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FLORAE MALESIANAE PRAECURSORES LXII
ON THE GENUS THOTTEA (ARISTOLOCHIACEAE)

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CONTENTS

SUMMARY

The generic delimitation of *Thottea* and *Apama* has been reviewed. Arguments are given for treating them as one genus, under the name of *Thottea*.

Techniques used for clearing the leaves and for preparing reproductions of the venation have been described.

There are two leaf venation patterns, i.e. pinnate and acrodromous, with intermediate forms showing gradual variation.

The arrangement of stamens, chief character used for generic distinction, up until now known as occurring in one series *(Apama)* or two *(Thottea)*, has now also been found existing in three or four series.

One new type of seeds in this group has been found, which is rather smooth, flat and longitudinally curved. It resembles that of *Saruma* and some species of *Aristolochia*.

Scanning electronmicrographs of leaf surfaces, floral parts and seeds have been chosen to elucidate interesting or diagnostic characters.

There are eight new species described and eight new combinations made.

INTRODUCTION

Thottea and *Apama* were considered to be two very closely allied genera of the Aristolochiaceae known to have together about twenty species. Most of the species have been found in Malesia with only a few others occurring outside this region. As a result of studying mainly the herbarium collections of these two genera, in the course of a revision

of this family for the Flora Malesiana, I have concluded that they should be treated as one genus.

After having merged *Apama* with *Thottea,* this genus has now about twenty-five species; eight of them have been newly described and another eight are new combinations, and these are treated in the present paper. It is distributed from India (including Andaman I.), Sri Lanka, Bangladesh, Burma, Thailand, Indochina, China (Hainan), to Malesia (Sumatra, Malay Peninsula, Java, Borneo, Philippines, and Celebes).

Plants of this genus are herbs woody at the base or undershrubs, rarely shrubs, erect, sometimes rhizomatous or scrambling, from 0.5 to 2(–5) metres high. They are usually found growing sporadically in shady places in tropical lowland forests, rarely up to an altitude of about 1000 metres. Plants in vegetative state or sterile collections of this genus are difficult to recognize as belonging to the family.

The reproduction in some species of *Thottea* is probably dominantly by vegetative propagation; flowers of these species are borne either at the basal or upper part of the stem. In some others flowers are borne only at the basal part of the stem, close to the ground, which may be sometimes covered by fallen leaves in the field and have escaped the attention of collectors.

The plants of this genus often have only one or two open or ripe flowers at a time.

The above mentioned conditions may explain in part that, with the exception of *T. tomentosa* and *T. corymbosa,* fertile specimens are rather scant in the herbarium.

Floral characters are very important for specific identification in this genus. Whenever one has the opportunity to find the plant(s) in flower or fruit in the field, please collect, besides the normal specimen(s), if possible, some additional, loose flowers or fruits. It is highly desirable to have some flowering material preserved in alcohol (about 70%) or formalin.

In order to facilitate identification of the plants to the genus in general and to some species in particular, a detailed generic description, diagnostic characters for some species, leaf venation patterns, and many scanning electronmicrographs of abaxial leaf surfaces, floral parts, seeds and testa features, have been given here.

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My appreciation is due to my colleagues Dr W. Jülich, for kindly showing me how to operate the Scanning Electron Microscope, and Miss Ruth van Crevel, for her careful and accurate drawings especially those of the floral parts drawn from scanty, dried and often rather deformed material.

THOTTEA

Thottea Rottboell, Nye Samling Kongel. Danske Vidensk. Selsk. Skr. 2 (1783) 529; Endl., Gen. Pl. (1837) 345; Meissn., Pl. Vasc. Gen. (1841) Tab. Diag. 334, Comment. 246; Endl., Gen. Pl. Suppl. 1 (1841) 1379, Suppl. 4 (1848) 95; Klotzsch, Monatsb. Akad. Berlin (1859) 588; Duchartre in DC., Prod. 15,1 (1864) 428; Benth. in Benth. & Hook.*f.*, Gen. Pl. 3 (1880) 123; Hook.*f.*, Fl. Brit. Ind. 5 (1886) 74; Solereder in E. & P., Nat. Pfl. Fam. III,1 (1889) 271; King & Gamble, J. As. Soc. Beng. 75,ii (1912) 26; Ridl., Fl. Mal. Pen. 3 (1924) 15; Steen., Bull. Jard. Bot. Btzg III, 12 (1932) 204; O. C. Schmidt in E. & P., Nat. Pfl. Fam., 2nd ed., 16b (1935) 232; Gregory, Amer. J. Bot. 43 (1956) 113. — *Thottea* sect. *Thottea* Duchartre in DC., l.c. — T y p e: *T. grandiflora* Rottb.

[*Alpam* Rheede, Hort. Malab. 6 (1686) 51, t. 28.] — *Apama* Lamarck, Encycl. Méth., Bot. 1 (1783) 91; Tabl. Encycl. Mëth. (1823) t. 640; Baill., Hist. Pl. 9 (1888) 21; Solereder in E. & P., op. cit. 272; King & Gamble, op. cit. 24; Ridl., op. cit. 14; Steen., l.c.; O. C. Schmidt in E. & P., l.c. — T y p e: *Apama siliquosa* Lamk (=*Thottea siliquosa* Ding Hou).

Bragantia Loureiro, Fl. Cochinch. (1790) 528, ed. Willd. (1793) 645, *non* Vandelli 1771 (=*Gomphrena* L., Amaranthac.); Lindl., Bot. Reg. (1832) sub t. 1543, in footnote; Endl., Gen. Pl. (1837) 345; Bennett in Benn. & Brown, op. cit. 44; Rafinesque, Fl. Tellur. 4 (1838) 99; Meissn., l.c.; Endl. Gen. Pl. Suppl. 1 (1841) 1379; Griff., Trans. Linn. Soc. 19 (1845) 335; Endl. Gen. Pl. Suppl. 4 (1848) 95; Miq., Fl. Ind. Bat. 1, 1 (1858) 1067; Klotzsch, op. cit. 589; Duchartre in DC., op. cit. 429; Benth. in Benth. & Hook.*f.*, op cit. 122; Hook.*f.*, op. cit. 72; Trimen, Handb. Fl. Ceylon 3 (1895) 421. — *Bragantia* a. *Eubragantia* Endl., Gen. Pl. Suppl. 4 (1848) 95; Duchartre in DC., op. cit. 429. — *Apama* sect. *Bragantia* Solereder in E. & P., l.c.; O. C. Schmidt in E. & P., op. cit. 233. — T y p e: *B. racemosa* Lour. (=*Thottea racemosa* Ding Hou).

Ceramium Blume, Bijdr. (1826–27) 1134, *non* Roth 1797 *(nom. cons.; Rhodophyta), nec Ceramion* Adanson 1763 *(nom. rej.; Gracilariaceae).* — *Munnickia* Blume *ex* Reichenbach, Consp. (1828) 85, subtitute name for *Ceramium* Blume. — *Vanhallia* J. A. & J. H. Schultes, Syst. Veg. 7 (1829) xviii & 166, *non* L. Marchand 1828, new name for *Ceramium* Blume. — *Cyclodiscus* Klotzsch, op. cit. 591. — *Bragantia* sect. *Cyclodiscus* Duchartre in DC., op. cit. 431. — *Apama* sect. *Cyclodiscus* Solereder in E. & P., l.c.; O. C. Schmidt in E. & P., op. cit. 234. — T y p e: *C. tomentosum* Bl. (=*Thottea tomentosa* Ding Hou).

Trimeriza Lindl., Bot. Reg. (1832) sub t. 1543, in note; Endl. Gen. Pl. (1837) 345; Rafin., op. cit. 100. — *Bragantia* sect. *Trimeriza* Duchartre in DC., op. cit. 430. — *Apama* sect. *Trimeriza* Solereder in E. & P., l.c.; O. C. Schmidt in E. & P., op. cit. 234. — T y p e: *T. piperina* Lindl. (=*Thottea siliquosa* Ding Hou).

Asiphonia Griff., Trans. Linn. Soc. 19 (1845) 333. — T y p e: *A. piperiformis* Griff. (=*Thottea corymbosa* Ding Hou).

Lobbia Planchon in Hook., Lond. J. Bot. 6 (1847) 144; Endl., Gen. Pl. Suppl. 4 (1848) 95. — *Thottea* sect. *Lobbia* Duchartre in DC., op. cit. 428. — T y p e: *L. dependens* Planch. (=*Thottea dependens* Klotzsch).

Bragantia b. *Ceramostiga* Endl., Gen. Pl. Suppl. 4 (1848) 95. — L e c t o t y p e (here chosen): *B. tomentosa* Bl. (=*Thottea tomentosa* Ding Hou).

Strakaea Presl, Epim. Bot. (1851) 221. — T y p e: *S. melastomaefolia* Presl, (=*Thottea corymbosa* Ding Hou).

Herbs woody at the base, or undershrubs, rarely shrubs, erect, sometimes rhizomatous or scrambling. Stems bearing small bract-like (reduced) *leaves* at the lower 2/3–1/2, then one basal, smaller leaf, and followed by normal foliage leaves. *Leaf blades* entire, nervation palmate (or 3-nerved) or pinnate. *Flowers* actimorphic, axillary or subradical, solitary or a few on short branches, in spicate or racemose, cymose, corymbose, or cincinnal inflorescences, bracteate (bract usually opposite to the flower), Flower bud (not including the ovary) distinctly triangular in top view. *Perianth* often broadly campanulate, urceolate, bowl- or cup-shaped, 3-lobed, lobes valvate, deciduous. *Disk*(?) O, rarely cupular, adnate to the perianth tube with the apical part free and ring-like (e.g. *T. tomentosa*). *Stamens* 6–36(–46), in 1 or 2, rarely 3 or 4 series, inserted around the style column; *filaments* free or partly mutually united, usually (partly) adnate to the style

column forming a gynostemium; *anthers* extrorse, connective at the back of anthers and almost as broad as them. *Ovary* inferior, elongate, 4-angular, 4-celled; ovules often many in each cell, pendulous; *style* (2–)5–20-lobed, lobes radiating or sometimes erect, sometimes some of them relobed; stigmatic tissue at the apex, lateral or on the surface of the (style)lobes. *Capsules* usually siliquiform, elongate, often 4-angular and sometimes cruciform in cross section. *Seeds* oblong, ellipsoid, or broadly ovoid, usually 3-angular, rarely flat and longitudinally curved, often coated with remains of the placenta; *testa* crustaceous or hard, usually (transversally) rugose, or deeply furrowed, rarely rather smooth or sparsely granular.

This genus consists of *c.* 25 species, distributed in India, including Andaman I. (3 spp.), Sri Lanka (1), Bangladesh (1), Burma (2), Thailand (2), Indochina (2), Hainan, China (1), and Malesia: Sumatra (10), Malay Peninsula (7), Java (1), Borneo (11), Philippines (2) and Celebes (1). Plants of this genus are found, often growing sporadically, in shady places in tropical lowland forests, rarely up to altitude *c.* 1000 m.

N o m e n c l a t u r e. The genera *Thottea* Rottb. and *Apama* Lamk as cited above were established in 1783. *Apama* was published on December the 2nd 1783 (cf. Stafleu, Tax. Liter. 1967, 255). However, the publication date of *Thottea* regarding the month and date in that year has not yet been found out.

Dr Bertel Hansen, The Botanical Museum, Copenhagen, in a letter addressed to Prof. Dr C. G. G. J. van Steenis, concerning the publication date of *Thottea*, dated on 28 September, 1978, stated: 'The date of publication is more difficult. However, the Academy seems to have good records. The archivarian informed me that Rottböll read his paper Dec. 13th 1782, and bill for the plates (copperplates) is dated June 2nd 1783. This would probably ensure the priority for Rottböll's name'.

In 1979 Dr W. T. Stearn, British Museum (Nat. Hist.), London, kindly checked for me the copy of the original publication which contains Rottböll's new genus *Thottea* and found that it was printed on 7th November 1783.

From the information as far as known, *Thottea* would have priority over *Apama*.

GENERIC DELIMITATION AND NOTES ON SUBDIVISION

Since the genera *Thottea* Rottb. (l.c.) and *Apama* Lamk (l.c.) were published in 1783, no less than seven related new ones were described as cited in the synonymy under the genus *Thottea* as treated in this paper. When Duchartre (in DC. Prod. 15,1, 1864, 421–491) revised the Aristolochiaceae, he retained only two of those genera, *Thottea* and *Bragantia* (=*Apama*) with good characters to separate them, and justly reduced the others into sections or synonymy. Hooker *f.* (Fl. Brit. Ind. 5, 1886, 72–74) accepted this treatment and added one new species to each of the genera; he found that the important character to distinguish them is the arrangement of stamens: 2-seriate in *Thottea* and 1-seriate in *Bragantia*, and expressed that they 'may well be united'. This generic concept has been followed, for example, by Solereder (l.c.), King and Gamble (l.c.), Ridley (l.c.), Schmidt (l.c.), Gregory (l.c.), etc.

Van Steenis (l.c.), in connection with describing a new plant of his own collection of the

Aristolochiaceae from Natuna I. (near NW Borneo), studied the material of the Malesian species published under *Apama* and *Thottea*. He paid special attention to the generic concept and remarked that these two genera only differ in the androeceum as indicated above and agree very well in other respects. Based on the limited material examined by him, it was not yet shown that the separating character is an artificial one, so he left open the question of generic delimitation.

Up till now the stamens were only known to occur in either one or two series in the species described under *Apama* and *Thottea* respectively. However, they are now also found to occur in four series in *T. parviflora* (fig. 38, 70D) and in three series in *T. triserialis* (fig. 41). After having studied the types or representative specimens of almost all the described species, the two genera appear to have more similarities than differences, so I have concluded that they cannot be separated into two genera but should be treated as one genus, under the name of *Thottea*.

The number and arrangement of the stamens and style-lobes (or arms) had been used for subgeneric (or sectional) delimitation of *Bragantia* and *Thottea*. These characters vary from one species to another. The number of stamens or style-lobes may vary in one species or even in one specimen. Although several botanists have made generic subdivisions, the distinction between them has become obscure and obsolete.

As all subgeneric (or sectional) names have been cited in the synonymy of the present genus, it may be superfluous to review them here. However, I may mention here that Duchartre (l.c.) divided the genus *Bragantia* into three sections which were based on already published genera. This system of subdivision was followed by Solereder (l.c.). Later Schmidt (l.c.) also accepted these three sections but ascribed wrongly the authorship of the sectional names to Solereder.

The present genus can be divided or arranged in various ways for subgeneric groups by using only one or a combination of a few of the following characters, for example leaf surface features, leaf venation patterns, inflorescences, bracts, shape and size of perianth, number and arrangement of stamens, style-lobes, shapes of seeds, surface features of testa, etc. No satisfactory or natural groups have been obtained. Since it is a rather small genus, I refrain from dividing it into subgenera and sections.

LEAF VENATION

The leaf venation in *Thottea* can be used as a helpful diagnostic character for identification. The fine venation can be more conveniently examined in a cleared leaf. It is not my intention to make a systematic study of the venation or to give a detailed description of it for each species. Cleared leaves of four species have been selected to show the venation patterns of the genus (fig. 1–4). I hope that these figures can serve also to convey a general impression on (fine) venation of this genus to paleobotanists and other specialists.

For detailed study and descriptive terminology of leaf venation, readers should consult the following publications: L. J. Hickey, Classification of the architecture of dicotyledonous leaves. Amer. J. Bot. 60 (1973) 17–33, fig. 1–107; a revised version of this article in C. R. Metcalf & L. Chalk, Anatomy of the dicotyledons, 2nd ed., 1 (1979) 25–39, fig. 4.1–4.6; D. L. Dilcher, Approaches to the identification of angiosperm leaf remains. Bot.

Rev. 40 (1974) 1–155, with many fig.; R. Melville, The terminology of leaf architecture. Taxon 25 (1976) 594–561, t. 1–8.

Techniques for clearing leaves. There are various techniques for clearing leaves (Hickey, l.c., 18 & 19; Dilcher, l.c., 54–61) to facilitate the study of (fine) venation patterns. Dr E. P. Klucking, Central Washington University, Washington, U.S.A., kindly told me his personal experience for making such preparations. For herbarium leaf material, I have been using a simple procedure as follows. Take a leaf from a specimen and soak it in hot or boiling water until it is soft. Put it in a (glass or pyrex) dish or pan filled with about equal parts of commercial bleach solution and (cold or warm) water and keep it immersed in the solution by using a piece of glass (or a plastic screen, cf. Hickey, l.c.). The time required for clearing and bleaching depends on the texture of the leaf and concentration and temperature of the solution. It is advisable to check the material frequently. When the leaf appears cream coloured or whitish, remove it and rinse it in water, then dry it by pressing it between sheets of (blotting and/or corrugated) papers. Such a cleared leaf is neither stained nor mounted (between two glass slides) and is kept with the original specimen; it has the cuticular and epidermal layers still attached to the venation, so it can be used not only to examine the (fine) venation, but also some surface features (e.g. hairs, papillae, glands, crystals, wax, shape of epidermal cells, etc.).

Preparing reproductions of venation. There are different methods for making reproductions or illustrations of the venation patterns (cf. Dilcher, l.c.; Rury & Dickison, J. Arn. Arb. 58, 1977, 211–212, t. 1–12). After having tried several methods, I found that the photographic technique is more convenient for me and gives good results. The cleared leaf together with a transparent plastic line ruler beside it was placed on a tracing box or table equiped with very even light; a piece of glass was used to keep the leaf flat. It was photographed by using a 35 mm camera with Kodak High Contrast Film. The negative (film) was enlarged to the size desired on hard paper. If one prefers white (venation) lines on black background, it can be easily obtained by using the (positive) photograph to make a contact print. If the leaf has a prominent venation or if it is impossible te remove it from the only sheet of a (type) specimen available, as in the case of *T. philippinensis*, I would try to control the lighting set up and then photograph it (cf. fig. 1).

Venation patterns and vein orders. The venation patterns of this genus, according to the classification of Hickey (l.c.) vary from pinnate to acrodromous ('Two or more primary or strongly developed secondary veins running in convergent arches toward the leaf apex. Arches not curved at base.'). Followed the terms as defined by Hickey (l.c.), short descriptions of the venation patterns, their intermediate forms, and vein orders are given in the following.

1) P i n n a t e (Fig. 1) — The secondary veins (i.e. nerves) are pinnately arranged more or less at regular intervals, along the primary vein (i.e. midrib). They are usually unbranched or rarely few-branched, attenuating exmedially ('away from the leaf axis') (e.g. *T. philippinensis*, fig. 1); they are slightly curved, sometimes rather straight especially the basal pair, extending obliquely and gradually diminishing apically or towards the margin, or joining superadjacent secondaries at right or acute angles and forming

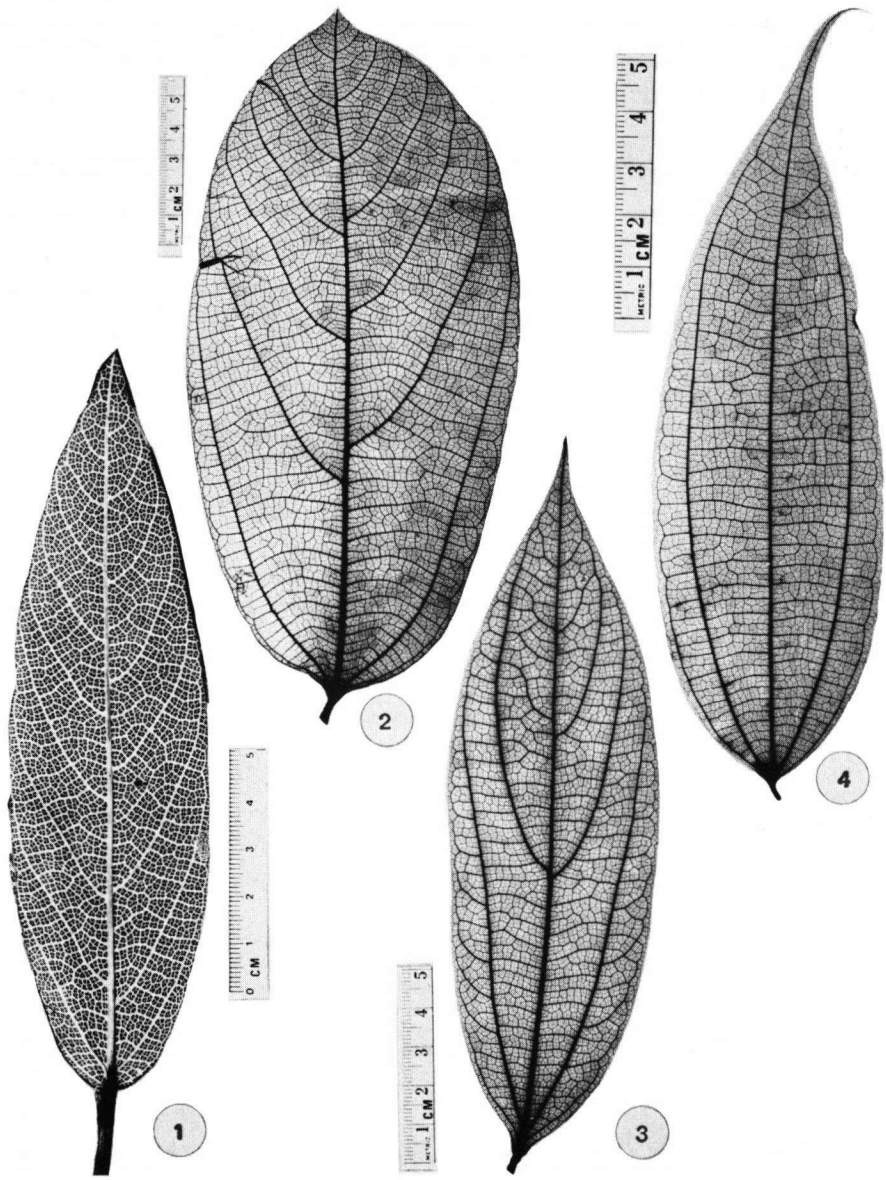


Fig. 1–4. Leaf venation patterns of *Thottea*. — 1. *T. philippinensis (FB 30249,* UC*). — 2. *T. tricornis (v. Balgooy 2627).* — 3. *T. siliquosa (Kramer & Nair 6604).* — 4. *T. corymbosa (Hou 732).* (1. photographed directly from the herbarium specimen; 2, 3, 4. photographed from cleared leaves)

* Herbarium of deposition of the specimen used. If a specimen is not followed by the usually used symbol of herbarium name, it is preserved in L).

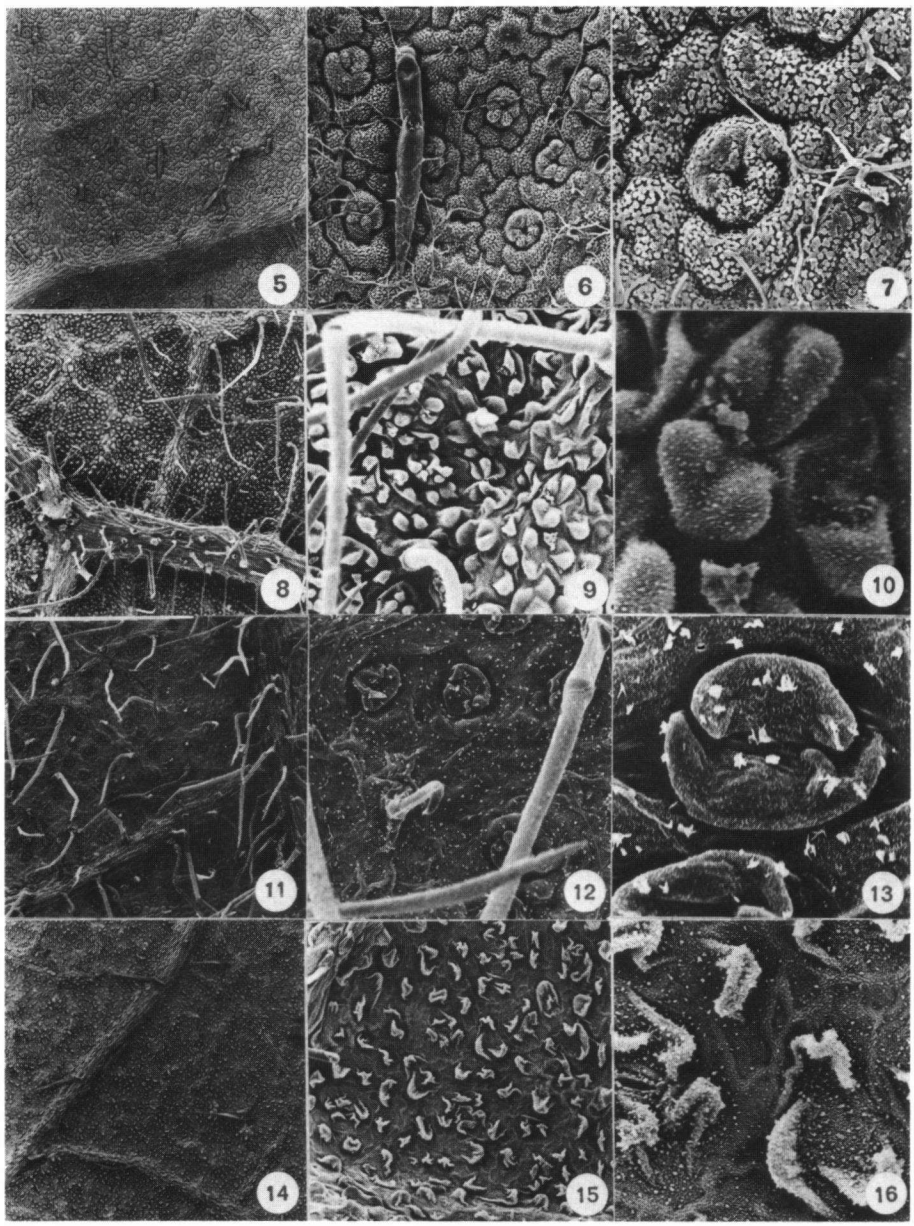
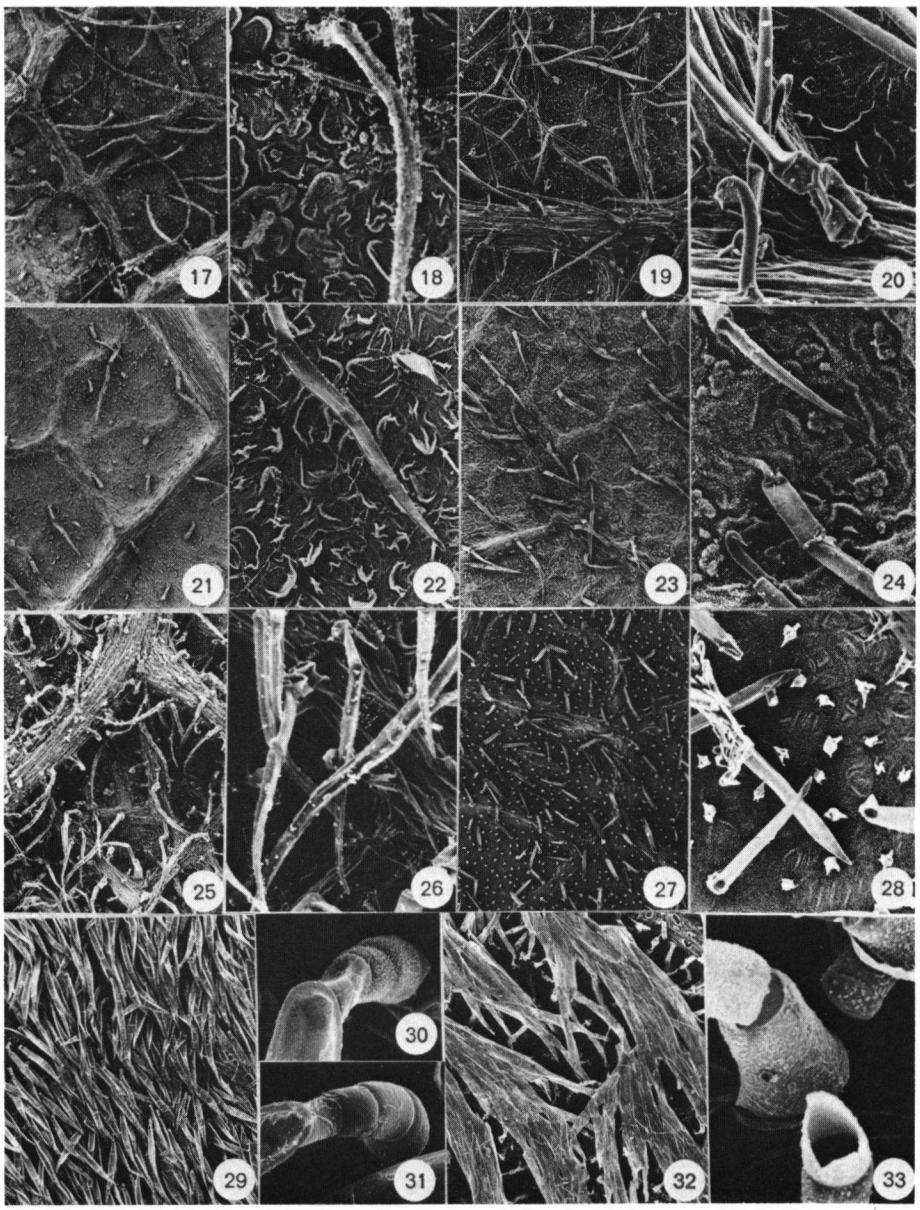


Fig. 5–33. Scanning electronmicrographs of abaxial leaf surfaces of *Thottea*. — 5–7. *T. dependens (Sidek bin Kiah 296)*. — 8–10. *T. grandiflora (Jumali 2952)*. — 11–13. *T. macrantha (de Wilde & de Wilde-Duyfjes 12331)*. — 14–16. *T. penitilobata (Argent et al. 691, E)*. — 17 & 18. *T. tricornis (Herb. Maingay 1819)*. — 19 & 20. *T. reniloba (de Wilde & de Wilde-Duyfjes 18829)*. — 21 & 22. *T. celebica (Straatman s. n.*, BO). — 23 & 24. *T. paucifida (Brooke 10009)*. — 25 & 26. *T. beccarii (Beccari PS*



528, FI). — 27 & 28. *T. siliquosa (Kramer & Nair 6604)*. — 29–31. *T. borneensis:* 30. hair stalk cells papillose; 31. hair stalk cells glabrous. (*29* & 30. *van Steenis 24294*; 31. *Woerjantor 126*). — 32 & 33. *T. curvisemen (S 14747):* 33. hair stalk cells. (5, 8, 11, 14, 17, 19, 21, 23, 25, 27, 29, 32, all × 33; 6, 9, 12, 15, 18, 20, 22, 24, 26, 28, all × 180; 7, × 400; 10, × 800; 13, × 700; 16, × 770; 30 & 31, × 500; 33, × 370).

rather weak loops, e.g. in *T. celebica* (fig. 70A1), *paucifida* (fig. 71A), *penitilobata* (fig. 72A1). They are braced exmedially by higher order veins.

2) A c r o d r o m o u s (Fig. 4) — In addition to the primary vein there are two lateral, strongly developed secondary veins starting from the leaf base and extending slightly curved towards the apex. It represents the basal, perfect acrodromous (= Convergate, fide Melville, l.c.) venation which occurs only in one species, *T. corymbosa.*

3) P i n n a t e - A c r o d r o m o u s (Fig. 2, 3) — There are intermidiate forms between the two types recorded above. In addition to one pair of basal or suprabasal secondary veins running upward to about half to two-thirds of the leaf length (Acrodromous type), there are four to eight pairs of pinnately arranged veins, e.g. *T. siliquosa* (fig. 3), *tricornis* (fig. 2).

I n t e r s e c o n d a r y v e i n s — These veins are usually simple, sometimes composite, one or more, interspersed between the secondaries of pinnate venation and parallel (or nearly so) to them, e.g. *T. borneensis, parviflora, sumatrana.*

R e l a t i o n s h i p of tertiary veins to primary vein — Tertiary veins joining the primary vein and secondaries are more or less perpendicular to both of them and appear usually in a series of straight or slightly curved lines (e.g. *T. corymbosa,* fig. 4). Those joining the secondaries are predominently opposite, in a series of straight or slightly curved lines at acute or right angles; they are slightly oblique and usually in an obtuse angle to the primary vein, and appear scalariform or percurrent (in most of the species), or random reticulation usually in the upper half (e.g. *T. paucifida,* fig. 71A).

The outer tertiary veins originating from the secondaries, especially the basal pair in some species, are usually at right or acute angles, straightly or slightly curved towards the margin, or turning sharply upward joining superadjacent ones to form loops or an intramarginal vein (e.g. *T. corymbosa, siliquosa, tricornis;* fig. 2–4).

H i g h o r d e r v e n a t i o n — The resolution of high order venation is distinct. Quaternary and quinary veins can usually be distinguished from each other. The veins between the tertiary ones are usually arising at right angles (orthogonal) or reticulate.

HAIRS AND LEAF SURFACE FEATURES

In the genus *Thottea,* the leaf surfaces, especially the abaxial side, when examined under the dissecting microscope at a magnification up to about × 64, can provide sometimes usefully diagnostic characters especially for identification of sterile specimens.

Hairs are simple and uniseriate. Sometimes such a hair possesses a stalk consisting of one to several cells which may remain after the hair-proper has fallen off (fig. 29–33).

On some organs of the plant one can often observe rather short, hooked hairs (cf. fig. 12, 20, 36, 48–50) and sometimes also glandular(?) or papilla-like trichomes on the inner surface of perianth (fig. 34–37). They are variable and differ in length, shape and density. The lower leaf surface varies from densely hairy with hairs covering almost the whole surface (e.g. *T. borneensis,* fig. 29) to sparsely hairy or seemingly glabrous (e.g. *T. penitilobata,* fig. 14–16). (cf. Metcalf & Chalk, Anat. Dicot. 2, 1950, 1114–1116, fig. 269).

In addition to the hairiness, the lower leaf surface often has other sculpture features or ornamentation (cf. Wilkinson in Metcalf & Chalk, Anat. Dicot., 2nd ed., 1, 1979, 140–162, fig. 10.11–10.15) which may be protuberances of epidermal cells, cuticular markings, or may also be formed by epicuticular substances, e.g. wax. The surface characters will be used chiefly based on their appearance as observed under the dissecting microscope.

In order to facilitate a survey, artificial convenient groups with representative species as far as the material has been examined, have been prepared based on some selected characters. The stereoscan photomicrographs are chosen to illustrate various surface features, at different magnifications, which can be observed under an (ordinary) dissecting microscope. It is not my intention to use only the leaf surface characters to prepare a key to all the species. The leaves of some species possess mixed features which may have different appearances according to the magnifications (cf. fig. 8–10), so some of the species have been listed repeatedly under different groups.

Thottea borneensis has been cultivated in the botanical garden, Bogor, Java, under the nos. *XI.B.(XIII) 76 & 134*. The specimens *Woerjantoro 126*, Nov. 1959 (BO,L), and *van Steenis 24294*, June 1980 (L), were both collected from the plant growing there under the *no. XI.B(XIII) 134*. It is interesting that the hair stalk cells are glabrous on Woerjantoro's collection while they are finely papillose on van Steenis' specimen (fig. 30, 31).

SURVEY OF SPECIES

1a. Hairs densely covering almost the whole lower leaf surface and the surface usually hidden: *Thottea borneensis* (fig. 29), *curvisemen* (fig. 32), *tomentosa* (*p.p.*, often the young leaves).

b. Hairs rather loosely or sparsely covering the lower leaf surface and the surface always exposed. ..... 2.

2a. Papillae distinct, minutely dotted (forming rings or loops), granulate, or pebble-like (the papillae of some species bear many minute projections shown at higher magnifications): *Thottea barberi (p.p.), dependens* (fig. 5–7), *grandiflora* (fig. 8–10), *macrantha* (fig. 11–13), *macrophylla (p.p.), paucifida* (p.p., fig. 23, 24), *robusta (p.p.), siliquosa* (fig. 27, 28), *sumatrana (p.p.)*.

b. Thickenings short-filamentous, crescent, curved, or hooked (sometimes also with minute projections on these structures shown at higher magnifications): *Thottea celebica* (fig. 21, 22), *corymbosa, reniloba* (fig. 19, 20), *parviflora, paucifida (p.p.*, fig. 23, 24), *penitilobata* (fig. 14–16), *rhizantha, sumatrana (p.p.), tricornis* (fig. 17, 18).

c. Papillae or ornamentation obscure or none under low magnification up to about × 35: *Thottea barberi (p.p.), beccarii* (fig. 25, 26), *macrophylla (p.p.), philippinensis, robusta (p.p.), sumatrana (p.p.), tomentosa* (*p.p.*, often the old leaves).

STAMENS, STYLES AND STYLE-LOBES

The stamens of *Thottea* are usually inserted on or around a style column with filaments (partly or almost completely) united with it or sometimes at its base to form a structure usually described as the gynostemium (fig. 41–50). They are often arranged in one (fig.

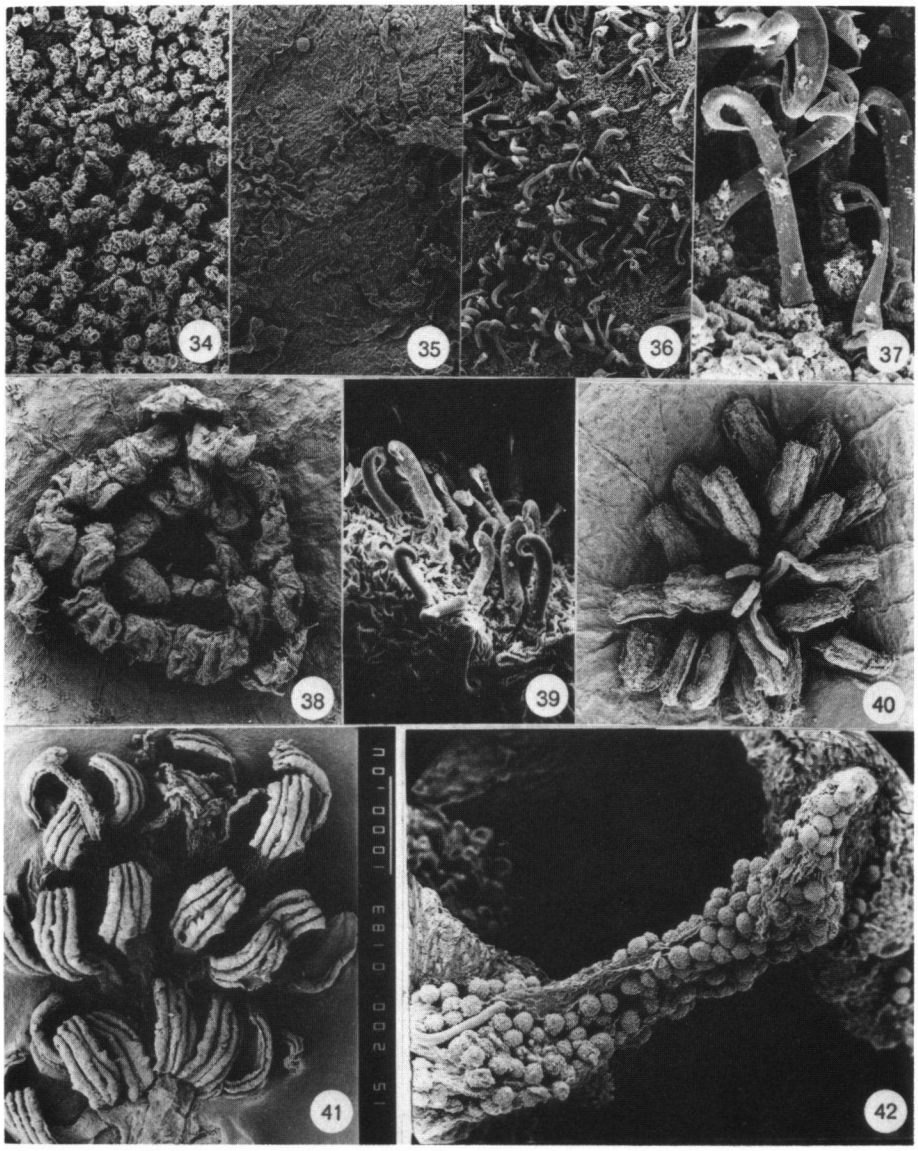
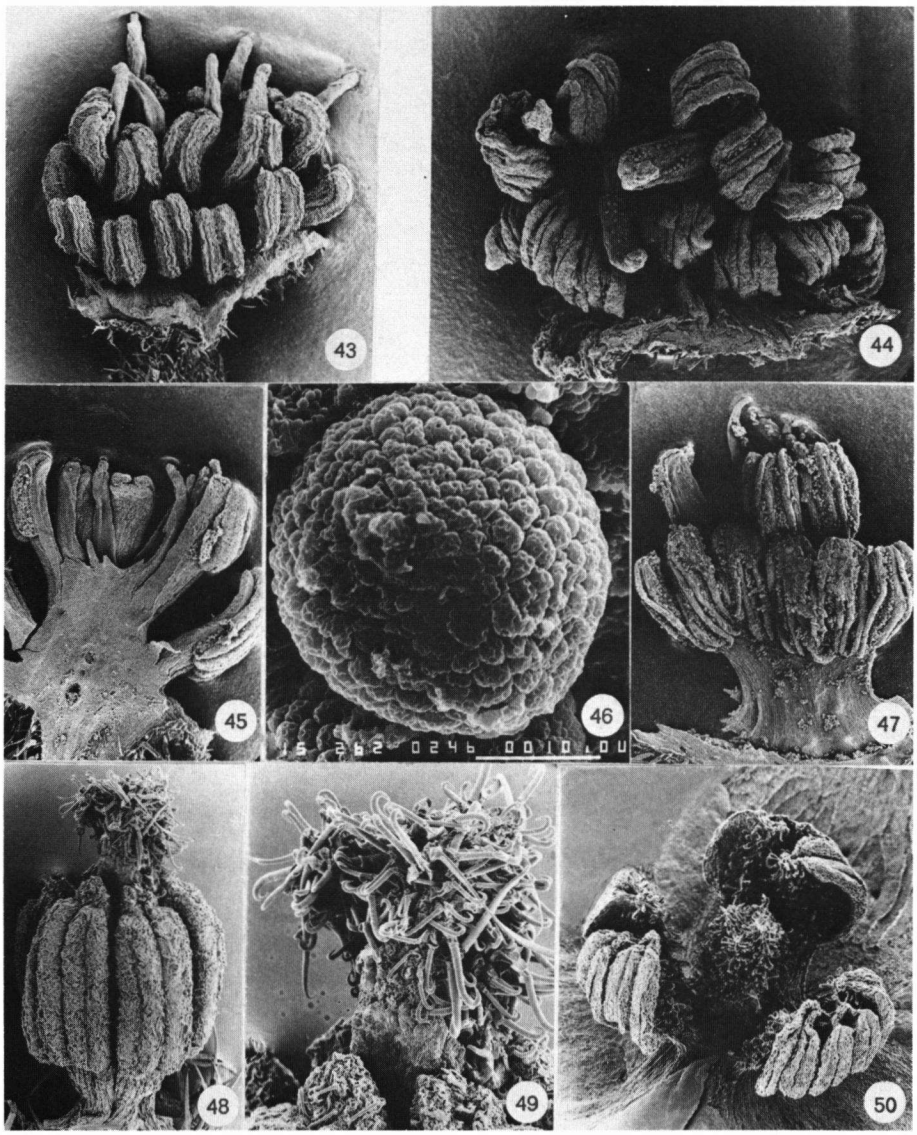


Fig. 34–50. Scanning electronmicrographs of floral parts of *Thottea*. — *T. macrophylla:* 34. inner surface of perianth lobe *(Beccari PB 1855,* Fl*)*, × 65, — *T. triserialis:* 35. inner surface of perianth lobe *(S 34434)*, × 65. — *T. robusta:* 36 & 37. inner surface of perianth lobe *(van Steenis 1270);* 36, ×65; 37, × 320. — *T. parviflora (Geesink & Santisuk 5101):* 38. inner top view of a very young flower (perianth) bud showing stamens arranged in 4 series; style-lobes hardly shown, × 20; 39. part of inner surface of anthers showing hooked hairs, × 240; 40. inner view of an older flower, × 16. — *T. triserialis (S 34434):* 41. gynostemium in side view showing stamens arranged in 3 series, × 15; 42. style-lobe full of pollen grains, × 110. — *T. tricornis (van Balgooy 2627):* 43. gynostemium of young



flower with style-lobes erect, × 19; 44. gynostemium of ripe flower showing anthers curved and style-lobes recurved with pollen grains attached, × 22. — *T. rhizantha (Jacobs 5283):* longitudinal section of young gynostemium showing insertion of stamens and style-lobes, × 15; 46. pollen grain, × 1600; 47. ripe gynostemium bearing 2 series of stamens with opened anthers, × 14. — *T. tomentosa (Keng 8836):* 48. gynostemium with stamens arranged in 1 series, × 40; 49. upper parts of style-lobes bearing hooked hairs, × 100. — *T. siliquosa (Kostermans 24455A):* 50. gynostemium with 9 stamens arranged in 1 series in 3 groups; hooked hairs on both inner surfaces of anthers and style-lobes, × 30.

48–50) or two (fig. 43–47) series, or in three series found only in *T. triserialis* (fig. 41). However, they are inserted at the base of the perianth, arranged in 4 series around the style column, easier to observe in a young flower bud, in *T. parviflora* (fig. 38–40; 70D2 &3).

The number of stamens in the flower varies from species with about 36(–46) (e.g. *T. grandiflora)* to some with only 6 (e.g. *T. tomentosa,* fig. 48). It is usually constant in the species with lower numbers, for example, 6, 9 or 12. However, it is rather variable in those with higher ones, for example, more than 20. The anthers are usually glabrous, but in a few species they are densely covered with hooked hairs on the inner surface (fig. 39, 40, 50).

The styles seem to be united into a short column which is discoid or obtuse at the apex and then divides, sometimes redivides, into a number of radiate or erect lobes. The number of styles or style-lobes in a flower varies from species with about 20 (e.g. *T. macrophylla*) to only 2 or 3 (e.g. *T. paucifida*). It is not constant in a species or even in one specimen. The styles or style-lobes are erect or spreading when young and often reflexed or irregularly twisted at anthesis. In this way they may come into close contact with the anthers for receiving pollen grains (fig. 43, 44).

No distinct structure of stigma or stigmatic surface can be observed under the dissecting microscope. In alcohol preserved flowering material, one may find that the styles or style-lobes or only their apical parts are sometimes enveloped in a jelly-like substance. In a few species the upper half of the style-lobes or only their apical parts are densely covered with hooked hairs (fig. 48–50). These hairs and those on the dorsal side of the anthers as mentioned above appear to be a useful structure for catching or holding pollen grains when the anthers burst open. In an old or mature flower, one may observe that usually the upper two-thirds of the styles or style-lobes are covered by pollen and such lobes could be probably described as stigmas. Further morphological study is needed to clarify the structure of stigmas.

FRUITS, SEEDS AND TESTA FEATURES

Within the Aristolochiaceae the slender, elongate, or siliquiform fruits are characteristic for *Thottea*. They are 3–25(–35) cm long and 0.5–1 cm wide, usually 4-angled, 4-celled, twisted or rarely straight, often pendulous, rarely erect, hairy or glabrescent, and dehiscing septicidally from the apex towards the base with the four valves separating from a placentiferous column. The fruit contains several to many seeds which are pendulous, attached to the furrows of the placenta in vertical rows, and immersed in spongeous tissue of the placenta.

The seeds are a few millimetres in length. Up till now they were known to consist of only one type: oblong, ellipsoid or broadly ovoid and distinctly or obscurely trigonous (fig. 51–63), with a ridge-like raphe or funicle along one side. However, a second type has now been found, which is flat but longitudinally curved and appearing boat- or shell-shaped with a raphe or funicle along one margin (fig. 64, 65, 67, 68); its shape resembles that of *Saruma* and some species of *Aristolochia*. The (ripe) seed is often coated with spongeous tissue which obstructs the examination of the details of the testa. The enveloping tissue is membranous when dry and seems to adhere to the testa.

The seed-coat is often irregularly transversely corrugated (fig. 51, 63), tubercular or granular (fig. 53, 61), or rather smooth with only scattered minute wart-like thickenings (fig. 64, 67). If the coating membranous tissue on the testa has been peeled off, the surface of the rest appears as reticulate or papillose under the dissecting microscope (e.g. fig. 51, 54).

The testa surface reveals interesting features under the Scanning Electron Microscope (SEM). It appears that each pit or foveola represents a single cell of the testa and its periclinal wall may adhere to the membranous tissue which has been removed. On surface view each cell has a central, cylindric or conical body or bundle of fibrous (cellulose) thickenings projecting into the cell-lumen from the bottom or inner wall (cf. Solereder, Bot. Jahr. 10, 1889, 504–507, t. 13, f. 19–21; O. C. Schmidt in E. & P., Nat. Pfl. Fam., 2nd ed., 16b, 1935, 221; Corner, Seeds Dicot. 1, 1976, 74) (fig. 52, 56, 58, 69). The anticlinal wall is polygonal in outline with longitudinal, lineal thickenings on the inner surface (fig. 55, 56, 69) (cf. Solereder, l.c.; Nair & Narayanan, Lloydia, 24, 1961, 199–203, fig. 1–29).

It is interesting to note that the surface features of the seed testa of *Thottea* resemble those of the achene epidermis of some *Scirpus* species (Cyperaceae) (cf. Schuyler, in Proc. Acad. Nat. Sci. Philidelphia 123, 1971, 29–52, fig. 1–129).

1. Thottea barberi (Gamble) Ding Hou, *comb. nov.*

Apama barberi Gamble, Kew Bull. (1924) 386; Fl. Pres. Madras pt 7 (1925) 1200; Subramanyam & Henry, Bull. Bot. Surv. Ind. 12 (1972) 1, f. 1–5. — L e c t o t y p e: Barber 3093 (K); s y n t y p e: Barber 2981 (K); both from Kannikatti, southern India.

The type of this species as cited above was collected in 1901 from Kannikatti, southern India. According to Subramanyam and Henry (l.c.), additional specimens were obtained from the type locality 'after a lapse of over six decades'. In 1976, Dr C. Ridsdale (no. *384*, L) on his field trip to southern India collected fertile material both in flower and fruit of this species from Papanasam.

This species can be distinguished from a closely related one, *T. siliquosa*, another species occurring in India and also in Sri Lanka, by the following characters: 1). the basal pair of nerves scarcely reaching halfway up of the leaf (against reaching *c.* 2/3 of the leaf length), 2). perianth lobes broad-elliptic, acuminate (against suborbicular, slightly acute), and 3). stamens arranged not in groups (against in 3 distinct groups, fig. 50), and 4). anthers and style-lobes glabrous (against anthers on the inner surface and style-lobes covered with hooked hairs).

2. Thottea beccarii Ding Hou, *spec. nov.* — **Fig. 25, 26, 51, 52.**

Suffrutex 75–120 cm altus. *Lamina* firme chartacea, elliptica, raro lanceolata vel oblanceolata, 19.5–25 × 9.5–15 cm, apice breviter acuminata, basi cuneata, pagina supera subglabra, infera pubescens; nervis 6–9 paribus, venis arte reticulatis vel leviter transversis; petiolo 5–7 mm longo. *Inflorescentiae* prope basim caulis, spiciformis, *c.* 5 cm longae, sparse puberulae; bracteae lanceolatae, oblanceolatae vel lineares, raro bilobatae, 5–6

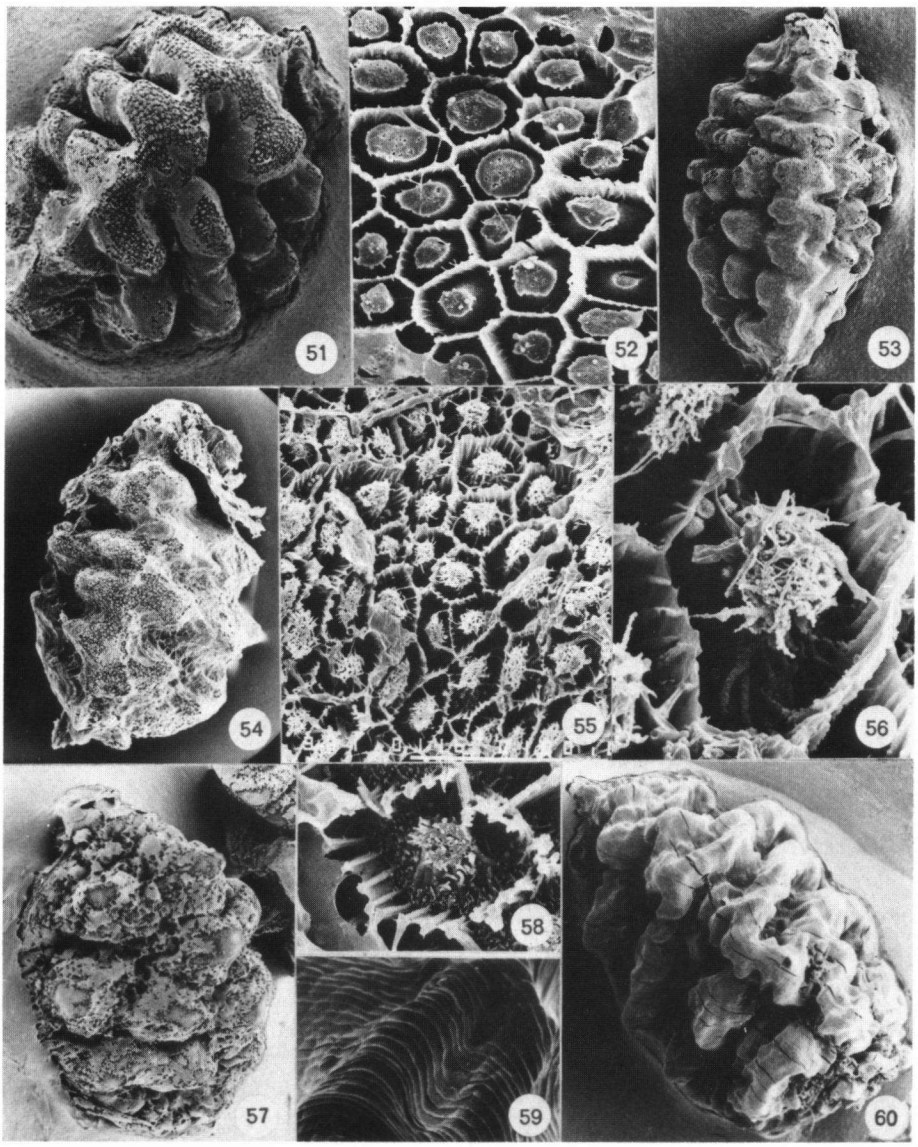
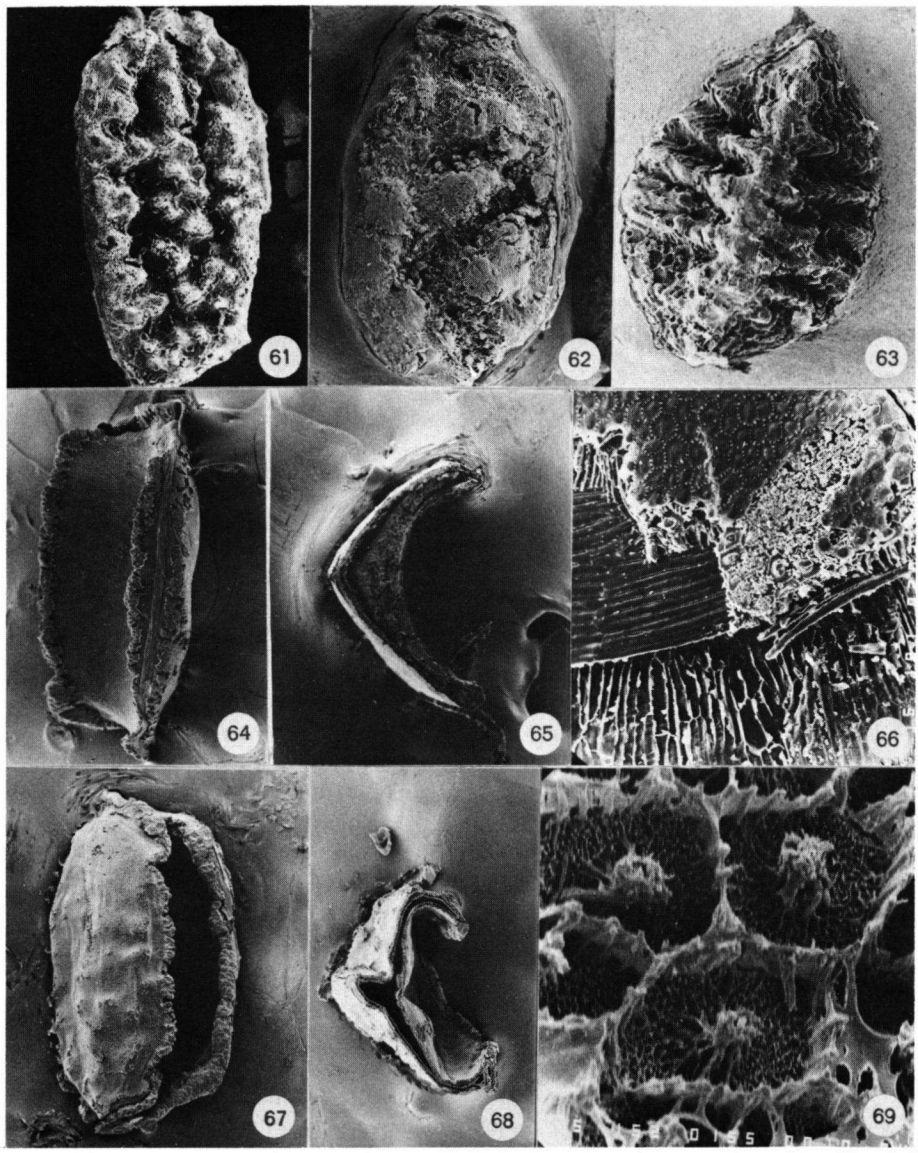


Fig. 51–69. Scanning electronmicrographs of seeds and testa features of *Thottea*. — *T. beccarii (Beccari PS 528,* FI*)*: 51. seed with coating tissue partially peeled off, × 25; 52. surface view of the testa with periclinal cell walls peeled off, × 300. — *T. reniloba (de Wilde & de Wilde-Duyfjes 18829)*: 53. seed coated with dried tissue, × 21. — *T. macrantha (Lörzing 12434,* BO*)*: 54. seed with coating tissue partially peel off, × 20; 55. surface view of the testa, most of cells with periclinal walls peeled off, × 260; 56. one cell as shown in fig. 55, × 1000. — *T. robusta (van Steenis 1270)*: 57. seed coated with dried tissue, × 13; 58. one cell of the testa with periclinal wall peeled off, × 600; 59. part of fig. 60 in higher magnification, × 600; 60. seed with testa brushed away showing fibrial layer(s) of tegmen, × 15. — 61–63. seeds coated with dried tissue: 61. *T. tricornis,* × 14 *(van Balgooy 2025)*; 62. *T.*



grandiflora, ×13 (*Jumali 2952*); 63. *T. siliquosa*, × 20 (*Kramer & Nair 6604*). — *T. curvisemen (S 14747)*: 64. seed slightly in longitudinally oblique view with funiculus along the margin on one side, × 16; 65. transverse section of seed, × 16; 66. surface view of peeled seed coat showing various layers; two fibrial layers of tegmen placed at right angles to each other, × 110. — *Thottea sp. (Haviland & Hose 3242)*: 67. shell-shaped seed in longitudinally oblique view with a part of funiculus along the margin seen on one side, × 15; 68. transverse section of seed, × 15; 69. cells of the testa with periclinal walls peeled off, × 950.

mm longae, utrique sparse puberulae. *Pedicellus* et *ovarium* 15–17.5 mm longum, sparse puberulum. *Perianthium* chartaceum, cupulatum, 12–15 mm longum, obscure lobatum, extus sparse puberulum, intus dense papillosum; tubus *c.* 10 mm longus; lobi arcuati, 3–5 × 15–20 mm. *Stamina* biseriata, serie superiore 7–10, inferiore 13 vel 14; filamenta hirta (?) vel glabra. *Columna stylina c.* 2 mm longa, lobi *c.* 10, erecti, *c.* 1 mm longi. *Capsulae* siliquiformes, rectae, 6.5–9 cm longae, glabriusculae. *Semina* late ellipsoidea vel subglobosa, 2×1.5–1.75 mm, manifeste rugosa vel tuberculata, profunde sulcata.

T y p u s: Central western Sumatra. Padang: Ayer Mancior = Ajer Mantjo(e)r, alt. *c.* 360 m, fl. & fr., *Beccari PS 528* (FI; iso in K, L).

Further specimen examined: Sumatra. Asahan, Vicinity of Loemban Ria, with one fl., *Rahmat si Boeea 7438* (A).

The specimens of *Thottea beccarii* are, at first glance, similar to those of *T. borneensis* which occurs also in Padang, CW Sumatra (*Beccari PS 921*, FI; *PS 949*, BM, FI, K, L). However, they can be easily separated from each other even just by examining their leaves. On the lower leaf surface the closely reticulate venation and rather irregularly scattered, slightly curved hairs of the new species differ from the scalariform or loosely reticulate venation and dense hairs which bend near the base at right angles and cover the whole surface in *T. borneensis* (fig. 29–31).

The new species is also closely allied to *T. tricornis* but can be distinguished from it by: 1). leaf venation closely reticulate (against loosely reticulate; veins or veinlets often parallel to each other), 2). inflorescences near the base of stem, in the axils of bract-like, reduced leaves (against at the upper part of stem, in the axils of foliage leaves), 3). fruits straight, less than 10 cm long, sparsely hairy or almost glabrous (against fruits twisted, 15–25 cm long, densely pubescent), and 4). seeds broad-ellipsoid or subglobose, 2×1.5–1.7 mm, surface prominently rugose, deeply furrowed, fig. 51 (against seeds oblong, 4–5×2 mm, surface coasely granulate, obscurely furrowed, fig. 61).

3. Thottea celebica Ding Hou, *spec. nov.* — **Fig. 21, 22, 70A.**

Suffrutex usque 70 cm altus. *Lamina* chartacea vel coriacea, lanceolata, 22.5–32×6.5–9 cm, apice acuminata, basi obtusa, pagina supera glabra, infera sparse puberula; nervis *c.* 12 paribus, venis reticulatis; petilo *c.* 5 mm longo. *Inflorescentiae* prop basim caulis, spiciformes, 5.5 cm longae, puberulae; bracteae ellipticae, 4–8 mm longae, utrique puberulae. *Flores* atropunicei. *Pedicellus* et *ovarium c.* 12.5 mm longum, puberulum. *Perianthium* campanulatum, extus puberulum, glabrescens, intus trichomatibus glandulosum; tubus *c.* 6 mm longus; lobi semiorbiculati, *c.* 10×15 mm. *Stamina* biseriata, serie superiore 10–12, inferiore 12–15; filamenta glabra. *Columna stylina* brevis, *c.* 1 mm longa, lobi *c.* 12, erecti, *c.* 2 mm longi. *Capsula* immatura, siliquiformis, torta, 4 cm longa, sparse puberula.

T y p u s: Central Celebes. Lambarese, 100 km NE of Palopo, open, shady places in high forest, low alt., fl. & young fr., *Straatman s. n.*, July 1966 (BO).

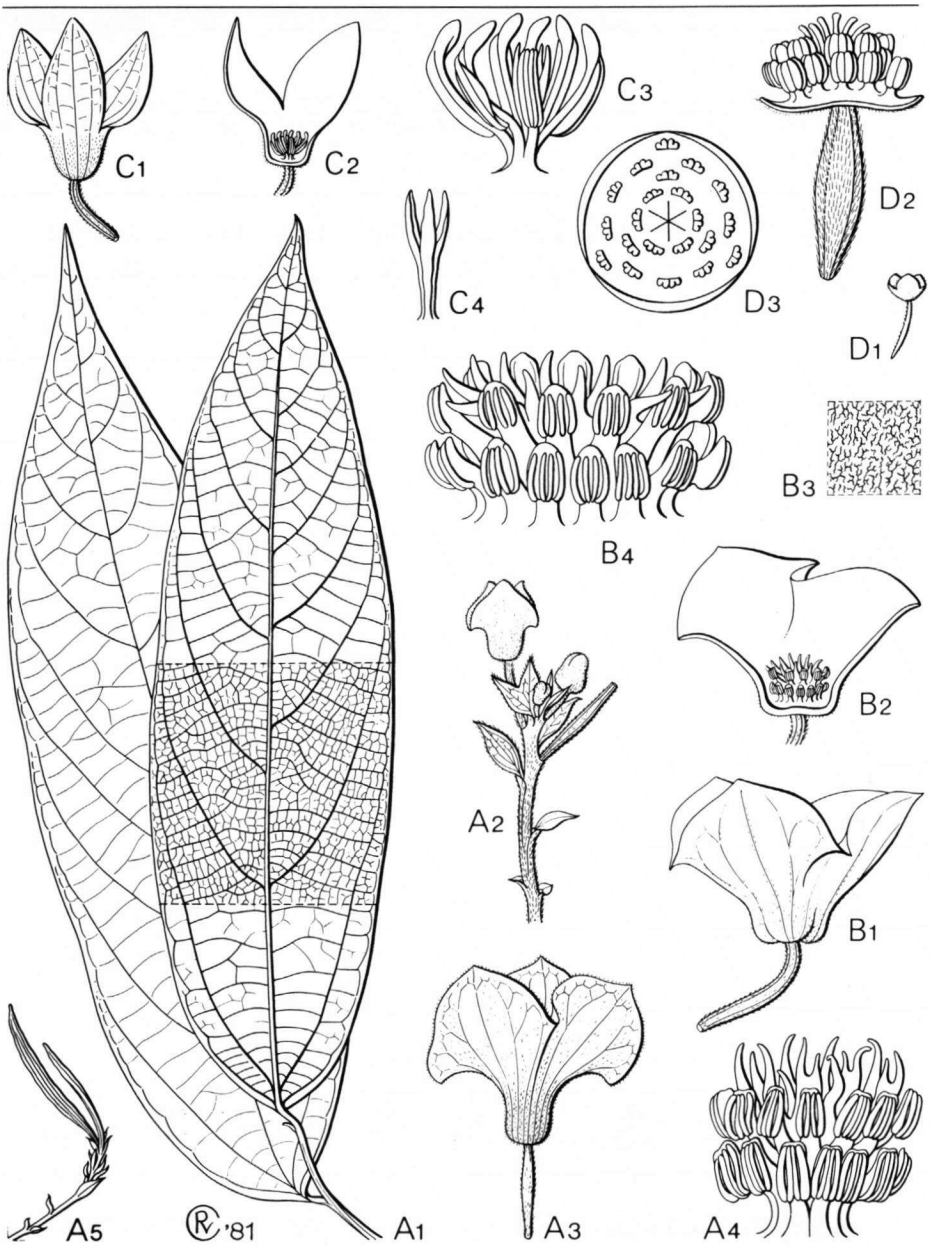


Fig. 70. *Thottea celebica* Ding Hou — A1. Habit, × 1/2; A2. short flowering shoot, × 1; A3. flower, × 1; A4. gynostemium, × 5; A5. short fruiting shoot, × 1/2. — *T. tricornis* Maingay *ex* Hook. *f.* — B1. flower, × 1; B2. longitudinal section of perianth, × 1; B3. indumentum on inner surface of perianth, × 10; B4. gynostemium, × 5. — *T. sumatrana* (Merr.) Ding Hou — C1. flower, × 1; C2. longitudinal section of perianth, × 1; C 3. gynostemium, × 5; C 4. style, 3-lobed at upper half, × 5. — *T. parviflora* Ridl. — D1. flower, × 1; D2. flower with perianth removed, × 5; D3. floral diagram. (A. *Straatman s.n.*, BO; B. *van Balgooy 2627;* C. *Kostermans 284;* D1. *van Beusekom & Phenklai 694;* D2 & 3. *Geesink & Santisuk 5101*).

This species is so far the only representative of *Thottea* found in Celebes. It is known only by the type, a fertile specimen with flowers and young fruits, which was collected by an entomologist, Mr R. Straatman, in July 1966, who sent it to the Herb. Bogor., Java, for naming.

T. celebica is closely related to *T. philippinensis* and can be distinguished from the latter by 1). the leaf sparsely puberulous on the lower surface which has filamentous, curved or hooked thickenings, fig. 21, 22 (against the leaf pubescent on the lower surface which does not have the surface thickenings as the former), 2). venation on the lower leaf surface slightly elevated and loosely reticulate, fig. 70A1 (against prominently and closely reticulate, fig. 1), 3). perianth *c.* 2 cm long, with several longitudinal veins, and contracted at the lower 1/3 (against perianth 1–1.5 cm long, with loosely reticulate venation, and gradually expanded from the base upward), and 4). style-lobes *c.* 12 (against 4–6).

4. Thottea corymbosa (Griff.) Ding Hou, *comb. nov.* — **Fig. 4.**

Bragantia corymbosa Griff., Trans. Linn. Soc. 19 (1845) 335. — *Asiphonia piperiformis* Griff., op. cit. 333, t. 37. — *Apama corymbosa* Willd. *ex* Solereder in E. & P., Nat. Pfl. Fam. III, 1 (1889) 272. — T y p e: *Griffith s. n.* (K), Malacca.

Strakaea melastomaefolia Presl, Epim. Bot. (1851) 222. — *Bragantia melastomaefolia* Duchartre in DC., Prod. 15, 1 (1864) 429. — T y p e: *Cuming 2333* (iso in BM, K, L), Malacca.

Asiphonia was established by Griffith (l.c.) with one species, *A. piperiformis*, based on his own collection as cited above. He was aware that his new genus may be 'a subordinate modification of *Bragantia*', so he described the species again under an alternative name *Bragantia corymbosa* and placed his new species *Asiphonia piperiformis* in the synonymy.

I have discussed the matter concerning nomenclature of these two specific names with my colleague Dr H. F. Veldkamp and concluded that both of them are validly published (cf. Code, ed. 1978, Art. 34. 4). Because the epithet *'corymbosa'* has already been used and the species is very well known under the name *Apama corymbosa*, I select *Bragantia corymbosa* as the basionym. The epithet refers to the characteristic, corymbose inflorescences.

This species can rather easily be identified by the leaf with three prominent nerves, reaching often to the apex, which are all joined by almost parallel and transverse veins (fig. 4). There are many specimens of this species in the herbarium, which were collected from Sumatra and the Malay Peninsula. The specimens of this species together with those of *T. tomentosa* amount to about half of all the collections of this genus examined by myself.

5. Thottea curvisemen Ding Hou, *spec. nov.* — **Fig. 32, 33, 64–66.**

Frutex 1–1.3 m altus. *Lamina* chartacea, late elliptica vel elliptica, 18.5–24.5×9–16 cm, apice acuminata, basi rotundata, pagina supera glabra, infera seriacea; nervis 8–11 paribus, venis scalariformibus vel reticulatis; petilo *c.* 10 mm longo. *Inflorescentiae* axillares, spiciformis, *c.* 3 cm longae, puberulae; bracteae ellipticae vel leviter obovatae, 2.5–3 mm longae, utrique puberulae. *Flores* vivide purpurati. *Pedicellus* et *ovarium* 7–12

mm longum, pubescens. *Perianthium* breviter cupulatum, chartaceum, *c.* 12.5 mm longum, extus sparse puberulum, intus dense hirtum glandulosum; tubus brevissimus; lobi arcuati, *c.* 3×10 mm. *Stamina* biseriata, serie superiore 8–10, inferiore 11–14; filamenta glabra. *Columna stylina c.* 2 mm longa, lobi 6–10, patentes, *c.* 1.5 mm longi. *Capsula* anguste fusiformis, recta, 4.5 cm longa, 4-costata, glabra. *Semina* complanata, longitudinaliter curva et late ellipsoidea a latere visus, 2–2.5 mm longa, utrique sparse granulosa.

T y p u s: Borneo. Sarawak, Kapit Distr. (Bukit Raya, Pelagus). In lowland dipterocarp forest, on slope of steep ridge, alt. 240 m, fl. & fr., *Anderson S 14747* (SAR; iso in BO, K, L, SING).

Thottea curvisemen is closely allied to *T. borneensis*. Their leaves are similar to each other especially the dense indumentum covering the lower surface. The hairs bend at right angles near the base and are parallel to the surface; they appear very thin in dry state and stick together resembling a layer of gelatin in the new species (fig. 32), while those of *T. borneensis* are shorter, thicker and free from one another (fig. 29). Each hair has a short but distinct stalk which remains after the hair proper has fallen off (cf. fig. 30–33).

There is one short section of twig, 15.5 cm long, on the type specimen, which has one fruit and three flowers still attached. The fruit looks just like those of other species. However, the seed of this species is flat, slightly longitudinally curved, rather smooth and only sparsely granulate on both surfaces, and differs from the usually ellipsoid, triangular and (transversely) rugose ones of other species (cf. fig. 51–63, 64–66).

The specific epithet is chosen for indicating the characteristic and slightly curved seed.

6. Thottea hainanensis (Merr. & Chun) Ding Hou, *comb. nov.*

Apama hainanensis Merr & Chun, Sunyatsenia 2 (1935) 220, t. 43; Kao, in Fl. Hainan. 1 (1964) 326, f. 162. — T y p e: *Chun & Tso 43437* (iso in K), Hainan, China.

I have seen a duplicate of the type and an additional collection *(C. Wang 34000)* of this species from Hainan in the Kew Herbarium. This species is characterized by 1). the cylindric, cupular perianth (*c.* 14 mm long) with longitudinal veins, lobed at the upper one-third, and lobes erect, 2). stamens 8 arranged in 1 series, and 3). style-lobes 9, radiate.

This species is closely allied to the Indochinese *T. racemosa*. More collections of these two species are needed for checking their differences.

7. Thottea macrantha (Boerl.) Ding Hou, *comb. nov.*

Bragantia macrantha Boerlage, Handl. 3 (1900) 64; Valeton, in Ic. Bogor. (1908) sub t. 260, emend. — *Apama macrantha* Weisse, Ber. Deutsch. Bot. Ges. 45 (1927) 234, in obs.; Steen., Bull. Jard. Bot. Btzg III, 12 (1923) 204. — T y p e: *Anonymus 'Deli 189d'* (BO, sheet no. *HB 108633)*, Deli, Sumatra.

T. hirsuta Ridl., J. Mal. Br. R. As. Soc. 1 (1923) 87. — T y p e: *Nur SF 7223* (K; iso in BM, BO, SING), Sibolangit, Sumatra.

Bragantia macrantha was published by Boerlage (l.c.); the original description is rather short and incomplete. It is validly published because there are some essential

characters of the species described. Valeton (l.c.) gave a detailed description and made drawings based on a plant cultivated in the botanic garden, Bogor, Java, under no. *XI. B. XIII. 133.* A branch of the original plant from Deli, East Coast of Sumatra, marked as *'Deli 189d'*, is kept in the Herbarium, Borgor (sheet no. *108633*), which is the type of Boerlage's species.

In the original description of *Thottea hirsuta,* Ridley (l.c.) described 'the stamens 12, in two rows'. The one open flower of the type, which I have examined, showed that the stamens are actually arranged in one row and that the radiately reflexed style-lobes were mistaken as another row of stamens.

This species is known so far only from Sumatra. Recently Dr W. J. J. O. de Wilde and Dr B. E. E. de Wilde-Duyfjes made several fertile collections from Atjeh, northern region of the island (their nos. *12331, 12549, 15057, 15516, 15644*) and took beautiful photographs of the plant in colour. The flowers (actually the perianth) are reddish or purple brown outside and white inside. The colour pattern of the perianth is very characteristic.

This species is characterized by 1). the chartaceous or subcoriaceous leaves, usually 20–36 by 8–21 cm, 2). inflorescences axillary in a series of leaf axils, 3). perianth (in fresh state) reddish or purple brown outside and white inside, 4). perianth lobes emarginate and reflexed, 5). stamens 9–12, in one row, radiately patent or reflexed in an open flower, and 6). fruits erect.

8. Thottea muluensis Ding Hou, *spec. nov.* — **Fig. 72B.**

Frutex. *Lamina* chartacea, elliptica, lanceolata vel oblanceolata, 15–29×1–11.5 cm, apice acuta vel acuminata, basi cuneata, pagina supera glabra, infera sparse puberula; nervis 7–11 paribus, venis scalariformibus vel reticulatis; petiolo *c.* 10 mm longo. *Inflorescentiae* prope basim caulis, racemosae, 12–14 cm longae, puberulae; bracteae lanceolatae, 5–10 mm longae, utrique puberulae. *Flores* atropurpurei. *Pedicellus* et *ovarium c.* 9 mm longum, puberulum. *Perianthium* campanulatum, utrique sparse puberulum; tubus 17–20 mm longus; lobi triangulares, 20–25 × *c.* 20 mm. Stamina biseriata, serie superiore 9, inferiore 12; filamenta glabra. *Columna stylina c.* 3 mm longa, lobi 7, patentes, *c.* 1.5 mm longi. *Capsula* ignota.

T y p u s: Borneo. Sarawak, 4th Div., Baram Dist.; Gunong Mulu National Park, park boundary near Sungai Lansat, *c.* 4°01'N, 114°49'E, somewhat open position in lowland rain forest, *c.* 35 m alt., fl., *Argent, Nagang & Chai 760* (E; iso in L, SAR).

Further specimens examined: Borneo. Sarawak, 4th Div., Baram Distr., Gunong Mulu Nat. Park, Melinau River by Long Berar, in light situation in gap in alluvial rain forest, *c.* 50 m alt., fl., *Argent 722* (E, SAR); S. Melinau, outside Gunong Mulu Nat. Park, alt. *c.* 15 m, *Lewis 272* (K; fl. coll. in SAR not seen).

Thottea muluensis is closely related to *T. dependens*. At first glance specimens of both species resemble each other by the leaves and flowers. However, *T. muluensis* can be easily separated from *T. dependens* by examining the lower leaf surface which has crescent, curved or hooked thickenings (cf. fig. 14–16 of *T. penitilobata*) but bears minute

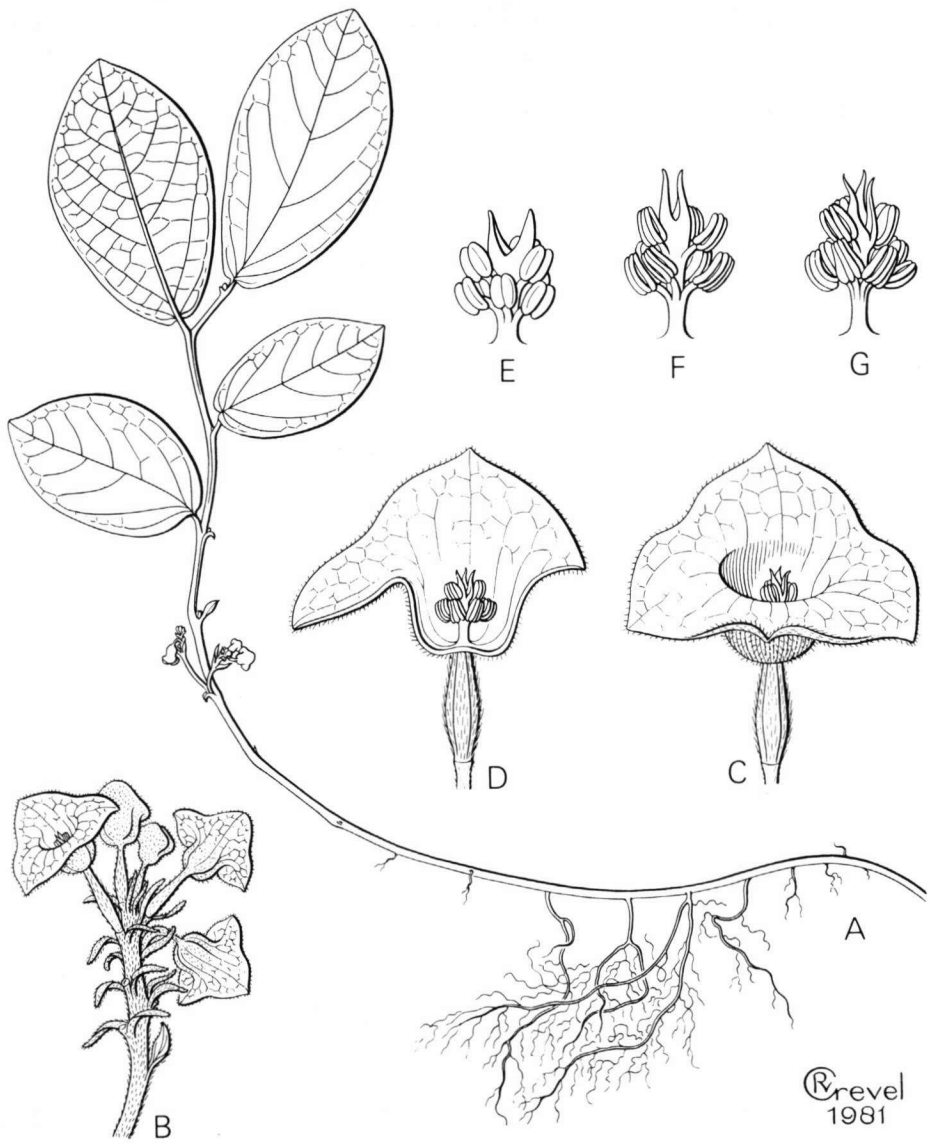


Fig. 71. *Thottea paucifida* Ding Hou — A. Habit, × 1/2; B. short flowering shoot, × 2; C. flower, × 4 1/2; D. flower with half of perianth removed, × 4 1/2; E–G. young and old gynostemia, with 2- or 3-fid style, × 9. (*Brooke 10009*, B. from duplicate specimen in US, under Herb. no. *2319968*).

papillae forming rings or loops in the latter (fig. 5–7). Furthermore, they can be distinguished by flower details.

In the present species the perianth is puberulous outside and is divided to about half its length; the perianth tube gradually enlarges upward and is smooth at its apical part inside. In *T. dependens,* the perianth is glabrous outside and is divided to one-third of its length; the perianth tube is contracted at about the lower 10 mm and has an annular thickening or ring at the apical part inside.

9. Thottea paucifida Ding Hou, *spec. nov.* — **Fig. 23, 24, 71.**

Suffrutex usque 30 cm altus. *Lamina* chartacea, obovata, late elliptica vel elliptica, 4.5–8×2.5–4.5 cm, apice acuta vel obtusa, basi rotundata vel obscure cordata; utrinque sparse pubescens; nervis 4–6 paribus, venis laxe reticulatis; petiolo 2–3 mm longo. *Inflorescentiae* prope basim caulis, spiciformis, 1–3 cm longae, puberulae; bracteae lineares, 2–5 mm longae, utrique dense puberulae. *Flores* cremei. *Pedicellus* et *ovarium* 4.5–5 mm longum, dense puberulum. *Perianthium* chartaceum, cupulatum, 6 mm longum, extus puberulum; tubus 3 mm longus, intus dense papillosus; lobi subrotundates, 3×3.5 mm, intus sparse puberulae. *Stamina* biseriata, serie superiore 3, inferiore 6; filamenta glabra. *Columna stylina* 1.3 mm longa, lobi 2 vel 3, erecti, *c.* 0.5 mm longi. *Capsula* ignota.

T y p u s: Borneo. Sarawak, 5th Div., Lawas, on the bank of a stream through rubber and other trees, fl., *Brooke 10009* (L; iso in BM, SING, US).

This species is known only from the type. At a glance the plant resembles *T. tomentosa.* However, by a close examination, the present species differs from *T. tomentosa* by 1). scattered pubescence on the lower leaf surface (against densely tomentose or villous on the lower leaf surface), 2). perianth smooth at the apical part of tube inside (against perianth with an annular ridge slightly protruding beyond the apical part of tube inside), 3). stamens 9 arranged in 2 series (against 6 in one series), and 4). style-lobes 2 or rarely 3, glabrous (against usually 3, rarely 4, often with hooked, very rarely straight, hairs at the apical part, fig. 48, 49).

The specific epithet refers to very low number of the style-lobes.

10. Thottea penitilobata Ding Hou, *spec. nov.* — **Fig. 14–16, 72A.**

Frutex 1 m altus. *Lamina* chartacea, oblanceolata vel elliptica, (12–)16–22×5–9.5 cm, apice acuminata, basi cuneata vel leviter obtusa, pagina supera glabra, infera sparse puberula; nervis 5–8 paribus, venis transversis, scalariformibus vel reticulatis; petiolo 5–7.5 mm longo. *Inflorescentiae* prope basim caulis, spiciformis, 3–6.5 cm longae, puberulae; bracteae ovatae vel lanceolatae, 2–7 mm longae, utrique puberulae. *Flores* flavovirentes. *Pedicellus* et *ovarium c.* 6 mm longum, sparse puberulum. *Perianthium c.* 15 mm longum, penitus lobatum, extus sparse puberulum, intus dense papillosum glandulosum; tubus brevis; lobi late ovati vel suborbiculati, 10–12× *c.* 11 mm. *Stamina* biseriata, serie superiore 10, inferiore *c.* 14; filamenta glabra. *Columna stylina c.* 6 mm longa, lobi 10–14, erecti-patentes, 1.5–2 mm longi. *Capsula* ignota.

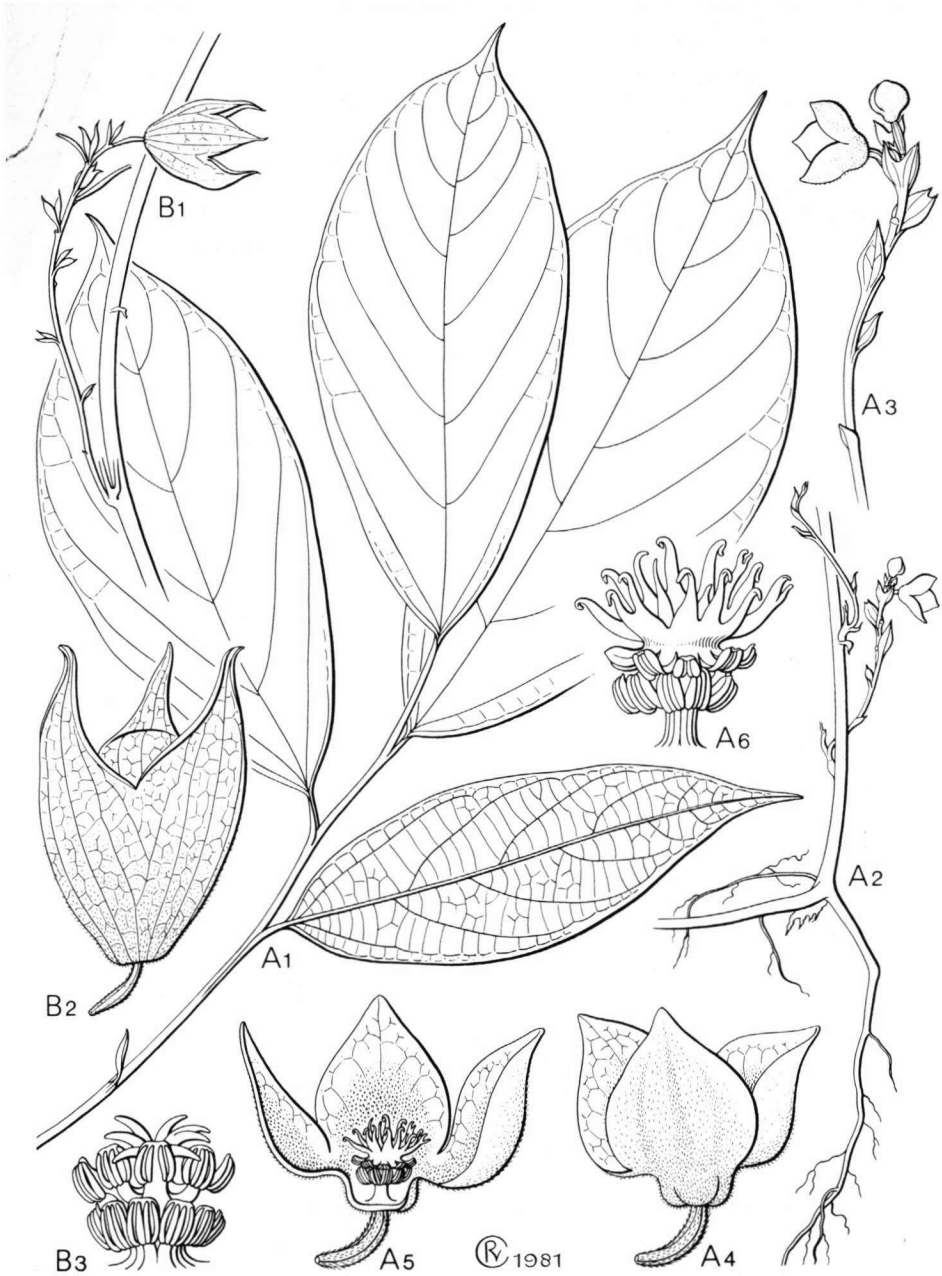


Fig. 72. *Thottea penitilobata* Ding Hou — A1. Habit, × 1/2; A2. lower part of plant showing rooting branch, roots, and short flowering shoots borne at base of stem, × 1/2; A3. short flowering shoot, × 1; A4. flower, × 2; A5. flower with part of perianth removed, × 2; A6. gynostemium, × 5. — *T. muluensis* Ding Hou — B1. stem with short flowering shoot, × 1/2; B2. flower, × 1; B3. gynostemium, × 5. (A. *Argent et al. 691*, E; B. *Argent et al. 760*, E).

T y p u s: Borneo. Sarawak, 4th Div., Baram Distr., Sungai Lansak, *c.* 4°01' N, 114°51' E, on bank at riverside in lowland rain forest, *c.* 40 m alt., fl., *Argent, Kerby, Leche, Siduk, Nagang& Lieng 691* (E; iso in L, SAR).

Thottea penitilobata is closely allied to *T. muluensis* and has the leaf and its surface characters similar to those of the latter. So far, sterile specimens of these two species could not be separated with certainty. However, the flower characters of these two species are quite different. In *T. penitilobata,* the perianth is *c.* 15 mm long, deeply lobed, and with broad-elliptic or suborbicular lobes; it has 10–12 style-lobes. In *T. muluensis,* the perianth is 37–45 mm long, lobed to about half of its length, and with triangular lobes; it has 7 style-lobes.

The specific epithet alludes to the characteristic deeply lobed perianth.

11. Thottea racemosa (Lour.) Ding Hou, *comb. nov.*

Bragantia racemosa Lour., Fl. Cochinch. (1790) 528; Benn. in Benn. & Brown, Pl. Java. Rar. (1838) 45. — *Apama racemosa* O. Ktze, Rev. Gen. (1891) 563; Merr., Comm. Lour. Fl. Cochinch. (1935) 142. — T y p e: *Loureiro s.n.* (BM), Cochinchina.

The genus *Bragantia* was established by Loureiro (l.c.) with only one species, *B. racemosa,* based on a Cochinchinese plant of his own collection which is kept in the BM (see Bennett, l.c.). The generic name of Loureiro is illegitimate because it is a later homonym (cf. the citation in the synonymy of the genus *Thottea*). It has not been included in the Aristolochiaceae by Lecomte for the Fl. Gén. I.-C. 5 (1910) 53–58 (cf. also Merr. l.c.).

Bennett (l.c.) examined two flowers of the type and stated that 'one had 9 stamina and 6 stigmata, and the other 8 of the former and 5 of the latter; while Loureiro describes the flowers as hexandrous'. This species is known only by the type. I have also seen this specimen and have not yet found any other collection to match it.

The close ally of this species is *T. hainanensis* from Hainan, China (see note under that species).

12. Thottea reniloba Ding Hou, *spec. nov.* — **Fig. 19, 20, 53.**

Suffrutex. *Lamina* chartacea, oblanceolata, lanceolata vel elliptica, 18–24×6–11.5 cm, apice acuminata, basi cuneata, pagina supera glabra, interdum costa leviter pubescenti, infera pubescens; nervis *c.* 7 paribus, venis transversis, scalariformibus vel laxe reticulatis; petiolo 4–7 mm longo. *Inflorescentiae* axillares, pendulae, spiciformis, 2–3.5 cm longae, puberulae; bracteae anguste ellipticae, oblanceolatae vel spathulati, 3–7 mm longae, utrique pubescentes. *Flores* purpurascentes ruberi. *Pedicellus* et *ovarium* 10–15 mm longum, puberulum. *Perianthium* breviter cupulatum, tenuiter chartaceum, *c.* 10 mm longum, extus sparse puberulum, intus sparse hirtum glandulosum; tubus 4–6 mm longus; lobi reniformes, 5–6×11–12 mm, per anthesin margine reflexo. *Stamina* biseriata, serie superiore 9 vel 10, inferiore 9–14; filamenta glabra. *Columna stylina c.* 1.5 mm longa, lobi 8, patentes, *c.* 2 mm longi. *Capsula* siliquiformis, pendula, torta, 9 cm longa, pubecens. *Semina* ellipsoidea, *c.* 2.5×1.5 mm, tuberculata, profunde sulcata.

T y p u s: Northern Sumatra. Atjeh, Gunung Leuser Nature Reserves: Alas River valley, near the mouth of the Bengkong River, *c.* 50 km S. of Kutacane, *c.* 3° N, 97°50′ E. alt. 50–125 m, very shaded place, rich soil over basalt rock, fl. & fr., *de Wilde & de Wilde-Duyfjes 18829* (L)

Further specimens examined: Sumatra. Atjeh, Gunung Leuser Nature Reserves, fl., *de Wilde & de Wilde-Duyfjes 18476 & 18517* (L); Tapanoeli, Div. Padang, fl., *Rahmat si Boeea* (not si Toroes) *5394* (A, L, NY); East Coast, Asahan, fl., *Rahmat si Boeea* (not si Toroes) *929* (A, K, L, MICH), *9534 & 9917* (A, MICH); upper Bila, sterile, *Lörzing 9598* (BO).

The specimens of *Thottea reniloba* as cited above are quite homogeneous. The flowers resemble those of *T. borneensis* especially in the perianth lobes with their margins reflexed during anthesis and appearing deeply 3-lobed in a top view. Specimens of these two species can easily be separated by examining with a hand lens the indumentum on the lower leaf surface which is loosely pubescent in *T. reniloba* and densely sericeous in *T. borneensis*.

Furthermore *T. reniloba* differs from *T. borneensis* by the following characters: 1). lower part of the leaf with a basal pair of nerves connected by reticulate veins (against by transverse veins which are more or less at right angles to the midrib), 2). the rachis of the inflorescence with spaced bracts and long internodes (against the rachis with rather densely set bracts and shortened internodes), 3). perianth smooth (against perianth with a distinct annular fold or ridge at the mouth on the inner surface of the tube).

The specific epithet of this new species refers to the reniform perianth lobes.

13. Thottea siliquosa (Lamk) Ding Hou, *comb. nov.* — **Fig. 3, 27, 28, 63.**

[*Alpam* Rheede, Hort. Malab. 6 (1686) 51, t. 28]. — *Apama siliquosa* Lamk, Encycl. Méth., Bot. 1 (1783) 91; Tabl. Encycl. Méth. (1823) t. 640; Gamble, Fl. Pres. Madras pt 7 (1925) 1200; Alston in Trimen, Handb. Fl. Ceylon 6 (1931) 245. — T y p e: *Alpam* Rheede, l.c., quoad t. 28, Malabar, India.

Trimeriza piperina Lindl., Bot. Reg. 18 (1832) sub. t. 1543, in note; Hook.*f.*, Fl. Brit. Ind. 5 (1886) 73. — T y p e: A Ceylonese plant, no other information, (*n.v.*), quoad descript.

Bragantia wallichii R. Brown *ex* [Wall., List (1832) no. 7415;] Wight & Arnott, Edin. New Phil. J. 15 (1833) 181; Bennett in Benn. & Brown, Pl. Java. Rar. 1 (1838) 44; Wight, Icon. 2 (1843) t. 520; Griff., Trans. Linn. Soc. 19 (1845) 335; Klotzsch, Monatsb. Akad. Berlin (1859) 590; Thwaites, Pl. Zeyl. (1861) 291; Duchartre in DC., Prod. 15,1 (1864) 430; Hook.*f.*, l.c.; Trimen, Handb. Fl. Ceylon 3 (1895) 421. — T y p e: *Wallich* no. *7415* (K-W, *n. v.*; on IDC microfiche, L), India.

Apama laurifolia Rafinesque, Sylva Tellur. (1838) 13, quoad descript.; Merr., Ind. Rafin. (1949) 114. — T y p e: Description.

Bragantia wallichii var. *latifolia* Duchartre in DC., l.c.; Trimen, Handb. Fl. Ceylon 3 (1895) 422. — *B. hispida* Thwaites *ex* Duchartre, l.c., *pro syn.* — T y p e: *Thwaites C. P. 3457* (G-DC, *n.v.*; on IDC microfiche, L; P, *n. v.*; iso in K), Sri Lanka.

Bragantia wallichii var. *brachycarpa* Hook.*f.*, l.c.; Trimen, Handb. l.c. — *B. brachycarpa* Thwaites *ex* Hook.*f.*, l.c., *pro syn.* — T y p e: *Thwaites C. P. 3533* (K), Sri Lanka.

Bragantia dalzellii Hook.*f.*, l.c. — *Apama dalzellii* O. Ktze, Rev. Gen. (1891) 563; O. C. Schmidt in E. & P., Nat. Pfl. Fam., 2nd ed., 16b (1935) 234. — T y p e: *Dalzell s. n.* (K), India.

This species is the type of the genus *Apama* Lamk. It was based on a Malabar plant commonly called *'alpam'*, as depicted by Rheede (l.c.). The plate which was published

by Lamarck (l.c.) is the same as that of Rheede as cited above. There is no specimen under this name in Lamarck's Herbarium (cf. IDC microfiche of Lamk Herb. in P).

The granule-like thickenings on the lower leaf surface at higher magnification are actually young hairs or hair stalks; there are also fine papillae (fig. 27, 28).

This species is so far known from India and Sri Lanka and is closely allied to *T. barberi* from southern India (see also note under that species). It is characterized by 1). the leaf with a basal pair of nerves next to the midrib reaching *c.* 2/3 of the leaf length (fig. 3), 2). the stamens usually 9 arranged in 3 distinct groups (fig. 50), and 3). the dorsal surfaces of anthers and style-lobes densely covered with hooked hairs (fig. 50).

14. Thottea sumatrana (Merr.) Ding Hou, *comb. nov.* — **Fig. 70C.**

Apama sumatrana Merr., Papers Mich. Acad. Sc. 23 (1937) 178. — T y p e: *Rahmat si Boeea* (not si Toroes) *5259* (NY; iso in UC, US), Sumatra.

This species was only known from Sumatra. It is now found also occurring in Malay Peninsula (e. g. Perlis, *SF 35290*, A, BO, K, L, SING), Peninsular Thailand (Pattani, *Kerr 7383*, K; Kwae Noi Basin Exp., *Kostermans 284*, K, L), and Peninsular Burma (*Kerr 21628*, K). Sterile specimens of this species are very difficult to identify. Flowering material of this species can be easily recognized by the following characters: 1). deeply lobed perianth, 2). stamens 6 in one series, 3). anthers with characteristic connective at the apex and protruding 0.5–1 mm beyond them, and 4). style-lobes 3.

15. Thottea tomentosa (Bl.) Ding Hou, *comb. nov.* — **Fig. 48, 49.**

Ceramium tomentosum Bl., Bijdr. (1826–27) 1135. — *Bragantia tomentosa* Bl., En. Pl. Jav. (1827) 82; Bennett in Benn. & Brown, Pl. Java. Rar. (1838) 43, t. 11; Hook.*f.*, Fl. Brit. Ind. 5 (1886) 73. — *Vanhallia tomentosa* J. A. & J. H. Schultes, Syst. Veg. 7 (1829) 166. — *Bragantia blumii* Lindl., Bot. Reg. 18 (1832) sub t. 1543, in note, new name for *Ceramium tomentosum* Bl.; Veg. Kingd. (1846) 793, f. 526. — *Cyclodiscus tomentosus* Klotzsch, Monatsb. Akad. Berlin (1859) 592. — *Apama tomentosa* Engl. in E. & P., Nat. Pfl. Fam. III, 1 (1889) 272; O. Ktze, Rev. Gen. 2 (1891) 563; Steen., Bull. Jard. Bot. Btzg III, 12 (1932) 204, excl. Bornean coll.; Back. & Bakh.*f.*, Fl. Java 1 (1963) 162. — L e c t o t y p e (here chosen): *Herb. Blume '1690'* (*HLB* no. *898, 131–369*, L); s y n t y p e s: *Herb. Blume '213' & '1690'* (*HLB* no. *898,131–373*, L), *s. n.* (*HLB* no. *898,131–368*, L), *s. n.* (*HLB* no. *907,135–835*, L).

Bragantia latifolia Lindl., Bot. Reg. 18 (1832) sub t. 1543, in note, quoad descript. (fide Hook.*f.*, l.c.); Duchartre in DC., Prod. 15, 1 (1864) 431. — *Cyclodiscus latifolius* Klotzsch, Monatsb. Akad. Berlin (1859) 592, t. 1, f. 5. — T y p e: A plant from Burma *(n. v.)*.

Bragantia khasiyana Griff., Trans. Linn. Soc. 19 (1845) 336, *nom. illeg.*, quoad descript. (fide Hook. *f.*, l.c.). — T y p e: A drawing of a plant from Khasiya Hills *(n. v.)*; Griffith could not locate the specimen.

Bragantia affinis Planchon *ex* Rolfe, Kew Bull. (1913) 265. — *Apama affinis* Weisse, Ber. Deut. Bot. Ges. 45 (1927) 235, *in obs.* — L e c t o t y p e (here chosen): *Cuming 1689* (K), Panay; s y n t y p e s: *Ramos BS 13370* (US), Tayabas; *Merrill 6700* (BM, K, PNH, US), Panay.

Bragantia brevipes Merr., Philip. J. Sc. 17 (1920) 248. — *Apama brevipes* Weisse, l.c. — T y p e: *Ramos & Pascasio BS 34811* (iso in BO), Surigao Prov., Mindanao.

In 1826–27 Blume (l.c.) described a monotypic genus in the 'Onagreae' with the species *C. tomentosum* from Java and Noesa Kambangan. He soon found out that his new generic name was a later homonym (see the citation in the synonymy of the genus *Thottea)* and its affinity is with *Bragantia,* Aristolochiaceae (cf. also Bennett, l.c.). In

1827 Blume (l.c.) reduced his new genus to *Bragantia* and renamed his species *B. tomentosa*. This is so far known the only species of this genus found in Java and adjacent islands.

There are several specimens of *Ceramium tomentosa* and/or *Bragantia tomentosa* in the Rijksherbarium, Leiden (L), which are similar to each other, match the original description and bear annotation in Blume's handwriting. They are evidently the authentic specimens, for example, under the sheet numbers: Herb. Lugd. Bat. (=L) *898,131–368, –369, –373; 907,135–835*. There is only one label of the specimen marked 'Bl' in Blume's own handwritting, which may be an indication of his own collection or his herbarium. For convenience, I treat these specimens as 'Herb. Blume'.

For readers who are not familiar with the sheet number system used on the Leiden specimens, I may add a short note here. The sheet number, for example, '898,131–369' means that this specimen was mounted in the year 1898, on the 131th day of that year; the last part of the number '–369' is just a numerical figure in three digits, run from 1 to 999, and after reaching 999, it will return to 0 for starting again from 1 onwards. For any (old) collection which does not have collector's name and/or field number, the sheet number is useful for citation or to quote for discussion.

This species is the most widely distributed one of the genus *Thottea*. It occurs in India (incl. Andaman I.), Bangladesh, Burma, Thailand, Vietnam, and Malesia.

In Malesia, this species is known to occur in Sumatra, the Malay Peninsula, Java and the Philippines. It has not been found in Borneo. Van Steenis (l.c.) reported its presence in Borneo; his record was based on a collection made by Jaheri (no. *790,* BO) from Sg. Dengey (=Dingei), Indonesian part of that island, which consists of two sheets. I found one very young flower, still attached to the stem, which has the stamens arranged in two series and which differs from that of *T. tomentosa* with stamens occurring in only one series. This Jaheri's collection represents a not yet described species.

I have examined many specimens of the present species, but most of them are sterile. The leaves are very variable in shape and size, and several species were described based on the leaf characters. For example, the types of the two Philippine species names, *Apama affinis* and *A. brevipes*, as cited above, seem to be different from the present one by the leaf shape and size. When more specimens were examined, their vegetative characters and especially their flower structure appeared to match those of the present species. Van Steenis (l.c.) rightly stated that these two species belong to *Apama tomentosa* (=*Thottea tomentosa*).

There are only a few specimens bearing usually rather short young fruits which are often not open. Blume (l.c.) and later botanists, for example Backer & Bakhuizen*f.* (l.c.), described the fruits of this species as indehiscent. There is one collection, *Hansen & Smitinand 11809* (L), from Thailand, bearing an open fruit with four distinct valves.

Thottea tomentosa is closely allied to *T. siliquosa* by the flowers (e.g. stamens in one series, style-lobes usually 3 and often with hooked hairs at the apical part) and to *T. paucifida* by the leaves. However, it can be rather easily distinguished from these two and other species by a combination of the following characters: 1). the stem bearing 1–5 (mostly 2 or 3) leaves at the apical part, 2). leaves densely tomentose or villous on the lower surface especially when young, 3). inflorescences near the base of the stem, 4). a cupular disk(?) adnate to the perianth tube inside and slightly protruding beyond the

apical part forming an annular ring or ridge, 5). stamens 6 occurring in one series inserted at the base around the style column, and 6). style-lobes usually 3, often with hooked hairs at the apical part.

16. Thottea triserialis Ding Hou, *spec. nov.* — **Fig. 35, 41, 42.**

Suffrutex. *Lamina* chartacea, elliptica, late elliptica vel subobovata, 23–34.5×11–23 cm, apice acuminata, basi cordata, sinu valde angusto, pagina supera glabra, infera sparse pubescens; nervis *c.* 10 paribus, venis scalariformibus vel reticulatis; petiolo 0–5 mm longo. *Inflorescentiae* axillares, apiciformis, 3–5 cm longae, pubescentes; bracteae lanceolatae raro ellipticae vel oblanceolatae, 3–10(–15) mm longae, utrique pubescentes. *Flores* subrosei brunnei. *Pedicellus* et *ovarium* 18–20 mm longum, dense pubescens. *Perianthium* chartaceum vel leviter carnosum, cupulatum, 10–15 mm longum, utrique sparse puberulum; tubus *c.* 5 mm longus; lobi semi-orbiculares, 5–10× 10–15 mm. *Stamania* triseriata, serie superiore 5–8, mediano 7–12, inferiore 12–15; filamenta hirta. *Columna stylina c.* 2 mm longa, lobi 11–20, patentes, 1.5–2 mm longi. *Capsula* (fide *S 13622*, SAR) immatura, siliquiformis, 12 cm longa, pubescens. *Semina* immatura, complanata(?).

T y p u s: Borneo. Sarawak, 1st Div., Lundu Distr., Gunong Pueh, on gentle ridge slope, with very shallow brown clayey soils derived from granite, rock surfaces exposed, alt. *c.* 1080 m, fl., *Mamit et al. S 34434* (SAR; iso in K, L).

Further specimen examined: Sarawak, 1st Div., Lundu Distr., G. Pueh, in primary lowland dipterocarp forest, alt. 600 m, *Ilias Paie S 13622* (K, L, SING, with young fl.; SAR, with one young fr.).

Thottea triserialis is very closely allied to *T. macrophylla* Becc. and *T. robusta* Steen. The leaves of these three species are similar to one another and their sterile specimens, so far, could not be identified with certainty.

The flower of this new species has the stamens arranged in three series (fig. 41). This kind of arrangement is unique, so far known, in this genus, and the specific epithet has been chosen to refer to this.

The perianth characters of this new species from Lundu District, e.g. texture, size, shape, and the lobes, are rather more like those of *T. robusta* from the Natoena Islands than those of *T. macrophylla* found near Kuching. The inner surface of the perianth looks quite different in these three species; it is seemingly rather smooth in the new species and densely hairy in the other two species; either covered with glandular hairs *(T. macrophylla)* or with mainly hooked hairs *(T. robusta)* (fig. 34–37).

There is, besides the type, another collection, *S 13622* (K, L, SAR, SING), also from Lundu, with flowers and one detached fruit (on SAR sheet). The flower has the stamens distinctly arranged in three series. The fruit is very young. The seed is seemingly flattened, but its shape could not be ascertained.

DOUBTFUL COLLECTIONS

There are three doubtful collections, all with fruits, from Sarawak: *S 15693* (Serian Dist., SAR), *Hewitt 328* (Kuching, SAR) and *Clemens 20182* (Mt Poi, A, BO, K). The seeds are broad-ovoid or oblong, 3-angular in cross-section, and tuberculate or rugose, which resemble those of *T. robusta* (Steen., Bull. Jard. Bot. Btzg III, 12, 1932, 205). The last collection as listed above has also been examined by van Steenis (l.c., p. 207) who stated that this specimen agrees entirely with his new species, *T. robusta,* but might also belong to the allied *T. macrophylla.*

There is another collection, *Haviland & Hose 3242* (K, L, SAR), obtained near Kuching, with a good fruit. It is interesting that the seed is rather smooth, flattened but longitudinally curved resembling in the appearance of a shell (fig. 67, 68). It may belong to either *T. macrophylla* or *T. triserialis,* or even a not yet described species.

Because of the lack of specimens with both flowers and fruits from the same collection, the four collections mentioned above could not be identified with certainty. More fertile material is needed.

INDEX TO BOTANICAL NAMES

New names are in bold type, synonyms in italics, accepted and other names in plain type. Page numbers in bold type refer to figures.