Rediscovery of *Mucuna macropoda* (*Leguminosae: Papilionoideae*), and its pollination by bats in Papua New Guinea

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Summary. The flowers of *Mucuna macropoda*, from Central Province, Papua New Guinea, whose fruits were collected in 1885, are described for the first time. They are greenish white and arranged in dense inflorescences on long, thin, pendent peduncles. They attract small nectarivorous bats at night. To obtain nectar, the bat pushes its snout forcibly into a flower, releasing the androecium and style from within the keel petal, and thus pollen is deposited on the bat's throat.

In the most recently published account of *Mucuna* (*Leguminosae: Papilionoideae: Phaseoleae*) in New Guinea, Verdcourt (1979) states that *Mucuna macropoda* is known only from the type, *Forbes* 289 (BM), from Sogere (sic), 3200 ft, Sogeri (sic) Region, 28 October 1885. *Forbes* 289 consists of leaves, peduncles and fruits. The species has now been recollected in flower and fruit at Varirata National Park on the Sogeri plateau, in Central Province, Papua New Guinea, close to the type locality. Since the type description by Baker was based on a single gathering that lacked flowers, a full description is given here. Measurements of floral parts are taken from material preserved in spirit. Baker's measurements for leaves and fruits fall within the range given here for the newly found plants, except where indicated. A generic description for *Mucuna* is given by Wilmot-Dear (1984).

Mucuna macropoda *Bak. f.*, J. Bot. 61 (Suppl.): 11 (1923).

Woody climber up to c. 5 m high × 5 mm diam. at 1 m; younger parts of stem with adpressed pale hairs. *Leaves* 13–22 cm long, distal ones smaller than the proximal; stipules not seen; terminal leaflet ovate, 6·9–12·6 × 3·5–7·4 [13 × 9 fide Baker] cm, apex acute to caudate, sometimes apiculate, base broadly cuneate; lateral leaflets asymmetrical, 5·4–11·0 cm long, abaxial part 2·4–4·9 cm wide, adaxial part 1·2–2·2 cm wide. All leaflets with 5–7 lateral veins, prominent below, upperside with sparse, pale, stiff hairs, more persistent on the veins; underside with even, ± dense covering of adpressed, pale yellowish hairs. Petiole 3·6–7·0 cm long, rachis 1·7–2·8 cm long, both with adpressed pale hairs; petiolules 0·4–0·7 cm long, with dense pubescence. *Inflorescence* borne on old wood or less often in leaf axil; peduncles 1(–2) per node, pendent, 29–61 cm long, terminating in a rachis 2–18 cm long, somewhat zigzag distally, bearing 5–31 knob-like side branches, sparse in basal portion of longer rachises and clustered in distal portion, each c. 0·2–0·4 cm long, usually three-flowered, all

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parts with short, adpressed, pale hairs; pedicels 1·1–2·0 cm long, with white pubescence; bracts at base of side branches asymmetrical, 6–7·5 × 3–4 mm, with short hairs on outer surface; bracts at base of flowers green, ± symmetrical, a pair overlapping the calyx, 16–18 × 10–12 mm, apex mucronate, base rounded and inflated, with short hairs on both surfaces. *Flowers* at anthesis, c. 3 cm long. *Calyx* green, with short adpressed hairs on both inner and outer surfaces, and sparse, longer, irritant bristles on outer surface; tube broadly cup-shaped, inflated, 6 mm long × 8–10 mm diameter, with 4 teeth; upper lip broadly triangular, 8–10 mm long; lateral teeth narrowly triangular, 7 mm long; lower tooth narrowly triangular, 10 mm long, apex cirrhose. *Corolla* greenish white; standard 24–25 mm long (including basal claw of 3–4 mm), 20 mm broad (when flattened), almost 5/6 length of wings, sparse hairs on outer surface, margin eciliate, apex obtuse, readily splitting, basal auricles fleshy, 2 mm long; wings 28–31 mm long (including basal claw of 6·5–7 mm), 9–10 mm broad, enclosing keel, apex rounded, region behind apex inflated, auricle 3–3·5 mm long, lower margin of claw with dense brown cilia, auricle region fleshy, wrinkled, sparsely hairy on outer surface and along upper margin; keel 26–28 mm long (including basal claw of 6–8 mm), 11 mm broad (when flattened), apex curved, horny, readily splitting, base readily splitting, auricle < 1 mm with hairs on margin. *Androecium* with staminal tube 23–26 mm long, curving at 20–22 mm where fusion of filaments ceases; free filament 23 mm long; anthers hairy, c. 1 mm long. *Gynoecium* with style 20–21 mm long, bare at apex and with white hairs 1 mm long towards base; stigma capitate, shortly hairy; ovary 6–7 mm long plus stipe of 1–1·5 mm, densely hairy. Young pods covered in dense white hairs. *Mature pods* green to brown, 1–3 per infructescence, dehiscent down both sutures, valves narrowly oblong, tapering gradually towards the base, 15–20 × 2·8–3·2 [4–4·5 fide Baker] × c. 1·7 cm, each with marginal longitudinal wings 0·5–0·7 cm wide, a central longitudinal wing 0·5 cm wide, and obscure partial cross ribs, covered with red-brown irritant hairs, especially on the wings; apex caudate with the persistent style 1·5–3·2 cm long; basal stipe 1·0–1·8 cm long, enclosed within persistent calyx; endocarp papery, internal septa visible externally as ill-defined grooves. Seeds up to c. 8 per pod, 2·5–2·9 × 1·8–2·5 × 1·2–1·5 cm, hilum 1·8–2·3 cm, i.e. extending c. ¼ of circumference. Figs 1 & 2.

DISTRIBUTION AND ECOLOGY. Known only from Sogeri Plateau, Central Province, Papua New Guinea. Recent collections are from mixed forest dominated by *Castanopsis*, with an understory of shrubs, *Pandanus* and bamboo, along the ridge of the Astrolabe Mts at 800 m.

PAPUA NEW GUINEA. Central Province: Varirata National Park, 9°27'S, 147°21'E, 800 m, fl. only, 28 July 1988, *Hopkins & Hopkins* 982 in UPNG 13513 (UPNG); ibid., fr. & lvs. from same plant as *H&H* 982, 1 Oct. 1988, *Hopkins & Hopkins* 983 in UPNG 13514 (K, UPNG); ibid., fr. & lvs. from another plant, 1 Oct. 1988, *Hopkins & Hopkins* 984 in UPNG 13515 (K, UPNG); Sogeri Region, fr. & lvs., 8 Oct. 1885, *Forbes* 289 (BM n.v., photo K!).

The pods appear to be unique in New Guinea *Mucuna* in having longitudinal wings and obscure transverse ridges (Fig. 1B). The pods of *Hopkins & Hopkins* 983

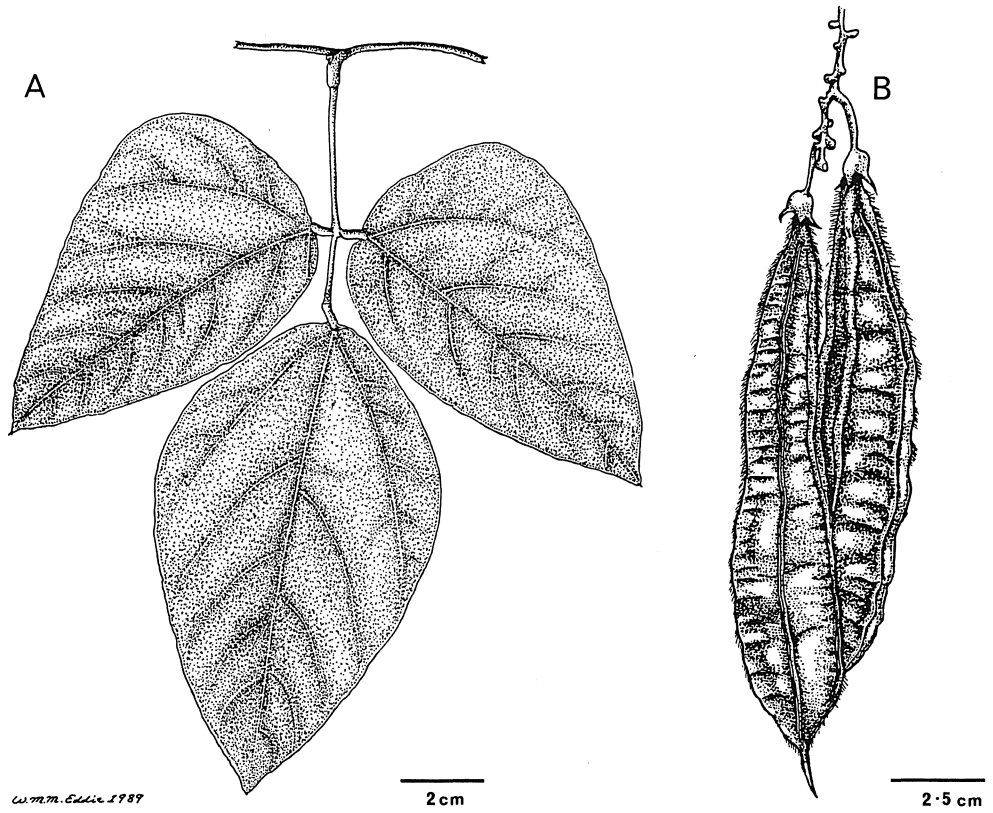

FIG. 1. *Mucuna macropoda*. **A** leaf; **B** almost mature pods. From *Hopkins & Hopkins* 983.

and 984 agree closely with those of *Forbes* 289.

The inflorescence is similar to that of *M. schlechteri* Harms, as both have a long thin peduncle with a terminal group of flowers, although the short side shoots bearing the pedicels are usually much more closely packed in *M. schlechteri* (see fig. 105 in Verdcourt (1979)). The arrangement of pedicel scars, open flowers and buds also suggests that flowering over a longer period is usual in *M. schlechteri*.

Comparison of the description of *M. macropoda* with that of *M. schlechteri* by Verdcourt (1979) suggests that the two may differ in the leaves and calyx, but these characters do not appear to be definitive. The leaves of *M. macropoda* have adpressed hairs on the under surface, while those of *M. schlechteri* are usually glabrous or sparsely hairy (e.g. *Brass* 23975 and 24083 from Milne Bay Province), and the lateral leaflets of *M. macropoda* are almost triangular while those of *M. schlechteri* are more oblong with a more pronounced acumen. While the calyx of *M. schlechteri* generally has scarcely developed teeth, a minority of specimens are intermediate or deeply lobed, as in *M. macropoda* (*Stevens & Veldkamp* LAE 54139, *White et al.* NGF 46432, *Streimann* NGF 28751). The last two specimens also have fruits, which are those of *M. schlechteri*. Collection data for specimens of *M. schlechteri* are given by Verdcourt (1980).

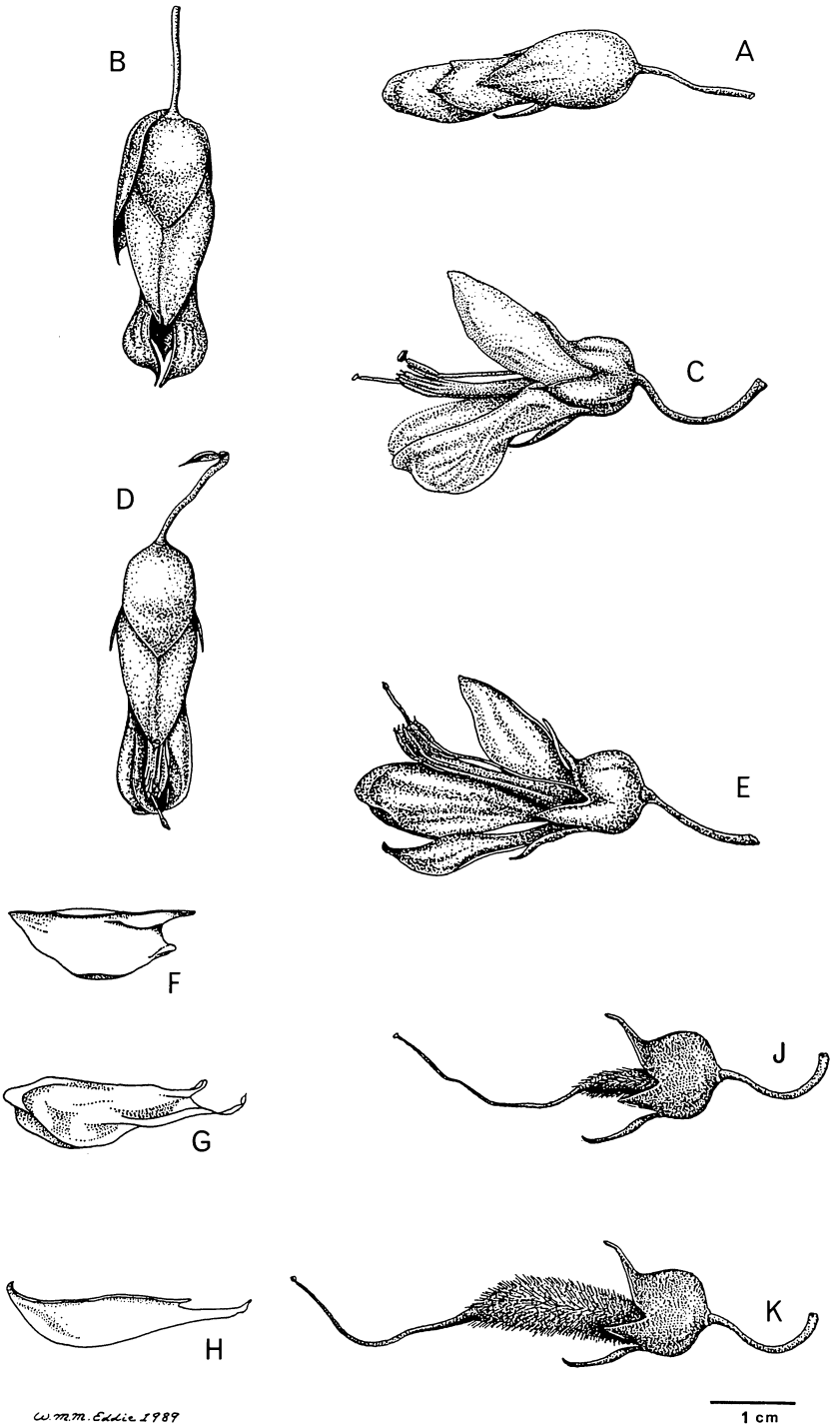

FIG. 2. Flowers and young fruits of *Mucuna macropoda*. **A** bud, partly enclosed by bracts; **B** prior to anthesis, one bract fallen; **C** after anthesis; **D** the same, from above; **E** after anthesis, half the corolla removed; **F** half of standard; **G** wing; **H** half of keel; **J & K** developing fruit. From *Hopkins & Hopkins* 982.

Floral Biology

The flowers of *Mucuna macropoda* are arranged in a more or less spherical mass, at the ending of a long, thin peduncle hanging clear of the foliage in the understorey. Each ball contains numerous flowers (15–93, mean 52, n = 15) arranged in groups of three on short side shoots. The flowers towards the base of each inflorescence open first, and each flower lasts one night. A typical inflorescence has flowers reaching anthesis over several successive nights.

In large buds, the green-cream petals are held tightly together (Fig. 2A). Immediately prior to anthesis the corolla is in a horizontal position and the wing petals, which extend beyond the standard, are inflated towards the apex. They completely enclose the keel, which itself encloses the androecium, and gynoecium. The standard is slightly raised and the wings begin to part (Fig. 2B). Nectar is concealed at the base of the corolla. In the field, only a very faint sweet smell could be detected, although an inflorescence placed in a plastic bag for 2 hours had a more musty scent.

When a bat visits (see below), pressure on the base of the petals suddenly releases the androecium and stigma from within the keel and showers pollen onto the visitor. The standard is raised and the wings, still enclosing the keel, point downwards (Fig. 2C). The petals are held in this 'mouth open' position by the interlocking of the basal claws of the standard and wing petals (Fig. 2F, G & H). This explosive release of the anthers and stigma, and the 'locking' of the bases of the petals to hold the mouth of the flower open are typical features of *Mucuna* species in both the Old and New Worlds (Baker, 1970; van der Pijl, 1941; Skutch, 1987; Vogel, 1969). Many flowers fall to the ground whole at this stage but in those that do not, the corolla and androecium fall leaving the calyx and the densely hairy young pod with a persistent style (Fig. 2J & K).

Pollination

Black puncture marks on the petals, flagelliflory and white flower colour, all of which were evident in *Mucuna macropoda* in the field, are suggestive of chiropterophily (van der Pijl, 1941). Nocturnal observations at Varirata National Park, Central Province, in July 1988 confirmed that small bats visit the flowers.

To observe the details of flower-visiting by bats, an individual *Syconycteris australis* (Peters) (*Megachiroptera: Pteropodidae*), caught in a mist net within 50 cm of an inflorescence, was released indoors close to a suspended inflorescence. The bat landed on the inflorescence, more or less head upwards, the feet and wing claws puncturing the petals (Fig. 3A & 4). The bat inserted its snout forcefully into several flowers in turn, pushing the petals apart so that its mouth was close to the nectar. When the pressure on the base of the petals released the androecium and gynoecium from within the keel, the anthers deposited pollen in a broad band on the throat of the bat (Fig. 3B).

Ants of several species were seen crawling over the flowers, and small nitidulid beetles were collected from an inflorescence. No birds or bees were seen but diurnal observations were only cursory.

Syconycteris australis is a small, largely flower-visiting bat (forearm length 39–43

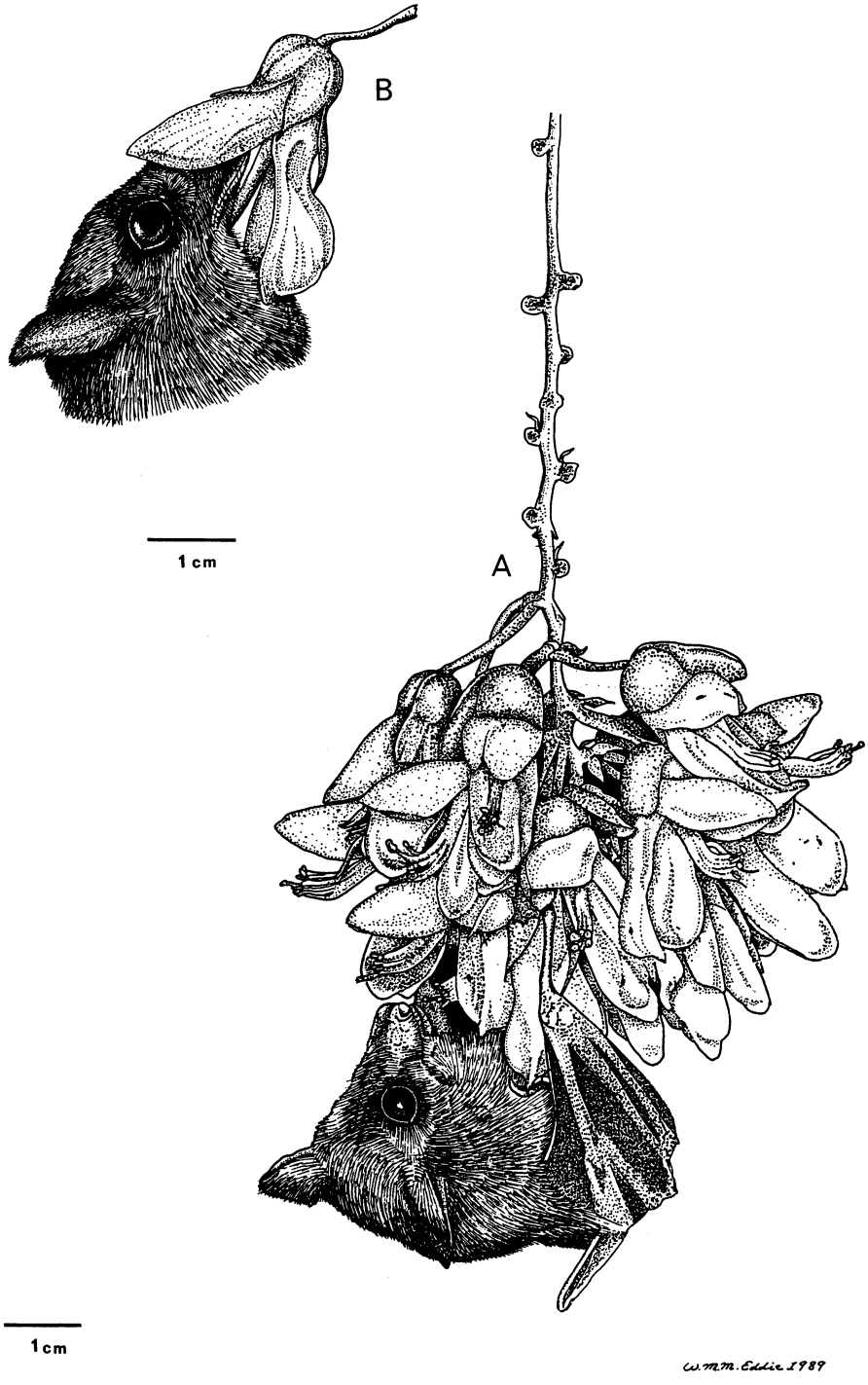

FIG. 3. *Syconycteris australis* visiting the flowers of *Mucuna macropoda*. **A** bat clinging to pendent inflorescence; **B** snout of bat inserted into flower. From photographs by M. J. G. Hopkins.

FIG. 4. *Syconycteris australis* visiting the flowers of *Mucuna macropoda*. Photographed by M. J. G. Hopkins.

mm; head and body length c. 50 mm (Hall & Richards, 1979)), common throughout New Guinea, the Bismarck Archipelago and NE Australia (Hall & Richards, 1979; Smith & Hood, 1981; Ziegler, 1982). In Australia it has previously been recorded feeding on flowers of several species of woody plants (Armstrong, 1979). It is similar in size to *Macroglossus minimus* (Geoffroy), a more specialized nectarivore, which might also be expected at chiropterophilous *Mucuna* species in New Guinea.

Pollination of *Mucuna* by bats is already well documented from both the Old and New World tropics. Small nectarivorous bats, such as *Glossophaga soricina* (Pallas) (*Microchiroptera: Phyllostomidae*), visit the flowers of at least three species in Brazil and Costa Rica (Baker, 1970; Dobat, 1985; Vogel, 1969). Pollination by megachiropteran bats has been recorded in Africa and Asia (see Dobat, 1985) but in some cases this has been based only on the circumstantial evidence of flower colour, inflorescence morphology and puncture marks on petals (e.g. van der Pijl, 1941), and this appears to be the first published record of the details of the bat's behaviour at the flowers of any palaeotropical species of *Mucuna*.

Bats involved in the pollination of *Mucuna* in the Old and New World tropics are only distantly related. Further studies are necessary to determine whether there are differences, for example in inflorescence morphology, between Eastern and Western hemispheres, related to pollination by different groups of bats, and whether chiropterophily in *Mucuna* has evolved only once or several times in different places.

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