less than 1/2 of seed; brown or tan.

Seed $2.8\text{--}3.5 \times 2\text{--}2.5 \times 1.2\text{--}1.8$ mm; not overgrown; not angular or angulate; asymmetrical; oblong or rectangular (more or less); compressed; with surface smooth; with visible radicle and cotyledon lobes; without external groove between radicle and cotyledon lobes; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy; not modified by a bloom; colored; monochrome or streaked and mottled (large or

minute); with frequent mottles; with frequent streaks; reddish to greenish brown or green; with purple overlay; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum visible or fully concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; punctiform or larger than punctiform; 0.3 mm long; with straight outline; oblong; apical at apex of radicle tip and between cotyledon and radicle lobe; recessed; within rim. Hilum rim color of testa (or nearly so). Lens discernible; equal to or greater than 0.5 mm in length; 0.8 mm long; with margins straight or curved; oblong; not in groove of raphe; confluent with hilum; mounded; similar color as testa; darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thin; covering entire embryo; adnate to testa. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly length of cotyledons. Plumule rudimentary; glabrous.

Distribution: Southwestern Europe and northwestern Africa.

Stauracanthus: *S. boininii* (P.B. Webb) G.A. da S.F. Sampaio (A), *S. genistoides* (F.d'A. Brotero) G.A. da S.F. Sampaio (C–E), *S. spp.* (B). A, Inner and outer valve surfaces ($\times 5.7$); B, seeds ($\times 6.3$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 14$).



Genus: *Ulex* C. Linnaeus

Phylogenetic Number: 30.25.

Tribe: Genisteae.

Species Studied—Species in Genus: 7 spp.—20 spp.

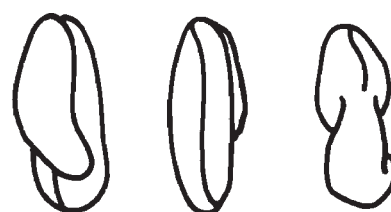
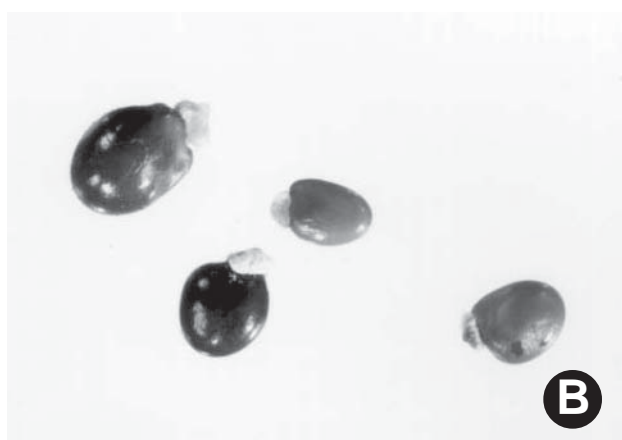
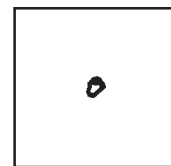
Fruit a legume; unilocular; $0.8-2 \times 0.4-0.45 \times 0.14-0.15$ cm; with persistent calyx; with calyx shorter than fruit; without orifice formed by curving of fruit or fruit segments; straight; not plicate; not twisted; symmetrical or asymmetrical; linear (oblong), oblong, ovate, or rhombic; when asymmetrical with both sutures nearly straight; not inflated; compressed or terete; without or with beak; straight; with solid beak the same color and texture as fruit; tapered at apex; apex aligned with longitudinal axis of fruit; short tapered at base; base aligned or oblique with longitudinal axis of fruit; with the apex and base uniform in texture; coriaceous, ligneous, or fragile, thinner than chartaceous like *Trifolium* (23.07); seed chambers externally visible or invisible. Fruit margin not constricted; without sulcus; plain. Fruit wings absent. Fruit substipitate or nonstipitate. Fruit with all layers dehiscent; splitting along sutures. Dehiscence of valves along both sutures; apical and down; active; with valves twisting. Replum invisible. Epicarp dull; monochrome or multicolored; bichrome (upper portion darker than lower portion); reddish brown; with surface texture uniform or not uniform, with patches of different texture not restricted to the base and apex; pubescent and indurate; with 1 type of pubescence; villous; with pubescence more or less golden or gray; with pubescence uniformly distributed; with simple hairs; pliable; with hair bases plain; eglandular; without spines; smooth; not veined; not tuberculate; not exfoliating; without cracks. Mesocarp thin; surface not veined; 1-layered; without balsamic vesicles; without fibers; solid; coriaceous or ligneous (sub). Endocarp dull; monochrome; reddish brown; smooth; nonseptate; chartaceous; not exfoliating; remaining fused to mesocarp and epicarp; entire. Seeds 1–6; length parallel with or oblique to fruit length; neither overlapping nor touching; in 1 series. Funiculus less than 0.5 mm long; of 1 length only; thick; curved. Aril fleshy or dry; topknotlike; rim-aril; brown, tan, cream, or ivory.

Seed $2-3 \times 1.3-3.5 \times 1-2.7$ mm; not overgrown; not angular or angular; asymmetrical; oblong, ovate, rectangular, triangular, circular, or irregular; compressed or terete; with surface smooth; with or without

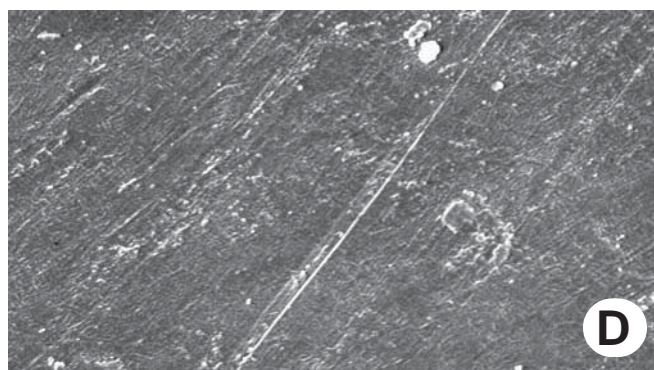
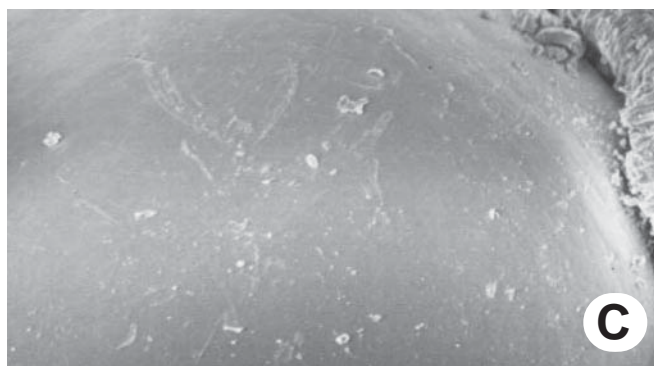
visible radicle and cotyledon lobes; without or with (faint) external groove between radicle and cotyledon lobes; with external groove between radicle and cotyledon lobes same color as testa; without hilar sinus; without umbo on seed faces. Testa not adhering to endocarp; glossy or dull; not modified by a bloom; colored; monochrome; reddish to greenish brown, tan (greenish), or green; glabrous; smooth; coriaceous. Fracture lines absent. Rim absent. Wings absent. Raphe not visible. Hilum fully concealed; concealed by aril; with faboid split; with the lips of the faboid split the same color as the rest of the hilum; larger than punctiform; 0.5–1 mm long; with curved outline; elliptic or oval; apical at apex of radical tip, subapical to radicle tip, or between cotyledon and radicle lobe; recessed; within rim. Hilum rim color lighter (greenish-tan) or darker (dark brown) than testa. Lens discernible; equal to or greater than 0.5 mm in length; 0.7–1 mm long; with margins straight or curved; oblong (with or without central groove) or key-hole shaped (more or less); not in groove of raphe; confluent with hilum; flush or recessed; same or similar color as testa; lighter or darker than testa; reddish brown; not within corona, halo, or rim. Endosperm thick; covering entire embryo; adnate to embryo. Cotyledons smooth; both outer faces convex; both the same thickness; both more or less of equal length; not folded; margin entire 180 degrees from base of radicle; similar at apex; not concealing radicle; split over radicle; with lobes; with the interface division terminating at base of radicle; without margins recessed; tan; inner face flat; glabrous around base of radicle. Embryonic axis deflexed; oblique to length of seed; without a joint evident between the radicle and the cotyledons. Radicle bulbous; lobe tip straight; deflexed and parallel to cotyledon length; centered between cotyledons; 1/2 to nearly or equaling length of cotyledons. Plumule rudimentary or moderately developed; glabrous.

Distribution: Native to Western Europe and northern Africa; introduced elsewhere.

Ulex: *U. parviflorus* P.A. Pourret de Figeac (C–E), *U.* spp. (A–B). A, Dehiscent fruits with one in calyx and bracts ($\times 2.6$); B, seeds ($\times 6$); C–D, testa ($\times 50$, $\times 1000$); E, embryos ($\times 10$).



E



Character List

- #1. Subfamily:/
 - 1. Caesalpinioideae/
 - 2. Mimosoideae/
 - 3. Faboideae/
- #2. Phylogenetic number: /
- #3. Tribe: <of Caesalpinioideae>/
 - 1. Caesalpinieae/
 - 2. Cassieae/
 - 3. Cercideae/
 - 4. Detarieae/
 - 5. Amherstieae/
- #4. Tribe: <of Mimosoideae>/
 - 1. Parkieae/
 - 2. Mimozygantheae/
 - 3. Mimoseae/
 - 4. Acacieae/
 - 5. Ingeae/
- #5. Tribe: <of Faboideae>/
 - 1. Swartzieae/
 - 2. Sophoreae/
 - 3. Dipteryxseae/
 - 4. Dalbergieae/
 - 5. Abreae/
 - 6. Amorpheae/
 - 7. Millettieae/
 - 8. Robinieae <including Sesbanieae>/
 - 9. Indigofereae/
 - 10. Phaseoleae/
 - 11. Desmodieae/
 - 12. Psoraleeae/
 - 13. Loteae/
 - 14. Aeschynomeneae/
 - 15. Adesmieae/
 - 16. Galegeae/
 - 17. Carmichaelieae/
 - 18. Hedysareae/
 - 19. Fabeae/
 - 20. Cicereae/
 - 21. Trifolieae/
 - 22. Brongniartieae/
 - 23. Bossiaeeae/
 - 24. Mirbelieae/
 - 25. Podalyrieae/
 - 26. Hypocalypeteae/
 - 27. Crotalarieae/
 - 28. Euchresteae/
 - 29. Thermopsidaeae/
 - 30. Genisteae/
- #6. Subtribe: /
- #7. Group: /

- #8. Species: <studied>/
studied/
- #9. Species: <in genus>/
in genus/

FRUIT CHARACTERS

- #10. Fruit <recording of morphology>/
 - 1. internal and external morphology recorded/
 - 2. external morphology only recorded/
 - 3. internal morphology only recorded/
 - 4. morphology not recorded/
- #11. Fruit a <type>/
 - 1. legume <including dehiscent and indehiscent 1-seeded fruits>/
 - 2. loment (or a loment segment) <multiseeded, breaking into 1-seeded, usually indehiscent, segments SEE loment characters further back>/
 - 3. nutlet <SEE nutlet characters further back>/
- #12. Fruit <number of locules in legume, 1 or 2>/
 - 1. unilocular/
 - 2. bilocular/
- #13. Fruit <length, from apex to base of fruit>/
cm long/
- #14. Fruit <width, before dehiscence, at widest part>/
cm wide/
- #15. Fruit <thickness, before dehiscence, at thickest part>/cm thick/
- #16. Fruit <relationship of length to width>/
 - 1. length less than twice as long as width/
 - 2. 2-9 times longer than wide/
 - 3. more than 9 times longer than wide/
 - 4. wider than long/
- #17. Fruit with <occurrence of androecial sheath>/
 - 1. persistent androecial sheath/
 - 2. deciduous androecial sheath/
- #18. Fruit with <occurrence of corolla>/
 - 1. persistent corolla/
 - 2. deciduous corolla/
- #19. Fruit with <part of corolla persisting>/
 - 1. keel/
 - 2. standard/
 - 3. various petals/
- #20. Fruit with <calyx>/
 - 1. persistent calyx/
 - 2. deciduous calyx/
- #21. Fruit with calyx <relative length of fruit to calyx>/
 - 1. longer than fruit/
 - 2. equal in length to fruit/
 - 3. shorter than fruit/
- #22. Fruit <orifice formed by curving of fruit or fruit segments>/
 - 1. with orifice formed by curving of fruit or fruit segments <1 or more in either coiled or straight fruit>/
 - 2. without orifice formed by curving of fruit or fruit segments/
- #23. Fruit <declination prior to dehiscence>/
 - 1. 0.5-coiled/

2. 1-coiled/
3. 1.5-coiled/
4. 2-coiled/
5. 3-coiled/
6. 4-coiled/
7. 5- to 10-coiled/
8. contorted/
9. curved <including slightly curved>/
10. S-curved/
11. straight/
- #24. Fruit <plicated>/
 1. plicate/
 2. not plicate/
- #25. Fruit <twist prior to dehiscence>/
 1. twisted/
 2. not twisted/
- #26. Fruit <outline in valvular view symmetry>/
 1. symmetrical/
 2. asymmetrical/
- #27. Fruit <shapes, both symmetrical or asymmetrical>/
 1. C-shaped <asymmetrical>/
 2. circular <symmetrical or asymmetrical>/
 3. coiled <asymmetrical>/
 4. didymous <symmetrical>/
 5. dolabriform <asymmetrical>/
 6. elliptic <symmetrical or asymmetrical>/
 7. falcate <asymmetrical>/
 8. fusiform <symmetrical or asymmetrical>/
 9. irregularly fusiform <asymmetrical>/
 10. harp-shaped <asymmetrical>/
 11. irregular <asymmetrical shapes not classified>/
 12. lanceolate <symmetrical or asymmetrical>/
 13. linear <symmetrical or asymmetrical>/
 14. moniliform <symmetrical or asymmetrical>/
 15. oblanceolate <symmetrical or asymmetrical>/
 16. obliquely oblanceolate <asymmetrical>/
 17. oblong <symmetrical or asymmetrical>/
 18. obovate <symmetrical or asymmetrical>/
 19. obliquely obovate <symmetrical or asymmetrical>/
 20. ovate <symmetrical or asymmetrical>/
 21. obliquely ovate <asymmetrical>/
 22. quadrangular <symmetrical or asymmetrical>/
 23. rectangular <asymmetrical>/
 24. reniform <asymmetrical>/
 25. rhombic <symmetrical or asymmetrical>/
 26. S-shaped <asymmetrical>/
 27. samaroid <asymmetrical>/
 28. triangular <symmetrical or asymmetrical>/
- #28. Fruit when asymmetrical with <asymmetrical with sutures parallel or not>/
 1. 1 straight and 1 curved suture/
 2. both sutures nearly straight/

- 3. both sutures parallelly curved/
- 4. both sutures unequally curved/
- #29. Fruit <asymmetrical shape for those with 1 straight suture>/
 - 1. widest near apex/
 - 2. widest near middle or D-shaped/
 - 3. widest at base/
 - 4. narrowing in several places, resembling Desmodium (9.09) fruit/
 - 5. narrowest near middle, B-shaped/
 - 6. narrowing slightly once or twice on one side/
- #30. Fruit <inflated or not>/
 - 1. inflated <turgid>/
 - 2. not inflated/
- #31. Fruit <in transection>/
 - 1. compressed/
 - 2. cruciform/
 - 3. flattened/
 - 4. mounded on 1 side and straight on other side/
 - 5. quadrangular/
 - 6. subtriangular/
 - 7. terete <including subterete>/
- #32. Fruit <apex with beak>/
 - 1. with beak/
 - 2. without beak/
- #33. Fruit <beak apex>/
 - 1. straight/
 - 2. declined/
 - 3. hooked/
 - 4. coiled/
- #34. Fruit with <beak description>/
 - 1. papery fragile beak up to 1 cm long/
 - 2. white-bristle beak up to 3 mm long/
 - 3. solid beak the same color and texture as fruit/
- #35. Fruit <shape at apex>/
 - 1. abruptly long acuminate at apex/
 - 2. blunt at apex/
 - 3. cordate at apex/
 - 4. emarginate at apex/
 - 5. rounded at apex/
 - 6. long tapered at apex <gradually attenuate>/
 - 7. tapered at apex <attenuate>/
 - 8. short tapered at apex <abruptly attenuate>/
 - 9. truncate at apex/
- #36. Fruit apex <apex alignment>/
 - 1. aligned with longitudinal axis of fruit/
 - 2. oblique with longitudinal axis of fruit/
 - 3. right-angled with longitudinal axis of fruit/
 - 4. almost reaching longitudinal axis of fruit/
 - 5. exceeding (crossing) longitudinal axis of fruit/
- #37. Fruit <shape at base>/
 - 1. cordate at base/
 - 2. emarginate at base/

- 3. rounded at base/
- 4. long tapered at base <gradually attenuate>/
- 5. tapered at base <attenuate>/
- 6. short tapered at base <abruptly attenuate>/
- 7. truncate at base/
- #38. Fruit base <base alignment>/
 - 1. aligned with longitudinal axis of fruit/
 - 2. oblique with longitudinal axis of fruit/
 - 3. right angled with longitudinal axis of fruit/
- #39. Fruit with the apex and base <texture uniformity>/
 - 1. uniform in texture/
 - 2. differing in texture/
- #40. Fruit <textures with the apex and base differing in texture>/
 - 1. upper 1/2 hardened (coriaceous, leathery, or cartilaginous) and lower 1/2 membranous/
 - 2. upper 1/2 inflated and reticulate over seed cavity and lower 1/2 adnate and wrinkled to scurfy over seed cavity/
 - 3. upper 3/4 barely inflated, reticulate, and pubescent and lower 1/4 not inflated, reticulate, or pubescent/
 - 4. upper 1/4-2/3 firm and/or pubescent and lower 3/4-1/3 fragile and glabrous/
- #41. Fruit <texture>/
 - 1. chartaceous/
 - 2. coriaceous <including subcoriaceous>/
 - 3. drupaceous/
 - 4. fleshy <including subfleshy>/
 - 5. fragile, thinner than chartaceous, like Trifolium/
 - 6. leathery/
 - 7. ligneous <including subligneous>/
 - 8. membranous/
- #42. Fruit seed chambers externally <seed chamber externally visibility>/
 - 1. visible/
 - 2. invisible/
- #43. Fruit with the raised seed chambers <shape of raised seed chambers>/
 - 1. torulose/
 - 2. not torulose/
- #44. Fruit margin <constricted or not constricted>/
 - 1. constricted/
 - 2. not constricted/
- #45. Fruit margin <location of marginal constrictions>/
 - 1. constricted along both margins/
 - 2. slightly constricted along both margins/
 - 3. constricted only on 1 margin/
 - 4. slightly constricted only on 1 margin/
 - 5. constricted on 1 margin and slightly constricted on the other margin/
- #46. Fruit margin <sulcate or not sulcate>/
 - 1. with sulcus/
 - 2. without sulcus/
- #47. Fruit margin <plain or not>/
 - 1. embellished/
 - 2. plain/
- #48. Fruit margin with <embellishment>/

1. flange(s)/
 2. fringe/
 3. prickles/
 4. ridge(s)/
 5. spines/
 6. thickened sutural areas/
 7. wing(s)/
- #49. Fruit wing(s) <occurrence of wings on epicarp>/
1. present/
 2. absent/
- #50. Fruit wing(s) <number>/
- #51. Fruit wing(s) <width>/
- mm wide/
- #52. Fruit wing(s) <location>/
1. samaroid/
 2. valvular <on face of valve>/
 3. sutural <on suture>/
 4. continuous wing around fruit/
- #53. Fruit wing(s) <position of wing, basal or apical>/
1. apical <seed and style at opposite ends>/
 2. basal <seed and style at same end>/
- #54. Fruit wing(s) on <position of valvular wing(s)>/
1. 1 valve/
 2. both valves/
- #55. Fruit wing(s) on <position of sutural wing(s)>/
1. 1 suture/
 2. both sutures/
- #56. Fruit <presence of stipe>/
1. stipitate <5 mm or more long>/
 2. substipitate <0.1-5 mm long>/
 3. nonstipitate <sessile>/
- #57. Fruit with the stipe <length of fruit stipe>/
- mm long/

FRUIT DEHISCENCE

- #58. Fruit <dehiscence>/
1. with all layers dehiscing <opening regularly>/
 2. with epicarp and mesocarp dehiscing and endocarp not dehiscing/
 3. with epicarp and mesocarp breaking near center of valve and endocarp dehiscing along suture/
 4. indehiscent/
- #59. Fruit <type of dehiscence>/
1. splitting along suture(s)/
 2. separating from suture(s) and along loment segment margins/
 3. fenestrating, opening by a coiling strip of tissue/
 4. opening by deterioration of delicate strip of tissue along inner suture or both sutures/
 5. with epicarp and mesocarp splitting along suture, endocarp lomented, forming an envelope around each seed, with a flat winglike part/
 6. with epicarp and mesocarp splitting along suture, endocarp entire, forming an envelope around the seeds with flat winglike areas/

- #60. Dehiscence of valves along <on 1 or both sutures>/
 - 1. 1 suture/
 - 2. both sutures/
- #61. Dehiscence of valves <origin and direction>/
 - 1. apical and down/
 - 2. medial and up and down/
 - 3. basal and up/
- #62. Dehiscence of valves <active or passive>/
 - 1. active/
 - 2. passive/
- #63. Dehiscence of valves with valves <of active dehiscent fruits>/
 - 1. breaking/
 - 2. coiling/
 - 3. enrolling/
 - 4. reflexing/
 - 5. revolute/
 - 6. twisting/
- #64. Replum <result of deciduous valves>/
 - 1. visible <valves deciduous>/
 - 2. invisible <valves not deciduous>/
- #65. Loment <ligneous segment entire or partial>/
 - 1. an intact article <with epicarp>/
 - 2. a partial article <without epicarp>/
- #66. Loment <dehiscence>/
 - 1. dehiscing along 1 suture/
 - 2. dehiscing along both sutures/
 - 3. indehiscent/
- #67. Loment segments (articles) <cleavage surface>/
 - 1. conspicuous/
 - 2. inconspicuous/
- #68. Loment segments (articles) <length; loment segment width and thickness are recorded as fruit width and thickness>
 - /mm long/
- #69. Loment segments widest across <article width>/
 - 1. seed area/
 - 2. each end/
- #70. Loment segments with <relative shapes to each other>/
 - 1. all essentially similar in shape/
 - 2. upper 1 different shape than middle one(s)/
 - 3. lower 1 different shape than middle one(s)/
 - 4. upper 1 different shape than lower 1/
- #71. Loment segments <article shape in outline>/
 - 1. circular/
 - 2. curved/
 - 3. D-shaped/
 - 4. elliptic/
 - 5. hippocrepiform <horseshoe or ring-shaped>/
 - 6. linear/
 - 7. oblong/
 - 8. ovate/
 - 9. quadrangular/

- 10. rectangular/
- 11. trapezoid/
- 12. triangular/

EPICARP

- #72. Epicarp <sheen>/
 - 1. dull/
 - 2. glaucous/
 - 3. glossy/
 - 4. semiglossy/
- #73. Epicarp <mono- or multicolored>/
 - 1. monochrome/
 - 2. multicolored/
- #74. Epicarp <color pattern when multicolored>/
 - 1. bichrome/
 - 2. mottled/
 - 3. streaked/
- #75. Epicarp <monochrome color>/
 - 1. black/
 - 2. brown/
 - 3. gray/
 - 4. green/
 - 5. orange/
 - 6. pink/
 - 7. purple/
 - 8. red/
 - 9. tan/
 - 10. yellow/
- #76. Epicarp with <overlying color for mottled and streaked fruits>/
 - 1. black overlay/
 - 2. brown overlay/
 - 3. gray overlay/
 - 4. green overlay/
 - 5. orange overlay/
 - 6. pink overlay/
 - 7. purple overlay/
 - 8. red overlay/
 - 9. tan overlay/
 - 10. yellow overlay/
- #77. Epicarp mottling color combination <mottling patterns>/
 - 1. constant/
 - 2. variable/
- #78. Epicarp with <constant combinations of mottling patterns>/
 - 1. mottling over seed chambers/
 - 2. without mottling over seed chambers/
- #79. Epicarp with surface texture <texture>/
 - 1. uniform/
 - 2. not uniform, with patches of different texture not restricted to the base and apex/
- #80. Epicarp <glabrous to pubescent>/
 - 1. glabrous/

- 2. glabrate/
- 3. pubescent and indurate/
- 4. pubescent but soon deciduous/
- #81. Epicarp with hairs <hair elevation>/
 - 1. erect/
 - 2. appressed/
- #82. Epicarp with <pubescence uniformity>/
 - 1. 1 type of pubescence/
 - 2. 2 types of pubescence/
 - 3. 3 types of pubescence/
- #83. Epicarp <type of pubescence>/
 - 1. hirsute/
 - 2. peltate <densely micropuberulous>/
 - 3. pilose/
 - 4. puberulent/
 - 5. sericeous/
 - 6. strigose/
 - 7. tomentose/
 - 8. velutinous/
 - 9. villous/
- #84. Epicarp with pubescence <pubescence color>/
 - 1. black/
 - 2. brown/
 - 3. golden/
 - 4. gray <including silver>/
 - 5. gray-brown/
 - 6. red/
 - 7. tan/
 - 8. white/
 - 9. yellow/
- #85. Epicarp with <pubescence color variability>/
 - 1. longitudinal bands of lighter and darker brown/
 - 2. appressed dark brown hairs and scattered erect gray hairs intermixed/
 - 3. appressed dark brown hairs and scattered erect white hairs intermixed/
 - 4. long appressed brown hairs and short and shorter white hairs intermixed/
 - 5. golden glandular hairs and short-pilose reddish-brown intermixed/
 - 6. erect golden hairs and white hooked or not hooked hairs/
 - 7. golden hooked hairs and gray plain hairs/
 - 8. gray and black hairs intermixed/
 - 9. long and short gray plain-tipped hairs/
 - 10. gray hairs on valves and golden hairs on sutures/
 - 11. long and short white hairs intermixed/
 - 12. long and short yellow hairs intermixed/
 - 13. long and short golden to brown hairs intermixed/
 - 14. long white and short golden hairs intermixed/
 - 15. contiguous areas of golden and white hairs/
- #86. Epicarp <uniformity of pubescence distribution within patterns of pubescence>/
 - 1. with pubescence uniformly distributed/
 - 2. with apical pubescence different from basal pubescence/

- 3. denser near sutures, sparse centrally/
- #87. Epicarp with <variable pubescence pattern>/
 - 1. apical 1/4 tomentose and basal 3/4 glabrous/
 - 2. apical 3/4 tomentose and basal 1/4 glabrous/
 - 3. apical 1/2 crinkly tomentose and basal 1/2 densely villose with straight hairs/
 - 4. apical 1/3-1/2 pubescent and basal 1/2-2/3 glabrous/
 - 5. apical 3/4 glabrous and basal 1/4 pilose/
 - 6. stipe (only) sericeous <Styphnolobium, in literature>/
- #88. Epicarp with <type of hairs>/
 - 1. simple hairs/
 - 2. glandular hairs/
 - 3. oleaginous hairs/
 - 4. complex hairs/
- #89. Epicarp with <with complex hairs>/
 - 1. bristle-like hairs/
 - 2. plumose hairs/
 - 3. scales/
 - 4. setae/
 - 5. stellate hairs/
 - 6. T-shaped hairs/
- #90. Epicarp <pubescence flexibility>/
 - 1. stiff/
 - 2. pliable/
- #91. Epicarp with hair bases <shape of pubescence base>/
 - 1. swollen/
 - 2. plain/
- #92. Epicarp <hair orientation when bristle-like>/
 - 1. antrorse/
 - 2. retrorse/
 - 3. straight <not bent>/
- #93. Epicarp <apex shape of bristle-like hairs>/
 - 1. straight at apex/
 - 2. coiled at apex/
 - 3. curved at apex/
 - 4. hooked at apex/
- #94. Epicarp <surface>/
 - 1. glandular/
 - 2. eglandular/
- #95. Epicarp with glandular <gland structure>/
 - 1. disks/
 - 2. dots/
 - 3. hairs/
 - 4. papillae/
 - 5. setae/
- #96. Epicarp <gland distribution>/
 - 1. distributed over entire fruit/
 - 2. limited to a portion of fruit/
- #97. Epicarp <relative amount of fruit with glands>/
 - 1. upper 1/4-2/3 glandular and lower 3/4-1/3 eglandular/
 - 2. upper 1/2 glandular and lower 1/2 eglandular/

- 3. upper 2/3 glandular and lower 1/3 eglandular/
- 4. upper 3/4 glandular and lower 1/4 eglandular/
- #98. Epicarp <armature>/
 - 1. with spines <= prickles>/
 - 2. without spines/
- #99. Epicarp with spines <spine persistence>/
 - 1. persistent/
 - 2. broken off and their bases evident/
- #100. Epicarp with spines <spine coloration>/
 - 1. same color as the rest of the fruit/
 - 2. (or their basal remanent) a different color from the rest of the fruit/
- #101. Epicarp <topography>/
 - 1. smooth/
 - 2. not smooth/
- #102. Epicarp with <topography classes>/
 - 1. elevated features/
 - 2. recessed features/
- #103. Epicarp <venation _ elevated feature>/
 - 1. veined/
 - 2. not veined/
- #104. Epicarp <type of venation>/
 - 1. longitudinally veined relative to fruit length/
 - 2. obliquely veined relative to fruit length/
 - 3. transversely veined relative to fruit length/
 - 4. reticulately veined <net-like>/
 - 5. irregularly veined/
- #105. Epicarp <tuberculate>/
 - 1. tuberculate/
 - 2. not tuberculate/
- #106. Epicarp with <position of tubercles>/
 - 1. spongy tubercles on each valve/
 - 2. solid tubercles on each valve/
- #107. Epicarp <topography for nonsmooth types with elevated features>/
 - 1. blistered/
 - 2. concentric whorls like a fingerprint/
 - 3. dotted/
 - 4. faveolate/
 - 5. glandular dotted <include resinous globular>/
 - 6. knobbed/
 - 7. lenticular/
 - 8. muricate/
 - 9. papillose/
 - 10. pusticulate/
 - 11. raised reticulate/
 - 12. ribbed/
 - 13. rugose/
 - 14. scaly/
 - 15. scurfy/
 - 16. shagreen/
 - 17. striate/

- 18. subvesicular/
- 19. tessellate/
- 20. tuberculate/
- 21. verrucose-rugose/
- 22. warty/
- 23. wrinkled/
- #108. Epicarp <topography for nonsmooth types with recessed features>/
 - 1. glandularly punctate/
 - 2. grooved/
 - 3. pitted/
 - 4. punctate/
 - 5. slitted obliquely/
- #109. Epicarp <exfoliation>/
 - 1. exfoliating/
 - 2. exfoliating in part/
 - 3. checking/
 - 4. not exfoliating/
- #110. Epicarp <cracked>/
 - 1. with cracks/
 - 2. without cracks/
- #111. Epicarp cracking <orientation of cracking pattern>/
 - 1. longitudinal to fruit length/
 - 2. oblique to fruit length/
 - 3. transverse to fruit length/
 - 4. irregular/

MESOCARP

- #112. Mesocarp <occurrence>/
 - 1. present/
 - 2. absent/
- #113. Mesocarp <thickness>/
 - 1. thick/
 - 2. thin/
 - 3. trace/
- #114. Mesocarp surface <venation when epicarp exfoliating>/
 - 1. uniformly veined/
 - 2. veined over seed chamber and inconspicuously veined on wing/
 - 3. not veined/
- #115. Mesocarp <number of layers; if solid then only 1-layered>/
 - 1. 1-layered/
 - 2. 2-layered/
 - 3. 3-layered/
- #116. Mesocarp <occurrence of balsamic vesicles>/
 - 1. with balsamic vesicles/
 - 2. without balsamic vesicles/
- #117. Mesocarp <occurrence of fibers>/
 - 1. with fibers/
 - 2. without fibers/
- #118. Mesocarp <presence of reniform canals>/
 - 1. with reniform canals/
 - 2. without reniform canals/

- #119. Mesocarp <texture in 1-layered types>/
1. firm-walled open empty cells/
 2. fibrous throughout <shreds>/
 3. fleshy <including pulpy>/
 4. glassy beads/
 5. mealy <soft>/
 6. spongy <soft>/
 7. vitreous <glasslike as in lava rock obsidium>/
 8. solid <of uniform texture but none of above>/
- #120. Mesocarp with fibers <fibrous types in 2-layers>/
1. over mealy tissue/
 2. over solid layer/
 3. over spongy tissue/
 4. over vitreous layer/
 5. embedded in mealy tissue over solid layer/
 6. below solid or compacted fibrous layer/
- #121. Mesocarp with <nonfibrous types in 2-layers>/
1. empty space (with or without spongy tissue) within solid layer/
 2. honeycomb layer over solid layer/
 3. solid layer over solid layer/
 4. solid layer over spongy layer/
 5. solid layer over vitreous layer/
 6. spongy layer over solid layer/
 7. veins over solid layer/
 8. vitreous layer over solid layer/
- #122. Mesocarp with <nonfibrous types in 3-layers>/
1. solid layer over spongy layer over solid layer/
 2. solid layer over 2 distinct spongy layers/
 3. solid layer over 2 distinct solid layers/
 4. solid layer over vitreous layer over solid layer/
 5. spongy layer over vitreous over solid layer/
 6. vitreous layer over 2 distinct solid layers/
- #123. Mesocarp <durability>/
1. chartaceous/
 2. coriaceous/
 3. fleshy/
 4. ligneous <including subligneous>/

ENDOCARP

- #124. Endocarp <occurrence>/
1. present/
 2. absent/
 3. concealed by adnate testa/
 4. concealed by fleshy mesocarp/
- #125. Endocarp <sheen>/
1. dull/
 2. glossy/
- #126. Endocarp <opaqueness>/
1. opaque/
 2. translucent/
- #127. Endocarp <color pattern>/

1. bichrome/
 2. monochrome/
 3. mottled/
 4. streaked/
- #128. Endocarp <monochrome color>/
1. black/
 2. brown/
 3. gray/
 4. green/
 5. purple/
 6. orange/
 7. red/
 8. tan/
 9. white/
 10. yellow/
- #129. Endocarp with <mottling patterns>/
1. mottling/
 2. mottling over seed chambers/
 3. mottling above and below seed chambers/
- #130. Endocarp with <streaking patterns>/
1. streaking/
 2. streaking over seed chambers/
 3. streaking above and below seed chambers/
- #131. Endocarp with <overlying color for mottling and streaking>/
1. black overlay/
 2. brown overlay/
 3. gray overlay/
 4. green overlay/
 5. pink overlay/
 6. purple overlay/
 7. red overlay/
 8. tan overlay/
 9. yellow overlay/
- #132. Endocarp <appearance on inner surface>/
1. cobwebby/
 2. cracked/
 3. fibrous/
 4. floury-filamentous/
 5. hairy/
 6. pithy/
 7. pulpy/
 8. reticulate/
 9. rugose/
 10. scurfy/
 11. smooth/
 12. spongy/
 13. veined/
 14. vitreous/
 15. transversely wrinkled/
- #133. Endocarp <adherence of pieces of testa to the endocarp>/
1. with adhering pieces of testa/

- 2. without adhering pieces of testa/
- #134. Endocarp with hairs <pubescence pattern>/
 - 1. restricted to sutures/
 - 2. in longitudinal rows/
 - 3. scattered over endocarp/
 - 4. surrounding seed chambers/
- #135. Endocarp <septation>/
 - 1. septate/
 - 2. subseptate/
 - 3. nonseptate/
- #136. Endocarp with septa <septa texture>/
 - 1. thin (tissue paper-like), flexible/
 - 2. thicker than paper, firm/
 - 3. composed of minute fringe of hairs/
- #137. Endocarp with septa <septa glandularity>/
 - 1. glandular/
 - 2. eglandular/
- #138. Endocarp <durability>/
 - 1. chartaceous/
 - 2. coriaceous/
 - 3. ligneous <including subligneous>/
 - 4. osseous/
 - 5. pulpy/
- #139. Endocarp <exfoliation>/
 - 1. exfoliating/
 - 2. exfoliating in part/
 - 3. not exfoliating/
- #140. Endocarp <fused to or separating from epicarp and mesocarp>/
 - 1. remaining fused to mesocarp and epicarp/
 - 2. separating from mesocarp/
 - 3. separating with mesocarp from epicarp/
- #141. Endocarp <fused to or separating from epicarp when mesocarp absent>/
 - 1. remaining fused to epicarp/
 - 2. separating from epicarp/
- #142. Endocarp <occurrence of wings>/
 - 1. without wings/
 - 2. with wing(s) extending into epicarp/
 - 3. with wing(s) not extending into epicarp/
- #143. Endocarp <entire or separating into 1-seeded winged segments>/
 - 1. entire/
 - 2. separating into 1-seeded winged segments/

SEEDS IN FRUIT

- #144. Seed(s) <number>/
- #145. Seed(s) length <alignment with fruit length>/
 - 1. parallel with fruit length/
 - 2. oblique to fruit length/
 - 3. transverse to fruit length/
- #146. Seed(s) <proximity with each other>/
 - 1. overlapping/
 - 2. touching/

- 3. neither overlapping nor touching/
- #147. Seed(s) in <arrangement in pod>/
 - 1. 1 series/
 - 2. 2 or more series/

FUNICULUS

- #148. Funiculus <whether very small>/
 - 1. <less than 0.5 mm long>/
 - 2. <0.5 mm long or more>/
- #149. Funiculus <length>/
 - mm long/
- #150. Funiculus of <lengths _ 1, 2, or 3>/
 - 1. 1 length only/
 - 2. 2 different lengths/
- #151. Funiculus <thickness>/
 - 1. filiform/
 - 2. flattened/
 - 3. partially filiform and partially thick/
 - 4. thick/
 - 5. triangular/
- #152. Funiculus <outline>/
 - 1. anvil-shaped/
 - 2. coiled/
 - 3. contorted/
 - 4. convoluted/
 - 5. curved/
 - 6. S-curved/
 - 7. hooked/
 - 8. plicate/
 - 9. straight/
 - 10. triangular/

ARIL

- #153. Aril <occurrence>/
 - 1. present/
 - 2. absent/
- #154. Aril <texture>/
 - 1. fleshy/
 - 2. dry/
- #155. Aril when fleshy <if fleshy, shape>/
 - 1. annular/
 - 2. caplike/
 - 3. cupshaped/
 - 4. expanded funiculus/
 - 5. flat from apex to near base/
 - 6. hippocrepiform rim-aril/
 - 7. hooked/
 - 8. horseshoe shaped/
 - 9. irregular/
 - 10. knotty/
 - 11. leaflike and attached to marginal hilum/

- 12. 2-lipped rim-aril/
- 13. marginal around seed/
- 14. marginal hilar/
- 15. spherical with prominent apical depression/
- 16. topknotlike/
- #156. Aril <if fleshy, margin shape>/
 - 1. crenate/
 - 2. entire/
 - 3. fimbriate/
 - 4. laciniate/
- #157. Aril covering <if fleshy, amount of seed covered>/
 - 1. less than 1/2 of seed/
 - 2. 1/2 to nearly all of seed/
- #158. Aril when dry <if dry, shape>/
 - 1. caplike/
 - 2. cupshaped/
 - 3. hippocrepiform rim-aril/
 - 4. hooded/
 - 5. 2-lipped rim-aril/
 - 6. rim-aril/
 - 7. partial rim-aril/
 - 8. tongue-aril/
- #159. Aril <if dry, margin shape>/
 - 1. crenate/
 - 2. entire/
 - 3. fimbriate/
 - 4. laciniate/
- #160. Aril covering <if dry, amount of seed covered>/
 - 1. less than 1/2 of seed/
 - 2. 1/2 to nearly all of seed/
- #161. Aril <presence or absence of tongue(s) or flap(s) on lip(s) of 2-lipped rim-aril>/
 - 1. with tongues (or flap-like) on lips of 2-lipped rim-aril/
 - 2. without tongue (or flap-like) on lips of 2-lipped rim-aril/
- #162. Aril with <number of tongue(s) or flap(s) on lip(s) of 2-lipped rim-aril>/
 - 1. 1 tongue or flap on 1 lip of 2-lipped rim-aril/
 - 2. 2 tongues or flaps, 1 on each lip of 2-lipped rim-aril/
- #163. Aril <color>/
 - 1. black/
 - 2. brown/
 - 3. cream/
 - 4. gray/
 - 5. green/
 - 6. ivory/
 - 7. olive/
 - 8. orange/
 - 9. pink/
 - 10. red/
 - 11. tan/
 - 12. white/
 - 13. yellow/

SEED CHARACTERS

- #164. Seed <recording of morphology>/
 - 1. internal and external morphology recorded/
 - 2. external morphology only recorded/
 - 3. internal morphology only recorded <<testa absent or damaged>>/
 - 4. morphology not scored/
- #165. Seed <length>/
 - mm long/
- #166. Seed <width>/
 - mm wide/
- #167. Seed <thickness>/
 - mm thick/
- #168. Seed <overgrown or not overgrown>/
 - 1. overgrown, 1 seed filling entire fruit cavity/
 - 2. not overgrown/
- #169. Seed <angular>/
 - 1. angular/
 - 2. not angular/
- #170. Seed <symmetrical or asymmetrical disregarding hilum>/
 - 1. symmetrical/
 - 2. asymmetrical/
- #171. Seed <shape in outline>/
 - 1. bilobed, cicerlike <bilobular to subglobular and beaked>/
 - 2. C-shaped/
 - 3. circular/
 - 4. cordate/
 - 5. D-shaped/
 - 6. elliptic/
 - 7. falcate/
 - 8. hippocrepiform/
 - 9. irregular/
 - 10. lanceolate/
 - 11. linear/
 - 12. mitaform <mitten shaped>/
 - 13. oblong/
 - 14. obovate/
 - 15. ovate/
 - 16. pyriform/
 - 17. quadrangular/
 - 18. rectangular/
 - 19. reniform/
 - 20. rhombic/
 - 21. samaroid/
 - 22. trapezoid/
 - 23. triangular <including cuneate>/
- #172. Seed <transection>/
 - 1. terete <1:1 ratio including subterete>/
 - 2. quadrangular <1:1 ratio>/
 - 3. compressed <more or less 2:1 ratio>/
 - 4. flattened <greater than 4:1 ratio>/
 - 5. mounded on 1 side and straight on other side/

- #173. Seed with surface <external characters reflecting cotyledon characters>/
 - 1. grooved/
 - 2. ridged/
 - 3. smooth/
 - 4. wrinkled/
- #174. Seed with grooves <orientation of grooves>/
 - 1. longitudinal/
 - 2. oblique/
 - 3. reticulate/
 - 4. transverse/
- #175. Seed <external visibility of radicle & cotyledon lobes>/
 - 1. with visible radicle and cotyledon lobes/
 - 2. without visible radicle and cotyledon lobes/
- #176. Seed <presence of external groove between radicle and cotyledon lobes>/
 - 1. with external groove between radicle and cotyledon lobes/
 - 2. without external groove between radicle and cotyledon lobes/
- #177. Seed with external groove between radicle and cotyledon lobes <color of external groove between radicle and cotyledon lobes>/
 - 1. same color as testa/
 - 2. lighter in color than testa/
- #178. Seed <presence and depth of hilar sinus>/
 - 1. with deep hilar sinus/
 - 2. with shallow hilar sinus/
 - 3. without hilar sinus/
- #179. Seed <occurrence of umbo on seed face>/
 - 1. with umbo on seed faces/
 - 2. without umbo on seed faces/
- #180. Seed with umbo on <presence of umbo on 1 or 2 faces>/
 - 1. 1 face of seed/
 - 2. both faces of seed/
- #181. Seed <face with medial ridge>/
 - 1. with medial ridge on each face <Coronilla varia>/
 - 2. without medial ridge on each face/

CUTICLE

- #182. Cuticle <exfoliation>/
 - 1. exfoliating/
 - 2. not exfoliating/
- #183. Cuticle <inflation>/
 - 1. inflated/
 - 2. not inflated/
- #184. Cuticle inflated around <position of inflation>/
 - 1. hilum/
 - 2. margin of seed/
- #185. Cuticle <wrinkling>/
 - 1. wrinkled/
 - 2. not wrinkled/

TESTA

- #186. Testa <occurrence on embryo>/
 - 1. present/
 - 2. absent <usually fused to endocarp, not discernible>/

- #187. Testa <adherence of pieces of epicarp>/
 - 1. with pieces of adhering epicarp/
 - 2. without pieces of adhering epicarp/
- #188. Testa <adherence to endocarp>/
 - 1. partially adhering to endocarp/
 - 2. not adhering to endocarp/
 - 3. completely adhering to endocarp/
- #189. Testa <fusion to endocarp>/
 - 1. free from endocarp/
 - 2. fused to endocarp, at most a transparent brown tissue/
- #190. Testa <sheen>/
 - 1. dull/
 - 2. glaucous/
 - 3. glossy/
 - 4. velvet/
- #191. Testa <color modified by a bloom>/
 - 1. not modified by a bloom/
 - 2. modified by a bloom/
- #192. Testa <pigmentation of testa>/
 - 1. colored/
 - 2. clear <color absent>/
- #193. Testa <color pattern>/
 - 1. bichrome <2 different colored areas>/
 - 2. monochrome/
 - 3. mottled/
 - 4. streaked/
- #194. Testa with <degree of mottling>/
 - 1. frequent mottles <more than 3 marks per face>/
 - 2. infrequent mottles <1-3 marks per face>/
- #195. Testa with <degree of streaking>/
 - 1. frequent streaks <more than 3 marks per face>/
 - 2. infrequent streaks <1-3 marks per face>/
- #196. Testa <color>/
 - 1. black/
 - 2. blue/
 - 3. brown/
 - 4. cream/
 - 5. gray/
 - 6. green/
 - 7. ivory/
 - 8. olive/
 - 9. orange/
 - 10. pink/
 - 11. purple/
 - 12. red/
 - 13. scarlet/
 - 14. tan/
 - 15. white/
 - 16. yellow/
- #197. Testa with <overlying color for mottling and streaking>/
 - 1. black overlay/

- 2. brown overlay/
- 3. gray overlay/
- 4. green overlay/
- 5. orange overlay/
- 6. pink overlay/
- 7. purple overlay/
- 8. red overlay/
- 9. tan overlay/
- 10. yellow overlay/
- #198. Testa <glabrous or pubescent>/
 - 1. glabrous/
 - 2. minutely pubescent/
- #199. Testa <smooth or ornamented>/
 - 1. smooth/
 - 2. not smooth/
- #200. Testa with <topography classes>/
 - 1. elevated features/
 - 2. recessed features/
- #201. Testa <topography for nonsmooth types with elevated features>/
 - 1. bearing endocarp remnants/
 - 2. bearing a raised line/
 - 3. blistered cuticle/
 - 4. corrugate/
 - 5. echinate/
 - 6. papillate/
 - 7. powdery and not rubbing off/
 - 8. pustulate/
 - 9. reticulate/
 - 10. with 1 longitudinal ridge on each face/
 - 11. ridged longitudinally more than once/
 - 12. transversely ridged/
 - 13. rugose/
 - 14. shagreen/
 - 15. tessaroid/
 - 16. tuberculate/
 - 17. veined/
 - 18. verrucose/
 - 19. warty/
 - 20. wrinkled/
- #202. Testa <topography for nonsmooth types with recessed features>/
 - 1. concaved/
 - 2. cracked/
 - 3. large depressions on each face/
 - 4. grooved/
 - 5. pitted with large concatenated pits/
 - 6. pitted with small separate pits/
 - 7. pitted with stomata in the bottom of the pits/
 - 8. punctate/
 - 9. striate/
- #203. Testa <thickness>/
 - 1. chartaceous/
 - 2. coriaceous <including subcoriaceous>/

- 3. osseous <including subosseous>/
- #204. Pleurogram <occurrence <do not use in faboid descriptions>>/
 - 1. present/
 - 2. absent/
- #205. Pleurogram <degree of occurrence as a percentage <do not use in faboid descriptions>>/
 - %/
- #206. Pseudopleurogram <occurrence <do not use in faboid descriptions>>/
 - 1. present/
 - 2. absent/
- #207. Pseudopleurogram <degree of occurrence as a percentage <do not use in faboid descriptions>>/
 - %/
- #208. Fracture lines <occurrence>/
 - 1. present/
 - 2. absent/
- #209. Fracture lines <type>/
 - 1. concentric/
 - 2. irregular/
 - 3. longitudinal/
 - 4. reticulate/
 - 5. transverse/
- #210. Rim <appearance>/
 - 1. present/
 - 2. absent/
- #211. Rim wing-like <type of wing-like rim>/
 - 1. at 1 end of seed/
 - 2. at both ends of seed/
 - 3. around seed/
 - 4. along 1 side of seed/
- #212. Wing(s) <occurrence>/
 - 1. present/
 - 2. absent/
- #213. Wing(s) <type>/
 - 1. at 1 end/
 - 2. at both ends/
 - 3. continuous around seed/

RAPHE

- #214. Raphe <visible or not>/
 - 1. visible/
 - 2. not visible/
- #215. Raphe from <position>/
 - 1. hilum through lens to base of seed and terminating/
 - 2. hilum through lens to base of seed and bifurcating/
 - 3. hilum to lens/
 - 4. hilum to near base of seed and terminating/
 - 5. hilum through lens and base of seed to point opposite hilum/
 - 6. hilum through lens and terminating before base of seed/
 - 7. hilum through base of seed and up the other side/
 - 8. lens to base of seed and terminating/

- 9. lens to base of seed and bifurcating/
- #216. Raphe <bifurcating>/
 - 1. bifurcating at base of seed with each arm going up antiraphe side turning (U-shaped) down and approaching bifurcation/
 - 2. not bifurcating/
- #217. Raphe <color contrasted to testa>/
 - 1. color of testa/
 - 2. lighter than testa/
 - 3. darker than testa/
- #218. Raphe <color different than testa>/
 - 1. black/
 - 2. brown/
 - 3. purple <reddish>/
 - 4. tan/
- #219. Raphe <elevation in relation to testa>/
 - 1. raised/
 - 2. flush/
 - 3. recessed/

HILUM

- #220. Hilum <occurrence>/
 - 1. present <may be concealed>/
 - 2. absent/
- #221. Hilum <concealment>/
 - 1. visible <exposed>/
 - 2. partially concealed/
 - 3. fully concealed/
- #222. Hilum concealed by <how concealed>/
 - 1. aril/
 - 2. aril remnant/
 - 3. funiculus/
 - 4. funicular remnant/
 - 5. fusion to endocarp/
 - 6. radicle lobe/
 - 7. wing/
- #223. Hilum <with faboid split>/
 - 1. with faboid split/
 - 2. without faboid split/
- #224. Hilum with the lips of the faboid split <relative color of lips of faboid split>/
 - 1. the same color as the rest of the hilum/
 - 2. lighter colored than the rest of the hilum and therefore conspicuous/
- #225. Hilum <punctiform or larger>/
 - 1. punctiform <less than 0.3 mm in diameter>/
 - 2. larger than punctiform/
- #226. Hilum <length or diameter>/
 - mm long/
- #227. Hilum with <larger than punctiform>/
 - 1. angular outline/
 - 2. curved outline/
 - 3. straight outline <linear>/
- #228. Hilum <curved outline>/

- 1. circular/
- 2. elliptic/
- 3. fusiform/
- 4. heart-shaped/
- 5. oval/
- #229. Hilum <angular outline>/
 - 1. irregular/
 - 2. triangular/
 - 3. V-shaped/
 - 4. wedge-shaped/
- #230. Hilum <straight outline>/
 - 1. oblong/
 - 2. linear/
- #231. Hilum <relative to radicle>/
 - 1. apical at apex of radicle tip <or nearly so>/
 - 2. subapical to radicle tip/
 - 3. apical according to radicle tip but marginal according to seed length/
 - 4. marginal according to radicle tip <or nearly so>/
 - 5. between cotyledon and radicle lobe/
- #232. Hilum <elevation>/
 - 1. raised/
 - 2. flush/
 - 3. recessed/
- #233. Hilum <within rim, corona, or halo>/
 - 1. within corona/
 - 2. within halo/
 - 3. within rim/
 - 4. not within corona, halo, or rim/
- #234. Hilum corona color <color>/
 - 1. of testa/
 - 2. lighter than testa/
 - 3. darker than testa/
- #235. Hilum halo color <color>/
 - 1. of testa/
 - 2. lighter than testa/
 - 3. darker than testa/
- #236. Hilum rim color <color>/
 - 1. of testa/
 - 2. lighter than testa/
 - 3. darker than testa/

LENS

- #237. Lens <visibility>/
 - 1. discernible/
 - 2. not discernible/
- #238. Lens <length>/
 - mm long/
- #239. Lens with margins <margin curvature>/
 - 1. straight/
 - 2. curved/
- #240. Lens <shapes with straight margins>/
 - 1. diamond-shaped/

- 2. irregular/
 - 3. linear/
 - 4. oblong/
 - 5. rectangular/
 - 6. rhombic/
 - 7. square/
 - 8. triangular/
 - 9. wedge-shaped/
- #241. Lens <shapes with curved margins>/
- 1. circular/
 - 2. elliptic/
 - 3. hourglass or dumbbell-shaped/
 - 4. irregular/
 - 5. key-hole shaped/
 - 6. 2 circular mounds separated by groove/
 - 7. 2 oblong mounds separated by groove/
 - 8. oblong/
 - 9. ovate/
 - 10. punctiform/
- #242. Lens <position relative to raphe>/
- 1. in groove of raphe/
 - 2. not in groove of raphe/
- #243. Lens <position relative to hilum>/
- 1. confluent with hilum <touching hilum or hilar rim>/
 - 2. adjacent to hilum <not touching hilum or hilar rim and less than 45 degrees from hilum>/
 - 3. 180 degrees from hilum/
 - 4. 270 degrees from hilum/
- #244. Lens <separation of lens from hilum in mm>
/mm from hilum/
- #245. Lens <elevation>/
- 1. mounded/
 - 2. flush/
 - 3. recessed/
- #246. Lens <similarity of lens color to testa>/
- 1. same color as testa/
 - 2. similar color as testa/
 - 3. dissimilar color from testa/
- #247. Lens <contrast to testa having similar color>/
- 1. lighter than testa/
 - 2. darker than testa/
- #248. Lens <color>/
- 1. black/
 - 2. brown <including shades of brown>/
 - 3. gray/
 - 4. green/
 - 5. orange/
 - 6. purple <reddish>/
 - 7. red/
 - 8. tan/
 - 9. white/
 - 10. yellow/

- #249. Lens <within rim, corona, or halo>/
1. within corona/
2. within halo/
3. within rim/
4. not within corona, halo, or rim/

- #250. Lens corona color <color>/
1. of testa/
2. lighter than testa/
3. darker than testa/

- #251. Lens halo color <color>/
1. of testa/
2. lighter than testa/
3. darker than testa/

- #252. Lens rim color <color>/
1. of testa/
2. lighter than testa/
3. darker than testa/

ENDOSPERM

- #253. Endosperm <occurrence>/
1. present/
2. absent/

- #254. Endosperm <thickness>/
1. thick/
2. thin/
3. trace/

- #255. Endosperm <pluglike>/
1. pluglike and resembling tip of radicle/
2. not pluglike and not resembling tip of radicle/

- #256. Endosperm <degree covering embryo>/
1. covering entire embryo/
2. covering at least 1/2 of embryo, but not entire embryo/
3. restricted to region of embryo/

- #257. Endosperm adnate to <adnation>/
1. testa/
2. embryo <encasing>/

COTYLEDONS

- #258. Cotyledons <smooth or not smooth>/
1. smooth/
2. not smooth/

- #259. Cotyledons <topography for nonsmooth types>/
1. convoluted/
2. dimpled once/
3. dotted/
4. glandular dotted (yellow latex-like substance inside)/
5. 1-3 grooves on each face/
6. 4-6 grooves on each face/
7. 5-7-branched grooves (from veins of testa) on each face/
8. with midrib/
9. pitted/

- 10. glandular pitted/
- 11. glandular punctate/
- 12. rugose/
- 13. runcate/
- 14. sulcate/
- 15. veined/
- 16. wrinkled/
- #260. Cotyledons <outer face topography>/
 - 1. outer face of one cotyledon flat and other cotyledon convex/
 - 2. outer face of one cotyledon flat and other cotyledon concave/
 - 3. both outer faces convex/
 - 4. outer face of one cotyledon concave and other cotyledon convex/
 - 5. both outer faces flat/
 - 6. with 2 outer faces on each cotyledon, one flat and the other convex/
- #261. Cotyledons <relative thickness>/
 - 1. one thicker than the other/
 - 2. both the same thickness/
- #262. Cotyledons <relationship of length of 1 to other>/
 - 1. 1 longer than other/
 - 2. both more or less of equal length <<equal if not stated>>/
- #263. Cotyledons <folded or not folded>/
 - 1. with only 1 folded/
 - 2. with both folded/
 - 3. not folded/
- #264. Cotyledons <degree of folding>/
 - 1. sufficiently folded for inner face to touch itself/
 - 2. not sufficiently folded for inner face to touch itself/
- #265. Cotyledons portions of inner folded face <equality of folded ends>/
 - 1. equal/
 - 2. unequal/
- #266. Cotyledons margin <margin 180 degrees from base of radicle>/
 - 1. entire 180 degrees from base of radicle/
 - 2. not entire 180 degrees from base of radicle/
- #267. Cotyledons <not entire margin 180 degrees from base of radicle>/
 - 1. bearing flaps/
 - 2. notched/
 - 3. wavy/
- #268. Cotyledons <comparison of apices>/
 - 1. similar at apex/
 - 2. differing at apex (1 concealed by overarching radicle and other auriculate and concealing radicle)/
- #269. Cotyledons <apex>/
 - 1. completely concealing radicle/
 - 2. partially concealing radicle/
 - 3. not concealing radicle/
- #270. Cotyledons <apical margin entire, split, or lobate>/
 - 1. entire over radicle/
 - 2. notched at radicle/
 - 3. split over radicle/
 - 4. 1 cotyledon scooped out to accommodate plicate radicle and other cotyledon entire/

- #271. Cotyledons <split over radicle _ occurrence of lobes>/
 - 1. with lobes/
 - 2. without lobes/
- #272. Cotyledons with lobes <condition of lobes>/
 - 1. overlapping/
 - 2. touching (auriculate)/
 - 3. not touching/
- #273. Cotyledons <formation of basal groin>/
 - 1. with basal groin formed by lobes/
 - 2. without basal groin formed by lobes/
- #274. Cotyledons with the interface division terminating <interface division termination>/
 - 1. at base of radicle/
 - 2. in radicle tissue/
- #275. Cotyledons <recession of margins>/
 - 1. with margin(s) recessed/
 - 2. without margins recessed/
- #276. Cotyledons with <recession of margins>/
 - 1. 1 margin recessed/
 - 2. both margins recessed <cotyledons dumb bell-shaped in transection>/
- #277. Cotyledons recessed on <relative position of a single recessed margin>/
 - 1. same side as hilum (terminal radicle)/
 - 2. same side as radicle/
 - 3. side opposite from radicle/
- #278. Cotyledons <color>/
 - 1. brown/
 - 2. green/
 - 3. orange/
 - 4. pink/
 - 5. red/
 - 6. tan/
 - 7. white/
 - 8. yellow/
- #279. Cotyledons inner face <inner face topography>/
 - 1. flat/
 - 2. concave/
 - 3. wavy/
 - 4. with central ridge on 1 and central groove on other/
 - 5. wrinkled/
 - 6. glandular dotted (with yellow latex-like substance inside)/
- #280. Cotyledons <pubescent or glabrous>/
 - 1. glabrous around base of radicle/
 - 2. pubescent around base of radicle/

EMBRYONIC AXIS

- #281. Embryonic axis <alignment of cotyledons and radicle>/
 - 1. deflexed <radicle-cotyledon axis deflexed>/
 - 2. oblique <radicle-cotyledon axis oblique>/
 - 3. parallel <radicle length parallel to cotyledon length>/
 - 4. right angled <radicle right angled to length of cotyledons>/
 - 5. S-curved <radicle-cotyledon axis S-curved>/
 - 6. straight <radicle-cotyledon axis aligned>/

- #282. Embryonic axis <angle in relationship to length of seed>/
 - 1. oblique to length of seed/
 - 2. parallel to length of seed/
 - 3. perpendicular to length of seed/
 - 4. plicate to length of seed/
- #283. Embryonic axis <jointed _ with a structure similar to a pulvinus>/
 - 1. with a joint evident between the radicle and the cotyledons/
 - 2. without a joint evident between the radicle and the cotyledons/

RADICLE

- #284. Radicle <visibility>/
 - 1. differentiated from cotyledon/
 - 2. not differentiated from cotyledon/
- #285. Radicle <shape>/
 - 1. bulbous/
 - 2. linear/
 - 3. triangular/
 - 4. truncate/
- #286. Radicle lobe tip <shape>/
 - 1. straight/
 - 2. curved/
 - 3. hooked/
- #287. Radicle <internal relationship to cotyledons>/
 - 1. deflexed and parallel to cotyledon length/
 - 2. deflexed and parallel to cotyledon width/
 - 3. oblique to cotyledons/
 - 4. with 90 degree turn/
 - 5. with 180 degree turn/
 - 6. with 360 degree turn/
 - 7. straight with embryonic axis <like mimosoid & caesalpinoid>/
- #288. Radicle <centering of radicle and cotyledons>/
 - 1. centered between cotyledons/
 - 2. not centered between cotyledons (radicle outside 1 cotyledon and inside other, therefore junctions for each cotyledon different)/
- #289. Radicle <internal length when compared to cotyledon length>/
 - 1. less than 1/2 length of cotyledons/
 - 2. 1/2 to nearly length of cotyledons/
 - 3. equaling length of cotyledons/
 - 4. exceeding length of cotyledons/

PLUMULE

- #290. Plumule <development>/
 - 1. rudimentary/
 - 2. moderately developed/
 - 3. well developed/
- #291. Plumule <pubescent or glabrous>/
 - 1. glabrous/
 - 2. pubescent/

DISTRIBUTION

- #292. <Distribution>/
- #293. Distribution in world <native>/

1. New World/
 2. Old World/
 3. pantropical/
 4. pansubtropical/
 5. pan warm temperate/
- #294. Distribution in world <cultivated crop>/
1. worldwide crop/
 2. New World crop/
 3. Old World crop/
- #295. New World <distribution>/
1. Canada/
 2. United States <Continental _ Hawaii included in Old World>/
 3. Mexico/
 4. West Indies/
 5. Central America/
 6. South America/
- #296. Old World <distribution>/
1. Europe/
 2. Mediterranean/
 3. Russia/
 4. Asia/
 5. China/
 6. Japan/
 7. Africa/
 8. Madagascar/
 9. Indian Ocean/
 10. India/
 11. Indochina/
 12. Indonesia/
 13. Australia/
 14. New Zealand/
 15. Pacific/
 16. New Guinea/
 17. Fiji/
 18. Hawaii/
 19. Korea/

NOTES

- #297. <Notes>/

LEGENDS

- #298. <Legend 1a-alphabetical list of taxa illustrated with plate letter(s)>/
- #299. <Legend 1b-morphological content of plate, alphabetical by plate letter>/
- #300. <Legend 2a-alphabetical list of taxa illustrated with plate letter(s)>/
- #301. <Legend 2b-morphological content of plate, alphabetical by plate letter>/
- #302. <Legend 3a-alphabetical list of taxa illustrated with plate letter(s)>/
- #303. <Legend 3b-morphological content of plate, alphabetical by plate letter>/

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<i>Faba</i> P. Miller, see <i>Vicia</i> , p. 894		<i>G. maculata</i> (K.S. Kunth) K.S. Kunth ex G.W. Walpers (not illustrated)	
<i>Fiebrigiella</i> H.A.T. Harms (14.06)	766	<i>G. sepium</i> (N. von Jacquin) K.S. Kunth ex G.W. Walpers (A, C–E, dehisced fruit and valves, testa, embryos)	
<i>F. gracilis</i> H.A.T. Harms (A–F, fruit, fruit and article, seed, testa, embryos)		<i>Glottidium</i> A.N. Desvaux (8.01A)	392
<i>Fissicalyx</i> G. Bentham (4.07)	244	<i>G. vesarium</i> A.N. Desvaux (A–E, fruits (dehisced fruit and nondehisced endocarp), seeds, testa, embryos)	
<i>F. fendleri</i> G. Bentham (A–E, fruits, seed, testa, embryos)		<i>Glycine</i> C.L. von Willdenow (10.35)	516
<i>Flemingia</i> W. Roxburgh ex W.T. Aiton (10.77)	620	<i>G. max</i> (C. Linnaeus) E.D. Merrill (B, D–F, seeds, testa, embryos)	
<i>F. macrophylla</i> (C.L. von Willdenow) E.D. Merrill (C–E, testa, embryos)		<i>Glycyrrhiza</i> C. Linnaeus (16.22)	866
		<i>G. lepidota</i> F.T. Pursh (C–E, testa, embryos)	

<i>Gompholobium</i> J.E. Smith (24.01)	960	<i>H. mexicana</i> J.N. Rose (not illustrated)	
<i>G. latifolium</i> J.E. Smith (<i>E</i> , embryos)		<i>H. parvifolia</i> H.S. Irwin & M.T.K. Arroyo	
<i>G. papuanum</i> E.D. Merrill & L.M. Perry		(not illustrated)	
(not illustrated)		<i>H. robusta</i> H.S. Irwin & M.T.K. Arroyo	
<i>G. scabra</i> R. Brown (<i>C–D</i> , testa)		(not illustrated)	
<i>Gonocytisus</i> É. Spach (30.20)	1116	<i>Hebestigma</i> I. Urban (8.02)	396
<i>G. angulatus</i> (C. Linnaeus) É. Spach (<i>C–E</i> ,		<i>H. cubense</i> (K.S. Kunth) I. Urban (<i>A–E</i> , valves,	
testa, embryos)		seeds, testa, embryos)	
<i>Goodia</i> R.A. Salisbury (23.05)	948	<i>Hedysarum</i> C. Linnaeus (18.02)	884
<i>G. lotifolia</i> G. Salisbury (not illustrated)		<i>H. coronarium</i> C. Linnaeus (<i>C–E</i> , testa, embryos)	
<i>G. medicagnea</i> F.H.J. von Mueller (<i>C–E</i> , testa,		<i>Herpyza</i> C. Wright (10.28)	2, 500
embryos)		<i>H. grandiflora</i> C. Wright (<i>A–B</i> , fruit, seed)	
<i>Grazielodendron</i> H.C. de Lima (4.09)	248	<i>Hesperolaburnum</i> R.C.J.E. Maire (30.10)	1094
<i>G. rio-docensis</i> H.C. de Lima (<i>A–E</i> , fruits, seed,		<i>H. platycarpum</i> (R.C.J.E. Maire) R.C.J.E. Maire	
testa, embryos)		(<i>A–E</i> , valves showing endocarp and epicarp,	
<i>Gueldenstaedtia</i> F.E.L. von Fischer (16.19)	858	seeds, testa, embryos)	
<i>G. himalaica</i> J.G. Baker (<i>C–E</i> , testa, embryos)		<i>Hesperothamnus</i> T.S. Brandege (Millettiae)	338
<i>Halimodendron</i> F.E.L. von Fischer ex A.-P. de Candolle		<i>H. littoralis</i> (T.S. Brandege) T.S. Brandege	
(16.10)	836	(<i>B–E</i> , seed, testa, embryos)	
<i>H. halodendron</i> (P.S. von Pallas) A. Voss (<i>A–E</i> ,		<i>Hippocrepis</i> C. Linnaeus (13.13)	742
fruits, seeds, testa, embryos)		<i>H. ciliata</i> C.L. von Willdenow (not illustrated)	
<i>Hammatolobium</i> E. Fenzl (13.17)	752	<i>H. emerus</i> (C. Linnaeus) P. Lassen (<i>B</i> , fruits and	
<i>H. kremerianum</i> (E.St.-C. Cosson) C.H. Muller		fruit segments)	
(<i>E</i> , embryos)		<i>H. unisiliquosa</i> C. Linnaeus (<i>D–F</i> , testa, embryos)	
<i>H. lotoides</i> E. Fenzl (<i>A–D</i> , fruits with calyx and		<i>Hoita</i> P.A. Rydberg (12.06)	708
1 article, seeds, testa)		<i>H. macrostachys</i> (A.-P. de Candolle) P.A. Rydberg	
<i>Haplormosia</i> H.A.T. Harms (2.16)	154	(<i>C–E</i> , testa, embryos)	
<i>H. monophylla</i> (H.A.T. Harms) H.A.T. Harms		<i>H. strobilina</i> (J.W. Hooker & G.A. Arnott) G.A.W.	
(<i>A</i> , <i>C–E</i> , fruits, testa, embryos)		Rydberg (not illustrated)	
<i>Hardenbergia</i> G. Bentham (10.48)	546	<i>Holocalyx</i> M. Micheli (1.12)	110
<i>H. violacea</i> (G.V. Schneevoogt) W.T. Stearn		<i>H. balansae</i> M. Micheli (<i>A–F</i> , fruits, seeds, testa,	
(<i>A</i> , <i>C–E</i> , fruits, testa, embryos)		embryos, embryo magnified)	
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<i>H. unifoliolatum</i> R.S. Cowan (<i>A–D</i> , fruit, seeds,		<i>H. heterophylla</i> A. Cunningham ex J.D. Hooker	
testa)		(not illustrated)	
<i>Harpalyce</i> A.-P. de Candolle (22.02)	936	<i>H. linearis</i> (J. Smith) R. Brown (not illustrated)	
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<i>H. sect. Brazilianae</i> M.T.K. Arroyo (not illustrated)		embryos)	
<i>H. sect. Cubenses</i> M.T.K. Arroyo (not illustrated)			
<i>H. brasiliana</i> G. Bentham (<i>C–E</i> , testa, embryos)			
<i>H. macrocarpa</i> N.L. Britton & P. Wilson			
(not illustrated)			

<i>Humularia</i> P. Duvigneaud (14.15)	786	<i>I. glandulosa</i> J.C. Wendland (not illustrated)	
<i>H. chevalieri</i> (E.A.J. De Wildeman) P.A. Duvigneaud (<i>D–F</i> , testa, embryos)		<i>I. kirilowii</i> C.J.M. Maximowicz & I.V. Palibin (<i>D–F</i> , testa, embryos)	
<i>H. drepanocephalus</i> (E.G. Baker) P.A. Duvigneaud (<i>B</i> , fruit)		<i>I. trifoliata</i> C. Linnaeus (not illustrated)	
<i>Hybosema</i> H.A.T. Harms (8.04)	400	<i>I. glandulosa</i> J.C. Wendland (not illustrated)	
<i>H. ehrenbergii</i> (F.R.R. Schlechter) H.A.T. Harms (<i>A–E</i> , valves, seeds, testa, embryos)		<i>I. linifolia</i> (C. Linnaeus) A.J. Retzius (not illustrated)	
<i>Hymenocarpos</i> C.G. Savi (13.04)	724	<i>I. luzonensis</i> . I. de Kort & G. Thijssse (not illustrated)	
<i>H. circinnatus</i> (C. Linnaeus) C.G. Savi (<i>A–E</i> , fruits, seeds, testa, embryos)		<i>I. parvifolia</i> B. Heyne ex R. Wright & G.A.W. Arnott (not illustrated)	
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<i>H. heringerianum</i> C.T. Rizzini (<i>C–E</i> , seeds, testa, embryos)		<i>Inocarpus</i> J.R. Forster & J.G. Forster (2.10)	138
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<i>Hypocalyptus</i> C.P. Thunberg (26.01)	1028	<i>Isotropis</i> G. Bentham (24.06)	970
<i>H. coluteoides</i> (J.B.A.P. de M. de Lamarck) R.M.T. Dahlgren (not illustrated)		<i>I. wheeleri</i> G. Bentham (<i>C–E</i> , testa, embryos)	
<i>H. sophoroides</i> (P.J. Bergius) H.E. Baillon (<i>A–E</i> , fruits and valve, seeds, testa, embryos)		<i>Jacksonia</i> R. Brown ex J.E. Smith (24.08)	972
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<i>I. argyraeum</i> (C.F. Ecklon & C.L.P. Zeyher) B.D. Schrire (not illustrated), see <i>Indigofera</i> , p. 430		<i>Kennedia</i> É.P. Ventenat (10.47)	544
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<i>I. parvifolium</i> (B. Heyne ex R. Wright & G.A.W. Arnott) B.D. Schrire (not illustrated), see <i>Indigofera</i> , p. 430		<i>Kotschyia</i> S.F.L. Endlicher (14.11)	778
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<i>L. tauris</i> G. Bentham (<i>C–E</i> , testa, embryos)		<i>M. nidulans</i> J.J. Bennett (<i>A–F</i> , “bird cage,” fruits,	
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<i>Machaerium</i> C.H. Persoon (4.06)	240	<i>M. hypogaea</i> E. Small (not illustrated)	
<i>M. lunatum</i> (C. Linnaeus filius) W.A. Ducke		<i>M. plicata</i> (P.E. Boissier) G.I. Sirjaev	
(not illustrated)		(not illustrated)	
<i>M. opacum</i> J.R.T. Vogel (<i>C–E</i> , testa, embryos)		<i>M. popovii</i> (E.I. Korneva) G.I. Sirjaev	
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<i>M. robiniiifolium</i> (A.-P. de Candolle) J.R.T. Vogel		(not illustrated)	
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<i>M. mindanaensis</i> E.D. Merrill (<i>A</i> , fruit)		<i>M. bicolor</i> P.E. Boissier & B. Balansa	
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<i>M. atropurpureum</i> (A. P. de Candolle) I. Urban		<i>M. indicus</i> (C. Linnaeus) C. Allioni (<i>C–E</i> , testa,	
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(not illustrated)		(not illustrated), see <i>Indigofera</i> , p. 430	
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J.C. Baudet (not illustrated)			

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