

FLORAE MALESIANAE PRAECURSORES LXV.  
NOTES ON ARISTOLOCHACEAE

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SUMMARY

One new species of *Aristolochia*, *A. singalagensis*, from Sumatra is described here. This is the only Malesian species to have the fruit dehiscing from the apex towards the base.

Remarks are given for some Asiatic and Malesian species, all belonging to *Aristolochia* except one to *Thottea*, on their taxonomy, nomenclature, typification, characteristics for identification, relationship, distribution, etc.

The phenomena and significance of aristolochiaceous plants–butterflies relationship have been discussed.

Germinated pollen grains have been found in dehisced anthers of open flowers in both *Aristolochia* and *Thottea*.

Pollination of the Aristolochiaceae has been concisely reviewed.

INTRODUCTION

The Aristolochiaceae in Malesia have never been taxonomically revised as a whole since Duchartre published in 1864 his comprehensive, world-wide treatment of this family (in DC., Prod. 15, 1: 420–498). They are represented in this region by only two genera: *Aristolochia* and *Thottea*.

During the revision of the Aristolochiaceae for the Flora Malesiana, five new species of *Aristolochia* and nine of *Thottea* have been found. As a result, in Malesia, this family is now known to have 28 species of *Aristolochia* and 22 of *Thottea*.

This is my third precursor on the Aristolochiaceae. The revision of this family for the Flora Malesiana and the present paper will be published at about the same time. I am grateful to Prof. Dr. C. G. G. J. van Steenis for thoroughly going through and polishing these two typescripts. Some of the items or remarks recorded and illustrations reproduced in the precursors can serve as supplements to the revision.

Techniques for clearing leaves and for reproduction of the venation were described in my paper in Blumea (27, 1981, 306).

In order to study with the scanning electron microscope, herbarium material of leaves or seeds was directly glued on a stub (1 × 1 cm) and coated with gold in a vacuum evaporator. The preparation was examined and photographed with a JEOL JSM-35 SEM.

Collections used for the revision of this family will be enumerated and published separately in the 'Identification Lists of Malaysian Specimens'. My acknowledgement and appreciation to the directors and curators of the institutes or herbaria for sending material on loan and those colleagues and friends for their kind help have been recorded in my precursor 'On the genus *Thottea*' (Blumea 27, 1981, 302) or in the text of the precursors.

#### ARISTOLOCHIA AND THOTTEA

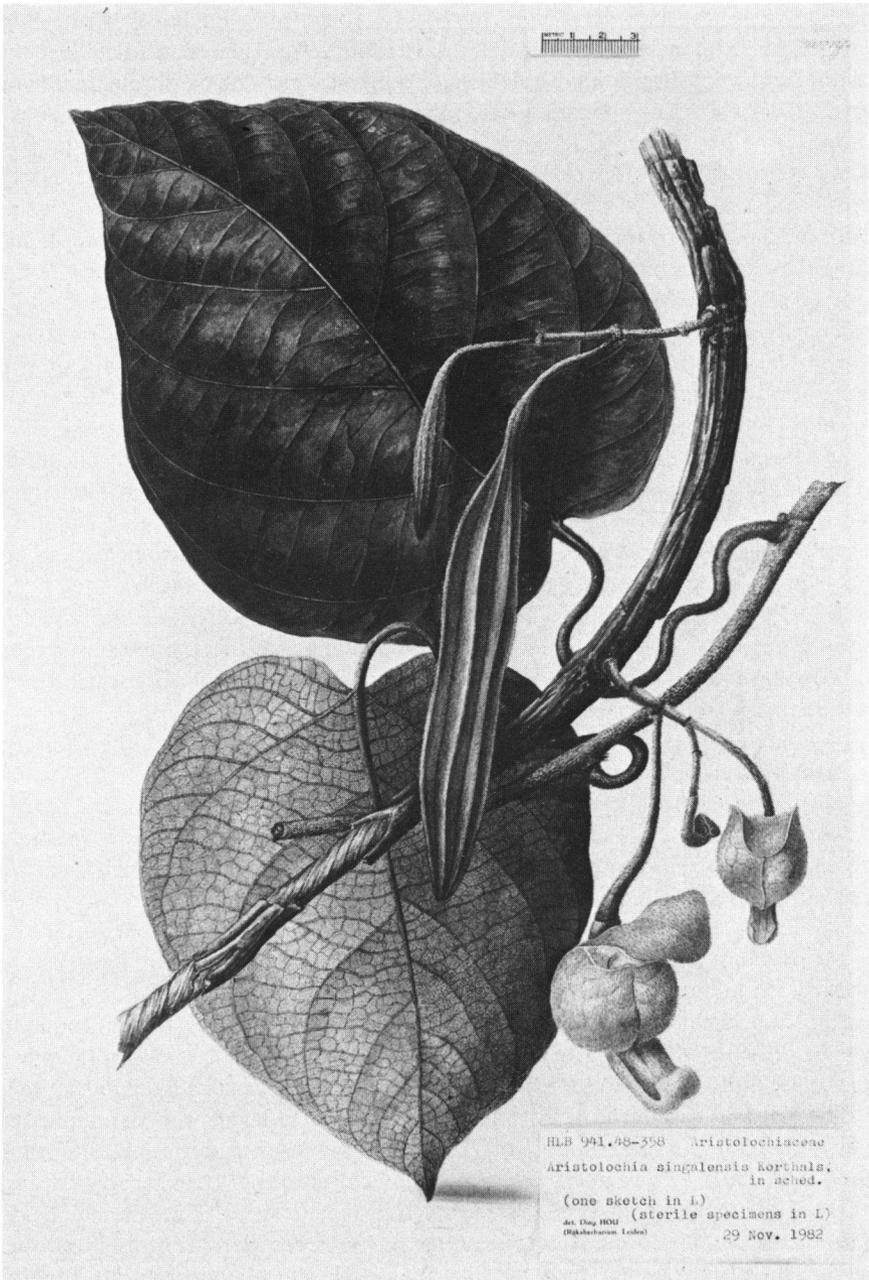
##### 1. *Aristolochia singalagensis* Korthals ex Ding Hou, *spec. nov.* – Fig. 1, 2a, 3c, d, 7a.

Planta volubilis usque ad 20 m alta; caulis teres vel leviter complanatus, plerumque 1–1.5 cm crassus, longitustrorsum vel procatus. *Lamina* subcoriacea, suborbiculata, late ovata, interdum ovata, raro ovato-oblonga, (14–)24–33 × (6–)11–14 cm, apice acuminata or breviter acuminata, basi cordata, supra nervis pubescentibus, subtus lanata, villosa, vel dense tomentosa; nervis c. 6 paribus, venis transversis vel reticulatis, subtus areolis distinctis; petiolus crassus (3–)6–14 cm longus, villosus vel tomentosus. *Inflorescentia* caulina, solitaria, c. 4 cm longae, floribus disparatis, tomentosae vel dense pubescentes; bracteae parvae, triangulatae, c. 3 mm longae. *Pedicellus* et ovarium usque ad 7 cm longum, tomentosum vel pubescentia. *Perianthium* luteolo-viride, valde flexum, extus pubescens; utriculus cylindricus, c. 7 × 1–1.5 cm; tubus cylindricus, 4 × 0.6–1.2 cm, parallelus ad utriculum; limbus profunde trilobatus, lobis triangulati, 3 × 4.5–6 cm, obtusis. *Stamina* et columna styli ignota. *Capsula* elongato-oblonga, 14–15 × 2.5–3 cm, dehiscentia ab apice usque ad immum, tomentosa vel pubescens. *Semina* concavo-convexa, c. 8 × 5 mm, utrinque levia.

Typus: W. Sumatra, Batang Singalang, *Korthals 2* (as 'ii') (HLB no. 908, 157–1005, L).

Further specimens examined: Sumatra: Atjeh, Boer ni Bias, forest slope, gigantic liana, stem up to wrist thick, alt. 1300 m, sterile, *van Steenis 6169* (BO); Atjeh, Gajo lands, Paja, flat forest ridge, alt. 1100–1250 m, sterile, *van Steenis 9931* (BO); Atjeh, Gunung Leuser Reserves, at edge of grassy marshland in the forest, fruit pendent on the main stem, at c. 2 m, alt. 1250 m, *de Wilde & de Wilde-Duyffjes 18386* (L); Batang Singalang, *Korthals s.n.* (probably dupl. of his coll. no. 2; HLB no. 908, 157–1004, L); Mt Singalang, c. 1700 m alt., sterile, *Beccari s.n.* (sheet no. 2493, FI); Dolok Ulu, near Pematang Siantar, along trail in depleted forest, alt. c. 350 m, sterile, *van Steenis 24293* (L); Palembang, Mt Pakiwang, primary forest, climber c. 20 m high, alt. c. 700 m, sterile, *van Steenis 3767* (L); no precise locality, sterile, *Anonymus s.n.* (probably from Batang Singalang, coll. by Korthals; HLB no. 925, 250–690, L).

Drawings and photographs: Sumatra: Batang Singalang, *Korthals 1* (plate in water-colour; HLB Icones no. 941, 48–358, L), 538 (original sketch, partly in water-colour; HLB Icones no. 941, 48–423, L); Pematang Siantar, *Arbaimun s.n.* (photograph of bare fl. twig, L); Mt Sago, 700–800 m alt., *Meijer 88* (photograph of bare fl. twig, in icones collection of Prof. van Steenis).



**Fig. 1.** *Aristolochia singalagensis* Korthals ex Ding Hou. — Photograph of a plate in water-colour of Korthals' collection,  $\times 0.4$ : leafy twig with two leaves ( $\frac{1}{2}$  of nat. size in original plate) and one section of stem bearing an inflorescence and an infructescence (nat. size in original plate).

The Korthals specimens as cited above were collected at Batang (= River) Singalang, W. Sumatra, in 1834 (cf. Fl. Males. I, 1, 1950, 297). The original field label of it has the following data in his handwriting as “no. ii, *Aristolochia singalensis* Khs, Sumatra, Korthals”. The subcoriaceous, suborbiculate leaves, with woolly, villous or densely tomentose lower surface, are very characteristic.

My colleague Dr. P.W. Leenhouts called my attention to a beautiful plate in water-colour under that name in the icones collection of the Rijksherbarium at Leiden. In addition, there is also the original sketch, which was possibly drawn from fresh material in the field, bearing the name of the new species (*Aristolochia singalangensis*), the number (as no. 538), locality (Batang Singalang), and magnification of the leaves (half of the natural size). The finally finished, beautiful, colour plate, as reproduced here in black-and-white, was evidently redrawn based on both the original sketch and herbarium specimens preserved in Leiden. Unfortunately I could not find the original flowering and fruiting material.

Specimens of this species were not found after Korthals made his collection in 1834 until 1878 by Beccari. Van Steenis made several collections in Sumatra between 1927 and 1937 as cited above. In 1980, Prof. van Steenis visited Dolok Ulu, near Pematang Siantar, East Coast, Sumatra, where plants of *Aristolochia* had been collected, and found also a specimen (*van Steenis 24293*) of this species.

In 1979, Dr. W.J.J.O. de Wilde and Dr. B.E.E. de Wilde-Duyfjes collected a fruiting specimen (no. 18386) of this species at the Gunung Leuser Nature Reserves, Atjeh, North Sumatra. This is the only Malesian species of *Aristolochia* which has the fruit dehiscing from the apex towards the base.

It is interesting that the close allies of *A. singalangensis* are, e.g., the Himalayan *A. griffithii* Duchartre (cf. A.R. Smith in Curtis's Bot. Mag. n.s. 178, 1970, t. 576, under *Isotrema griffithii*) and the Chinese *A. kwangsiensis* Liang (Acta Phytotax. Sinica 13, 1975, 12, t. 1, 1 & t. 2, 1–3). These species are related to one another by the characters of leaves (shape, size, indumentum), flowers (e.g. strongly bent perianth), fruits (elongate-oblong, dehiscing basipetally), and seeds (strongly convex-concave, testa smooth). However, the present species can be distinguished from them by the different size of floral parts, perianth limb deeply 3-lobed, and lobes pale yellowish green on the inner surface (not pinkish purple or purple).

Sterile specimens of some *Aristolochia* and *Phytocrene* (Icacinaceae) sometimes may be difficult to identify to the proper genus. For example, leaves of the present species are quite similar to those of *Phytocrene macrophylla* (Bl.) Bl. var. *macrophylla*. The Korthals specimens of the present species as cited above were determined and cited under the species (variety) of *Phytocrene* mentioned above (cf. Blumea 17, 1969, 239–240). After having examined many collections of both genera, the useful character for separating their sterile specimens is the character of the petiole. In *Aristolochia* the petiole does not possess an abscission zone; the old or dried leaves just hang on the plant for some time and then the petiole irregularly breaks off. In *Phytocrene* the petiole has an abscission zone occurring between its base and the stem; after the leaf falls, there is always a round, concave scar left on a cushion-like thickening of the stem (cf. Sleumer, Fl. Males. I, 7, 1971, 79–80).

## 2. *Aristolochia coadunata* Back.

*A. coadunata* Back., Trop. Natuur 8 (1919) 154, f. 13; Bull. Jard. Bot. Btzg III, 2 (1920) 320; Steen., Mount. Fl. Java (1972) sub t. 4, 1. — Lectotype (here chosen): *Schouten s.n.* (BO, Herb. Bog. no. 108722; iso BO, L), Preanger, Java.

This species is characterized by the following characters: 1) subterete or slightly flattened stem with a central, longitudinal furrow on each side and in cross-section having the appearance of the figure '8'; 2) leaves subcoriaceous, usually ovate-oblong to lanceolate, and densely villous or tomentose on the lower surface; 3) perianth strongly bent and the tube closely in contact with the utricle; 4) perianth dark purple with a yellow throat and a narrow rim-like, obscurely 3-lobed limb; and 5) style 3-lobed. Unfortunately the fruits and seeds have not been found.

This species is closely allied to the Himalayan *Aristolochia saccata* Wall. (Pl. As. Rar. 2, 1830, 2, f. 103) as stated by Backer (1920, l.c.) and Van Steenis (l.c.) but differs from that species by the smaller, not saccate flowers which have the perianth tube closely in contact with the utricle.

## 3. *Aristolochia curtisii* King — Fig. 2e.

*A. curtisii* King, Ann. Bot. Gard. Calc. 5 (1896) 161, t. 195; Gamble, Kew Bull. (1910) 78; King & Gamble, J. As. Soc. Beng. 75, ii (1912) 32; Ridl., Fl. Mal. Pen. 3 (1924) 18. — Syntypes: *Curtis 330* (BM, K, SING); *King's Coll. (Kunstler) 1453* (K); both from Penang.

This species has been validly published by King (l.c.) with a detailed description and good drawings of the plant. Gamble (l.c.) overlooked King's publication and erroneously treated the specific name as an unpublished one. This mistake was repeated by King & Gamble (l.c.) and followed by Ridley (l.c.).

This species is so far found in Penang and Lower Thailand (Khaw Pok Hill, Khsoon, *SF 3906*, SING). It is closely allied to *A. jacksonii* (see note under that species).

## 4. *Aristolochia foveolata* Merr.

*A. foveolata* Merr., Philip. J. Sc. 13 (1918) Bot. 280; En. Philip. 2 (1923) 119; Igarashi, Food Pl. Papilionidae (1979) t. 26 (fig. on the lower right) & 27 (as *Aristolochia* sp. 2); Liu & Lai, Quart. J. Taiwan Mus. 33 (1980) 247. — Type: *Ramos BS 30370* (iso BM, BO, K, US-xerox copy seen), Catanduanes, Philippines.

*A. kaoi* Liu & Lai, Fl. Taiwan 2 (1976) 573, t. 411. — Type: *Kao 7275* (TAI, n.v.), Pingtung, Taiwan.

The type of this species as cited above is a fruiting specimen from Catanduanes, Philippines. The leaves are subcoriaceous, ovate-lanceolate, deeply cordate at the base, and palmately nerved with the inner pair nearly reaching the apex; the lower surface is characteristically closely foveolate-reticulate, as alluded to by the specific epithet, and densely puberulous. The fruits are cylindrical and not angular or ridged. The seeds are immarginate. Until recently this species was only known by the type

collection. It is now found to occur in Sumatra, Malay Peninsula, Borneo, Philippines, and Taiwan (China).

The present species is allied to *A. tagala* by the leaf shape (usually with cordate base) and the 1-lipped flowers. It is easy to distinguish from the latter by the leaves with palmate nervation, lower surface distinctly foveolate-reticulate and densely puberulous, perianth not strongly contracted and stipe-like at the base, and seeds immarginate (cf. fig. 3e & f).

The leaves of this species are variable in shape (ovate to lanceolate, sometimes broad-ovate, rarely suborbiculate), size (length/width = e.g. 7/3, 9.5/3, 12/9, 18/11, 24/21 cm), and the base (deeply cordate with the auricles sometimes overlapping, cordate to slightly concave, or subtruncate). Such a variation can be observed on the collections made on Mt Kinabalu by the Clemenses (e.g. no. 26639 & 28732, mounted on one sheet in A, K, L, UC; 27732, BO).

From the seeds of this species received in October 1981, collected in Mt Kinabalu by Dr. W. Meijer (under *SAN 94104*), which were placed for germination, several plants were raised and survived. One of the plants is growing well under room temperature in my office and the others are planted in the Botanic Garden, Leiden. The plant in my room is 3.5 m high and shows very well the leaf variation as mentioned above.

Dr. Meijer also collected fruiting material (his no. 15796) together with one leaf and one section of stem of this species in NE. Sumatra. Ten seeds were placed for germination and several of them germinated; two plants grew to c. 1 m high and then died (material preserved in L). He found the plants are cultivated in private gardens for larval food of butterflies. From his information and through the help of my colleague Dr. M.M.J. van Balgooy, I received flowering specimens from Mr. Arbaimun, Brastagi, and hope to receive the fruiting material obtained from the same plant.

There are specimens collected by entomologists from the Philippines (Palawan: e.g. *Jumalon s.n.*, L; *Igarashi s.n.*, phot. seen) and Sumatra (NE. region: *Otto-Surbeck 14, 15, 16*, with also drawings and colour-photographs of the plant, L; *Straatman s.n.*, L; *Arbaimun s.n.*, L). From the information recorded, it is interesting to note that the larvae of *Trogonoptera brookiana* (butterfly) feed on these plants.

The type of *A. kaoi* Liu & Lai (l.c.) is a fruiting specimen collected in southern Taiwan. I have not examined it but have seen the beautiful plate with the original description. Mr. Lai, then at the Smithsonian Institute, U.S., examined a duplicate of the type of *A. foveolata* and informed me (in litt.) that these two species are conspecific. Later Liu & Lai (1980, l.c.) have reduced *A. kaoi* to the present species. Recently I saw one beautiful colour-photograph of a flowering plant of *A. kaoi* taken in southern Taiwan in a book entitled 'The Rare & Threatened Plants of Taiwan' (p. 45, 1980; ed. by K.S. Hsu and published by Taiwan Prov. Keelung Junior High School).

##### 5. *Aristolochia glaucifolia* Ridl. – Fig. 2d.

*A. glaucifolia* Ridl., Kew Bull. (1925) 88. – Type: *C.J. Brooks s.n.* (K), Bencoolen, Sumatra.

This species is so far found only in Sumatra. The type matches the specimen *C.J.*

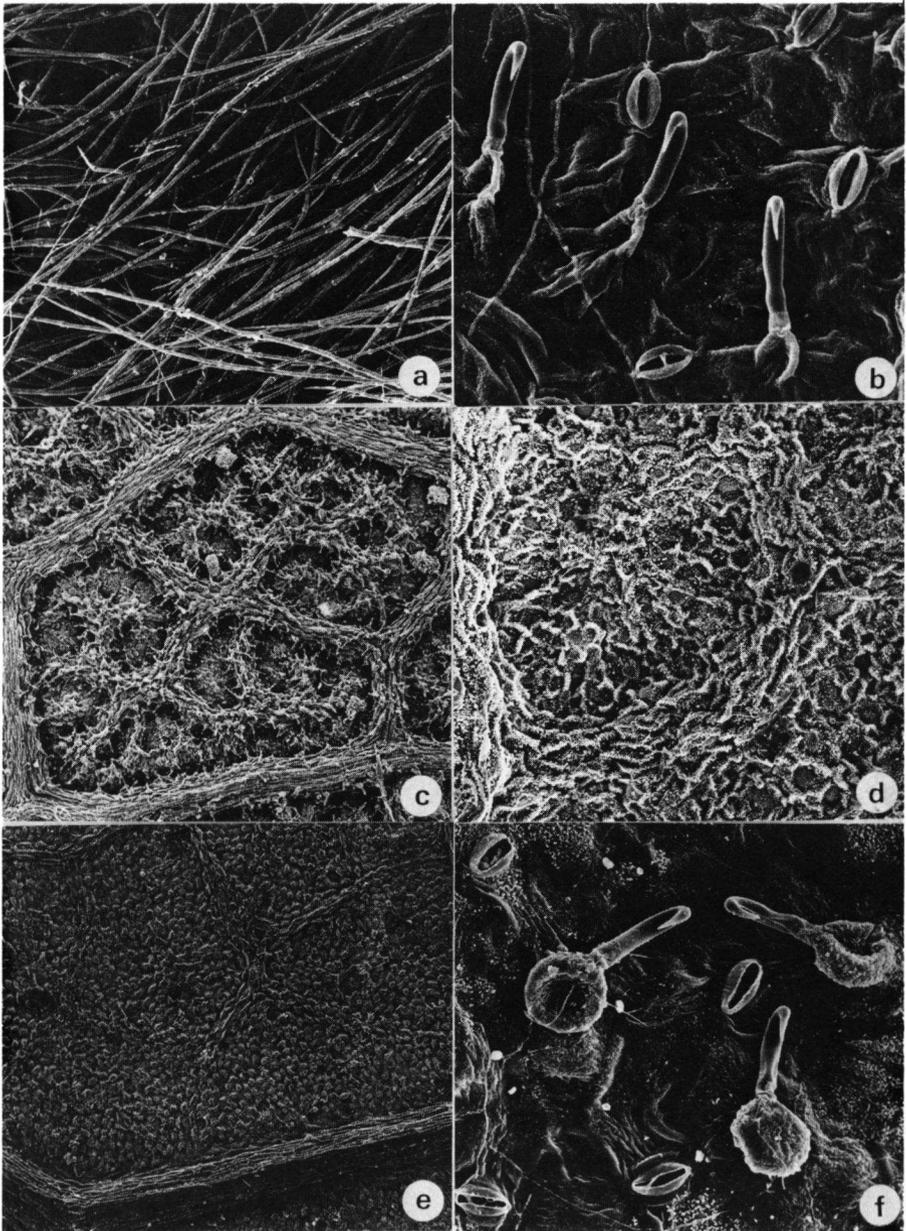


Fig. 2. Scanning electron micrographs of abaxial leaf surfaces of *Aristolochia*. — a. *A. singalagensis* Korthals ex Ding Hou,  $\times 34$  (van Steenis 24293); b. *A. rumphii* Kosteletzky,  $\times 450$  (van Borssum Waalkes 3225); c. *A. zollingeriana* Miq.,  $\times 35$  (Koorders 20377); d. *A. glaucifolia* Ridl.,  $\times 120$  (Brooks 13547, BO\*); e. *A. curtisii* King,  $\times 50$  (Curtis 330, SING\*); f. *A. linnemannii* Warb.,  $\times 450$  (van Royen 4508). — \*Herbarium of deposition. Specimens without \* are preserved in L.

*Brooks 13547* (BO) which has the original field label and note. The Kew specimen may be a duplicate of this collection in Bogor.

Specimens of this species are easy to recognize by examining the rather thin-chartaceous, cordate-sagittate leaves. The lower leaf surface is glaucous as referred by the specific epithet; it seems to be sprinkled with a layer of powder (formed by epicuticular substances, e.g. wax) (fig. 2d).

On the field note of *Brooks 13547* the following features were recorded: 'orifice dull yellow changing to grey at entrance to tube, back of orifice and tube pale lilac grey ...; flowers no scent, but the leaves especially in evening strongly aromatic. Food plant of *Papilio helena* Cum.'

Dr. de Wilde & Dr. de Wilde-Duyfjes collected recently one flowering specimen (no. 15866, L) in the Gunung Leuser Nature Reserves, Atjeh, North Sumatra, alt. c. 1100 m. According to their field notes, this plant is a slender twiner, c. 8 m tall with leaves only at the top of the plant. The flowers are cauliflorous. The perianth is pale whitish-yellowish with purple throat and inside the tube.

## 6. *Aristolochia jackii* Steud.

*A. jackii* Steud., Nom. Bot. ed. 2 (1840) 132, new name for *A. hastata* Jack.

*A. hastata* Jack, Malay Misc. 2, 7 (1822) 6, nom. illeg., non H.B.K. 1817, nec Nuttall 1818; Merr., J. Arn. Arb. 33 (1952) 217. – Type: *Jack s.n.* (n.v.; extant?), Sumatra, West Coast (Natal); quoad descript.

*A. unguifolia* Masters, J. Linn. Soc. Bot. 14 (1875) 494; Hook. f., in Curtis' Bot. Mag. 121 (1895) t. 7424. – Lectotype (here chosen): *Motley s.n.* (K), Borneo, Labuan I.; syntype: *Barber s.n.* (K), Labuan I.

*A. tripartita* Back., Trop. Natuur 8 (1919) 161 & 165, f. 14; Bull. Jard. Bot. Btzg III, 2 (1920) 322. – Lectotype (here chosen): *Lörzing 938* (BO; iso L), Java, Mt Wilis; syntype: *Backer s.n.* (BO, Herb. Bog. no. 108923 & 108924), cult., originated from Nusa Kambangan I.

In 1822, Jack (l.c.) published a new species of *Aristolochia*, *A. hastata*, based on material 'found at Natal on the west coast of Sumatra', about 0°N, 90°E. The specific name is a later homonym. In 1840, Steudel (l.c.) correctly renamed it as *Aristolochia jackii*. Since then the present species was quoted by later authors under either one of these two names. The type material has not been found; it might be lost by the fire of the ship 'Fame' in 1824 (cf. Fl. Males. I, 1, 1950, 257).

There are several specimens of *Aristolochia*, which were collected in the northern region of Sumatra (about 2–4°N and 98–100°E) (e.g. *Lörzing 5375, 12423, 17293, 17398; Surbeck 51*), which match very well with the original description of Jack's species.

Jack (l.c.) gave a detailed description of the species. The specific epithet alludes to the 'hastately three-lobed' leaves. He made keen observation on the arrangement of stamens and remarked that 'the anthers might properly be considered as twelve in number, each two-celled, as they are all arranged at equal distances round the stigma, ...'. He might have dissected a (rather young) flower with anthers not yet opened. I examined a flower (from *Lörzing 938*, BO) with anthers already opened and found that

the lobes (thecae, each with two pollen sacs) are in (six) pairs each opposite a style lobe. On a cross-section of the gynostemium, one can observe that there are six vascular bundles, each opposite one pair of anther lobes. It is evident that the flower of this species possesses six (two-lobed, four-loculed) anthers (cf. Johri & Bhatnagar, *Phytomorphology* 5, 1955, 123–125, f. 8, 44–47).

Hooker (l.c.) stated that '*A. unguilifolia* was first described by Dr. Masters, F.R.S., from specimens exhibited in 1880 at the Exhibition of the Royal Horticultural Society, South Kensington ...'. This species was actually described and validly published by Masters (l.c.) in 1875 as Hooker (l.c.) correctly cited among his references.

Backer (l.c.) found a very rare Javanese plant of *Aristolochia* and described it in great detail as a new species, *A. tripartita*. The specific epithet is referring to the characteristic 3-lobed leaves. There is one plant of this species, originated from Nusa Kambangan I., southern Java, growing in the Hort. Bog. sub no. XV-D-46. Specimens of this species are similar to those of *A. jackii*, so these two species have been treated as one here as cited above.

O.C. Schmidt (Bot. Jahrb. 58, 1923, 488) named a specimen, *Ledermann 7391* (n.v.), from May River, Sepik, New Guinea, *A. unguilifolia*. So far, I have seen only one leafy specimen, *Pullen 1648* (L), also from Sepik, which may belong to the present species. Fertile material is needed to ascertain the identity.

Two flowering specimens of *A. jackii* were collected from plants which were raised from seeds originated from northern Palawan and are growing in the garden of Prof. J.N. Jumalon (his specimens: *s.n.*, Oct. 1981, L), Cebu city, Philippines. This is the first time that this species is found in Palawan. Prof. Jumalon recorded that the size of the leaves is up to 50 by 30 cm and some are even larger seen in the field.

This species is related to *A. curtisii* by the deeply digitately 3-lobed leaves, the inflorescences with spaciouly arranged flowers and bracts, and the 1-lipped limb. It can be easily distinguished from *A. curtisii* by 1) leaf base usually emarginate, subcordate or almost truncate (against leaf base cuneate), 2) bracts small, c. 1.5 mm long (against bracts conspicuous, 7–10, rarely 15 mm long), 3) perianth 7.5–11 cm long (against perianth c. 5 cm long), and 4) seeds winged (against seeds not winged).

## 7. *Aristolochia klossii* Ridl.

*A. klossii* Ridl., Kew Bull. (1926) 78. – Type: *Kloss SF 14767* (K; iso BO, SING), Mentawai I., W. Sumatra.

This species is only known from the flowering type collection. It is characterized by the 1) deltoid leaves with obtuse apex, cordate or shallowly cordate base, and broad, triangular sinus, 2) basal pair of leaf nerves curved, ascending upward to the apex, 3) leaf veins loosely reticulate or transverse, 4) flowers deep crimson, white at base, limb pinkish with crimson edge, 5) perianth 1-lipped, and 6) limb obovate-oblong, apex slightly retuse or mucronate.

Its leaves are rather similar to those of *A. gaudichaudii* so far known from Molucas and New Guinea (and neighbouring islands). I hope that before long more specimens, especially fruiting material, of the present species will be collected.

**8. *Aristolochia rumphii* Kosteletzky – Fig. 2b.**

*A. rumphii* Kosteletzky, Allg. Med.-Pharm. Fl. 2 (1883) 465: Merr., Int. Rumph. (1917) 209. – Type: Rumph., Herb. Amb. 5, t. 177, Amboina, Moluccas.

The present species is closely related to *A. indica* Linn. by the characters of leaves, 1-lipped flower and the perianth with a distinct stipe-like part. The leaves of both of them are very variable; specimens, especially the sterile ones, are rather similar to each other. The former is now known to occur in the Lesser Sunda Islands, Celebes, and Moluccas, while the latter is found in extra-Malesia, mainly in India and Sri Lanka.

*A. rumphii* can be distinguished from *A. indica* by 1) inflorescences with distinct internodes and few-flowered (against inflorescences with shortened and obscure internodes and often seemingly fasciculately many-flowered), 2) pedicel and ovary rather long, up to 3 cm (against up to c. 1.5 cm), 3) stipe part of the utricle c. 5 mm long (against c. 2.5 mm), 4) perianth tube rather long, up to c. 17 mm (against up to c. 8 mm), 5) capsules small, c. 2.3 cm long (against 4–5 cm), and 6) seeds immarginate (against seeds distinctly winged).

**9. *Aristolochia tagala* Chamisso.**

*A. tagala* Chamisso, Linnaea 7 (1832) 207, t. 5, f. 3; Koidzumi, Fl. Symb. Orient.-Asiat. (1930) 16. – Type: von Chamisso (*Romanzoff Exp.*) s.n. (B, n.v.), Cavite Prov., Luzon.

*A. japonica* Miq., Ann. Mus. Bot. Lugd.-Bat. 2 (1866) 136; Prol. Fl. Jap. (1866) 68. – Type: 'Siebold' s.n. (L, HLB no. 898, 131–132), locality uncertain, see note below.

Miquel (l.c.) described a new species of *Aristolochia*, *A. japonica*, and ascribed the only specimen cited as collected by Von Siebold in Japan. The type of this species is in Leiden, as cited above, and bears a field label of Japanese plants collected by Von Siebold.

Koidzumi annotated the type, dated 5 Dec. 1925, as *A. tagala* Cham. and remarked that 'This is not native of Japan'. He published the result later in 1930 as cited above.

After having examined the type, I found that it is similar to some specimens of *A. tagala* from Java in Leiden (e.g. Herb. Reinwardtianum HLB no. 898, 131–32; Herb. Waitz HLB no. 898, 131–16). It appears that this type may be an incidental mixture of a loose (Javanese) specimen with a label of Von Siebold's collections of Japanese plants.

**10. *Aristolochia zollingeriana* Miq. – Fig. 2c, 3a, b.**

*A. zollingeriana* Miq., Fl. Ind. Bat. 1, 1 (1858) 1066. – Type: *Zollinger 2744* (iso BM, BO), Puger, Java.

*A. ramosii* Merr., Philip. J. Sc. 29 (1926) 478. – Type: *Ramos BS 43775* (UC; iso BM, BO, K), Bohol, Philippines.

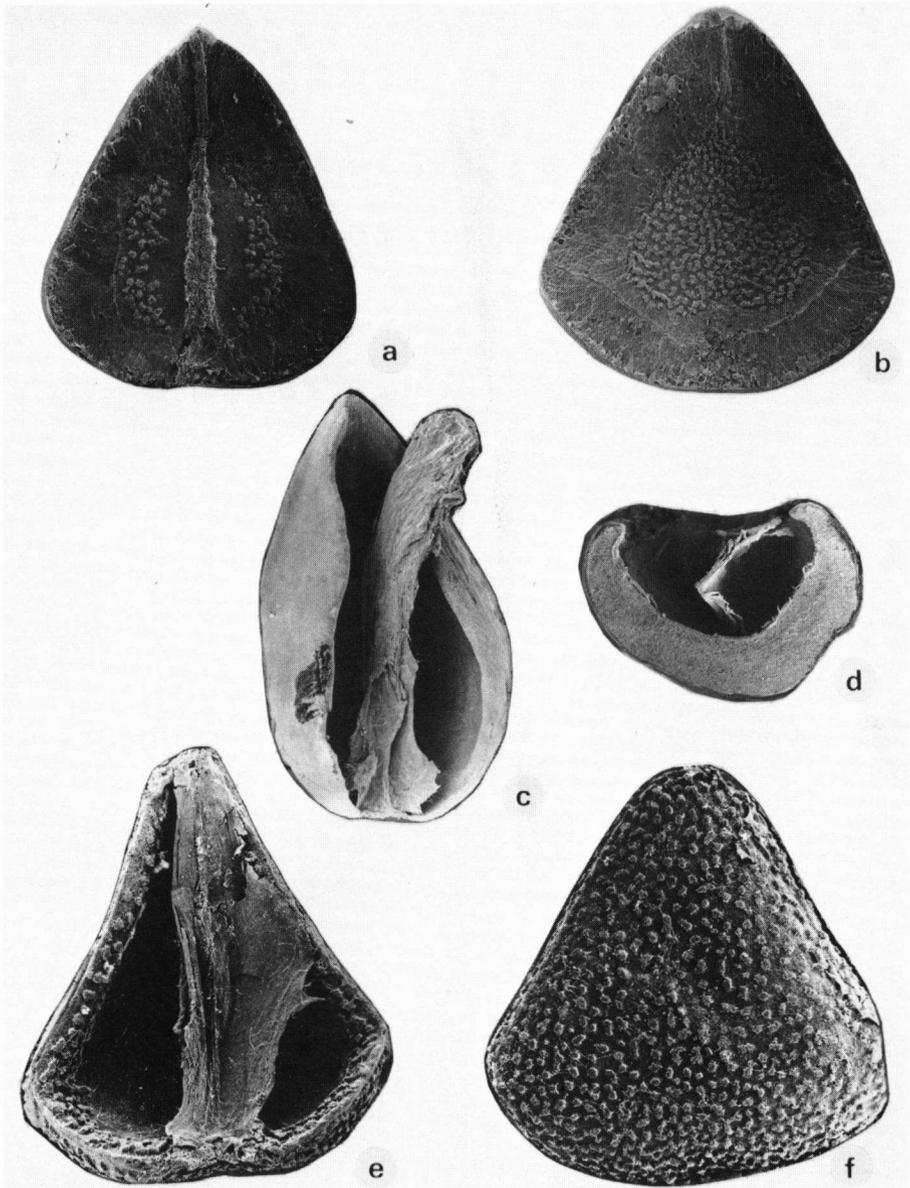


Fig. 3. Seeds of *Aristolochia*. — *A. zollingeriana* Miq., flat seed with a distinct marginal wing and verrucose on seed proper: a. adaxial surface, b. abaxial surface,  $\times 7$  (PNH 19836). — *A. singalagensis* Korthals ex Ding Hou, immarginate, longitudinally curved seed,  $\times 7$  (de Wilde & de Wilde-Duyffes 18386): c. obliquely ventral view showing smooth testa and laterally dilated, shrunken funicle free from testa and only attached to one end of seed; d. cross-section. — *A. macgregorii* Merr., immarginate, slightly convex-concave seed,  $\times 20$  (Bartlett 15090, PNH): e. adaxial surface showing laterally dilated, dried funicle still partly covered marginal part of seed; f. abaxial surface with verrucose testa.

- A. kankauensis* Sasaki, Trans. Nat. Hist. Soc. Form. 21 (1931) 251; Liu & Lai, Fl. Taiwan 2 (1979) 572. – *A. roxburghiana* subsp. *kankauensis* (Sasaki) Kitamura, Acta Phytotax. Geobot. 20 (1962) 135. – *A. tagala* var. *kankauensis* (Sasaki) Yamazaki, J. Jap. Bot. 50 (1975) 341, as '*kandaoensis*'; Igarashi, Food Pl. Papilionidae (1979) t. 13. – Type: *Sasaki s.n.*, 19 July 1919 (n.v.), Kankau, Hengchun Peninsula, Taiwan.
- A. tagala* auct. non Chamisso: Hatusima, Fl. Ryukyu (1971) 243; Walker, Fl. Okin. S. Ryukyu Is. (1976) 424.

This species is so far found in Sumatra, Java, Philippines, China (Taiwan), and southern Ryukyu. Its leaves are polymorphic and are very variable, e.g. in shape, size, texture, etc. The leaf base can be shallowly cordate (with two divergent lobes), or sagittate (with a deep sinus and two  $\pm$  parallel lobes). The leaves on the specimens collected from Sumatra and Java are ovate-oblong and sagittate at the base, but those from the southern Ryukyu and Taiwan are often deltoid, ovate, or suborbiculate, and shallowly cordate at the base. However, there are intermediate forms on the specimens from the Philippines; sometimes various leaf forms are even found on one specimen, e.g. *Edaño 3758* (= *PNH 17785*), *Jumalon & Aviluna Jr s.n.*, April 1970 (L). Such a polymorphic phenomenon of leaves in the present species can be compared with the well collected and cultivated Japanese species *A. kaempferi* Willd.

Kitamura (l.c.) and Yamazaki (l.c.) examined the type of *A. kankauensis* from Taiwan and found that some specimens from southern Ryukyu are similar to it. Kitamura treated *A. kankauensis* as a subspecies of *A. roxburghiana* (= *A. tagala*) while Yamazaki recognized it as a variety of *A. tagala*. There are several specimens in Leiden from southern Ryukyu Islands, which were cited by Walker (l.c.) under *A. tagala*, viz. *Walker et al. 7316*, *Hatusima 19060 & 23274*, *Fosberg 38144*, belong also here.

After having studied the literature and examined the specimens, I found that *A. kankauensis*, *A. ramosii* and *A. zollingeriana* are conspecific.

*A. zollingeriana* is related to *A. tagala*. They can be easily separated from each other even just by examining the leaves. In the former, the undersurface of the leaf is minutely hairy and with distinct aereolation; however, in the latter the undersurface of the leaf is sparsely short-hairy, rarely glabrous and with obscure aereolation. They are also different in flowers, fruits and seeds.

Some of the polymorphic leaves are similar to those of *A. foveolata* especially in shape and indumentum on the lower surface. In the present species, the leaves are rather thin, minutely hairy and distinct aereolation while in the latter they are thicker, densely shortly hairy and prominent aereolation. However, these two species are quite different in flowers and seeds.

#### 11. *Aristolochia crassinervia* O.C. Schmidt – Fig. 4, 5b.

- A. crassinervia* O.C. Schmidt, Bot. Jahrb. 58 (1923) 491; Igarashi, Food Pl. Papilionidae (1979) t. 23. – Type: *Ledermann 13083* (n.v.), Sepik region, NE. New Guinea.

This is one of the species of *Aristolochia* in New Guinea which can be easily recognized by the characteristic leaves. I have not seen the type, but from the original description, one can identify the plants of this species. The characteristic leaves are sub-

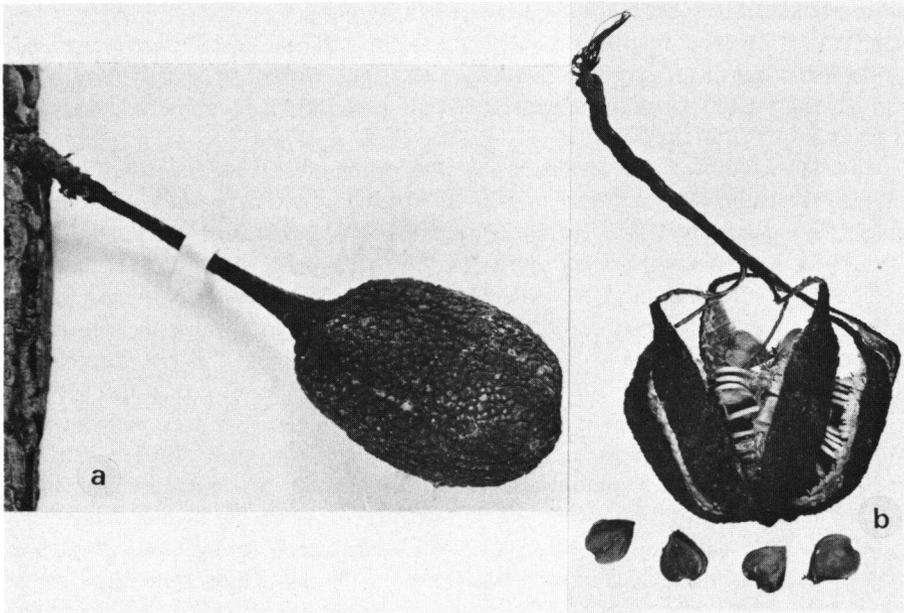


Fig. 4. *Aristolochia crassinervia* O.C. Schmidt. — Fruits in hanging position: a. one not yet opened fruit borne on a brachyblast of a stem,  $\times 1$  (NGF 28557); b. one fruit dehiscent from pedicel end towards apex, with four loose, flat, smooth seeds,  $\times 0.7$  (Hutton s.n., sheet no. 225461, LAE).

coriaceous or coriaceous, with a deeply cordate base and the auricles often overlapping when dry, prominently palmately 5(–7)-nerved, and have a prominent, closely reticulate venation (fig. 5b). The flowers are 1-lipped. The fruits are cylindric or oblong (not ridged or angular), 2.5–4.5  $\times$  2–3 cm, and minutely glandular (when dry) (fig. 4a). The seeds are triangular or deltoid, not winged, and rather smooth or obscurely muriculate on both surfaces.

The fruit, as examined in herbarium specimens, is very hard and seems indehiscent. It is actually a dehiscent capsule (fig. 4b). A beautiful plate of the plant was drawn and sent to me by Mr. M. Parsons, entomologist, Papua New Guinea, showing a dehiscent fruit.

*A. crassinervia* is allied to *A. foveolata* found in Taiwan, Philippines, Borneo and Sumatra. These two species can be distinguished from each other by the shape, size, and other details of the leaves, flowers, fruits, and seeds.

## 12. *Aristolochia dielsiana* O.C. Schmidt – Fig. 6a.

*A. dielsiana* O.C. Schmidt, Bot. Jahrb. 58 (1923) 490. — Type: *Ledermann 9169* (n.v.), Etappenberg, NE. New Guinea.

The type of this species as cited above is a flowering specimen. I have not seen any duplicate of it. According to Schmidt (l.c.) this species and *A. schlechteri* have similar flowers but it differs from the latter by the smaller, lanceolate, usually not sinuate and never cordate leaf (with its widest part more or less in the middle) and also by the colour of the flower.

The flower buds or not yet opened flowers of the present species and *A. schlechteri* may resemble each other. However, the opened flowers are quite different in these two species. The flower (perianth) is 3-lobed (fig. 6a) in the former and 6-lobed (fig. 6c) in the latter.

The leaves are very variable in shape, size and texture. They are often coriaceous, rather rough when old, broad-ovate, ovate, lanceolate or narrow-lanceolate; their size in herbarium specimens examined is usually 19–37 × 4.5–23.5 cm. The base is slightly sinuate or shallowly cordate, more or less truncate, rarely cordate.

There are several collections from New Guinea bearing good flowers and/or young fruits, and rather variable leaves.

Mr. R. Straatman (J. Lepidopterists' Soc. 25, 1971, 58–64), entomologist, was in southeastern New Guinea between 1967–1970 to study the life history and behaviour of the largest known butterfly species of Rhopalocera, *Ornithoptera alexandra*. This butterfly is monophagous and its larvae feed on plants named by him '*Aristolochia schlechteri*'. He reported: 'The flower is shaped like a starfish with three long arms and is dark purple-brown with a yellow heart. The fruit is green, shaped like a small cucumber, 20 to 30 cm long, strongly ribbed longitudinally and has a rough skin. It matures slowly and when full rotten the seeds fall to the ground and are carried away by rainwater generally over short distances, resulting in a number of plants growing in a restricted area. In primary forest the vine reaches the top of tall trees of over 40 meters high.'

I examined two collections of Straatman: Port Glasgow, Central Dist., fl., *Straatman M6* (LAE); Popondetta, Northern Dist., fl., *Straatman 231* (LAE). These collections are actually belonging to the present species, *A. dielsiana*. When Mr. Straatman visited Leiden in 1981, he kindly made sketches of the flower and fruit of the plant and told me that the leaves can grow up to the size of 100 × 70 cm; he also lent me two colour transparencies of the plants of this species growing in his garden.

There is one unicate specimen, collected at Yapa (Hunstein R.), Sepik Dist., in rain forest, c. 150 m alt., *Hoogland & Craven 10753* (CANB), which consists of a (bare) flowering twig, with additional flowers and one (young) fruit preserved in FAA (this is the only liquid preserved flowering material of *Aristolochia* from New Guinea ever examined). The plant was twining into a tall tree in rain forest on river bank. The flowers and fruit were collected along the lower 5 m of the stem but the leaves were not located. 'The corolla is pale green outside and the lobes orange-yellow and purple inside'.

In addition, the following specimens were examined: Popondetta, Northern Dist., disturbed primary rain forest, fr., *LAE 67855* (L); Brown River Forestry, Central Dist., fl. & fr., *Carver 73* (LAE), ditto, c. 30 m alt., two rough leaves, *Hutton s.n.*

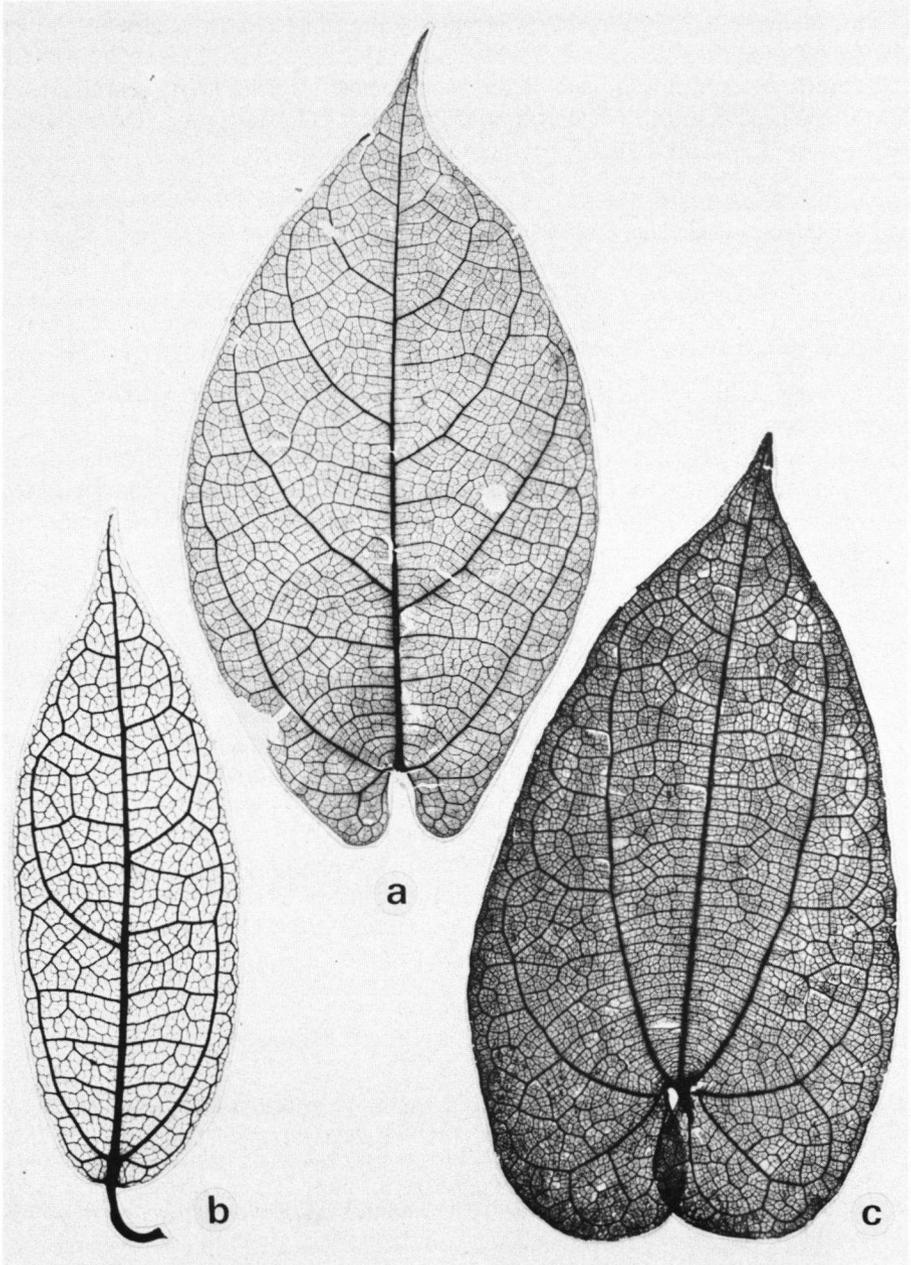


Fig. 5. Venation patterns of cleared leaves of *Aristolochia*. — a. *A. momandul* K. Sch.,  $\times 0.5$  (Clemens 986); b. *A. engleriana* O.C. Schmidt,  $\times 1.1$  (Hiepko et al. 1278); c. *A. crassinervia* O.C. Schmidt,  $\times 0.8$  (NGF 45343). Each of the cleared leaves is preserved on the original specimen.

(LAE); Idenburg R., 1200 m alt., fl. greenish white, tinged and veined with purple, *Brass* 12909 (A).

There is also a beautiful plate of the plant, named '*A. schlechteri*', sent to me by Mr. M. Parsons, consisting of drawings of leafy twig, 3-lobed flowers and cylindric, ridged fruit. This plant evidently belongs to the present species.

### 13. *Aristolochia engleriana* O.C. Schmidt – Fig. 5b, 7b.

*A. engleriana* O.C. Schmidt, Fedde, Rep. 23 (1927) 288, nom. nov. – *A. ledermannii* O.C. Schmidt, Bot. Jahrb. 58 (1923) 489, non Engler 1911. – Type: *Ledermann* 12055 (n.v.), Schraderberg, NE. New Guinea.

The type of this species as cited above, collected in mossy forest at 2070 m alt., is a fruiting specimen. I have not seen it or any duplicate of it.

According to Schmidt (1923, l.c.) this species can be easily distinguished from others in this region by the leaf characters. The leaf is characterized by the narrowed, obtuse, rounded, sometimes cuneate, or broadly truncate base and is prominently 3-nerved at the base. The fruit is pyriform.

Among the species of *Aristolochia* occurring in New Guinea, this is the only one so far known with such a leaf base. There is a photograph of a plant of *Aristolochia* in vegetative state by Igarashi (Food Pl. Papilionidae, 1979, t. 22) under the name of '*A. schlechteri*'. According to the leaf characters, this plant is evidently belonging to *A. engleriana*.

The following specimens, which were collected often in low montane or montane forest, 1830–2250 m alt., rarely lower, once at 600–700 m, are either in flower or fruit, and may all probably belong to this species: E. Highlands Dist.: Mt Bosavi, 6°26' S, 142°50' E, fr., *Jacobs* 9108 (L); Warrapuri R., 6°10' S, 144°50' E, bare twig with fl., *NGF* 18108 (L); confluent of Warapuri & Warrangga R., 6°10' S, 144°50' E, fr., *NGF* 18278 (LAE); summit of Kassam Pass, 6°12' S, 146°02' E, fr., *NGF* 29210 (L). S. Highlands Dist., Was River valley, fr., *Sillitoe* 210 (CGE). W. Irian, Eipomek-Tal, 4°25' S, 140°01' E, fl., *Hiepko & Schultze-Motel* 1278 (L).

### 14. *Aristolochia gaudichaudii* Duchartre.

*A. gaudichaudii* Duchartre, Ann. Sc. Nat. Bot. 2 (1854) 72, t. 6, f. 3–5; in DC., Prod. 15, 1 (1864) 481; Laut., Bot. Jahrb. 52 (1914) 105; Roepke, Trop. Natuur 24 (1935) 80, f. 5; Igarashi, Food Pl. Papilionidae (1979) t. 26 (fig. on the left & top right). – Type: *Gaudichaud* s.n. (n.v.), Rawak=Lawak, Waigeo I., W. New Guinea.

*A. roxburghiana* auct. non Klotzsch: Warb., Bot. Jahrb. 13 (1891) 300, quoad *Warburg* 20598 (A, WRSL).

Duchartre (1854, l.c.) published this species and gave a detailed description together with drawings of the leaf and flowers. It can be recognized by the chartaceous, glabrous leaves which are ovate, broadly ovate, triangular or deltoid in outline, 11–22 × 10–18 cm, and palmately 5-nerved. The leaf base is subtruncate (especially

when young), subcordate or cordate (often at adult stage). The perianth is 1-lipped. The fruits are oblong and  $4-6 \times c. 3$  cm. The seeds (incl. wing) are transversely oblong,  $6-11.5 \times 12-16$  mm, and smooth on both surfaces; the marginal wing is 2.5–4 mm broad.

This species has been found so far in Moluccas (Batjan and Ceram) and New Guinea and neighbouring islands (Sorong, Fakfak, Manokwari, Sidei, Schouten I., Biak I., Toronta, Sepik, New Ireland, Job I., and Lawak, off N. Waigeo I.). The plants grow in primary forest, sometimes in beach, secondary, or swampy forest, clearing ground and thicket, at low altitudes.

#### 15. *Aristolochia linnemannii* Warb. – Fig. 2f.

*A. linnemannii* Warb., Bot. Jahrb. 13 (1891) 301; Laut., Bot. Jahrb. 52 (1914) 105. – Type: Warburg 20599 (fragments of the type in WRSL; iso BM), Finschhafen, NE. New Guinea.

Of the type material I have available one leaf and part of the inflorescence, together with Lauterbach's drawings of the flower and fruit, on loan from WRSL. I have also examined and photographed the isotype in BM.

Specimens of this species are very rare. Besides the authentic material, I have one good collection, *van Royen 4508* (L, with fl. & fr.; sterile dupl. in BO, SING), from Hollandia, former Netherlands New Guinea, which bears several flowers and one fruit.

This species is characterized by 1) the chartaceous leaves which are triangular, deltoid or heart-shaped,  $5-8 \times 4.5-6$  cm, shallowly cordate at the base, minutely hairy on the undersurface, and palmately 5-nerved, 2) perianth glabrous outside, 1-lipped, 3) capsule glabrous, broadly ellipsoid or subglobose, rather small,  $2.5 \times 1.75-2.5$  cm, 6-ribbed or -angular, and 4) seeds winged, triangular,  $c. 6 \times 5$  mm (incl. marginal wing,  $c. 1$  mm broad), densely granulate on the lower surface.

The plants occur so far known in thickets or along the road at low altitudes.

#### 16. *Aristolochia momandul* K. Sch. – Fig. 5a, 6b, 7c.

*A. momandul* K. Sch. in K. Sch. & Hollr., Fl. Kais. Wilh. Land (1889) 105; Laut., Bot. Jahrb. 52 (1914) 106. – Type: *Hollrung 520* (iso BO, WRSL), Konstantinhafen, NE. New Guinea.

*A. pithecurus* Ridl., J. Bot. 52 (1914) 296; Igarashi, Food Pl. Papilionidae (1979) t. 24. – Type: *Forbes 621* (BM; iso L, WRSL), Sogeri region, New Guinea.

*A. gracilifolia* O.C. Schmidt, Bot. Jahrb. 58 (1923) 490; Merr. & Perry, J. Arn. Arb. 23 (1942) 383. – Type: *Ledermann 12458* (n.v.), Felsspitze, NE. New Guinea.

*A. dictyophlebia* Merr. & Perry, J. Arn. Arb. 29 (1948) 152. – Type: *Clemens 4901* (A; iso BRI), Ogeramnang, NE. New Guinea.

Schumann (l.c.) published a new species of *Aristolochia*, *A. momandul*, which was based on a fruiting specimen as cited above. He stated that on account of the characters of the leaf and fruit, this species is related to *A. deltantha* F.v.M. (Fragm. Phyt. Austr. 6, 1868, 179 & 255), and that *A. deltantha* is very different in the form and size of the leaf and fruit.

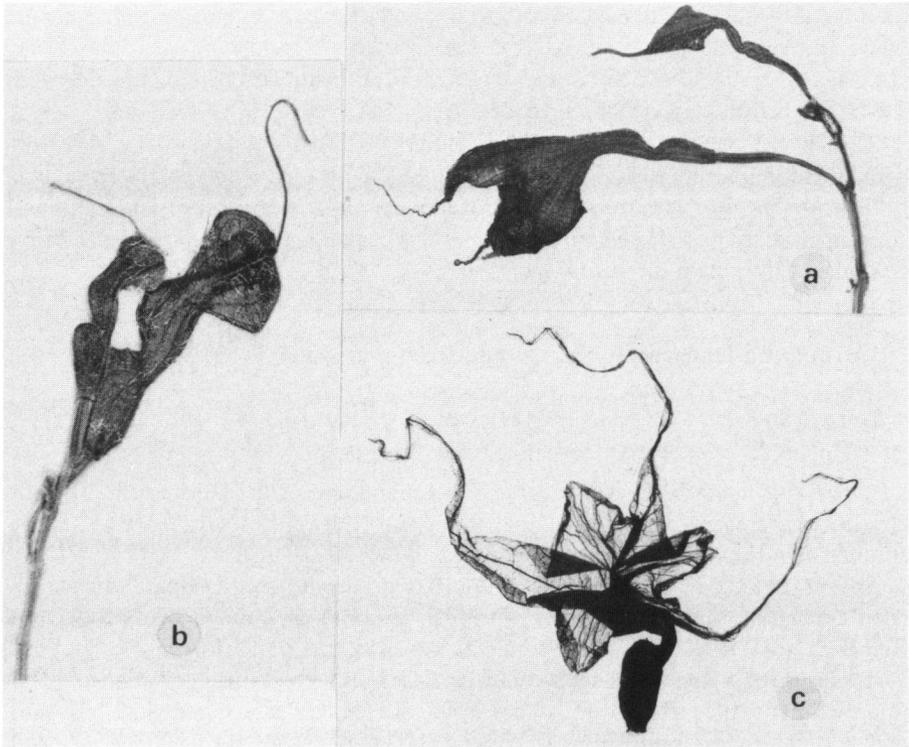


Fig. 6. Flowers of *Aristolochia*. – a. *A. dielsiana* O.C. Schmidt, apical part of an inflorescence with one flower bud, showing triangular limb gradually narrowed towards a filiform, tail-like apex, and one open flower,  $\times 0.6$  (Carver 73, LAE). – b. *A. momandul* K. Sch., apical part of an inflorescence showing two flower buds each with a tail-like apex,  $\times 1$  (NGF 13469, LAE). – c. *A. schlechteri* Laut., detached perianth showing limb with distinctly 6 (3 short and 3 rather long) lobes,  $\times 0.7$  (Hoogland & Craven 10489).

Lauterbach (l.c.) examined a flowering specimen, *Forbes 621* in L, which has one flower and one flower bud, and found that it agrees fully with the type of this species in habit and leaf-form, so he emended the original description with flowering characters. He described, erroneously, the perianth limb of the flower as 6-lobed (actually it is 3-lobed). He stated that its proper identity should naturally remain to be determined and its affinity with *A. deltantha*, suggested by Schumann (l.c.), does not hold.

In November 1914, Ridley (l.c.) published a new species, *A. pithecurus*, based on the specimen *Forbes 621* in BM, at almost the same time as Lauterbach (l.c., 24 Nov. 1914) who described its flower for the species *A. momandul* as mentioned above. Ridley described the 'corolla' (= perianth) 'has three short lobes, and one slender, filiform one slightly dilated towards the tip and resembling a monkey's tail'.

In herbarium material, a flower bud or a not yet opened flower has a filiform or tail-like apex which is easily broken. From the dried flowering material dissected, this filiform apex is very difficult or sometimes hardly possible to be separated into three parts, so sometimes it appears that only one or two of the three perianth lobes bear (part of) the filiform apex.

On the specimen *Aet & Idjan 173* (BO), the filiform process appears to be inserted between two perianth lobes similar to the situation described by Ridley (l.c.).

*A. dictyophlebia* was published by Merrill and Perry (l.c.). It was based on a flowering specimen. I have examined the type and also a duplicate of it which are similar to *Forbes 621*. There are only detached flowers seen and the filiform apex appears to be broken off.

O.C. Schmidt (l.c.) described a new species, *A. gracilifolia*, which was based on a flowering specimen, *Ledermann 12458*. I have not seen the type or any duplicate of it. From the detailed original description, the flowering characters are similar to those of the present species, so *A. gracilifolia* has been treated as a synonym.

The leaves of the present species are very variable in texture, shape, size, base, etc. According to the leaves, it seemed possible to arrange them into groups. When more collections, from various regions, different habitats and altitudes, were examined, I found that the characters of flowers and fruits are similar to one another, so I treated them as belonging to one species with variable leaves.

In some specimens (e.g. *NGF 13469*, L, LAE) the leaves have many rounded holes (fig. 7c) which are caused by insects feeding on them.

The fruits on the specimens examined seem indehiscent, but a copy of a beautiful plate of the plant of this species, based on cultivated living material, sent to me by Mr. M. Parsons, shows a dehiscing capsule.

As pointed out by Schumann (l.c.) the present species is related to *A. deltantha* from Queensland. Sterile specimens of these two species resemble each other. However, this species can be easily distinguished from the latter by, for example, 1) the flower bud with an apical filiform, tail-like extension (fig. 6b), and 2) the perianth distinctly 3-lobed (against hardly lobed).

This species as treated here has the following distribution: Moluccas (Halmahera: *Idjan & Mochtar 227*, BO, L), New Guinea (Japen-Biak; Sepik, Madang, Morobe and Central Dist.) and New Britain. The plants often occur in forest from the lowland up to 1650 m.

#### 17. *Aristolochia schlechteri* Laut. — Fig. 6c.

*A. schlechteri* Laut. in K. Sch. & Laut., Nachtr. Fl. Deut. Schutzgeb. Südsee (1905) 260; Bot. Jahrb. 52 (1914) 107. — Type: *Schlechter 14156* (part of the type and carbon rubbing print of leaves, WRS�), Ramu, NE. New Guinea.

The flower of this species is unique among Malesian *Aristolochia* species in having the perianth 6-lobed. Fortunately I have part of the authentic material on loan from WRS�, which consists of one leaf, two bare branches of inflorescences, one flower, one

carbon rubbing print of two leaves, and Lauterbach's original drawings of the flower.

Lauterbach (1905, l.c.) remarked that this species is closely related to *A. deltantha* from Queensland but differs from it by the size and shape of the flowers. He also suggested that perhaps *A. momandul* should be united with it. However, the flowers of these three species are quite different from one another (see note under *A. momandul*).

There is one specimen, *Hoogland & Craven 10489* (L), which has one very beautifully preserved flower with the 6-lobed perianth (fig. 6c) similar to the type. It is the second flowering collection of this species known.

Sterile collections of the present species and *A. momandul* cannot be distinguished from each other. It is necessary to have flowering material.

### 18. *Aristolochia kaempferi* Willd.

*A. kaempferi* Willd.; Ohwi, Fl. Jap. (ed. Meyer & Walker) (1965) 401.

*A. lineata* Duchartre, Rev. Hort. IV, 3 (1854) 284, t. 15; in DC., Prod. 15, 1 (1864) 439; Koidz., Fl. Symb. Orient.-Asiat. (1930) 32, excl. syn. *A. zollingeriana* Miq. – Type: a drawing (G, n.v.; reproduced by Duchartre, 1854, l.c.), Japan.

Duchartre (l.c.) described a new species of *Aristolochia*, *A. lineata*, which was based on a drawing of a Japanese plant by an anonymous artist in the collection of Delessert. The drawing was reproduced by Duchartre to accompany his paper. He stated that this species is allied to the Japanese *A. kaempferi* more than any other.

Koidzumi (l.c.) examined duplicates of Zollinger's collections: no. 155 (collected from a cultivated plant in Java; distinctly indicated by Zollinger as 'ex Japonia') and no. 2744 (type of *A. zollingeriana* Miq., Java) in the Herb. Mus. Paris. He found that these two specimens are 'quite identical' to the plate published by Duchartre (l.c.). He reduced, erroneously, *A. zollingeriana* to *A. lineata*. He also treated *A. lineata* as a Javanese species by indicating as 'Hab. Java'. Ohwi (l.c.) has correctly treated *A. lineata* as a synonym of the Japanese *A. kaempferi*.

Leaves of *A. kaempferi* and *A. zollingeriana* are polymorphic. Sterile specimens of these two species resemble each other at a glance. However, they can be separated by examining the lower leaf surface: loosely appressed hairs in *A. kaempferi* against densely minute hairs in *A. zollingeriana*.

Fertile specimens of *A. kaempferi* can be easily distinguished from *A. zollingeriana* by the following characters: 1) perianth without a stipe-like part at the base (against with a distinct stipe-like part), 2) perianth curved at the middle, more or less V-shaped (against perianth bent at about a right angle to the utricle), 3) limb obscurely 2-lobed and suborbicular in outline (against limb distinctly 1-lipped, obovate-oblong), and 4) seeds concave-convex, not winged (against seeds flat and winged).

### 19. *Thottea philippinensis* Quis.

*T. philippinensis* Quis., Philip. J. Sc. 41 (1930) 322, t. 2. – Type: *Roque FB 30249* (iso UC), Lanao, Mindanao.

Mr. B.L. Burt, Edinburgh, made one collection (no. 11595, E) on a sheltered sandstone cliff, c. 450 m alt., Lambir National Park, Sarawak. It consists of two sheets, one of them bearing one flower and one empty, open fruit, and another having one leafy twig (leaves 19–20 × 7.5 cm) together with one rather large, detached leaf (36 × 13.3 cm). One twig and some parts of the leaves are covered with a layer of whitish, hair-like or fibrous mycelia of fungi. There is also one bottle of well preserved material in alcohol containing one flower and several pieces of a leaf.

The leaves are similar to those of *T. philippinensis* in having the characteristic pinnate nervation, closely reticulate venation, and very well developed, prominent areolation. The floral characters, e.g. the shape and size of perianth and its lobes, the number of stamens, partly free filaments, gynostemium distinctly stipe-like at the base, and style-column 4–6-lobed, match those of the present species. Unfortunately the mature seeds are not known.

On the field note Mr. Burt recorded: 'Flower basal, dark-red outside and round margin, whitish in cup; stamens and stigmas dark red, anthers deep yellow'.

There are only two collections of this species known. It is closely related to *T. celebica* (see Blumea 27, 1981, 320). It is characterized by: 1) leaves often lanceolate or oblong-elliptic with distinctly pinnate nervation, 2) leaves pubescent and prominently closely reticulate on the lower surface, 3) perianth campanulate, 16–22 mm long, 3-lobed at about the upper 1/3, 4) stamens arranged in two series, and 5) style column 4–6-lobed.

#### ARISTOLOCHIACEOUS PLANTS—BUTTERFLIES RELATIONSHIP

Mr. R. Straatman (1961, 1962, 1969, 1971) made besides field notes and descriptions on the life history of some butterflies (Papilionidae) in Sumatra, SE. New Guinea, Queensland, and Solomon I., also observations on the food plants of their larvae which feed on the young foliage leaves and tender shoots. Some of the specimens of the food plants belonging to *Aristolochia* and *Thottea* he collected in Sumatra are preserved in the Rijksherbarium, Leiden.

The female butterflies (e.g. belonging to *Atrophaneura*) lay their eggs on the host plants of their choice often attracted by scent. The pupa is generally found at the base, sometimes above it, of the stem of the host plant. The larvae of some butterflies have food preferences. They are either monophagous (confined to plants of a single species), oligophagous (feed on plants of a few species), or polyphagous (feed on plants of several or many species).

The larvae often consume (or damage) the buds and new shoots of the host plants. They sometimes may feed on wrong plants which may even belong to the same family as the natural host, but because of the toxic effects they may not be able to survive beyond the first or second instar (cf. Straatman, 1962).

Some species of *Aristolochia* are high lianas. They have bare, corky stems and bear foliage leaves high in the forest canopy. Mr. Straatman told me that rootstocks together with the lower parts of the stem of such plants were taken from the forest and

replanted in his private garden. When young shoots developed after a few months, the plants attracted, by scent, many female butterflies from the nearby forest.

Ehrlich and Raven (1964) have studied coevolution using the butterflies as a model to investigate the relationship between these insects and their food plants. They made a comprehensive survey. According to them, the family Papilionidae of the swallow tail butterflies has three subfamilies. In subfamily Parnassiinae (holarctic and oriental in distribution) the larvae of all five genera of the tribe Zerynthiini feed on plants of the Aristolochiaceae. The subfamily Papilioninae is worldwide, mainly tropical, and consists of three tribes; the larvae of the tribe Troidini feed mostly on plants of the Aristolochiaceae (cf. also Munroe, 1953). Such a food plant choice of the larvae may provide useful indication of the biochemical similarities within a plant family. Based on their study they suggested that 'the site of greatest diversity for both Aristolochiaceae and Papilionidae is in Asia'; they also stated that their studies probably 'support suggestions of overall phenetic similarity among the plants utilized and among the groups of butterflies concerned.'

Igarashi (1979) published a book entitled: 'Food plants of Papilionidae' with beautiful black-and-white photographs of the plants (each of them generally consisting of habit, leaf, flower, and/or fruit), with scientific names of both the plants and butterflies, locality and short ecological data. He recorded nine species of *Aristolochia* from Malesia, mainly from New Guinea and the Philippines.

Some specimens of Aristolochiaceae have perforations and/or erose margins (fig. 7b–d) which were caused by larvae of butterflies or other insects feeding on them. Mr. J. Haugum, Denmark, entomologist, told me that such damaged leaves may be characteristic or helpful for identification of some groups of butterflies (cf. Smart, 1976). Haugum (1981) has compiled detailed lists of *Aristolochia* species as larval food plants of *Ornithoptera* butterflies mainly from the New Guinea region. He gave useful information concerning the collection of voucher specimens of food plants for identification.

Readers who are interested in the aristolochiaceous plants–butterflies relationship in detail should consult the following literature:

- EHRlich, P. R. & P. H. RAVEN. 1964. Butterflies and plants: A study in coevolution. *Evolution* 18: 586–608, with extensive literature.
- HAUGUM, J. 1981. Notes on the *Aristolochia* of the Papua region with particular reference to the larval food plants of the *Ornithoptera*. The *Lepidoptera* group of 1968, *Newsl.* 2: 171–184.
- IGARASHI, S. 1982. Food plants of Papilionidae.
- JACOBS, M. 1982. Aristolochiaceae, host plants of exotic butterflies. *Fl. Males. Bull.* no. 35: 3747–3749.
- MUNROE, E. 1953. The phylogeny of the Papilionidae. *Proc. 7th Pacif. Sci. Congr.* 4: 83–87.
- SMART, P. 1976. The illustrated encyclopedia of the butterfly world in colour: 28–49.
- STRAATMAN, R. 1962. Notes on certain *Lepidoptera* ovipositing on plants which are toxic to their larvae. *J. Lepid. Soc.* 16: 99–103.
- 1969. Notes on the biology and hostplant association of *Ornithoptera priamus urvilleanus* and *victoriae*. *J. Lepid. Soc.* 23: 69–76.
- 1971. The life-history of *Ornithoptera alexandrae* Rothsch. *J. Lepid. Soc.* 25: 58–64.
- & E. J. NIEUWENHUIS. 1961. Biology of certain Sumatran species of *Atrophaneura*, *Trogonoptera*, and *Troides* (*Lepidoptera*, *Papilionidae*). *Tijdschr. Entom.* 104: 31–41.

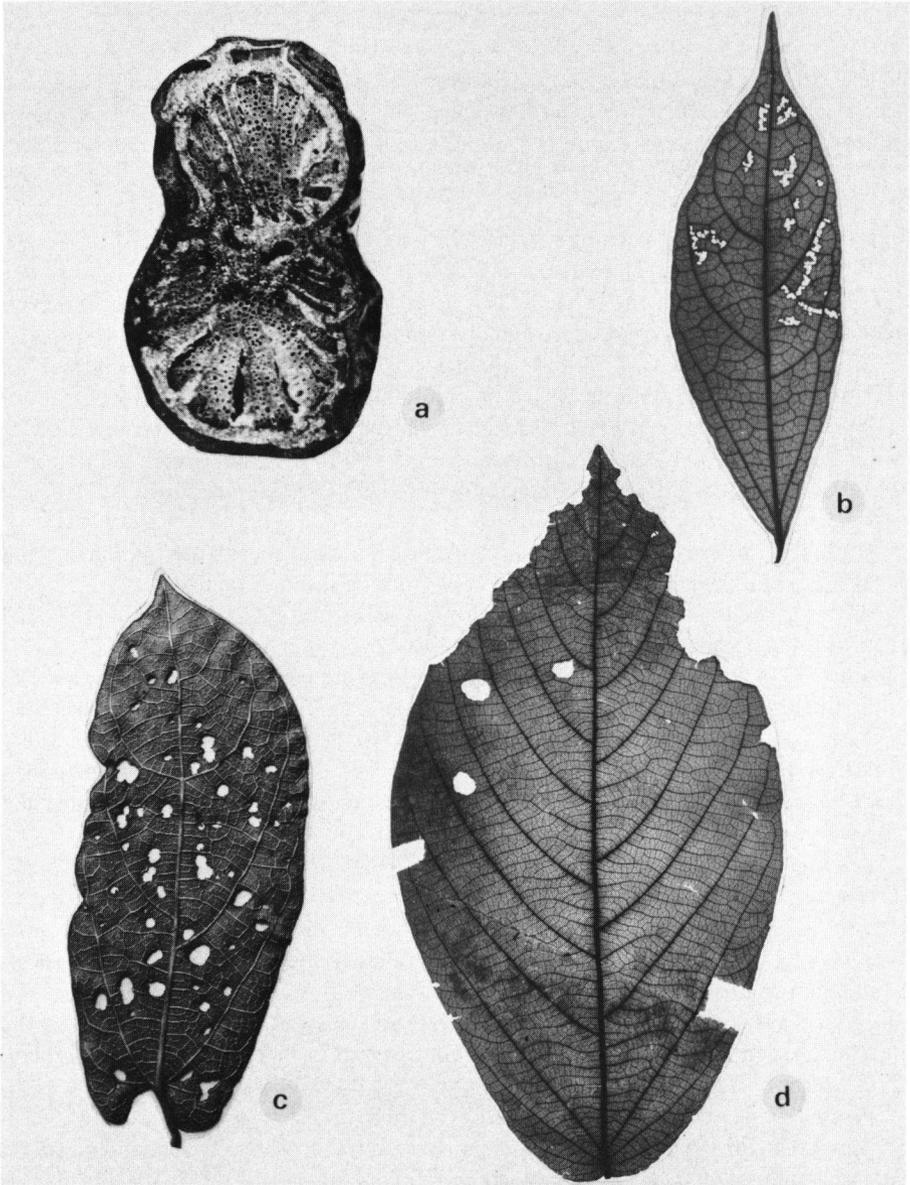


Fig. 7. a. *Aristolochia singalagensis* Korthals ex Ding Hou, cross-section of a rather flattened stem, resembling the figure '8', showing the vascular bundles elongating towards two opposite directions,  $\times 5$  (de Wilde & de Wilde-Duyffes 18386). – b-d. Leaves showing perforations and/or erose margin caused by insects feeding on them,  $\times 0.7$ ; b. *A. engleriana* O.C. Schmidt, alcohol preserved material (Jacobs 6360); c. *A. momandul* K. Sch., dried specimen (NGF 13469, LAE); d. *Thottea robusta* Steen., cleared leaf (two quadrangular parts on the margin at lower half being cut away for making epidermal preparations) (van Steenis 1270).

## POLLINATION

The study of pollination in Aristolochiaceae has been concentrated mainly on species of the genus *Aristolochia* and some on *Asarum*. Detailed study on flower biology and field observation on pollination of plants in this family are much needed.

The flowers of *Aristolochia* have a putrid or fetid smell and also a colour to attract small flies and have also a well modified (sometimes conspicuous) perianth to trap them. They are well adapted to insect- or cross-pollination.

Flowers of Aristolochiaceae are dichogamous (hermaphrodite flowers with one sex earlier mature than the other, which leads to cross-pollination). It has, however, been suggested that autogamy (self-fertilization) has occurred in some species.

The flowers of *Aristolochia* have often a well developed perianth. The limb of the perianth is connected with the utricle by a straight, funnel-shaped, slightly curved, or U-shaped passage or tube which has usually hinged hairs directed downward and/or grease papillae in it. When the insects land on the limb, they slide down the trap into the utricle and it is difficult or impossible for them to escape until the hairs in the tube become withered.

At the apical part of the utricle, the wall is in some species subtranslucent and forms the 'window area' for letting the light entering through there.

In the brighter utricle, where the reproductive organs are located, the imprisoned flies have to remain, feeding on nectar (secreted by the glandular food bodies) (Petch, 1924) and/or stigmatic secretions (containing concentration of amino-acids with nutritional potential) (Baker et al., 1973). The flies, contacting the dehisced anthers, are powdered with pollen grains and carry them away on their bodies whenever they have the opportunity to leave the flower. If the flies dusted with pollen grains enter another flower with receptive stigmatic surface, they will contact it and leave some pollen there, leading to pollination.

Petch (1924) reported that flowers of some *Aristolochia* species (e.g. *A. bracteata*, *A. elegans*, *A. indica*) are visited by insects, almost all belonging to a single species. Flowers of some *Aristolochias* are visited by more than one species of insect, e.g. *A. leuconeura* (having 13 species of insect visitors). He found as many as 128 flies (nearly all belonging to a single species) imprisoned in one flower of *A. elegans*.

Burck (1890, 1892) reported that some cultivated species of *Aristolochia* in the Botanic Garden Buitenzorg (= Bogor) are autogamous (self-fertilized), e.g. *A. barbata*, *A. ornithocephala* (= *A. brasiliensis*).

Petch (1924) made detailed observation on the species of *Aristolochia* cultivated in Sri Lanka (Ceylon). According to him, isolated plants of *A. ringens* bear abundant fruits. He also reported that *A. gigas* (= *A. grandiflora*) is self-sterile: isolated plants of this species do not bear fruits, but fruits will be produced if two or several plants are grown together. Self-sterility in *A. grandiflora* was also found by Cammerloher (1923).

Pfeifer (1966) reported that flowers of the American *A. serpentaria* have been suspected of being self-pollinated. Based on the meagre evidence obtained from specimens examined, he suggested that both the normal and cleistogamous flowers may produce fruits.



Fig. 8. *Aristolochia ringens* Vahl. — Germination of pollen grains in various developing stages: showing the pollen tube protruding through one end or growing outward along the long axis to opposite directions,  $\times 214$  (van Balgooy 2812).

Leemann (1927) made a comprehensive study on the plants of *Asarum europaeum*. From his observation and experiments he concluded that the flowers of this species are self-pollinated and insects are not entirely necessary for carrying out the pollination.

Vogel (1973, 1978) reported that some species of *Asarum* (e.g. *A. caudatum*, *A. hartwegii*) have flowers of which the ribbed or webbed inner surface of the perianth tube mimics the lamellae of mushrooms, and/or the mushroom odour, attracting fungus-gnats which act as pollen carriers to pollinate the flowers. He presumes that allogamy (cross-fertilization) by the help of fungus-gnats is a general feature of *Asarum*.

Lu (1982) made a detailed study of the pollination biology of *Asarum caudatum* in native habitats of northern California. She observed that the flowers of this species are proterogynous and receptive for cross-pollination for approximately one week; after this period self-pollination occurs. From her observations she concluded that autogamy predominates in this species.

In the genus *Thottea*, it appears that vegetative propagation is dominant in a few species. Information on this genus is very scanty. The flowers have no special structure to trap insects. Backer (1918) made observations on *Apama* (= *Thottea*) *tomentosa* in Java. He reported that the proterogynous flowers and the extrorse anthers made self-pollination impossible.

The rather large and colourful flowers of some *Thottea*, e.g. *T. grandiflora*, may attract insects. Some species, e.g. *T. rhizantha*, *T. tomentosa*, have generally cam-

panulate, purplish, odoriferous flowers at the basal part of the stem, sometimes hidden by fallen leaves, just above the ground, which may attract fungus-gnats as reported in *Asarum* by Vogel (1978).

The flowers of *Thottea* appear not to have any special mechanism to prevent self-pollination. The styles or style-lobes (with stigmas or stigmatic surfaces) are reflexed or twisted at anthesis and may easily come into close contact with the opened anthers for receiving pollen grains (Hou, 1981). Self-pollination and self-fertilization may also occur in this genus.

Germinated pollen grains were observed in dehisced anthers of open flowers in both *Aristolochia* and *Thottea*: e.g. in *A. grandiflora* (one flower collected from the Botanical Garden, Leiden, by Dr. G.J.C.M. van Vliet, preserved in alcohol in L), *A. ringens* (van Balgooy 2812, from cult. pl. in Java, alc. preserved fl. in L), and *T. triserialis* (S 34434, from dried specimen in L). During germination, the pollen grains swell, the inner part gradually increases in volume, and the outer wall splits on one side or one end. The pollen tube protrudes through the break of the outer wall often towards one end, sometimes outwards along the long axis to opposite directions (fig. 8).

It appears that all grades of self-sterility or self-fertility in the Aristolochiaceae may be expected (cf. Petch, 1924). Proctor and Yeo (1973) stated that self-pollination is not necessarily followed by self-fertilization, and that physiological adaptation prevents self-fertilization rather than structure adaptation prevents self-pollination.

The following literature relates to this chapter on pollination:

- BACKER, C.A. 1918–19. Javaansche Aristolochiaceën. Trop. Natuur 7: 177–183, f. 1–4; *ibid.* 8: 133–138, 150–155, 161–168, f. 5–15.
- BAKER, H.G., I. BAKER & P.A. OPLER. 1973. Stigmatic exudates and pollination. In: N.B.M. Brantjes (ed.), *Pollination and dispersal*: 47–60, tab. 1.
- BRANTJES, N.B.M. 1980. Flower morphology of *Aristolochia* species and the consequences for pollination. *Acta Bot. Neerl.* 29: 212–213.
- BURCK, W. 1890. Selbstbefruchtung bei geoeffneten Bluethen und verschiedene Anpassungen um dieselbe zu sichern. *Ann. Jard. Bot. Btzg* 8: 149–157, t. 23: f. 2–6.
- 1892. Über die Befruchtung der *Aristolochia*-Blüte. *Bot. Zeit.* 50: 121–129, 137–144, t. 3.
- CAMMERLOHER, H. 1923. Zur biologie der Blüte von *Aristolochia grandiflora* Swartz. *Österr. Bot. Zeitschr.* 72: 180–198, t. 5–7.
- FAEGRI, K. & L. VAN DER PIJL. 1966. *The principles of pollination ecology*. 3rd ed.: 49, 78, 87, 88.
- HOU, D. 1981. On the genus *Thottea* (Aristolochiaceae). *Blumea* 27: 311–314, f. 38–50.
- LEEMANN, A. 1927. Contribution à l'étude de l'*Asarum europaeum* L. avec une étude particulière sur le développement des cellules sécrétrices. *Bull. Soc. Bot. Genève* 19: 149–159, f. 98–107.
- LU, K.L. 1982. Pollination biology of *Asarum caudatum* (Aristolochiaceae) in northern California. *Syst. Bot.* 7: 150–157, tab. 1–3, f. 1–3.
- MEEUSE, B.J.D. 1961. The story of pollination: 135–139, f. 55–57.
- PETCH, T. 1924. Notes on *Aristolochia*. *Ann. R. Bot. Gard. Perad.* 8: 1–108, t. 1–5.
- PFEIFER, H.W. 1966. Revision of the north and central American hexandrous species of *Aristolochia*. *Ann. Missouri Bot. Gard.* 53: 119–120.
- PROCTOR, M. & P. YEO. 1973. *The pollination of flowers*: 304–307, f. 114 & 115, pl. 54b & IVb, with extensive bibliography.

- SCHMIDT, O.C. 1935. *Aristolochiaceae*. In: Engler & Prantl, *Nat. Pfl. Fam.* 2nd ed., 16b: 217–220, f. 112–115.
- TIONG CHUI HUONG. 1979/80. *Morphological and taxonomical studies on some Aristolochiaceae plants in Singapore*. (Not published). 41 & 42.
- VOGEL, S. 1973. *Fungus gnat flowers and fungus mimesis*. In: N.B.M. Brantjes (ed.), *Pollination and dispersal*: 13–18.
- 1978. *Pilzmückenblumen als Pilzmimeten*. I. *Flora* 167: 329–366, f. 1–12, with extensive literature.

## INDEX TO SPECIFIC NAMES

The numerical figures following the specific names refer to the numbered, accepted species. The new species is in **bold type**. Synonyms are followed by '=' preceding the number of the accepted species. Scientific names used or mentioned in legends, notes and general parts are omitted.

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| <i>Aristolochia</i> <i>coadunata</i> Back. 2 | <i>ledermannii</i> O.C. Schmidt = 13           |
| <i>crassinervia</i> O.C. Schmidt 11          | <i>lineata</i> Duchartre = 18                  |
| <i>curtisii</i> King 3                       | <i>linnemannii</i> Warb. 15                    |
| <i>dictyophlebia</i> Merr. & Perry = 16      | <i>momandul</i> K. Sch. 16                     |
| <i>dielsiana</i> O.C. Schmidt 12             | <i>pithecurus</i> Ridl. = 16                   |
| <i>engleriana</i> O.C. Schmidt 13            | <i>ramosii</i> Merr. = 10                      |
| <i>foveolata</i> Merr. 4                     | <i>roxburghiana</i>                            |
| <i>gaudichaudii</i> Duchartre 14             | ssp. <i>kankauensis</i> (Sasaki) Kitamura = 10 |
| <i>glaucifolia</i> Ridl. 5                   | <i>rumphii</i> Kosteletzky 8                   |
| <i>gracilifolia</i> O.C. Schmidt = 16        | <i>schlechteri</i> Laut. 17                    |
| <i>hastata</i> Jack = 6                      | <i>singalagensis</i> Korthals ex Ding Hou 1    |
| <i>jackii</i> Steud. 6                       | <i>tagala</i> Chamisso 9                       |
| <i>japonica</i> Miq. = 9                     | var. <i>kankauensis</i> (Sasaki) Yamazaki = 10 |
| <i>kaempferi</i> Willd. 18                   | <i>tripartita</i> Back. = 6                    |
| <i>kankauensis</i> Sasaki = 10               | <i>ungulifolia</i> Masters = 6                 |
| <i>kaoi</i> Liu & Lai = 4                    | <i>zollingeriana</i> Miq. 10                   |
| <i>klossii</i> Ridl. 7                       | <i>Thottea philippinensis</i> Quis. 19         |