BLUMEA 33 (1988) 329–342

A REVISION OF RHIZANTHES (RAFFLESIACEAE)

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SUMMARY

The Malesian genus *Rhizanthes* Dumort. (Rafflesiaceae) has 2 species. All data on the recorded distribution are enumerated, many of historical value, but also as an incentive to check again. *Rhizanthes zippelii* (Blume) Spach is a new record for the Malayan Peninsula. This species has a haploid chromosome number of 11.

INTRODUCTION

The genus *Rhizanthes* Dumort. was originally described by Blume (1827) as *Brugmansia*. This name is a later homonym of *Brugmansia* Pers. (1805; Solanaceae). The latter had been sunk into the synonymy of *Datura* L., whereby 19th century authors felt free to use the name again. For many years the illegitimacy was overlooked and the most usual name encountered in the literature is *Brugmansia*.

The homonymy was corrected by Dumortier (1829), who renamed the genus *Rhizanthes*. Reichenbach (1837), as so many others unaware of Dumortier's rather obscure publication, renamed it *Zippelia*, which, however, is also a later homonym, i.e. of *Zippelia* Blume ex Schult. & Schult. f. (1830; Piperaceae). Endlicher (1842) is usually given as the author of *Zippelia* sensu Reichenbach, but actually he cited this name in synonymy.

Blume had only a single species, *Brugmansia zippelii* Blume. His illustration with only partly opened flowers has often given the wrong impression of their habit, which is in fact not much different from that of *Rhizanthes lowi* Becc. Apparently he forcibly opened flowers still in bud. Heinricher (1905) was also led astray by it, but he gave valuable biological notes. *Rhizanthes*, compared to all other genera of the Rafflesiaceae in the circumscription of Dumortier, later also followed by Solms-Laubach (1901) and Harms (1935), shows remarkable, unique characters such as the 14–16 valvate perigone lobes, far more numerous than the 4-, 5-, or 10-lobed perigones of the other genera. There is a cavity at the apex of the column in which during the bud-stage the caudate extensions of the perigone lobes are packed together.

It has been suggested by Backer & Bakhuizen f. (1964), that the species had been previously described as *Rafflesia horsfieldii* R. Br. (1821). This enigmatic species

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purportedly had flowers only c. 7.5 cm in diameter (but later said by Brown, 1844, to be 'semipedali', i.e. c. 15 cm diam., twice as large!), which would make it an exceptionally small *Rhizanthes zippelii* (Blume) Spach. It obviously is a true *Rafflesia* R. Br., because it had 'a perianthium of the same general appearance (as *Rafflesia*) with indications of a similar entire annular process or corona at the mouth of the tube (i.e. a diaphragm), a pustular inner surface, and a central column terminated by numerous acute processes.' From this diagnosis it will be crystal clear that this species, of which the original material appears to have been lost, and of which we have not yet seen the drawing referred to by Brown, is undoubtedly a species of *Rafflesia*, not of *Rhizanthes*, and reminiscent of *Rafflesia manillana* Teschenm.

The flower of *Rhizanthes* is a bit larger than that of *Sapria* Griff. with its 10-lobed perigone. This genus is the most similar one because of the location and structure of its androecium, which is situated at the lower side of the rim of the column. In both genera it is less hidden than in *Rafflesia*. The anthers of *Sapria*, however, have 2 pores instead of 1.

By the structure of the seeds (Solms-Laubach, 1874), pollen (Takhtajan et al., 1985), its host preference for *Tetrastigma* spp. (Vitaceae), and its geographic distribution *Rhizanthes* fits well in the Rafflesiaceae. It seems to represent a special side line of evolution of the series between the ancestors of *Cytinus* L. and *Rafflesia*.

The greatest difference with *Rafflesia* and *Sapria* is the absence of a well-developed diaphragm. Instead, there are calli at the place where one would expect a diaphragm to be.

Beccari (1868) added another species, *Brugmansia lowi*, giving an extended description of the genus. This was emended again by Boerlage (1900), and this again was used by Koorders (1918), who gave an extensive review of the family. The epithet is usually spelled as *'lowii'*, which is against the explicit use of *'lowi'* by Beccari and the original orthography must be maintained.

Rhizanthes lowi is similar to *Rh. zippelii*, differing especially by the size of the flower, the distribution and shape of the hairs inside the bud, and the shape of the perianth lobes (cf. key).

Heinricher (1905) mentioned a collection from Pasir Datar, Priangan, Java, which he provisionally called *Brugmansia bakhuizenii*. Backer & Bakhuizen f. (1964) also distinguished two forms ('varieties') without making the necessary combinations, though:

'*Brugmansia zippelii* s.s.' with a white or flesh-coloured perigone, inside densely dark brown hairy, lobes mostly gregariously and rather firmly coherent (especially by their apices), the flower thereby becoming more or less zygomorphic, Salak, 500–600 m altitude.

Brugmansia bakhuizenii with a bright red perigone, inside less densely brown hairy, lobes mutually free, the flower thereby remaining actinomorphic, G. Gede, Cidadap, and Garut, 1000–1400 m altitude.

The difference in colour is erroneous: Heinricher himself already said that the flowers were ivory-coloured. Moreover, after the initial brief white stage the flowers always turn to various shades of red and red brown. There is no apparent difference

in pubescence of the flowers from different provenances. When the flowers are still white the hairs, also white, are less conspicuous (see also Van der Pijl, 1933). The supposedly densely brown pubescence is not corroborated by Meijer's own field observations, be it in that they have been made in Sumatra and Sabah, and by the various reports and pictures in the Tropische Natuur. The separation of the perigone lobes is irregular in various specimens and may not be considered to be of any value. Apparently, too, the picking, handling, and further treatment in the laboratory may influence the opening of the flower.

A n a t o m y. The haustorial structures of *Rhizanthes* have been studied and illustrated by Solms-Laubach (1875), Peirce (1893), and Von Cartellieri (1926), while the illustrations and text of Chatin (1892) are still the most up to date data on the general anatomy of the extra-matrical body. Since more recent studies are in progress we refrain from details here.

Solms-Laubach (1876) studied the development of the flowers.

Ernst & Schmid (1913) showed the anatomy of the anthers.

Takhtajan et al. (1985) studied the pollen of 7 species of Malesian Rafflesiaceae, among which that of the two *Rhizanthes* species. From the pollen morphology the idea that *Rhizanthes* is related to *Rafflesia* is again supported.

The development of ovules and seeds of *Rhizanthes zippelii* has been described by Solms-Laubach (1898).

C y t o l o g y. Although Harms (1935) cited a paper by Van der Pijl (1933) he completely overlooked the fact that here the chromosome number of *Rhizanthes zippelii* was mentioned, the only known record for the genus so far! In the pollen were extremely fine haploid plates showing 11 chromosomes. In the ovules no division was present, even in open flowers. Only in an old, unsightly, subterranean remnant that might be called a young fruit meiosis of the embryo mothersack cell was seen, again showing 11 chromosomes going to each pole. Such a late meiosis suggests that the development of the seeds is asexual. There are 12 chromosomes in *Rafflesia gadutense* Meijer and *R. patma* Blume. *Rafflesia* might be asexual as well. This knowledge may be of importance in attempts to save these species from extinction. *Mitrastemon yamamotoi* Makino (fide Watanabe, 1934), however, apparently needs pollination for the fruits to ripen.

The further chromosome numbers now known for the Rafflesiaceae may be summarized (Fedorow, 1969; Rutherford, 1970):

Cytinus hypocistis (L.) L.	2n = 32
Mitrastemon kawasasakii Hayata	2n = 40
yamamotoi Makino	2n = 40
Pilostyles thurberi A. Gray	2n = 60–62 + 02 B
berteri Guillemin	2n = 12

No chromosome numbers have as yet been reported for *Apodanthes* Poit., *Bdallophyton* Eichler, *Berliniachne* (Harms) Vattimo, *Botryocytinus* (E. G. Baker) Watanabe, and *Sapria* Griff.

Floral biology. Flowers in general are formed on the underground parts of the host plant, usually *Tetrastigma papillosa* (Blume) Planch., protruding in rows of clusters from the soil, and also occasionally on the lower parts of its stem, preferably on its aerial roots, up to 4 dm above the soil. The flowers are much more restricted to the ground than those of *Rafflesia*. They do not last more than 2 or 3 days.

As far as the smell is concerned the reports vary. Forbes (1885) said that *Rhizanthes lowi* had a powerful smell of putrid flesh. They were infested with a crowd of flies and overrun with ants. According to Winckel (1918, and his notes in BO) the flowers of *Rh. zippelii* produced a foul smell ranging from acid apples to cadaverous, while opening during the first two days. Van der Pijl, according to Van Slooten (1931), remarked that they had a nice carrion odour and were visited by many flies. According to De Voogd (1932) they had a curious, not unpleasantly acid smell. Coomans de Ruiter (1935), however, found them virtually scentless. My own (WM) observations at Ulu Gadut near Padang with *Rh. zippelii* were that the smell is much fainter than that of *Rafflesia,* yet strong enough to attract the same carrion flies and smaller fruit flies also observed by Forbes, Winckel, and Van der Pijl.

Flowers are bisexual, male, or female. Whether the plants themselves are thus separated is unknown. Van der Pijl (1933) remarked that all flowers and buds of *Rhizanthes zippelii* which he had found on a single root of its host were bisexual. That they were functionally so may be deduced from the fact that he found normal meiosis in both pollen and the embryo mothersack cell. Yet, from the fact that meiosis was only observed in a young fruit it may be deduced that pollination does not take place, and that the seeds are produced asexually, or that there is a long period between pollination and actual fertilization (as e.g. in Cycadales).

On *de Wilde & de Wilde-Duyfjes 19272-A* (L) of *Rhizanthes lowi* two flowers still attached to the root of their host (clearly *Tetrastigma papillosa*) were present: an open one, which is male, and distally 3 cm away a bud, which turned out to be strictly female. So, either this species is capable of producing flowers of both sexes after all (see key and descriptions), or we have here a case of a double infection by a male and a female individual. A similar case of both sexes being present on the same host plant was observed by Meijer in *Rafflesia micropylora* Meijer in the Leuser National Park, Sumatra. From anatomical evidence double infection will be impossible to deduce, of course. Again experiments on the biology of these fascinating species are sorely missed.

The pollination has not been studied, either, but, if it does occur at all, presumably is caused by flies as is the case in *Rafflesia.*

Flowering lasts only a few days (Heinricher, 1905). After the first day the white colour fades into various shades of red and brown. Flowers do not putrify like those of *Rafflesia* but they stay for weeks on the ground as dried-out brownish star-shaped bodies. Female or bisexual flowers can hide a ripening fruit under these structures.

The mode of seed dispersal is also still unknown, most likely the vectors are similar to those of *Rafflesia:* termites, ants, and small mammals (Justesen, 1922; own observations by WM). In fact nobody has yet followed the development of marked buds and flowers and unraveled the complete life cycles of any species of this genus.

ACKNOWLEDGEMENTS

Over the years many people, too numerous to mention, both in the field and in the herbarium have helped Meijer in finding living and conserved material. Several Institutes were visited for the study of dried and pickled materials e.g. B, BM, BO, BONN, HBG, IB, K, KEP, L, M, MO, SAR, SING, TNS, collections from S were sent on loan. The field and herbarium work for the revision of the Rafflesiaceae in the Flora Malesiana, for which this is a small precursor, has been supported by grants from the National Science Foundation (DEB-8018993-1981. NSF), the Research Committee of the National Geographic Society (1983, grant 2074), the Van Tienhoven Foundation. The logistic and financial assistance from the Missouri Botanical Garden in Meijer's function as Research Associate there has been of immeasurable help. Special mention must be made of the Flora Malesiana Foundation for its travel grant and the assistance of Dr. C.G.G.J. van Steenis with the search for literature data. All those who have helped so much are herewith most gratefully acknowledged for their help, advice, and assistance.

Dr. J.F. Veldkamp (L) who edited the final versions of this paper made so many valuable additions especially in nomenclatural and bibliographic matters, that he was invited to become co-author of this paper.

We express our thanks to Dr. W.J.J.O. de Wilde (L) for supplying us with photographs of *Rhizanthes lowi* from the Leuser National Park (reproduced on the frontispiece of Fl. Males. Bull. 9/4, 1987); to Dr. J.F.M. Cannon (BM) for kindly providing microscopic slides of *R. zippelii*, and to Dr. H.-D. Behnke (University of Heidelberg) for making photographs of them.

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Flowers unisexual or bisexual, from a basal cupula attached to or arising from the roots, or basal part of the stem and aerial roots, surrounded by three or four whorls of 5 scales, these sessile, imbricate, concave, ± ovate, entire, brownish. *Buds* ± pyriform-ellipsoid, outside glabrous, pinkish white, apices of the lobes curved inwards sunken in the crater-like depression in the globular apex of the disk of the central column. In bud (14–)16-ridged, the (7 or) 8 longer lobes meeting in the centre of the

apex, the (7 or) 8 shorter ones not quite reaching the centre. *Perianth* fleshy, whitish, actinomorphic, shallowly spread out, campanulate like an asteroid fungus, long hairy inside, ramentae especially in the campanulate tube; tube at anthesis closely striped with purple-brownish lines radiating from the center around the column; limb lobed, lobes (14–)16, in early anthesis ± coherent in groups of 2 or 3, or 5 or 6, curved downwards, narrowly lanceolate, apex caudate, filiform. Diaphragma absent. Central column without annuli at base. Margin of the crater of the disk dark brown and hairy; female or bisexual flowers with a stigmatic annular zone below this. *Bisexual* and *male flowers* with 38–60 anthers in a ring around the lower margin of the disk, close to each other, oblong; loculi two-locular, superimposed, each with a terminal pore; pollen sticky-slimy. *Female flowers* with a larger amount of tissue between the column and the cupula than the male ones. *Ovary* inferior, between the insertion of the perianth and halfway the central column and the cupula, 1-locular, also developed in the male flowers; placentas with numerous intruding, maze-like septs; ovules numerous, parietal, anatropous, covering all parts of the ovary walls. *Fruit* surrounded by the scales above the cupula and by the desiccated perianth, only to be recognized after a manual inspection of the stiff walls. *Seeds* at base with a chalazal outgrowth, at maturity surrounded by a whitish pulp with the consistency of the endosperm of young coconuts.

Distribution. Two species in Malesia: Sumatra, Malaya, Java, Borneo.

Ecology. The host of both species is in general *Tetrastigma papillosa* (Blume) Planch., sometimes *T. lanceolarium* (Roxb.) Planch., once on *T. dubium* (Laws.) Planch., *T. glabratum* (Blume) Planch., *Villebrunea rubescens* (Blume) Blume (Urticaceae) and, most unlikely, there is also a report for *Kadsura lanceolata* King (Schisandraceae).

KEY TO THE SPECIES

1a. Open flowers 18–28(–40) cm in diameter. Perianth inside long-hairy in the tube only, antler-hairs at least in the upper part of the tube well-developed, 3–8 mm long. Lobes gradually narrowed, not abruptly constricted into the linear appendages. – Flowers unisexual. (Fig. 1) ..... **1. Rh. lowi**

b. Open flowers 8–20 cm in diam. Perianth inside long-hairy all over, only the apical linear portions of the perianth lobes with short antler-hairs; lobes abruptly caudate. – Flowers unisexual or bisexual. (Fig. 2, 3) ..... **2. Rh. zippelii**

1. Rhizanthes lowi (Becc.) Harms – Fig. 1.

Rhizanthes lowi (Becc.) Harms in Fedde, Rep. 36 (1934) 287; in E. & P., Nat. Pfl. Fam. ed. 2, 16b (1935) 269; Veldk., Fl. Males. Bull. 9 (1987) frontisp. – *Brugmansia lowi* Becc., Atti Soc. Ital. Sc. Nat. 11 (1868) 198, *comb. incor.*; Nuova Giorn. Bot. Ital. 1 (1869) 85, t. 5, f. 1–13; ibid. 7 (1875) 74; Solms-Laubach in E. & P., Pflanzenr. IV, 75 (1901) 12; Forbes, Wanderings (1885) 154, 206 (fig., as 'sp. nov.'); Fawcett, Trans. Linn. Soc., London, Bot. II, 2 (1886) 244, t. 36, f. 12; Koord., Bot. Overz. Raffl. Ned.-Ind. (1918) 101, t. 17, f. C–E; Merr., Enum. Born. Pl. (1921) 244; Ridley, Fl. Mal. Pen. 3 (1924) 20, t. 137; Appelman, Trop. Natuur 19 (1930) 49, fig. 1; Van Slooten, Trop. Natuur 19 (1930) 49, fig. 2–4. — *Brugmansia zippelii* Blume var.

Fig. 1. *Rhizanthes lowi* (Becc.) Harms. Aberrant flower with dark brown lobes and a white tube. (*de Wilde & de Wilde-Duyfjes 12148*, Sumatra, G. Leuser National Park, 1972; photo W.J.J.O. de Wilde).

lowi Hook. f. in DC., Prod. 17 (1873) 113. — *Mycetanthe lowi* Hochr., Candollea 4 (March 1930) 188; Steen., Bull. Jard. Bot. Buitenz. III, 11 (June 1930) 18, *pro comb. nov.*; Trop. Natuur 23 (1934) 47. — T y p e: *Low s.n.* in Hb. Beccari (FI, holo, n.v.; B, iso?, sub Hb. Solms A° 1892), Sarawak, island in the Limbang River.

Rhizanthes zippelii auct. non Spach: Coomans de Ruiter, Trop. Natuur 24 (1935) 171, fig. 3–6.

Flowers unisexual. *Buds* ovoid-pyriform, up to 12 by 7 cm in diam.; open flowers infundibuliform, 18–28(–40) cm in diam.; tube inside long-hairy below, in the upper part with up to 8 mm long antler hairs; in male flowers with 50–60 lines, corresponding with the number of anthers; lobes 6–12 mm wide at base, gradually narrowed, basal hairy part c. 3 cm long, gradually narrowed into the geniculate, 2.5–3 cm by 1–2(–3) mm apical appendage, the upper part of c. 6.5 cm without long hairs. Central column c. 2 cm long, in female buds with a c. 0.5 by 1 cm diam. stipe and a globular ± depressed apex, 1–1.5 by 1.5–2.0 cm diam. Apical cavity c. 1 cm wide and deep. *Male flowers* with a c. 7 cm broad ring of 50–60 anthers around the base of the globular disk; stipe with c. 50–60 ridges. *Ovary* rudimentary. Columnar disk of female flowers with a c. 7 mm wide stigmatic hairy zone along the base; stipe not striped; ovary 0.8–1.5 by 2–3 cm diam. *Fruit* unknown.

D i s t r i b u t i o n. Sumatra, Malay Peninsula and Borneo.

SUMATRA. Aceh: G. Leuser National Park, near Ketambe, primary forest, 200–400 m alt., 19 May 1972, *de Wilde & de Wilde-Duyfjes 12148* (L) (Fig. 1); 31 July 1972, *de Wilde & de Wilde-Duyfjes 13927* (L); 23 April 1975, *de Wilde & de Wilde-Duyfjes 16508*; 12 June 1979, *de Wilde & de Wilde-Duyfjes 18118* (L); Ulu Mamas River valley, 15 km W of Kutacane, 1250 m alt., 23 June 1979, *de Wilde & de Wilde-Duyfjes 18422* (L); 30 July 1979, *de Wilde & de Wilde-Duyfjes 19272-A*. – East Coast: Sibolangit Nature Reserve, S of Medan, 325 m alt., *Lörzing 5434*, 26 Nov. 1917 (BO, dried herbarium material); Nature Reserve Tinggi Raja, 400 m alt., *Dirks s.n.*, May 1939 (BO). – Bengkulu: near Soebanajam plantation, *Ottolander s.n.* (= *Koorders 44052*), 3 Nov. 1917 (BO). – Palembang: G. Dempo, above Pau, 1300 m alt., anno 1881, coll. *Forbes* (BM) (Forbes, 1885: 206). – Lampung: no exact location, 400 m, *H. Witkamp s.n.*, Oct. 1933 (BO); Penanggoengan, 300 m, *Forbes* (BM) (Forbes, 1885: 154; Van Slooten, 1930).

MALAY PENINSULA. Pahang: Kuala Tembeling, *Ridley s.n.*, Aug. 1891 (SING). – Perak: Mt Tipas in Chegor, 14 Oct. 1927; *SF 19386 (Henderson)* (SING); Tekam F. R., Forester *Shariff*, coll. for *F.S.P. Ng* (KEP), 4 May 1981, 'parasite on *Tetrastigma dubium*', (bud too small to be sure of species, but most likely this one). – Trengganu: Kemanan, B. Kajang in swamp, 150 m, 9 Nov. 1935, *SF 30356 (Corner)* (SING); Ulu Lok F. R., Aug. 1968, *FRI (Whitmore) 12182* (KEP).

BORNEO. West Kalimantan: Sungei Raun, *Hallier s.n.* A° 1894 (Van Slooten, 1930, n.v., not in BO); G. Raya complex, G. Beor, Nov. 1933, *Coomans de Ruiter* (1935, as *Rh. zippelii*, n.v., the divisions of the hairs suggest *Rh. lowi*); Landak Hampardjawu, *Teijsmann s.n.*, 20 Aug. 1875 (BO, Koorders, 1918: 105, Coomans de Ruiter, 1935, n.v., apparently lost). – East Kalimantan: E. Kutai, G. Tapian Lobang on Menula River, Sangkulirang, *Kostermans 6156* (BO). – Sarawak: *Low s.n.* in Hb. Beccari, Limbang near Brunei (FI, n.v., B?: Hb. Solms A° 1892); Kapit Dist., 7th Div., Ulu Kapit, foot of Bt. Garam, 210 m, *S 36080 (Chai)* (K, KEP, L, SAR); 4th Div., Melinau Gorge, Ulu Sungai Melinau, G. Mulu Nat. Park, 5 July 1977, *S 35796* (Chai) (K, L, SAR); Sungai Medalam, near G. Buda, 12 Oct. 1977, *S 39784 (Chai)* (L, SAR); Dulit Trail, near Long Kapa, Mt Dulit Ulu-Tinyar, *Richards 1106*, 8 March or 3 Aug. 1932 (K).

Ecology. Lowland Dipterocarp and hill forest, on *Tetrastigma papillosa*, once on *T. dubium* (*SF 30356 Corner*) and on *T. glabratum* (Coomans de Ruiter, 1935), 210–1500 m altitude.

Notes. There is little material to base an extensive description on. Complete, fully expanded flowers appear to be absent from nearly all the herbaria; only some recent collections from the G. Leuser (*de Wilde & de Wilde-Duyfjes 12148*) were available in L. Much of the other specimens are old and brittle and have over the years ± disintegrated. From the buds, which conserve better, the dimensions of most flowers had to be extrapolated, and thus it may be deduced that the flowers of *Rhizanthes lowi* tend to be considerably larger than those of *Rh. zippelii*. It must be noted that the flowers shrink considerably in drying: those from the G. Leuser were noted to have been 35 cm in diameter, when dry they were only 19 cm!

From the material seen it seems that the flower is concolorous; photographs of the Leuser material show them with dark brown lobes and white tube. The specimen studied, a mature bud, showed no significant differences with material earlier seen.

Beccari (1868), followed by Fawcett (1886), Koorders (1918), Hochreutiner (1930) have consistently called the species *'lowi'* and not *'lowii'* as many later authors have done. As it is clearly no printing error by the original author, the original spelling should be maintained, even when exceptional in botanical nomenclature.

Only limited data are available on the sex distribution of *Rh. lowi* since no collector has yet made such field observations, while the collections available are too few to check this.

Fig. 2. *Rhizanthes zippelii* (Blume) Spach. Flower (Sumatra, Ulu Gadut near Padang, Bt. Gambir, June 1983; photo W. Meijer).

The collection by Forbes (1885, reproduced by Ridley, 1924, and Van Slooten, 1930) agrees with specimens of *Rh. lowi* preserved in BO, with Meijer's Kinabalu collection, and also with the illustration based on *Imadate s.n.* (TNS) from Bendokan, Pensiangan, Sabah (Corner & Watanabe, 1969).

2. Rhizanthes zippelii (Blume) Spach – Fig. 2, 3.

Rhizanthes zippelii (Blume) Spach, Hist. Nat. Vég. 10 (1841) 554; Harms in Fedde, Repert. 36 (1934) 286; in E. & P., Nat. Pfl. Fam., ed. 2, 16b (1935) 269, t. 140; Backer & Bakh. f., Fl. Java 1 (1964) 166. – *Brugmansia zippelii* Blume in Van Hall, Bijdr. Natuurk. Wetensch. 2 (1827) 422, *comb. incor.*; Fl. Javae 1, 2 (1828) 17, t. 3–6; Miq., Fl. Ind. Bat. 1, 2 (1859) 684; Solms-Laubach, Bot. Zeit. 34 (1876) 449, 464, 480, 496, 14 fig.; in E. & P., Nat. Pfl. Fam. III, 1 (1889) 280, t. 184; Peirce, Ann. Bot., London 7 (1893) 291; Solms in E. & P., Pflanzenr. IV, 75 (1901) 11; Heinricher, Denkschr. Akad. Wiss., Wien, Math.-Naturw. Klasse 78 (1905) 57, t. 1–3; Koord., Exk. Fl. Java 2 (1912) 179; Hub.Winkler, Bot. Jahrb. 49 (1913) 365; Ernst & Schmid, Ann. Jard. Bot. Buitenz. II, 27 (1913) 1, t. 8, f. 4; Koord., Overz. Raffl. Ned.-Ind. (1918) 94, t. 16, f. A–D; Winckel, Trop. Natuur 7 (1918) 81; Merr., Enum. Born. Pl. (1921) 244; Appelman, Trop. Natuur 19 (1930) 49; Van Slooten, Trop. Natuur 19 (1930) 49, t. 1–3. — *Zippelia brugmansia* Rchb., Handb. Nat. Pfl.-Syst. (1837) 164, *nom. superfl.* — *Mycetanthe zippelii* Hochr., Candollea 4 (March 1930) 188, *comb. incor.*; Steen., Bull. Jard. Bot. Buitenz. III, 11 (June 1930) 18, *pro comb. nov.*; Van Slooten, Trop. Natuur 20 (1931) 30, 39, 233, t. 3–6; Van Slooten, Trop. Natuur 21 (1932) 68; Van der Pijl, Trop. Natuur 22 (1933) 51, fig.; Steen., Trop. Natuur 23 (1934) 47, fig. — T y p e: *Zippel s.n.* in Hb. Blume s.n. (L, holo, in spirit), Java, Bogor, G. Salak. (It is not at all certain that the L collection is indeed the original Zippelian one, for Blume, 1828, said that numerous other collections had been brought in by the local people.).

Brugmansia bakhuizenii Heinricher, Denkschr. Akad. Wiss., Wien, Math.-Naturw. Klasse 78 (1906) 63, 66, t. 1, f. 1–4, t. 3, f. 3–5, 7, *nom. prov.*; Backer & Bakh. f., Fl. Java 1 (1963) 166, *in nota.* — V o u c h e r: *Bakhuizen van den Brink s.n.* (IB), Java, Priangan, Pasir Datar.

Brugmansia lowi auct. non Becc.: Molesworth Allen, Mal. Nat. J. 21 (1967) 29, fig. 3; Toleman, Mal. Nat. J. 23 (1969) 30; Corner & Watanabe, Ill. Guide Trop. Pl. (1969) 163, fig., pl. 2, opp. p. 176.

Flowers unisexual or bisexual, buds up to 10 by 5 cm diam., pinkish, smooth, at anthesis whitish, 8–21 cm in diam., incl. the worm-like apical appendages. *Perianth tube* 2–2.5 cm long, inside with 46–55 brown lines around the column which fade out towards the base of the lobes; lobes curved downwards touching the substrate, initially united at base in groups of 3 or 4, later free, on the outside splitting up to c. 1.5 cm from the base of the tube, inside up to c. 3 cm, forming a thin c. 1.5 cm long membrane; lobes c. 2.5 by 1.5 cm at base, free part 4.5–5 cm long (excl. the appendages), apex c. 0.5 cm thick, base and inside of the tube with 5–7 mm long hairs, apically slightly hooked; lobes in ± upper 1.8 cm with short brown hairs with antler-like apices. *Column* c. 2.0 cm long, base narrow, c. 1 cm thick, head globular, 1.8–2 cm wide, apex purplish brown, hairy, crater 0.5–0.9 cm diam. *Anthers* 38–50. Stigmatic ring c. 0.5 cm high, white. *Fruit* subglobose, up to 6.5 cm diam., brown. *Seeds* oblong, c. 0.75 by 0.3 mm, appendage oblong, c. 0.5 times as long as the seed.

D i s t r i b u t i o n. Sumatra, Malay Peninsula, Java, and Borneo.

Fig. 3. *Rhizanthes zippelii* (Blume) Spach. Flower (*Meijer 16001*, Sumatra, Padang, Ulu Gadut, Bt. Takeleh, 20 Oct. 1981; photo W. Meijer).

SUMATRA. Aceh: Gajolands, from bivouac 6, Lake Laut, Tiga Sigi and Pasar Lebar to Bivouac 7, deep wet soil in alluvial stream bed, 1300–1500 m alt., 23 March 1937, *Van Steenis 10045* (L). – West Sumatra: Salida, S of Padang, *Julien Dely s.n.*, s.d. (BM); Agam, Bt. Banting, 1200 m, July 1918, *W. Groeneveldt s.n.* (BO), still there in 1984 (Beaman, oral comm.); Alahan Panjang, Suri-an, Bt. Barisan, *C. Japing s.n.*, s.d. (BO); Kabupaten, Lima Puluh Kota, near Payakumbuh, Mt. Sago, *Meijer s.n.*, 1955/56 (photo records in MO). – Padang: Ulu Gadut, Oct. to Nov. 1981, *Meijer 16001* (MO) (Fig. 3), *17004* (BO); June 1983 (no coll., see Fig. 2). – Bengkulu: Kepahiang, 600 m alt., Dec. 1931, *de Voogd s.n.* (BO); Sukaraja, *Rappard s.n.*, s.d. (BO, herbarium coll.); Wai Rilau: upper region, 500–600 m alt., *H. Witkamp s.n.*, 1 Dec. 1932 (BO). – Lampongs: Semangko River, 30–50 km above the mouth of the river, on the slope of a mountain, 500 m alt., *H. Witkamp s.n.*, 6 Dec. 1933, 13 Nov. 1933 (BO); G. Tanggamus, 600 m alt., *Lieftinck s.n.*, 4 Dec. 1934, Jan. 1935 (BO).

MALAY PENINSULA. Perak: Binjung Melaka, N of Chenderiang, *Molesworth-Allen s.n.*, 14 Feb. 1960 (KEP). First record for the Malay Peninsula!

JAVA. Without locality: *Engler* A° 1906 (B). – Bogor: G. Salak, *Zippel s.n.* in Hb. Blume s.n. (L); *Scheffer s.n.*, A° 1874 (See Solms-Laubach, 1876; GOETT?, n.v.); *Schimper s.n.*, A° 1890 (see Peirce, 1893, BONN); *Büsgen s.n.*, A° 1903 (B); *Volkens 86* (B); *Zollinger 3457* (BM, L, S); Ciapus Canyon, 500 m, 3 Nov. 1912, *Koorders 40380* (BO) ('perigone lobes white'); *de Vriese s.n.*, s.d., 'Java', probably from this locality (K). – Priangan: G. Pangerango, above the tea-estate Pasir Datar, Pasir Cimunkat, A° 1908, *Valeton s.n.* (BO); Garut, no exact locality, March 1929, *Ader 1* (BO). Van Slooten (1930) mentioned a collection by Ader from G. Kracak above Garut, first said to have been found at 1838 m altitude, but later he (Van Slooten, 1931: 30) gave a more exact

locality and altitude: G. Godok near the triangulationpoint at 1070 m, in a steep thin forest near sacred burial grounds. Another *Ader* collection, *s.n.* May 1930, has been reported upon by Van Slooten (1931: 39): Southern slopes of G. Galungang, the most eastern locality. This has apparently been lost or was incompletely labelled at BO. Another locality given by Van Slooten (1932) is a ravine of the tea-estate Soekajadi above Singpama. – Sukabumi: G. Beser, S of Cibeber, 25 km E of Sukabumi, Cadasmalang, private Nature Reserve of Winckel near plantation Cidadap, 100 m alt.: *Backer 22770*, 15 June 1917 (BO) ('perigone lobes clear red'); *Bakhuizen van den Brink 416* (BO); *Bakhuizen van den Brink 950* (BO); *Winckel 207*, 25 June 1918 (BO); *Winckel 919*, 7 May 1917 (BO); *Winckel 1993* (BO); *Winckel 1994*, 29 Apr. 1917 (BO); *Winckel 1995*, Nov. 1917 (BO). These localities were described by Winckel, Trop. Natuur 7 (1918) 81 (*Winckel 1993, Bakhuizen van den Brink 950* illustrated). – W. side of Bt. Tungul, 1300–1400 m alt., *van der Pijl s.n.*, Oct. 1931 (BO) (Van Slooten, 1931: 233). We have not been able to locate this.

BORNEO. West Kalimantan: near Anjungan in primary forest on G. Bala, 13 Oct. 1937, *Koopman s.n.* (BO). Other records are still rather dubious, for example: SE. Kalimantan, *Winkler s.n.*, A° 1908 (Van Slooten, Trop. Nat. 19, 1930, 51). – Sabah: Tawau, Gemok F. R., 350 m, Oct. 1968, Binson, Bongsu, and Kumin, *SAN 63914* (SING); Mt. Kinabalu, above Poring, Sept. 1981, *Meijer s.n.* (MO); Bendok, Pensiangan, 21 Aug.1968, G. Imadate (TNS) (Corner & Watanabe, 1969, pl. 2).

E c o l o g y. Primary or secondary forests, often along streams on deep alluvial soils with *Tetrastigma papillosa*, occasionally *T. lanceolarium* or *Villebrunea ? rubescens* ('kayu nangsi') (Urticaceae) (fide Van der Pijl, 1933) as host, 500–1500 m altitude, once, and most unlikely, for *Kadsura lanceolata* (Molesworth Allen, 1967).

V e r n a c u l a r n a m e s. Perut susuan (Sund.) (fide Winckel, 1918, 'belly of susuan', i.e. of *Tetrastigma papillosa*), bunga padma or b. pakma (Malay) (fide Molesworth Allen, 1967).

N o t e s. Since World War II there have been no more reports of this species from Java (pers. obs.; Kostermans, oral comm.). There still are (Oct. 1981) some specimens of *Tetrastigma papillosa* (Blume) Planch. in the Ciapus Canyon on the G. Salak. Cultivation and tree plantations along G. Salak have crept up the mountain. Since most of the remaining forested area is very steep and since new houses in the area around Bogor are being built of stone, cement, and tiles, little local timber is used. Until all forests below 1400 m altitude have been totally devastated there is a good chance to find *Rhizanthes zippelii* again. The terrain is too rough to cover on short trips with only 1 or 2 guides; days have to be spent on finding and opening trails and inspecting hundreds of prospective hosts. The locality known until 1917 in the Ciapus Canyon was so heavily collected that it would be possible that the populations were exterminated by botanists. Heavy logging during the last 10–20 years around the S. slopes of G. Pangerango have reduced the chances of survival of *Rhizanthes* there. Still, nobody has yet carried out an intensive search at the classic localities. The network of observers and educated jungle hikers, stimulated by articles (in Dutch) in the journal 'Tropische Natuur', has vanished and is now gradually being replaced by high school and young student groups going for hikes in the mountains. However, they do not yet possess a knowledge of the local flora. Jacobs & De Boo (Conservation literature on Indonesia, 1982) have furnished a useful bibliography on the older literature, with short descriptions of the contents of the Dutch articles.

A few collections are too incomplete to be 100% sure about their identity. The W. Sumatra collections, 2 km W of Padang Panjang are more likely to be *Rh. zippelii*

than *Rh. lowi* (Bakhuizen f. det.). A Cibolangit collection was identified as *Rh. lowi* by Van Steenis. Without more recent records it is difficult to be sure about their identity. It is also not clear to which species the collection from the G. Sibayak, Sumatra East Coast, mentioned by Palm (Acta Horti Gotob. 9, 1924, 147) belongs.