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STUDIES IN THE BORAGINACEAE, XXIV
A. THREE GENERA SEGREGATED FROM LITHOSPERMUM

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CONCERNED HERE are three species of the Mediterranean and adjacent areas which have been accepted as members of the genus *Lithospermum*, viz., *L. apulum* (L.) Vahl, *L. microspermum* Boiss., and *L. callosum* Vahl. These three plants share a distinctive type of nutlet, and despite their many differences appear to be more closely related to one another than to any of the other species referred to *Lithospermum*. A consideration of their characters gives reasons for treating them as three monotypic genera.

The nutlets in our three species, as compared with those of true *Lithospermum*, are rather small and have a thin pericarp. Above the small, obliquely basal attachment they have a ventral keel formed by the overlapped margins of a closed ventral suture. In contrast the thick-walled, usually much larger and more broadly attached nutlets of *Lithospermum* have the ventral suture more or less obliterated. Its margins are tightly joined, commonly more or less confluent, and not well defined nor merely overlapping. Although our plants are not closely related to *Megastoma*, *Sericostoma*, and *Echiochilon*, the behavior of the ventral nutlet-suture in that group of interrelated genera is suggestive in interpreting that in our three species. In the genera mentioned the suture may be open nearly to the nutlet apex or be closed in varying degree by the overlapping of its margins. This variation is associated with the observable changes from a narrow elongate to a broad low gynobase and the accompanying shift from a distinctly lateral to a more and more basal nutlet-attachment. The suture in our three species, closed simply by the overlapping well-defined margins, gives every evidence of being the end product of a comparable series of changes in nutlet-attachment. In other words our three species probably had immediate ancestry with distinctly lateral rather than basal nutlet-attachment. In contrast, bony basifixed nutlets having the ventral suture obscured or obliterated by fusing and confluence of the seam-margins are present not only in true *Lithospermum* but also in a wide circle of obviously related genera, including such diverse plants as *Onosma*, *Cerinthe*, *Echium*, *Alkanna*, etc. This type of nutlet is a stabilized one and characteristic of a large and obviously old group of genera. It is not one from which the nutlets of our three species could have been derived. The indications are, therefore, that our plants are not directly related to *Lithospermum* or its immediate relatives.

Although having nutlets of a similar basic type, the three species differ from one another in many significant details, and each of them has one or more unusual developments that separate it from all species of *Lithospermum* as well. There seem the best of reasons, hence, for giving each of them generic recognition. Their salient characters are revealed in the following synopsis.

Moltkiopsis. Calyx circumscissile at the base. Corolla blue, evidently longer than the calyx, hairy outside, glabrous inside except for hairs on the swollen annular nectary low in the tube. Stamens affixed high in the corolla, two of them having shorter filaments and a slightly lower attachment than the other three, filaments much longer than the anthers. Pollen ellipsoid, 25–30 × 20–25 μ, in lateral profile with sides convex or nearly straight or with one of the sides obscurely angled, broadest at the middle; pores three, about the equator. Style elongate, more or less exserted; stigma obscurely bilobed. Nutlets smooth and shiny, somewhat asymmetric, straight. Plant a suffruticose perennial with pallid, pungently bristly foliage and white exfoliating bark on the older stems; cymes small.

Mairetis. Calyx tubular, elongate. Corolla blue, very small, scarcely longer than the calyx, with a villulose band inside at the base of the tube but otherwise completely glabrous; nectary not developed. Stamens affixed at equal heights high in the corolla, filaments twice as long as the anthers. Pollen spherical, 30–33 μ in diameter, with usually eight equatorial pores. Style reaching up to the corolla-throat; stigma simple. Nutlets sparsely warted, nearly straight. Plant an annual herb with inconspicuously bracted cymes.

Neatostema. Calyx divided. Corolla yellow, very small, the lobes minutely puberulent, throat with a continuous or broken band of hairs, inside of the tube villulose and bearing a ten-lobed, more or less hairy basal nectary. Stamens borne just above the nectary very low in the corolla; filaments much shorter than the anthers. Pollen ellipsoidal, 25–30 × 23–26 μ, in lateral profile with sides slightly angled, broadest at the middle; pores eight, equatorial. Style very short, less than half the length of the corolla; stigma bilobed. Nutlets very coarsely warted, angulate, bent. Plant an annual herb with conspicuously bracted cymes.

Moltkiopsis, *gen. nov.* BORAGINACEAE — LITHOSPERMEAE.

Calyx 5-partitus subsessilis maturitate sub basim loborum circumscissus, lobis lanceolatis conniventibus. Corolla caerulea elongata anguste tubuloso-infundibularis extus villulosa intus (nectario excepto) glaberrima, lobis aequalibus adscendentibus oblongis vel ovatis apice rotundatis, fauce ampliata nuda nullo modo appendiculata vel glandulifera, tubo elongato basim versus nectario annulato tumido non rariter sparse villuloso praedito. Stamina e fauce corollae breviter exserta fere ad apicem tubi corollae inaequaliter inserta, filamentis inaequalibus, duobus antheris aequilongis altitudine sinus corollae attingentibus, tribus antheris sesquilongioribus altitudine supra medium lobis corollae attingentibus, antheris oblongis medio-affixis aequalibus apice rotunda. Pollinia ellipsoidea medio poris 3 donata. Stylus filiformis tarde exsertus stamina evidenter vel vix superans. Stigma depresso-capitatum simplex vel obscure bilobatum. Nuculae saepe 2 vel 3 laeves nitidae lanceo-ovoideae subasymmetricae apice acutae basi angustatae truncatae cicatrice plana parva transverse elliptica donatae dorso et latere rotundatae ventre angulatae. Carina ventralis nuculae margines sulci longitudinali clausi imbricata sed haud confluentes composita. Gynobasis depressa subplana. — Planta humilis perennis suffruticosa ramosa hirsuta. Caules plures erecti cortice albo vetustiore exfoliato obtecti. Folia pallida alterna. Cymae terminales abbreviatae bracteatae. Flores caerulei. — Nomen derivatur a *Moltkia* et ὄψις, habitus, propter similitudinem cum genere *Moltkia.*

Moltkiopsis ciliata (Forsk.) comb. nov.

Lithospermum ciliatum Forsk. Fl. Aegypt.-Arab. 39 (1775); C. Christensen, Dansk Bot. Ark. **4**^{3}: 14 (1922).
Moltkia ciliata (Forsk.) Maire, Cat. Pl. Moroc. **4**: 1102 (1941).
Lithospermum angustifolium Forsk. Fl. Aegypt.-Arab. 39 (1775).
Lithospermum callosum Vahl, Symb. Bot. **1**: 14 (1790). — A renaming of *L. angustifolium* Forsk.
Moltkia callosa (Vahl) Wettst. Oesterr. Bot. Zeit. **67**: 368 (1918).
Lithospermum callosum var. *asperrimum* Bornm. Mitt. Thüringisch. Bot. Verein **6**: 58 (1894).

This desert plant, which ranges across northern Africa and east to Iran, has by some been treated as a member of *Moltkia* but by most botanists accepted as a species of *Lithospermum.* Its nutlets, as well as its triporate pollen and circumscissile calyx, distinguish it quickly from all members of both genera. Because of its fruticulose habit and elongate blue corollas its gross habit is most suggestive of *Moltkia.* Its corollas, however, differ from those of *Moltkia* in a number of important details. They are hairy rather than glabrous outside. They have a well-developed nectary in the tube. They bear stamens of two sizes, not at a single but at two levels in the throat. The stamen-attachment is of special interest. As in *Alkanna,* two of the five stamens have filaments shorter and attached slightly lower in the corolla-throat than the other three. Unlike *Alkanna,* however, the two shorter and lower stamens are not juxtaposed nor are they abaxial. They are separated by a long stamen and appear to represent the two adaxial lateral members of the androecium. They are not abaxial laterals as in *Alkanna.* The behavior of the calyx in *Moltkiopsis* is also unusual. As the fruit approaches complete maturity the calyx becomes circumscissile just above the base, its connivent lobes drop away, and the ripe nutlets are completely exposed. After the nutlets are shed all that remains of the flower on the old inflorescence is the knob-like base of the subsessile calyx and the flattened gynobasic surfaces on its truncate summit. This condition is unique among the herbaceous Boraginaceae.

Over most of its wide range the plant has blue subtubular corollas

10–15 mm. long. No evidence of cleistogamy has been detected. The only striking variation noted in the flower is that present among some, not all, plants collected in the region about the Persian Gulf. In these the corollas are very small (3–7 mm. long), the anthers are imperfectly developed, and the style is very short (2.5–6 mm.). The cymes on such plants tend to be very slender, the flowers very crowded, and the bracts unusually small. Although they appear to have functional stigmas, no fruit has been found on plants producing the small crowded flowers described. The condition described may be the result of virus infection. Possibly also it might be an expression of gynodimorphism comparable to that known in *Echium vulgare* and *Anchusa officinalis*. In those species occasional individuals produce not the normal hermaphrodite flowers, but only small functional female ones. Representatives of the small-flowered form of *Moltkiopsis* have been seen from Bushir, southern Persia, 1868, *Haussknecht* (Brit. Mus.), Bahrain Island, *Fernandez 489* (Kew), and Kuwait, *Dickson 224* (Kew).

Mairetis, gen. nov. BORAGINACEAE — LITHOSPERMEAE.

Calyx elongatus secus costas sparse hirsutus alibi sparse strigosus fere ad medium lobatus, sub anthesin subsessilis corolla paululo brevior tertiam partem inferioribus tubulosus, lobis erectis gracilibus donatus, in statu fructifero 4–5-plo accrescens breviter pedicellatus tubo quam lobis erectis cuneatis 1–2-plo longiore donatus. Corolla minuta symmetrica extus glaberrima, lobis caeruleis erectis vel adscendentibus longitudine corollae 6–7-plo brevioribus, fauce brevi glabra subcampanulata nullo modo appendiculata vel glandulifera, tubo elongato flavo intus basim versus villuloso alibi glabro nectarium haud gerenti. Stamina in fauce corollae aequaliter affixa apice altitudine basim sinus corollae attingentibus; filamentis aequalibus linearibus antheris duplo longioribus; antheris ellipticis vel oblongis apice mucronulatis infra medium affixis, thecis infra medium liberis et laeviter divergentibus. Pollinia globosa secus aequatorem poris saepe 8 donata. Stylus filiformis altitudinem staminum attingentibus in statu fructifero nuculis longioribus, stigmate capitato haud lobato abundanter papillato. Nuculae saepe 4 cinereae rosaceaeve sparse sed distincte verrucosae ovato-lanceolatae dorse latereque rotundae ventre obtusae carinatae (carina margines sulci longitudinali clausi imbricatas sed haud confluentes composita) basi angustatae cicatrice obliqua parva transverse elongata donatae. Gynobasis plana vel laeviter concava. — Planta annua herbacea erecta strigosa. Folia parva alterna. Cymae multibracteatae terminalis scorpoideae, maturitate elongatae secundae inconspicue bracteatae. Corolla minuta fauce et limbo caerulea, tubo flavo. — Nomen, derivatum a Maire et τις, datum est in honorem cl. René Maire (1878–1939), optime de flora Africae septentrionalis praesertim Moroccae meritae.

Mairetis microsperma (Boiss.), comb. nov.

Lithospermum microspermum Boiss. Diag. ser. 2, 3: 135 (1856) and Fl. Orient. **4**: 218 (1875).

Lithospermum Webbii Coss. & Dur. Bull. Soc. Bot. France **22:** 64 (1875). nomen; Ball. Jour. Linn. Soc. Bot. **16:** 574 (1878), nomen in syn.

A monotypic genus known only from Morocco and the Canary Islands. The plant is especially notable for its elongate tubular fruiting calyces. At anthesis the calyx is tubular for about a third of its length. At maturity it is greatly accrescent, several times longer than broad and tubular for a half to two-thirds its length. The nutlets, hence, are matured at the bottom of a deep investing calyx-tube. Among some anchusoid borages calyx-tubes are well developed. It is, however, a condition rare among other herbaceous borages and is entirely unknown in ***Lithospermum*** or any of the closely related genera. The stigma is also unusual. It is capitate and terminal and unlike the stigmas usually developed in the ***Lithospermeae*** is not only simple but shows no suggestion of lobing.

Although very distinct, ***Mairetis*** seems to have its closest relationship with *Neatostema* and *Moltkiopsis*. As to annual habit and roughened nutlets it is most like *Neatostema*. Its corolla, because of its color, elongate form, long filaments, and elevated stamen-attachment, is suggestive of that of ***Moltkiopsis***, although very different in size. The tiny corolla, scarcely longer than the calyx, is completely glabrous except for hairs low inside the tube on the site of the undeveloped nectary. The stamens are affixed at equal height low in the small corolla-throat and have filaments of equal length. The position of the stamen-attachments is usually marked by small depressions on the outer surface of the corolla.

Neatostema, gen. nov. BORAGINACEAE — LITHOSPERMEAE.

Lithospermum § *Oxyspermum* Visiani, Fl. Dalmatica **2:** 246 (1847).

Calyx 5-fidus, maturitate accrescens, lobis calycis fructiferi conniventibus conspicue costatis. Corolla anguste infundibuliformis symmetrica extus villulosa, lobis adscendentibus vel patentibus ovato-oblongis apice rotundis utrinque minutissime abundanterque glanduloso-puberulentis, fauce nullo modo appendiculato vel glandulifero pilis in annulo circumferentialiter angusteque dispositis vel in locis 5 congestis praedito, tubo intus villuloso supra basim nectarium 10-lobatum villulosum gerenti. Stamina 5 basim versus tubi corollae paulo supra nectarium aequaliter affixa; filamentis perbrevibus antheris 4-plo brevioribus, antheris parvis oblongis utroque obtusis rotundisve vel rare basi retusis infra medium affixis. Pollinia ellipsoidea medio poris 8 donata. Stylus brevissimus antheras haud superans maturitate nuculis duplo brevior, stigmate terminali bilobato lobis subglobosis. Nuculae saepe 4 brunneae angulatae evidenter verrucosae paulum curvatae utroque angustatae basi cicatrice parva obliqua donatae dorse convexae saepe verruculis longitudinaliter 4-serratis ornatae ventre obtusae. Carina ventralis nuculae margines sulci longitudinali clausi imbricatas sed haud confluentes composita. Gynobasis fere plana perdepresse pyramidali. — Herba annua hispida erecta humilis. Folia parva alterna. Flores parvi flavi in cymas terminales densas foliaceo-bracteatas mox elongatas scorpioideas dispositi. — Nomen derivatur a *νέατος*, infimus, et *στήμα*, stamen, quod stamina basim versus corollae affixa sunt.

Neatostema apulum (L.), comb. nov.

Myosotis apula L. Sp. Pl. **1:** 131 (1753).
Lithospermum apulum (L.) Vahl, Symb. Bot. **2:** 33 (1791); Stroh, Beih. Bot. Centralb. **58** ^{b}: 204 (1938).
Rhytispermum apulum (L.) Reichenb. Icon. Fl. Germ. **18:** 67, t. 1313, f. 8–14 (1858).
Lithospermum apulum f. *cleistogamum* Murbeck [Contr. Fl. Moroc. **2:**] Lunds Univ. Årsskrif. n. f. Avd. 2, **19**(1): 23 (1923).

A well-known plant widely distributed about the Mediterranean and eastward to Mesopotamia. It also occurs on the Canary Islands. Its corollas are distinctive. The stamens, on very abbreviated filaments, are borne just above the basal nectary in the tube and hence extremely low in the corolla. The corolla-throat has no intruding appendages but does have five small densely villous spots, or the latter more or less united to form a narrow villose band. The corolla-lobes on both surfaces are microscopically glanduliferous and velvety-puberulent. The tube is hairy on the inner as well as outer surface. The style is extremely short and at maturity is greatly overtopped by the nutlets. The nectary is very well developed and consists of ten projecting somewhat villulose closely juxtaposed quadrate lobes.

The nutlets are coarsely roughened and angulate. One of their distinctive features is the development of two adjacent paralleling lines of warts down the middle of the dorsum. The body of the nutlet is somewhat bent and the attachment appears to be oblique and suprabasal. Dissection shows, however, that inside the nutlet the tip of the cotyledons is directly above the attachment-surface. Whatever the appearance, the attachment is morphologically basal. As in *Mairetis*, the gynobase of *Neatostema* is flat or slightly higher in the middle and hence very depressed pyramidal. At extreme maturity, as a result of shrinkage of tissue, the gynobase may actually become lowest at the center.

Another rather unusual feature of *Neatostema* is the frequent development of cleistogamic flowers. Such flowers have tiny obconic corollas which eventually fall off unopened. Their calyx and fruit, as well as the cymes in which they are borne, are normal in appearance. Cleistogamy is known among a few American species of *Lithospermum* but has not been reported in the Old World species of the genus nor in related genera.

The expanded pollen grains of this genus are not unlike those of various species of *Lithospermum* and related genera, but the behavior of the dry grains as they expand in lactic acid is very different. In lactic acid the grains first become cylindric and because of their low-convex polar ends are almost oblong in lateral profile. Their most distinctive feature at this stage, however, is a localized strong deep narrow constriction halfway between the poles. In this well-marked deep equatorial groove the pores appear as eight sac-like depressions. These features all disappear as the grains swell to full size. The expanded grain is ellipsoidal, broadest at the equator, and in lateral profile with the sides slightly angulate.

B. SUPPLEMENTARY NOTES ON LITHOSPERMUM

DURING the past summer I had the opportunity of visiting Kew, London, and Paris, and examining the representation of *Lithospermum* in the large herbaria there. Through the courtesy of the curators, critical specimens of the genus which I selected were subsequently loaned me for close study at the Arnold Arboretum in conjunction with other critical specimens kindly sent at my request from Vienna. While preparing my recent paper on *Lithospermum*, Journal Arnold Arboretum 33: 299–366 (1952), I had no material available of two Afghan species, *Arnebia inconspicua* Hemsl. & Lace and *A. speciosa* Aitch. & Hemsl., nor was I aware that Dr. Rechinger had just published several closely related species also from Afghanistan. Material from the sources previously mentioned now makes it possible to describe and discuss these plants. Having seen more specimens, it is also possible to modify and extend my previous descriptions of a few other Asiatic species. Unhappily, a change of name for one of the most widely known species in the genus must also be recorded.

Lithospermum cyrousianum (Parsa), comb. nov.

Arnebia cyrousiana Parsa, Kew Bull. **1948**: 211 (1948).
Arnebia echioides (L.) DC. Prodr. **10**: 96 (1846).
Lithospermum Tournefortii Johnston, Jour. Arnold Arb. 33: 336 (1952).

The type of *Arnebia cyrousiana*, in the Kew Herbarium, has been studied. Its corollas have been dissected and its pollen examined. The specimen has all the characters of the plant well known to gardeners as *Arnebia echioides*, and at most is only a minor phase of the same species. The single plant mounted on the type-sheet has long-styled flowers, but both short- and long-styled corollas are represented in the pocket associated with it. Of all the synonyms of *Arnebia echioides* only Parsa's binomial has a specific epithet that can be used when the species is transferred to the genus *Lithospermum*. The binomial *Lithospermum cyrousianum* must replace *Lithospermum Tournefortii*, the name recently proposed by me when I was unaware of the identity of Parsa's species.

Lithospermum fimbriopetalum (Stocks) Johnston, Jour. Arnold Arb. 33: 326 (1952).

Arnebia fimbriopetala Stocks in Hooker, Jour. Bot. & Kew Miscl. 3: 180, t. 6 (1851).
Arnebia Bungei Boiss. Fl. Orient **4**: 215 (1875).
Lithospermum Bungei (Boiss.) Johnston, Jour. Arnold Arb. 33: 326 (1952).

Annual herb 5–15 (–40) cm. tall, sparingly branched. Leaves thickish, sparsely hairy or glabrous on the lower surface. Flowers heterostylic. Corolla yellow, 25–30 mm. long; limb 10–20 mm. broad, the lobes broad, rounded, margins distinctly lobulate or lacerate; throat bearing no glands nor appendages; tube slender, 20–24 mm. long, surpassing the calyx 5–8 mm., above the base inside bearing a membranous more or less hairy collar-like nectary 0.5–1 mm. high. Style slender, forked at apex, lobes 0.5 mm. long. Stigmas 2, compressed, as broad as long, obscurely bilobed. Long-styled flowers with corolla-tube cylindric, abruptly enlarging in diameter 6–8 mm. below the summit; anthers 2–2.3 mm. long, borne low in the upper third of the corolla-tube; pollen moderately constricted at the middle, 42–50 × 28–33 μ; style almost as long as the corolla-tube. Short-styled flowers with the tube gradually ampliate; anthers 2–2.3 mm. long, borne at summit of tube with their upper third exserted into the throat; pollen with sides straight and parallel or slightly concave, 46–56 × 33–41 μ; style two thirds as long as the corolla-tube. Calyx 15–17 mm. long at anthesis (with linear lobes), becoming very strongly accrescent (with lanceolate or ligulate lobes) in fruit, at maturity 25–30 mm. long with the major lobes 3–5 mm. broad near the base, glabrescent with the midrib and a few veins becoming evident, at times with papillate excrescences on the midrib of the lobes near the base. Nutlets olivaceous or rubiginous, tuberculate, 3–3.5 mm. long, 3 mm. broad at the base, beaked above the middle, lower half of dorsum swollen on either side of a broad medial depression, upper half with a low rounded medial keel, venter angulate, attachment-surface broadly triangular, basal. Gynobase very depressed.

BALUCHISTAN: Upper Baluchistan, *Stocks 977* (Kew, TYPE of *A. fimbriopetala*); Gival, 5–6000 ft., 6/5, *A. V. Monro* ex Duthie (Kew).

PERSIA: 20 mi. from Isphan on Shiraz road, 6000 ft., open hills, Apr. 1944, *A. C. Trott 906* (Kew); pr. Sser-tschah, March 12, 1859, *A. Bunge* (G, ISOTYPE of *A. Bungei*).

A careful study and comparison of the above cited collections has shown conclusively that *Arnebia fimbriopetala* and *A. Bungei* are conspecific. The species is most closely related to *Lithospermum detonsum* of northern Persia and Transcaucasia, agreeing with that more northern and western plant in habit of growth, in large, much accrescent calyces, and in size, form, and markings of nutlets. It differs sharply from *L. detonsum* in several respects. Unlike that species its flowers are decidedly heterostylic. Furthermore, its corollas are not merely larger but also have a more elongate tube, conspicuously longer than the calyx, and lobes that are not entire but evidently lobulate or lacerate-fimbriate on the margin.

Lithospermum Szechenyi (Kanitz) Johnston, Jour. Arnold Arb. 33: 330 (1952).

My previous description of this species was based on a collection with short-styled flowers from Hsuin Hwa, Kansu (*R. C. Ching 731*), supplemented by the original description (of a long-styled plant) given by Kanitz. Additional information concerning this species of western China is now available through the study of three collections made by Father Licent. These were obtained at Ta-la-chi, Kansu (ca. 150 km. n. e. of Lanchow), no. *4017*, and at Sain-Nor, at the base of the Scharanarin-ula [Khara-narin ula] northwest of the Ordos in southern Inner Mongolia, almost 600 km. north-northeast of Lanchow, nos. *13612* and *13621*. The first collection, at the British Museum, contains both long- and short-styled flowers. Of the two other collections, both at Paris, *Licent 13612* is a short-styled plant with fruit; *Licent 13621* is the long-styled plant. These collections of Licent are less robust plants than those previously described, having noticeably more slender stems and narrower leaves. Their stems, 2.5 mm. thick at the base, are 2–4 dm. long and may become decumbent. The largest middle cauline leaves are 2–2.5 cm. long and only 5 mm. broad. The bracts in the cymes are elongate, foliaceous, and broader than the calyx-lobes. The corollas are 16–19 mm. long and retain evidences of having been yellow and provided with evanescent dark spots. The corolla-tube is 11–14 mm. long. There are no glands on the inner surface of the throat as reported previously. The style is not forked at the apex. Its two stigmas are terminal and juxtaposed. In the short-styled flowers the corolla-tube is gradually ampliate, the anthers (3 mm. long) are borne at the summit of the tube and partially exserted into the throat, the pollen ($39–43 \times 25–26\mu$) is barrel-shaped, having rounded ends and sides that are parallel or only very slightly concave; the style reaches up to the middle of the corolla-tube. In long-styled flowers the cylindric corolla-tube has a slight but distinct increase in diameter just above the middle, the anthers (1.3–2 mm. long) are borne at the middle of the corolla-tube, the pollen ($30–33 \times 16–20\mu$) is evidently constricted at the middle, and the style reaches up into the corolla-throat. The mature nutlets, 2.5 mm. long and 1.5 mm. broad, are weakly constricted just above the base and are abundantly tuberculate. Some of the wart-like roughenings are rounded but others bear a minute point or short stout hair and can almost be described as muricate. The attachment surface of the nutlet is broad, flat, and obliquely basal. The venter of the nutlets is angulate. The dorsum is rounded and obscurely keeled only towards the apex.

Lithospermum Hancockianum Oliver in Hooker, Icones 25: t. 2457 (1895); Johnston, Jour. Arnold Arb. 33: 354 (1952).

Among some duplicates recently received from Paris are six hitherto unstudied collections of this remarkable species from eastern Yunnan. They provide more numerous and better corollas for dissection than were previously available to me. I am, accordingly, able to correct and emend my previous description of the plant. The species appears to have weakly dimorphic flowers. The ten collections at hand sort into two types. One has the style evidently exserted from the corolla-tube, usually 3–5 mm., and the other has the style equaling the tube in length or 1–2 mm. shorter. In both types the anthers (1.5–1.7 mm. long) are borne at the summit of the corolla-tube. Those in the long-styled flowers tend to have their tips reaching only to the summit of the corolla-tube, while those in short-styled flowers tend to have the upper third of their length projecting above it. All the flowers on a given plant appear to belong to one or the other of these two types. There is no accompanying difference in pollen. Minute stipitate glands are abundant on the corolla-tube behind the anthers, in a band extending 1 mm. below to 1 mm. above the filament-attachments. They occur sparingly in the tube as far down as 5 mm. below its summit. The filaments are broadly affixed, attenuate, and laterally compressed and accordingly unguiculate. The style is perceptibly forked at the extreme apex, and its two oblong stigmas may become divergent. The glabrous nectary in the tube is not continuous but made up of ten projecting, closely juxtaposed quadrate lobes. The nutlets are white, smooth, sparingly pitted, stout pointed ovoid, 2.5–3 mm. long and 2 mm. thick. They have a lineate constriction just above the broad obliquely basal attachment-surface. The dorsum is convex and is keeled only near the apex. The venter is angulate and evidently keeled. The gynobase is depressed pyramidal.

Lithospermum Lindbergianum (Rech. f.), comb. nov.

Macrotomia Lindbergiana Rech. f. Ann. Naturhist. Mus. Wien **58**: 58 (1951).

Plant perennial, with a stout taproot crowned by a small caudex; branches of caudex short, stout, clothed with persistent leaf-bases. Indumentum cinereous, composed of numerous very slender, usually spreading bristles 2–5 mm. long and an abundance of very minute, frequently retrorse hairs 0.2–0.5 mm. long. Flowering stems 4–6 cm. long, erect, slender, simple, 1–2 mm. thick at the base, arising from the center of a cluster of functional leaves, terminated by the inflorescence. Leaves with an evident midrib, veinless; basal ones linear-oblanceolate, becoming 4 cm. long, 2–3 mm. broad below the acute apex; cauline leaves few, attenuate, gradually reduced up the stem, uppermost 2–3 cm. long, 1.5–2 mm. broad near the middle. Inflorescence a dense capitate terminal cluster ca. 4 cm. in diameter, comose from an abundance of slender protruding sepals; bracts shorter than the calyx. Calyx at anthesis 23–24 mm. long, hispid; lobes linear-attenuate and more or less flexuous, 21–22 mm. long, 0.8 mm. broad at the base, surpassing the corolla 2–4 mm. Calyx in fruiting state 30 mm. long, inside below the middle densely appressed white villose. Flower heterostyled with only the short-styled form known. Corolla 19–21 mm. long, slender and elongate, abundantly pubescent outside, inside glabrous except on the nectary; tube 16–17 mm. long, ca. 1.5 mm. thick for most of its length, upper 3 mm. of length swollen (and staminiferous) and 2–2.5 mm. thick, slightly constricted at the very summit, inside just above the base bearing a distinct membranous collar-like nectary 0.3–0.4 mm. high which is sparsely villulose on the inner face; throat funnelform, short, 2–3 mm. long, sparingly glanduliferous inside; limb ca. 4 mm. broad, composed of ascending triangular-ovate lobes ca. 1.7 mm. wide and 2 mm. long. Anthers 2.5 mm. long, borne just below the summit of the corolla-tube. Pollen 33–35 × 25–26 μ, in lateral profile with the sides parallel or practically so. Style 11–12 mm. long, reaching up to slightly above the middle of the corolla-tube, forked at the summit, the lobes 0.8–1 mm. long; stigmas 2, unequal, spathulate. Nutlets (only sub-mature ones seen) erect, lanceolate, 3.5 mm. long, 2.5 mm. broad below the middle, surface dull, densely and very minutely papillate, venter with prominent keel, dorsum with an obscure partial keel and probably irregularly tuberculate when completely mature, attachment broad and obliquely basal. Gynobase depressed pyramidal.

AFGHANISTAN: Bamian, Ajdaha, May 24, 1947, *K. Lindberg s.n.* (TYPE, Vienna).

This very distinct species is known only from a single collection obtained in the mountains about 100 km. northwest of Kabul, Afghanistan. Judging from the totality of its characters the plant is evidently a member of the group of species containing *L. Benthami, L. superbum, L. nobile* and *L. euchromon.* It comes from the same floristic area and has very similar elongate corollas with purpurescent limb. It differs from all these relatives in the small size of the plant and in having a well-developed collar-like nectary low in the corolla-tube. The nectary is especially noteworthy. In the related species mentioned the corolla-tube bears no nectary nor any rudiment of one such as tufts of hairs nor discolored or slightly swollen tissue. Those authors who have assigned such species to the segregate genus *Macrotomia* have usually laid great stress on the absence of a nectary. Though the present species in all other technical characters, as well as in general appearance, gives every evidence of close affinity with the species mentioned, it would be divorced from them in any classification in which the presence or absence of a nectary is made arbitrarily into a crucial character. We have here, in fact, further evidence that *Macrotomia* is neither a natural nor useful segregate; cf. Jour. Arnold Arb. 33: 313 (1952).

The present species agrees with its obvious relatives not only in the form of the corolla but also in the type of coloration. The corollas found on herbarium specimens of these species show no evidence of decided orange or yellow coloration so common in other groups of the genus. In drying they tend to become brownish, pinkish, or whitish, but in most inflorescences some are to be found having purple or purplish lobes and throat. The indications are that the corollas of this group of species have striking color-changes associated with the state of maturity. A collector of *L. nobile* reports the corollas as at first dark brown but later yellow. Aitchison, Jour. Linn. Soc. 18: 19 (1880), states that *L. euchromon* is "remarkable for its flowers varying from greenish yellow to deep purple-black." Although collectors of *L. inconspicuum* report the corollas as creamy or pale yellow, some of the corollas on their dried specimens have decidedly purple or purplish throat and limb.

The five species most closely related to *L. Lindbergianum* are distinguished from it in the following key:

Inflorescence globose or broader than long; leaves with midrib only.
  Corolla with a well-developed collar-like nectary in the tube; stems less than

1 dm. tall, arising from the center of a leaf-cluster; leaves narrow, 2–3 mm. broad; calyx linear-attenuate as much as 0.8 mm. wide at base .... *Lithospermum Lindbergianum.*

Corolla without a nectary in the tube.

Plant gray or silvery, the herbage not glanduliferous; calyx-lobes subulate-linear, 1 mm. wide at base; corolla with stipitate glands in the throat; stems less than 1.5 dm. tall, arising from the center of a basal leaf-cluster; leaves less than 5 mm. broad .... *Lithospermum inconspicuum.*

Plant green or somewhat tawny, the herbage usually glanduliferous; calyx-lobes lanceolate, 1–3 mm. broad; corolla without glands in throat; stems to 4 dm. tall, arising lateral to the basal cluster of leaves; leaves usually 5–10 mm. broad. .... *Lithospermum euchromon.*

Inflorescence elongate, a cylindrical thyrse evidently much longer than broad; lower leaves with 3–5 evident longitudinal ribs.

Thyrse continuous, with numerous exserted bracts; calyx-lobes very slender and flexuous. .... *Lithospermum Benthami.*

Thyrse interrupted, only the lowermost bracts protrudent; calyx-lobes stiff.

Basal leaves hispid; corolla hairy outside, not glanduliferous .... *Lithospermum speciosum.*

Basal leaves strigose; corolla glanduliferous but usually otherwise glabrous .... *Lithospermum nobile.*

Lithospermum inconspicuum (Hemsl. & Lace), comb. nov.

Arnebia inconspicua Hemsl. & Lace, Jour. Linn. Soc. **28:** 326 (1891).
Arnebia argyrea Rech. f. Ann. Naturhist. Mus. Wien **58:** 59 (1951).

Plant with herbage and stems pale and somewhat silvery from a dense mostly appressed indument composed of abundant pallid hairs of two sizes, coarse hairs 1–2 mm. long and minute very slender hairs 0.2–0.5 mm. long; perennial with a rather dense caudex formed of crowded branches ensheathed by old leaf-bases. Leaves firm, oblanceolate, 1–5 cm. long, 2–5 mm. broad, with evident midrib but no veins. Stems arising from the center of a leaf-rosette, usually 3–15 cm. long, 1–3 mm. thick at the base, simple, terminated by the capitate inflorescence, rarely much reduced in length and bearing the inflorescence in the center of the leaf-rosette. Middle and upper stem-leaves not numerous, not conspicuously smaller than the basal leaves. Cymes congested into a dense terminal capitate cluster 1.5–3.5 cm. in diameter at anthesis. Inflorescence lacking conspicuous bracts but frequently with some of the uppermost stem-leaves crowded at its base, rarely developing a small secondary cluster of cymes in leaf-axils below the major terminal cluster. Calyx 12–17 mm. long; lobes subulate-linear, 10–16 mm. long, ca. 1 mm. broad at the base, reaching up to the throat of the corolla. Flowers heterostylic. Corolla narrow and elongate, 12–19 mm. long, surpassing the calyx 2–3 mm., whitish or yellow, frequently somewhat purpurescent in drying, outside evidently appressed hairy, inside glabrous or with scattered hairs on the corolla-lobes; limb ascending, 2.5–4.5 mm. broad; tube-nectary not developed; throat short, ca. 2 mm. long, funnelform; lobes ascending, acute, ovate-triangular, 1–2 mm. long; throat somewhat glanduliferous, at least in the short-styled flowers; tube 9–14 mm. long, in long-styled flowers cylindric 12–14.5 mm. long and 2 mm. thick, in short-styled flowers 1–1.5 mm. thick below the middle and above very gradually broadening into the throat. Anthers 2 mm. long, borne on very short filaments either above the middle of the corolla-tube or in the corolla-throat. Pollen of short-styled flowers 40–43 × 24–28 μ, in lateral profile with sides straight and parallel or at most only slightly concave. Style evidently forked (branches slightly unequal), reaching to slightly above middle of corolla-tube or into the corolla-throat, short styles ca. 7 mm. long with lobes 1 mm. long, long styles ca. 15 mm. long with lobes 2–3 mm. long. Stigmas 2, distinct, compressed, nearly as broad as long. Fruiting state of plant and its fruit unknown.

BALUCHISTAN: Zahru, *Stocks 866* in pt. (Kew); without locality, 1891–94. *C. F. Elliott* (Kew).

AFGHANISTAN: Kabul, Gul Tara, fl. creamy white to yellow, *Neubauer 364* (Vienna); Cabul, *H. Collett 18* (Kew); Nozi, fl. pale yellow, 10000 ft., *W. Koelz 12015* (Vienna, TYPE of *A. argyrea*); Obeh, 1600 m., *M. Köie 4403* (Vienna); Tscharikar, Top Tara, *Neubauer 610* (Vienna); Jagdalek, fl. pale yellow, 7000 ft., *Koelz 11485* (Vienna).

A very distinct and readily recognizable species notable for its rather silvery indument and dense capitate inflorescence. Evidently a member of the same group of species as *L. Benthami* and *L. euchromon*, although not obviously related to any particular member of it. In technical characters it departs from all its allies in having stiputate glands on the inner surfaces of the corolla-throat.

Lithospermum speciosum (Aitch. & Hemsl.), comb. nov.

Arnebia speciosa Aitch. & Hemsl. Proc. Linn. Soc. **18:** 81 (1880) and **19:** 179. t. 24 (1882).

Plant perennial, coarse, very bristly. Stems simple, erect, becoming 4 dm. (6 dm. fide Aitch. & Hemsl.) tall and 8 mm. thick at the base, arising from the center of the basal leaf-cluster, hispid, its bristles 2–4 mm. long and towards the base of the stem retrorsely deflexed but elsewhere widely spreading. Leaves firm, those below the middle of the stem with three strong longitudinal ribs, hispid, the hairs 1–2 (–3) mm. long, slender, stiff, spreading to ascending and sometimes retrorse, those on the upper leaf-surface arising from minute discoid bases. Basal leaves to 10 cm. (15–25 cm. fide Aitch. & Hemsl.) long, narrowed above the broad sheathing dye-stained base, broadest (7–10 mm.) above the middle and then gradually narrowed to the acute apex. Cauline leaves gradually reduced up the stem, the middle ones lanceolate, 5–7 cm. long, 5–8 mm. broad near the base. Inflorescence an elongate interrupted cylindrical thyrse, 15–25 cm. long, 5–7 cm. thick, composed of a small terminal cyme and 10–15 slightly larger short-pedunculate cymes borne in the leaf-axils along the upper half of the stem. Cymes densely flowered, at first glomerate and 3–5 cm. broad, but in age tending to elongate and become evidently scorpioid (and eventually perhaps 4–7 cm. long); bracts shorter than the adjacent calyces; subtending leaves surpassing only the lower cymes. Calyx hispid, 17–18 mm. long at anthesis, 21 mm. long in fruit, if bearing stipitate glands these very few and inconspicuous; lobes ca. 15 mm. long, 1.5–2 mm. broad near the base, reaching up to the tip of the corolla-lobes or surpassing them 1–2 mm. Flowers heterostylic, but only the short-styled form seen. Corolla 16–17 mm. long (20–24 mm. fide Aitch. & Hemsl.), elongate, outside evidently hairy, especially on the lobes, bearing few if any stipitate glands, inside glabrous and devoid of basal nectary; tube 13 mm. long, 1.2 mm. thick at the middle, above gradually ampliate and becoming 3 mm. thick at the summit; throat short and broad; limb about 7 mm. broad, lobes ascending, 2.5 mm. broad and 2 mm. long, apex rounded. Anthers 2 mm. long, borne at the summit of the tube and partly exserted into the throat. Pollen (poor condition) 39–42 × 23–28 μ, sides evidently concave, pores 6 at each end. Style 5 mm. long, reaching up to the middle of the corolla-tube, obscurely forked at the apex, lobes ca. 0.3 mm. long. Stigmas 2, compressed, broader than long. Nutlets gray or brown, erect, 4–5 mm. long, attached obliquely by the broad base to a low-pyramidal gynobase, with a narrow very prominent ventral keel, apex truncate and sometimes toothed, back 2–3 mm. broad below the middle, then narrowed to the laterally compressed apex, usually with evident longitudinal ridges paralleling the dorsal keel, surface minutely tuberculate and irregularly verrucose.

PAKISTAN: hill behind Kaiwas, Kurrum Valley, 9–12000 ft., open grassy spots, July 3, 1879, *Aitchison 720* (TYPE, Kew).

I know this species only from the type specimen which is described above. The plant is related to *L. Benthami* of the Himalayas of northwestern India and Kashmir and to *L. nobile* of the high transverse ranges of eastern Afghanistan. It seems to be more like *L. Benthami*, with which it agrees in nutlets and pollen. It differs, however, in being clothed in stiffer, more spreading hairs and in having broader, stiffer, non-flexuous calyx-lobes and a not continuous but distinctly interrupted thyrse with not numerous but few if any salient bracts. From *L. nobile* it differs in the form of nutlets, smaller pollen, lack of evident stipitate glands, hairy outer corolla-surfaces, hispid rather than neatly strigose basal leaves, and perhaps more rounded tips of the corolla-lobes. The color of the corolla is not reported by the collector. As with specimens of *L. nobile*, however, some of the non-faded younger corollas on the type-specimen have distinctly purple lobes and throat.

Lithospermum nobile (Rech. f.), comb. nov.

Arnebia nobilis Rech. f. Ann. Naturhist. Mus. Wien **58**: 58 (1951).

Plant coarse, perennial. Stems erect, 2–5 dm. tall, as much as 8 mm. thick at the base, arising from the center of a basal cluster of leaves, below the middle usually antrorsely strigose, above the middle usually with some spreading hairs and commonly glanduliferous. Basal leaves firm, 8–23 cm.

long, with 3–5 longitudinal ribs, narrowed just above the broad sheathing dye-stained base, broadest (3–22 mm.) above the middle, apex slenderly acute, indument of short strongly appressed pallid hairs, hence neatly strigose. Cauline leaves gradually smaller up the stem, middle ones broadest at the base, 2–8 mm. wide, attenuate, usually clothed with appressed hairs and frequently ciliate on the margins. Inflorescence an elongate interrupted thyrse, cylindric, 5–12 cm. broad, at least several times as long as broad, composed of a small terminal cyme and numerous short-pedunculate lateral cymes arising from the leaf-axils along the upper half of the main stem and occasionally even down to near its base. Cymes densely flowered, at first glomerate and 2–3 cm. in diameter, eventually elongating, becoming scorpioid and 5–15 cm. long in fruit, hispid and glanduliferous; bracts shorter than the adjacent calyces; upper stem-leaves soon surpassed by the subtended cymes, only the lower ones protruding from the thyrse. Calyx hispid, frequently somewhat tawny, bearing scattered minute stipitate glands, 15–18 (–20) mm. long at anthesis, becoming as much as 25 mm. long in fruit; lobes 1–2 mm. broad, acute, in long-styled flowers 1–6 mm. shorter than the corolla, in short-styled flowers equaling the corolla or surpassing it 1–2 mm. Flowers heterostylic. Corolla elongate, 16–20 (–27) mm. long, outer surface usually bearing scattered stipitate glands but otherwise usually glabrous, inside glabrous, without basal nectary in the tube; corolla-tube 12–15 (–20) mm. long, 1–1.5 (–2) mm. thick below the middle, in short-styled flowers gradually ampliate above the middle and becoming 2.5–3 mm. thick at the summit, in long-styled flowers with upper 5 mm. cylindric and 2.5–3 mm. thick; throat short, abruptly enlarged and rounded, inside without gland or appendages; limb 5–7 (–10) mm. broad, lobes usually more or less triangular and commonly 2.5 mm. broad and 2–2.5 mm. long, ascending, the margins and tip of the lobes somewhat recurved. Anthers 2.3–2.5 (–3) mm. long; in short-styled flowers borne high in the tube (with their bases ca. 1 mm. below its summit) and protruding up into the corolla-throat; in long-styled flowers borne low in the upper cylindric section of the corolla-tube, their bases 5 mm. below the summit of the tube. Pollen with 6 pores at each end of the grain, in short-styled flowers subcylindric with rounded ends, in lateral profile with sides parallel or only very slightly concave, 49 × 33–35 μ; in long-styled flowers evidently constricted at the middle, 33–38 × 18–23 μ. Style reaching up to slightly above the middle of the corolla-tube or to the summit of the tube or even into the base of the corolla-throat, forked at the apex, lobes unequal, 0.5–1 (–1.5) mm. long; stigmas 2, compressed, broader than long. Nutlets gray, erect, usually only one developing, ca. 7 mm. long, broadest (2.5–3 mm.) at or just above the base, gradually narrowed upwards into a somewhat rostrate incurving apex, hence narrowly subconic in form, ventral and dorsal keel obscure except on the upper 2–3 mm. (i. e., on the beaked apex), surface very minutely tuberculate, longitudinally striate and rugose, the rugae irregular and sparsely verrucose; attachment-surface broad, obliquely basal. Gynobase low pyramidal.

AFGHANISTAN: Sanjadabad, May 1880, *H. Collett 22* (Kew); Sanjadabad, 7000 ft., April 1880, *H. Collett 77* (Kew); Dscheratu, May 7, 1949, *H. F. Neubauer 836* (Vienna, TYPE of *A. nobilis*); Paghman, rocky slope, 7000 ft., fl. at first dark brown, later yellow, leaves silvery, July 14, 1935, *W. R. Hay 350* (Kew); Sar-i-chasma, 2700 m., June 3, 1948, *L. Edelberg 1832* (Vienna); Hauz-i-Mahik, 2500 m., July 12, 1948, *M. Köie 3166* (Vienna); Farakulum, 3000 m., July 19, 1948, *M. Köie 3167* (Vienna).

A species of the high mountains (Hindu Kush) of eastern Afghanistan and most closely related to the more southerly ranging *L. speciosum* of the Pakistan-Afghanistan border. Distinctive of the species are its tidy and decidedly strigose basal leaves, the numerous stipitate glands on the inflorescence, calyx, and outer corolla-surface, the large pollen, and the narrowly conic longitudinally striate nutlets with incurved beak. Among the collections cited only one (*Hay 350*) has hairs on the outer surface of the corolla. Only one fruiting collection has been seen (*Edelberg 1832*). The elongate erect nutlets, broadest at or near the base and gradually narrowed upwardly into a slightly incurved beaked apex, have a form unique in *Lithospermum*. The roughening of their surface, numerous narrow longitudinal usually verrucose ridges which are separated by lineate grooves, is also unique. Another unusual feature is the suppression of the ventral keel except on the beak of the nutlet.

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A RECLASSIFICATION OF LIBOCEDRUS AND CUPRESSACEAE

HUI-LIN LI[1]

With two plates

THE GENUS *Libocedrus*, of the Cupressaceae, is well known as having a remarkably disjunct range. As currently interpreted, the species are widely scattered in lands bordering the Pacific Ocean: one in southern Chile, two in New Zealand, two in New Caledonia, three in New Guinea, one in southern China, one in Formosa, and one in Pacific North America. Such a generic range is indeed unique among the conifers, as it covers more or less equal areas in the Northern and Southern Hemispheres. All other genera are confined either to the northern or southern lands or have but occasional outlying species extending beyond the equator.

The northern and southern species were combined together because of the elongate, basically attached scales and the bi-winged seeds with the wings very unequally developed. These characters, as will be noted below, actually differ to a certain extent between the northern and southern species. It is possible that the resemblance is superficial and due to parallel variation. Two authors, Koch (19) and Kurz (20), noted some differences between the northern and southern species and established independently in the same year 1873 two genera, *Heyderia* and *Calocedrus* respectively, for two of the northern species, but their work was soon disregarded by most subsequent authors. In 1926, Pilger (28), noting the discrepancy between the northern and southern species, divided the genus into two subgenera — *Heyderia*, containing the northern species, and *Eulibocedrus*, the southern. However, he did not emphasize the significance of their fundamental differences, which, in my opinion, are of more value than subgeneric differentiation would indicate.

To clarify the taxonomy of the group of species currently included in *Libocedrus*, it will be helpful to trace briefly the bibliographical history of the genus. The first species of this assemblage were discovered in Chile and named in 1824 as *Thuja chilensis* D. Don and *Juniperus uvifera* D. Don (in Lambert, 21). Another was collected in New Zealand and first named *Dacrydium* (*?*) *plumosum* by D. Don in 1828 (In Lambert, 21, ed. 2). In 1842, W. J. Hooker (12) transferred *Dacrydium* (*?*) *plumosum* to the genus *Thuja*, renaming it *Thuja doniana*. In 1843, Hooker (13) described

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[1] This study was initiated several years ago at the National Taiwan University, Formosa, China, and was completed in the Department of Botany, Smithsonian Institution, to the authorities of which the author is indebted for their generosity in placing facilities at his disposal. Thanks are due to the curator of the herbarium of the Arnold Arboretum of Harvard University for the loan of certain specimens of *Libocedrus*. To A. C. Smith and C. V. Morton, U. S. National Herbarium, grateful acknowledgment is made for their kindness in reading the manuscript and offering valuable suggestions.

independently a new species from Chile which he called *Thuja chilensis*; this is regarded as the same species as that described previously as *T. chilensis* D. Don, which is based on a different type; the use of the same specific epithet is a coincidence, Hooker being unaware of Don's species. In 1844, Hooker (14) described a *Thuja tetragona* from Chile, which has turned out to be the same species as Don's *Juniperus uvifera*; in this instance, Hooker did know of Don's species, but was not sure of its identity with his own, inasmuch as Don had described the fruit as that of a true *Juniperus*. These three species of the Southern Hemisphere, attributed by Hooker to *Thuja*, which is otherwise a genus exclusively of the Northern Hemisphere, were made the basis of the genus *Libocedrus* by Endlicher in 1847 (5). I am following Pilger (28) and others in choosing *L. doniana* (Hook.) Endlicher, now correctly known as *L. plumosa* (D. Don) Sargent, as the type species. The other species of Chile, *L. tetragona* (Hook.) Endlicher, later known as *L. uvifera* (D. Don) Pilger, which differs from the other species in the 4-ranked, more or less equal leaves, and tetragonous and fastigiate branches, remained in the genus *Libocedrus* until Florin (7) segregated it to form the monotypic genus *Pilgerodendron* in 1930.

In 1853, Torrey (35) described a species from California as *L. decurrens*, the first species from the Northern Hemisphere attributed to the genus *Libocedrus*. This species differed from the southern species in having three instead of two pairs of cone-scales: a smaller outer pair, a much longer fertile middle pair, and an inner sterile pair fused together into a single plate, a structure not found in the southern species. Noting these differences, Koch (19) in 1873 made the Californian species the type of a genus *Heyderia*.

In the same year that Koch proposed the genus *Heyderia*, Kurz (20) described a plant from Yunnan, China, as *Calocedrus macrolepis*, a new genus considered by him to be related to *Libocedrus* and *Thujopsis*, differing from the former in the seed structure. Both *Calocedrus* and *Heyderia* were combined with *Libocedrus* by Bentham and Hooker (1) in 1880, although they noted that these species differ from the southern species of the genus in having the innermost pair of scales sterile and connate. Since that time these northern species have remained in the genus *Libocedrus*.

In 1867, a second species from New Zealand was named by J. D. Hooker as *L. bidwillii* (15). Another species, *L. austro-caledonica* Brongn. & Gris (2), was discovered in New Caledonia, considerably extending the generic range. The range was further extended by discovery of species in New Guinea and Formosa. Three species have been reported to occur in New Guinea, *L. papuana* F. Muell. (25), *L. torricellensis* Schlechter (ex Lauterbach, 23), and *L. arfakensis* Gibbs (11). The Formosan plant identified as *L. macrolepis* since 1902, has been described as a distinct species, *L. formosana* Florin (6). Recently two more species were discovered in New Caledonia, *L. chevalieri* Buchholz (3) and *L. yateensis* Guillaumin (38). The discovery of these different species from widely separated areas in both the Southern and Northern Hemispheres would make this, in its geographical range, a unique genus in the conifers.

A careful study of herbarium material and literature shows that these northern and southern species are different in their cone-structures and other characters. In all the southern species, including those from New Guinea, there are four scales in two pairs of very different sizes. The outer pair is small and sterile, while the inner pair is about two or three times as large and is fertile, each scale bearing one or usually two seeds at the base. In the three northern species, *L. decurrens*, *L. macrolepis*, and *L. formosana*, there are three pairs of cone-scales. The first pair is small, sterile, and recurved at tip when mature. The second pair is very long, over three to six times the length of the outer pair and fertile, each scale bearing two seeds at the base. The third pair is as long as the second pair or slightly longer and is sterile, the scales being connate throughout their entire length into a flat thin plate.

Of more significance is the fact that the disposition of these cone-scales in the northern and southern species is different. The southern species have their four cone-scales meeting at the edges, or in other words, these are valvately disposed. In this respect they differ fundamentally from *Thuja* and other related genera of the north. In the three northern species of *Libocedrus*, the three pairs of scales are imbricately disposed, the outer pair overlapping the inner. This disposition is exactly the same as in *Thuja*, which also has the innermost pair of cone-scales connate into one piece. In *Thuja* and the northern species of *Libocedrus*, the innermost pair is about the same size as the middle fertile pair. But as it is partly covered by the latter, the exposed parts are narrow and it thus appears to be smaller. Actually it is often slightly longer.

This difference in the disposition of the cone-scales indicates in my opinion that the affinities of the southern species of *Libocedrus* are, among the existing genera of the conifers, not with *Thuja*, but with *Diselma*, *Widdringtonia*, *Fitzroya*, and other related genera of the Southern Hemisphere. In all these genera, the cone-scales meet at their edges and are not imbricate. On the other hand, the three northern species are undoubtedly very close to *Thuja*. The cone of these species approaches closely that of *Thuja*, which, as noted above, has a similarly fused pair of scales in the center but with numerous outer sterile scales. Reduction in the number of these outer cone-scales would result in nearly the exact condition that we have in the cones of the northern species of *Libocedrus*. With a broader generic concept, these species could be included in *Thuja*, and this was the view actually expressed by Voss in 1908 (36). However, the leaves of these species are in apparent whorls of four instead of being strictly decussate as in *Thuja*. This difference in the organization of leaves on the stem as well as the fewer number of scales and unequally developed seed-wings keep these species out of *Thuja*.

The northern species of *Libocedrus* also differ from the southern species in having the scales mucronulate on the back of the tip, in having the seeds less unequally 2-winged, both wings being well-developed but with one about twice as long as the other, and in the generally larger number of stamens. In the southern species, the scales are provided with a short or long, more or less sharp spine or a bract at the back toward the tip or base or center, and the seed has a long, well-developed wing on one side and merely a narrow membranaceous margin on the other.

In vegetative structures, the northern and southern species of *Libocedrus* are also strikingly different. In the southern species, the leaves are very unequal and strictly decussate, alternately long and very short, the dorso-ventral being very small, and the lateral much larger, keeled and contiguous toward base. The lateral leaves only very slightly overlap the next above, and scarcely overlap laterally the dorso-ventral leaves. In the northern species, the leaves are more strongly decurrent, in apparent whorls of four, and the pairs are of about equal length, the dorso-ventral being narrow, and the laterals keeled, overlapping the next above at their bases and also the dorso-ventral ones laterally, while they themselves are not contiguous below. The leaves are more clearly imbricate in arrangement, reflecting the arrangement of the pistillate cone-scales.

In view of the important differences of the three northern species from the southern species of *Libocedrus* in both vegetative and reproductive characters, it seems desirable to consider the two groups as generically distinct. There are two generic names, *Heyderia* Koch and *Calocedrus* Kurz, published in the same year, available for the northern species. *Calocedrus* appeared in July, 1873; the exact date of publication of *Heyderia* is not known. As *Heyderia* was chosen by Pilger for the subgenus he proposed for the group, it is here adopted in preference to *Calocedrus*, at least until an earlier date for the latter can be definitely established.

The three species from New Guinea differ from the other southern species in certain important characters in both the staminate and ovulate cones. There are four scales in the ovulate cone and these are valvate, as in the other southern species. However, these scales are only slightly woody when mature and bear a large, triangular or ovate appendage on the back near the base or below the center. In the other species usually a short or long spine, or sometimes a triangular bract, is borne either toward the tip or above the center. In the New Guinean species, these appendages are thickened and they assume a slightly shield-like appearance. According to Gibbs (11), in her description of *L. arfakensis,* as the cone increases in size, a swelling appears between the two fertile scales. This swelling gradually develops into two ovate-oblong projections which displace the apices of the scales. The outer scales are modified in the same manner but to a lesser extent. However, as to the outer scales, it appears that they are formed by two bracts coalescing together, the outer becoming the smaller ovate appendage and the inner the scale proper. In *L. torricellensis*, Schlechter (ex Lauterbach, 23) actually described these appendages as bracts attached to the scales; they are found nearly at the base of the outer scales.

The seed-scale complex in the Cupressaceae is shown to develop by the intimate fusion of an axillary seed-scale complex, the sterile part of the flower, which faces the cone-axis and bears ovules in its basal regions, and a bract (10). Together they form the "ovuliferous scale." In the mature cone, the anterior side of the former is generally suppressed and fused to the bract, and the apophysis of the latter becomes the spine or bract-like appendage on the back of the ovuliferous scale. In the New Guinean species, this fusion is apparently less complete and the inner sterile part of the flower more developed than the bract. As a result the bract appears to be very distinct and of relatively larger size as compared with other Cupressaceae. A case somewhat similar to these species is found in *Libocedrus bidwillii* Hook. f. of Tasmania, which has an ovulate cone more or less approaching these species than other species of *Libocedrus*.

In the staminate flowers, the New Guinean species are very distinct in having numerous scales, spirally arranged instead of decussate. The cells are also more variable in number, varying from three to six. The spiral arrangement of the stamens is a unique character. It transcends the Cupressaceae and suggests some relationship with the Taxodiaceae. In vegetative appearance, these species, with their small decussate leaves of very dissimilar alternate pairs, approach most nearly *Chamaecyparis*. On the basis of these distinctive characters in both the staminate and ovulate cones, the New Guinean species are here segregated as a genus distinct from *Libocedrus, sensu stricto*.

In this connection, it is worthy to note that Peirce (27), in his study of the wood anatomy of the Cupressaceae, noted particularly the heterogeneous nature of the genus *Libocedrus, sensu lato*. He studied wood specimens of the following species: *L. bidwillii* (New Zealand), *L. chilensis* (Chile), *L. decurrens* (North America), *L. macrolepis* (China), *L. papuana* (New Guinea), and *L. uvifera* (Chile), the last being the type of *Pilgerodendron,* proposed by Florin (7) as a separate genus. With regard to the latter, Peirce noted that "the woody anatomy has failed to disclose any features that would warrant giving generic status to that species and not to some of the others, for *Libocedrus* is comparatively heterogenous." The wood anatomy of the other cupressaceous genera studied by him is all uniform and homogeneous within the genus. Perhaps an attempt to investigate further the wood anatomy of *Libocedrus sensu lato* and *Pilgerodendron* along the line of the present scheme of classification will bring out different results.

To summarize, the resemblances of the elongated cones in the northern and southern species of *Libocedrus* are superficial only, probably due to parallel variation. Two groups of species differ from each other in cone-structure as well as vegetative characters. Different affinities are indicated and it is therefore desirable to treat these two groups of species as generically distinct. Among the southern species, those from New Guinea differ from the rest in certain important characters of the ovulate as well as staminate cones and are treated as representing a separate genus. In addition to these three genera, there is *Pilgerodendron,* an earlier segregate from *Libocedrus* made by Florin. The classification of the four genera in question is as follows.

Heyderia K. Koch, Dendrol. 2(2): 179. 1873.

Calocedrus Kurz in Jour. Bot. **11**: 196. *t. 133.* July 1873.
Libocedrus sensu Benth. & Hook. Gen. Pl. **3**: 426. 1880, p. p., non Endlicher.
Libocedrus subgen. *Heyderia* Pilger in Engler & Prantl, Nat. Pflanzenfam. ed. 2. **13**: 389. 1926.

TYPE SPECIES: *Heyderia decurrens* (Torr.) Koch.

Trees; branchlets distichous, strongly compressed. Leaves scale-like, closely and distinctly imbricate, decussate, strongly compressed and decurrent, free only at the obtuse and minutely pointed tip, the pairs of about equal length, the dorso-ventral narrow, the lateral keeled, overlapping the dorso-ventral laterally, not joining together themselves. Flowers monoecious, solitary, terminal on different branchlets. Staminate flowers oblong, consisting of 6–16 decussate scales; anthers sessile, of 4 cells pendulous from the subpeltate, broadly ovate, pointed scale. Ovulate flowers oblong, formed of 6 erect woody imbricate persistent scales, the upper and lower pairs sterile, the middle pair only fertile; ovules 2 at the base of each fertile scale, erect. Mature cone oblong, more or less truncate, maturing the first year, the scales 6, in 3 pairs, woody, imbricate, mucronulate at the back near the tip, the lower pair small, ovate, sterile, recurved at tip, the middle pair much larger, 3–6 times as long as the outer or more, oblong, fertile, erect, the upper pair linear, about as long as or slightly longer than the middle pair, sterile, connate together into a flat woody erect plate. Seeds 2 to each fertile scale, erect, compressed, with 2 unequal, lateral, erect, oblong wings, the larger to nearly as long as the scales, the other about half as long; cotyledons 2.

Three species, one in Pacific North America, one in Formosa, and one in Yunnan, Hainan, and northern Burma.

1. **Heyderia decurrens** (Torr.) K. Koch, Dendrol. 2(2): 179. 1873.

Libocedrus decurrens Torrey in Smithson. Contr. Knowl. **6**(1): 7. *t. 3.* 1853.
Thuja craigiana Murray in Rep. Oreg. Exped. **2**: *t. 2.* 1854.
Thuja gigantea sensu Carriere in Rev. Hort. 1854: 224. 1854, non Nuttall.
Thuja decurrens Voss in Mitt. Deutsch. Dendr. Ges. 1907(16): 88. 1908.

North America, Oregon and California to Lower California, scattered among other coniferous trees at 1,000–2,500 meters.

The following forms are known in cultivation:

Heyderia decurrens f. **compacta** (Beissner) comb. nov.
Libocedrus decurrens compacta Hort. ex Beissner, Handb. Nadelh. 30. 1891.

Heyderia decurrens f. **glauca** (Beissner) comb. nov.
Libocedrus decurrens glauca Beissner in Jäger & Beissner, Ziergeh. ed. 2, 472. 1884.

Heyderia decurrens f. **aureo-variegata** (Schwerin) comb. nov.
Libocedrus decurrens aureo-variegata Schwerin in Mitt. Deutsch. Dendr. Ges. 1907(16): 256. 1908.

2. **Heyderia formosana** (Florin) comb. nov.

Libocedrus formosana Florin in Svensk Bot. Tidskr. **24**: 126. *f. 2 & t. 2.* 1930.
Libocedrus macrolepis sensu Forbes & Hemsl. in Jour. Linn. Soc. Bot. **26**: 540. 1902, p. p., non Benth. & Hook.
Libocedrus macrolepis var. *formosana* Kudo in Jour. Soc. Trop. Agr. (Formosa) **3**: 16. 1931.

Formosa, scattered in broad-leaved forests, rarely forming pure forests, in ravines and on mountain slopes at 150–1,900 meters, in the northern and central part of the island.

3. **Heyderia macrolepis** (Kurz) comb. nov.

Calocedrus macrolepis Kurz in Jour. Bot. **11**: 196. *t. 133.* 1873.
Libocedrus macrolepis Benth. & Hook. Gen. Pl. **3**: 426. 1880.
Thuja macrolepis Voss in Mitt. Deutsch. Dendr. Ges. 1907(16): 88. 1908.

A rare tree, at about 1,400–1,600 meters, southwestern Yunnan and along the Burmese border; also in Hainan.

Pilgerodendron Florin in Svensk Bot. Tidskr. **24**: 132. 1930.

Trees or shrubs, evergreens, the branchlets tetragonous. Leaves small, scale-like, ovate, quadrifarious, decussate, of about equal size, imbricate, adnate below, free and more or less spreading above, dorso-ventrally compressed, keeled on the back. Flowers dioecious, solitary, terminal on branchlets. Staminate flowers relatively large, subcylindric, with elongate scariose-margined basal leaves; scales large, decussate, imbricate; anthers of 4–8, usually 6 cells, pendulous from the subpeltate, short-stalked, erect, scales. Ovulate flowers with 4 elongate, decussate basal leaves, ovoid to ellipsoid, formed of 4 decussate persistent scales, slightly fleshy when young and cohering at margins, the outer smaller, sterile; ovules 2 at the base of each fertile scale, erect. Mature cone ovoid, the scales 4, in 2 pairs, separate, valvate, woody, with a long erect-incurved spine on the back near the tip, the lower scales small, oblong-lanceolate, sterile, the upper scales obovate-oblong, fertile, about 3 times as long as the lower, the axis often projected in the center of the cone into a very short ovoid or rarely subcylindric column. Seeds solitary or 2 at the base of each fertile scale, obtusely triangular, very unequally winged laterally, the longer wing erect, elongate, much longer than the seed, the other very short.

One species in southern Chile.

1. **Pilgerodendron uviferum** (D. Don) Florin, loc. cit. 133. 1930.

Juniperus uvifera D. Don in Lamb. Pin. **2**: 17. 1824.
Thuja tetragona Hook. in Lond. Jour. Bot. **3**: 148. *t. 4.* 1844.
Libocedrus tetragona Endlicher, Syn. Conif. 44. 1847.
Libocedrus cupressoides Sargent, Silva N. Amer. **10**: 134. 1896.
Libocedrus uvifera Pilger in Engler & Prantl, Nat. Pflanzenfam. ed. 2. **13**: 389. 1926.

Southern Chile, western slopes of the Andes from Valdivia southward to Terra del Fuego.

Libocedrus Endlicher, Syn. Conif. 42. 1947.

Libocedrus subg. *Eulibocedrus* Pilger in Engler & Prantl, Nat. Pflanzenfam. ed. 2. **13**: 389. 1926.

TYPE SPECIES: *Libocedrus doniana* (Hook.) Endlicher = *L. plumosa* (D. Don) Sargent.

Trees or shrubs; branchlets distichous and compressed, sometimes tetragonous when young. Leaves scale-like or short needle-like, imbricate only at the tip, decurrent, decussate or 3-ranked, compressed, very unequal, the dorso-ventral very small, the lateral much larger, keeled and contiguous below. Flowers monoecious, solitary, terminal on different branchlets. Staminate flowers oblong, of 6–10, decussately arranged scales; anthers sessile, of 4 cells pendulous from the peltate or subpeltate scale. Ovulate flowers ovoid, formed of 4 decussate, erect, woody, persistent scales, the outer smaller, sterile; ovules 2 at the base of each fertile scale, erect. Mature cone ovoid, obtuse, maturing the first year, the scales 4, in 2 pairs, valvate, woody, with a short or long spine or small triangular bract-like appendage on the back above the center or near the tip, the lower scales small, ovate, sterile, the upper scales ovate-oblong, fertile, about 2 or 3 times as long as the lower. Seeds solitary or 2 at the base of each fertile scale, compressed, very unequally winged laterally, the lower wing erect, oblong, to nearly as long as the scale, the other narrow, reduced; cotyledons 2.

Five species, widely scattered in regions bordering the Pacific in the Southern Hemisphere, one in southern Chile, two in New Zealand, and two in New Caledonia.

1. **Libocedrus plumosa** (D. Don) Sargent, Silva N. Amer. 10: 134. 1896; Druce in Rep. Bot. Exch. Cl. Brit. Isles 1916: 633. 1917.

Dacrydium (?) plumosum D. Don in Lamb. Pin. ed. 2. App. 143. 1828.
Thuja doniana Hook. in London Jour. Bot. **1**: 571. *t. 18.* 1842.
Libocedrus doniana Endlicher, Syn. Conif. 43. 1847.

New Zealand, northern and southern islands, in forests, rare.

2. **Libocedrus bidwillii** Hook. f. Handb. N. Zeal. Fl. 257. 1867.

New Zealand, northern and southern islands, on mountain slopes to 2,000 meters.

3. **Libocedrus chilensis** (D. Don) Endlicher, Syn. Conif. 44. 1847.

Thuja chilensis D. Don in Lamb. Pin. **2**: 19. 1824.
Thuja chilensis Hook. London Jour. Bot. **2**: 199. 1843.
Thuja adina Poepp. & Endl. Nov. Gen. et Sp. **3**: 17. *t. 220.* 1845.

Southern Chile, on slopes of mountain valleys, at about 950–1,500 meters.

4. **Libocedrus austro-caledonica** Brongn. & Gris. in Bull. Soc. Bot. France 18, 140. 1871.

New Caledonia, eastern slopes of Mt. Humboldt at about 1,000 meters.

5. **Libocedrus chevalieri** Buchholz in Bull. Mus. Hist. Nat. Paris **21** (2): 283. 1949.

New Caledonia, western slopes of Mt. Humboldt, at 1,450–1,550 meters.

6. **Libocedrus yateensis** Guillaumin in Bull. Mus. Hist. Nat. Paris **21**: 45, 1949.

New Caledonia, right bank of Blue River, at about 200 meters.

Papuacedrus Li, gen. nov.

Arbor alta; ramulis oppositis distichis compressis; foliis decussatim oppositis, adpresse quadrifariatim subimbricatis, difformibus, lateralibus longioribus complicato-carinatis subfalcatis acutis vel subacutis, pro parte maxima adnatis, apice solum liberis, facialibus minutis, planis adpressis squamiformibus triangularibus vel basim ramulorum versus oblanceolatis acutis vel acuminatis; strobilis in diversis ramis monoicis; strobilis staminibus in ramulis terminalibus solitariis cylindricis, antheris 16–∞-seriatis spiraliter dispositis, squamiformibus late ovatis subpeltatis breviter stipitatis chartaceis, loculis 2–6 globosis deorsum 2-valvatis; strobilis ovulatis in ramulis brevibus erectis, elongato-ovatis, squamis 4, decussatis, valvatis, 2 exterioribus sterilibus; strobilis ovulatis maturis ovoideis, squamis demum sublignosis, 2 exterioribus sterilibus ovatis vel oblongis ad basim bractea ovata acuta adnata munitis, 2 interioribus ad basim 2-ovulatis, longioribus lanceolatis subacutis vel rotundatis, exterioribus 2- vel 3-plo longioribus, infra medium bractea triangulari patula praeditis; seminibus 4 ellipsoidalibus plus minusve compressis lateraliter alatis, ala altera elongata, altera subobsoleta.

TYPE SPECIES: *Libocedrus papuana* F. Muell.

A genus of three species in New Guinea and Molucca.

1. **Papuacedrus papuana** (F. Muell.) comb. nov.

Libocedrus papuana F. Muell. in Trans. Roy. Soc. Vict. N. S. **1**(1): 32. 1889.
Thuja papuana Voss in Mitt. Deutsch. Dendr. Ges. 1907(16): 88. 1908.

New Guinea, in northern and southern parts at 1,700–3,000 meters, and Molucca, at about 2,000 meters.

2. **Papuacedrus torricellensis** (Schlechter) comb. nov.

Libocedrus torricellensis Schlechter ex Lauterbach in Bot. Jahrb. **50**: 53. *f. 2, H-N*. 1913.

New Guinea, Torricelli Mountains, at about 900–1,000 meters.

3. **Papuacedrus arfakensis** (Gibbs) comb. nov.

Libocedrus arfakensis Gibbs, Phytogeogr. & Fl. Arfak Mts. 84. *f. 6, a–b*. 1917.

New Guinea, Arfak Mountains, on ridges and in forests, at 2,300–2,600 meters.

CLASSIFICATION OF CUPRESSACEAE

With the above redefinition of the genera *Libocedrus, Papuacedrus, Heyderia,* and *Pilgerodendron,* a problem which follows is their proper classification within the family Cupressaceae. These genera are segregated mainly on the basis of the ovulate cones, and the structure of the ovulate cone has long been considered as important in classification and of great significance in interpreting relationships in the conifers. A general review of the structure and evolution of the ovulate cone in the Cupressaceae is given by Florin (8,10). He considers the cones in some species of *Juniperus* and in *Microbiota,* in which only one fertile axillary complex and one single ovule is developed, as the most strongly reduced.

It is interesting to note that although the northern and southern genera assigned to the Cupressaceae are grouped in separate taxa in most systems of classification of the conifers, *Libocedrus* has had various dispositions. The first important system was proposed by Endlicher in 1847 (5), in the work where *Libocedrus* was first established. In his order Cupressineae, the Actinostrobeae include these southern genera: *Widdringtonia, Frenela, Actinostrobus, Callitris,* and *Libocedrus*; while the Thujopsideae include the northern genera *Biota, Thuja,* and *Thujopsis.* At that time, it should be noted, only three species of *Libocedrus* were known, all from the Southern Hemisphere, and therefore the scope of the genus was clear and definite and its relationship was correctly indicated by the author.

In later years, when the northern species of the genus *Libocedrus* were discovered, practically all authors of later systems, such as Eichler (4), Neger (26), Vierhapper (37), and Saxton (32), included *Libocedrus* with the northern genera, apparently interpreting the genus on the basis of the northern species only.

A radical change was made by Pilger (28), who combined the northern and southern groups of genera, long referred to two different groups by all authors, into one subfamily Thujoideae under the Cupressaceae. His system of classification of the whole family is as follows:

Subfamily I. Thujoideae: *Actinostrobus, Callitris, Tetraclinis, Callitropsis, Widdringtonia, Fitzroya, ·Diselma, Thujopsis, Thuja, Libocedrus, Fokienia.*
Subfamily II. Cupressoideae: *Cupressus, Chamaecyparis.*
Subfamily III. Juniperoideae: *Arceuthos, Juniperus.*

The latest system, by Janchen in 1950 (17), classifies the Cupressaceae as follows:

Subfamily I. Juniperoideae.
  Tribe Junipereae: *Arceuthos, Juniperus.*
Subfamily II. Cupressoideae.
  Tribe 1. Cupresseae: *Cupressus, Chamaecyparis, Fokienia.*
  Tribe 2. Thujopsideae: *Pilgerodendron, Libocedrus, Microbiota, Biota, Thuja, Thujopsis.*
  Tribe 3. Actinostrobeae: *Diselma, Fitzroya, Widdringtonia, Neocallitropsis, Callitris, Tetraclinis, Actinostrobus.*

Pilger's system, appearing in a standard reference work, is widely known, but, compared with other systems, it is unsatisfactory in that it combines the usually separated and widely different Actinostrobeae and Thujopsideae into one. This arrangement may serve to obviate the problem of placing the questionable *Libocedrus,* but it obscures the different and divergent trends of development of these genera. Also unsatisfactory is Pilger's placing of *Fokienia* in his Thujoideae instead of Cupressoideae, as the cone of *Fokienia* is essentially the same as that of *Chamaecyparis*; the two should undoubtedly be closely associated, as in Janchen's system, where *Cupressus, Chamaecyparis,* and *Fokienia* constitute the tribe Cupresseae.

Saxton (30, 31, 32), working with embryogeny, considered that the Cupressaceae should be divided into at least two subfamilies: the Callitroideae, containing the genera *Actinostrobus, Callitris* and *Widdringtonia,* and the Cupressoideae, containing the remaining genera of the family. *Tetraclinis* and *Fitzroya* have affinities with both groups, but they should probably be considered as belonging to the Cupressoideae.

Moseley (24) based his evaluation of characteristics on the reproductive morphology and embryogeny, considered by him as of phylogenetic importance in 12 genera, and proposed an entirely different system for the Cupressaceae. The characters are listed in a chart, mostly presented in pairs, considered by him as either primitive or advanced. His modification of Pilger's system is as follows: (genera starred are considered by him as of doubtful status).

Subfamily Cupressoideae: *Cupressus, Chamaecyparis.*
Subfamily Juniperoideae: *Juniperus, Arceuthos*, Microbiota*.*
Subfamily Thujoideae: *Libocedrus, Biota, Tetraclinis, Fitzroya, Thujopsis, Thuja, Diselma*, Fokienia*.*
Subfamily Callitroideae: *Actinostrobus, Callitris, Widdringtonia, Callitropsis*.*

Considering the number of primitive characteristics, Moseley regards the Cupressoideae as lowest in the family and the Callitroideae as the most highly evolved. In the Thujoideae, *Libocedrus* and *Biota* possess the greatest number of primitive characteristics, while *Thuja* and *Fitzroya* are the most advanced. Callitroideae was originally established by Saxton and upheld by Moseley on the basis of these morphological characters: archegonia lateral in position, the absence of a prosuspensor in the embryo, a proembryo that completely fills the archegonium, the absence or obscurity of an archegonial jacket, and a proembryo which is not in definite tiers.

Moseley's phylogenetic scheme is very different from, and in some cases diametrically opposed to the various systems proposed by taxonomists on the basis of external morphology, especialy that of the cone. *Juniperus,* with fleshy fused cone-scales and wingless seeds, is considered by all others as more advanced than those genera in the Thujoideae, which have dry distinct cone-scales and winged seeds (10). In Moseley's system, the order is reversed. He considers that "the Callitroideae possess outstanding characters [as mentioned above] that distinguish them from the other groups of the Cupressaceae." However, when he compares *Fitzroya* and *Tetraclinis*, two genera in his Thujoideae, with the Callitroideae, he finds in *Fitzroya*, four, and in *Tetraclinis* three important characteristics in common with the latter group.

It remains to be seen whether characters in embryogeny will be sufficient to explain the phylogenetic trends in the Cupressaceae. At the present judgment on the phylogenetic significance of these characters is still controversial. Thomson (34, Radforth, 29) disagrees with Buchholz's idea, which Moseley follows, in the interpretation of certain fundamental phenomena in embryogeny pertinent to the phylogeny of conifers. In some cases, such as polyembryogeny, Thomson's view of the phylogenetic significance is just the reverse of that of Buchholz.

Using mainly the characters of the cone-scales, a revised system of classification for the Cupressaceae is presented below. Among the genera of the family, there are two main types of cones. In one group, the cone-scales are present in pairs or in whorls of three or four. Generally there are two pairs, and only more rarely two ternate whorls or two quadrate whorls. The scales are always thick and usually woody, and are valvate in arrangement, as the scales come into contact at their edges and do not overlap. All genera with cones of this type occur in the Southern Hemisphere, with the exception of the isolated *Tetraclinis*. These genera may be considered as constituting one subfamily, the Callitroideae (PLATE 1).

In this subfamily, there are three genera with ternate whorls: *Fitzroya, Actinostrobus*, and *Callitris*. In *Fitzroya*, there are three whorls of scales, the innermost being very rudimentary and minute, the middle largest and each scale bearing about two or three 3-winged seeds, and the outermost smaller and sterile. In *Actinostrobus*, there are two whorls surrounding a slightly protruding axis, the outer and inner scales being of about equal size and each bearing two 3-winged seeds. In *Callitris*, there are also two whorls, the inner being the larger, each scale bearing many winged seeds, and the outer ones slightly smaller and bearing fewer seeds. Both *Actinostrobus* and *Callitris* may sometimes possess a residuum of very rudimentary scales in the center of the cone as in *Fitzroya*. All three genera have 3-ranked leaves. These genera, of comparatively more primitive character in having ternate scales, few to many, winged seeds, and sometimes a whorl of rudimentary scales in the center, are clearly of close relationship and are here classified as representing one tribe, the Actinostrobeae. It should be noted that *Fitzroya* was described by the publishing author, Hooker, as having imbricate cone-scales. Pilger (28) described the scales as somewhat imbricate. So far as I can make out from herbarium specimens, the thick, coriaceous scales are valvate as in the other southern genera. For a definite determination it will be necessary to have fresh material.

The other southern genera have 2-, 4-, or 8-ranked leaves, and all have cones consisting of two pairs of scales, except *Octoclinis* and *Neocallitropsis* (*Callitropsis*). The cone of these genera has eight scales in two whorls, with a short axis protruding in the center. Each of the inner scales bears two, winged seeds. The leaves in these genera are in whorls of four. In *Widdringtonia* there are four scales of equal size, each bearing many, winged seeds. In *Diselma, Papuacedrus, Pilgerodendron,* and *Libocedrus,* there are two pairs of scales. In *Diselma,* the two pairs are of about equal size, one sterile and one fertile, the latter bearing at the base of each scale two or three winged seeds. In *Pilgerodendron, Papuacedrus,* and *Libocedrus* the two pairs of cone scales are of unequal size, the outer much smaller and sterile, and the inner larger and fertile, bearing one or two seeds at the base of each scale. These southern genera represent another tribe, the Libocedreae.

Papuacedrus, as noted above, differs from other genera of the Cupressaceae in the spiral arrangement of the scales in the staminate cone. This character may be of phylogenetic significance, as it indicates relationship with the Taxodiaceae. In this connection mention may be made of two genera of the Taxodiaceae with outstanding characters. *Metasequoia* has decussate scales in the ovulate cones, a character transcending the Taxodiaceae and suggesting relationship with the Cupressaceae (16, 33). *Athrotaxis,* of Tasmania, the only genus of the Taxodiaceae of the Southern Hemisphere, has either spirally or decussately arranged leaves and subspirally arranged staminate scales, characters somewhat intermediate between the Taxodiaceae and Cupressaceae. These genera, together with *Papuacedrus,* offer great possibilities in elucidating the relationships between these two families by further investigation.

A third tribe, the Tetraclineae, contains the more or less isolated genus *Tetraclinis* of northern Africa. It is the only genus of the Northern Hemisphere with valvate cone-scales. There are two pairs of cone scales, of equal size but of slightly different shape. The young scales are somewhat fleshy. The vegetative characters mostly closely approach *Heyderia* and *Thujopsis.* The cotyledons are three to five, instead of usually two as in other genera, and this character suggests *Juniperus. Tetraclinis* thus shows characters intermediate between the northern and southern genera, but its basically valvate cone-scales indicate closer relationships with those of the south.

In the northern genera, excepting *Tetraclinis,* the cone-scales show more varied development, but basically the arrangement is imbricate. These genera constitute another subfamily, the Cupressoideae. The scales occur in pairs with the exception of *Juniperus* and *Arceuthos,* where the scales are generally present in threes but sometimes also in twos. In this subfamily three tribes are discernible (PLATE 2).

In the first tribe, Cupresseae, including *Cupressus, Chamaecyparis,* and *Fokienia,* the cones, which are essentially globose, bear three to eight pairs of shield-like scales. Most of these scales except usually the outermost and innermost ones, are fertile, each bearing two to many, winged seeds. In the number of scales and seeds, this group is undoubtedly the most primitive. *Cupressus* has six to twelve scales, the fertile ones bearing many seeds each. *Chamaecyparis* also has six to twelve scales, but the fertile scales bear only three seeds each. *Fokienia* has a larger number of scales, varying from twelve to sixteen, but the fertile ones bear only two seeds each. Because of the thickness of the cone-scales they do not appear distinctly overlapping at the edges. Pilger (28) considers these scales as valvate. However, the outer scales cover the inner ones at almost the entire length and their disposition, much in the same manner as in *Heyderia*, is clearly imbricate. In *Fokienia*, the seeds are more unequal-winged than in the other two genera. This genus is probably more advanced than the other two and serves as a link with the following tribe, which it also resembles very closely in vegetative characters.

The second tribe, Thujopsideae, is characterized by fewer scales, of flat or concave, generally elongate shape. *Thujopsis* has six to eight thick scales, the innermost and outermost pairs being sterile. The fertile scales bear two winged seeds each. In *Thuja*, there are eight to twelve scales, with the innermost pair sterile and often fused into a plate. The middle pairs bear two winged seeds each at the base of each scale. In *Biota*,[2] sometimes included in *Thuja*, the scales are six in number, thick in texture, with the inner pair fused and sterile and the outer bearing one or two wingless seeds each. This genus probably connects with the following tribe, which has fleshy scales and wingless seeds. From *Thuja*, further reduction in the number of scales and seeds resulted in *Heyderia*, with only three pairs of scales, the inner fused and sterile, the middle fertile, and the outer much smaller and also sterile. The seeds are unequally winged.

The last tribe, Junipereae, consisting of *Arceuthos* and *Juniperus*, sometimes combined into one genus, has fleshy cone-scales, separate at first but fused together at maturity. The scales usually appear in two whorls of three each, but occasionally also in pairs. The seeds are wingless. This is undoubtedly the most highly evolved group of the whole family. Although the fleshy connate scales are distinctive, this tribe is clearly linked with the last tribe, inasmuch as *Biota*, with fleshy scales and wingless seeds, is somewhat intermediate. It is thus better treated as an advanced, specialized tribe of the northern subfamily, with imbricate scales, than as a subfamily by itself.

All genera of the subfamily Callitroideae, with the exception of *Tetraclinis*, are of the Southern Hemisphere; while all genera of the subfamily Cupressoideae are of the Northern Hemisphere. *Tetraclinis* occurs in northern Africa, within the range of the hypothetical Gondwana land as with all the rest of the southern genera. The geographical range shows that the two subfamilies have developed independently for a very long time. This pattern of distribution is in accord with that of other group of conifers, where the genera or higher categories are either of the north or of the south. The extraordinary geographical range that has been accredited to *Libocedrus*, *sensu lato*, was based upon a misconception of significant generic characters.

Fossil records have shown that the coniferous floras of the Northern and Southern Hemispheres have been distinct from each other since very

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[2] *Microbiota decussata* Komarov is an uncertain genus and species. Rehder (Man. Cult. Trees Shrubs, ed. 2. 55. 1940) suggests it as probably only a variation of *Biota orientalis* (L.) Endl. retaining the juvenile foliage up to the fruiting stage.

ancient times. In North America, for instance, Mesozoic and Cenozoic fossils all pertain to genera of the present northern type, such as *Cupressus*, *Juniperus*, *Thuja*, *Taxodium*, *Sequoia*, *Abies*, *Larix*, *Picea*, *Pinus*, *Psuedotsuga*, *Tsuga*, *Cephalotaxus*, and form genera related to these modern ones (18, 22).[3] Florin (9), in a detailed analysis of the Tertiary fossil conifers from the southern lands, shows the genera to be the same as those now existing in the Southern Hemisphere, and that none of the genera typical of the Northern Hemisphere mentioned above were present. Florin has convincingly proved that the separation of the northern and southern types has existed since the late Palaeozoic. He also indicates, however, that certain genera of the southern group might have forced their way northward into the region primarily occupied by the northern group and vice versa, which is also reflected by the recent distribution of some genera.

A system of classification for the family Cupressaceae is tabulated below. The synonymy of suprageneric groupings in the Cupressaceae, as well as in other conifers, is very complicated. Practically all the tribes given below have been treated at one time or another as families or subfamilies. In a very ancient group like the conifers, the existing genera, mostly of relic nature, naturally do not show intimate relationships between them, as do many more modern groups. The rather burdensome synonymy reflects the varied opinions expressed by many authors. It is suggested that in the conifers, a broader outlook must be taken in presenting systems of classification in order to show the relationships between the existing genera and to render the systems useful for practical purposes. As the synonyms have been given very fully by Janchen (17) in a recent publication, they are not repeated here.

Family CUPRESSACEAE Neger

I. Subfamily CALLITROIDEAE Saxton in New Phytol. **12:** 253. 1913.
  A. Tribe **Actinostrobeae** Endlicher, Syn. Conif. 3. 1847, p. p.
    1. *Actinostrobus* Miquel (2 species in western Australia).
    2. *Callitris* Ventenat (About 20 species in Australia, Tasmania, and New Caledonia).
    3. *Fitzroya* W. J. Hooker (1 species, in southern Chile).
  B. Tribe **Libocedreae** Li (Actinostrobeae Endlicher, op. cit., p. p.).
    Arbor vel frutex; foliis decussatim oppositis; squamis ovulatis 4 vel 8, 2-seriatis, similibus, aequalibus vel inaequalibus.
    1. *Neocallitropsis* Florin (*Callitropsis* Compton) (1 species, New Caledonia).
    2. *Octoclinis* F. Mueller (1 species, southwestern Australia).

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[3] A few doubtful records of fossil material pertaining to *Callitris* and *Podocarpus* are known from the Tertiary of the Northern Hemisphere. Florin noted (9, p. 73) that "Alleged occurrences of detached *Podocarpus* leaves and foliage-shoots in Tertiary strata of the Northern Hemisphere must as a rule be regarded with considerable suspicion," and (9, p. 83) that "All the Tertiary fossil coniferous remains from Europe and North America supposed to belong to *Callitris* appear to be referable to the northern genus *Tetraclinis*."

   3. *Widdringtonia* Endlicher (5 species, South Africa and southeastern Tropical Africa).
   4. *Diselma* J. D. Hooker (1 species, Tasmania).
   5. *Papuacedrus* Li (3 species, New Guinea, Moluccas).
   6. *Pilgerodendron* Florin (1 species, southern Chile).
   7. *Libocedrus* Endlicher (5 species, southern Chile, New Zealand, New Caledonia).
- C. Tribe **Tetraclineae** Li (Tetraclinaceae Hayata in Bot. Mag. Tokyo **46**: 27. 1932).
   1. *Tetraclinis* Masters (1 species, Morocco, Algeria, Tunisia).

II. Subfamily CUPRESSOIDEAE K. Koch
- A. Tribe **Cupresseae** Neger
   1. *Cupressus* Linnaeus (About 12 species, North America, Asia to eastern Mediterranean).
   2. *Chamaecyparis* Spach (About 6 species, North America, Japan, Formosa).
   3. *Fokienia* A. Henry and H. H. Thomas (1 species, southeastern China to Tonkin).
- B. Tribe **Thujopsideae** Endlicher
   1. *Thujopsis* Siebold & Zuccarini (1 species, Japan).
   2. *Thuja* Linnaeus (5 species, eastern Asia and North America).
   3. *Biota* D. Don (1 species, northeastern Asia).
   4. *Heyderia* K. Koch (3 species, Pacific North America, Formosa, Hainan, southwestern China to northern Burma).
- C. Tribe **Junipereae** Neger
   1. *Arceuthos* Antione & Kotschy (1 species, Europe to western Asia).
   2. *Juniperus* Linnaeus (About 60 species, widely distributed in the Northern Hemisphere).

SUMMARY

The genus *Libocedrus* is found to consist of two diverse groups of species with basic differences in the cone structure. The genus should be limited to those species, all of the Southern Hemisphere, with four valvate cone-scales. Three species from New Guinea have ovulate scales bracteate below and spirally-arranged staminate scales, indefinite in number, and are segregated from the other species as a distinct genus *Papuacedrus*. The three northern species, with six imbricate cone-scales, constitute another genus, *Heyderia*. The arrangement of cone-scales seems to be an important character in the classification of the Cupressaceae. As a result of the reclassification of *Libocedrus*, the family Cupressaceae can be reorganized as consisting of two subfamilies. The subfamily Callitroideae is composed of genera with valvate scales and can be divided into three tribes: Actinostrobeae, with ternate scales, Libocedreae, with paired or quadrate scales, and Tetraclineae, with paired dissimilar scales. The subfamily Cupressoideae is composed of genera with imbricate scales and can be divided into three tribes: Cupresseae, with thick, shield-like scales, Thujopsideae, with flat, more or less concave scales, and Junipereae, with fleshy scales coalescing at maturity. All genera of the Callitroideae, with the exception of the isolated *Tetraclinis*, are of the Southern Hemisphere,

while all genera of the Cupressoideae are of the Northern Hemisphere. This distribution pattern, together with their basic difference in the cone-structure, indicates that the two groups are probably of remote relationship, having been long isolated and having developed independently, like many other groups of conifers.

LITERATURE CITED

1. BENTHAM, G. and J. D. HOOKER. Genera Plantarum. 3 vol. London. 1862–83.
2. BRONGNIART, A. and A. GRIS. Supplément aux conifères de la Nouvelle-Calédonie. Bull. Soc. Bot. France **18**: 130–141. 1871.
3. BUCHHOLZ, J. T. Additions to the coniferous flora of New Caledonia. Bull. Mus. Nat. Hist. Paris **21**: 279–286. 1949.
4. EICHLER, A. W. Coniferae. In Engler and Prantl, Nat. Pflanzenfam. II. **1**: 28–116. 1887.
5. ENDLICHER, S. L. Synopsis Coniferum. Sangalli. 1847.
6. FLORIN, R. Die Koniferengattung Libocedrus Endl. in Ostaisien. Svensk Bot. Tidskr. **24**: 117–131. 1930.
7. ———. Pilgerodendron, eine neue Koniferen Gattung aus Süd-chile. Svensk Bot. Tidskr. **24**: 132–135. 1930.
8. ———. Die Koniferen des Oberkarbons und des unteren Perms. Paleontographica 85. Heft 1–7. 1938–45.
9. ———. The Tertiary fossil conifers of south Chile and their phytogeographical significance. Kungl. Svensk Vatenskapsakad. Handl. III. **19**(2): 1–107. 1940.
10. ———. Evolution in cordaites and conifers. Act. Hort. Berg. **15**: 285–388. 1951.
11. GIBBS, L. S. Dutch N. W. New Guinea. A Contribution to the Phytogeography and Flora of the Arfak Mountains, etc. Taylor & Francis, London. 1917.
12. HOOKER, W. J. On a new species of Thuja, and on Podocarpus totara of New Zealand. London Jour. Bot. **1**: 570–575. 1842.
13. ———. Figure and description of a new species of Thuja, from Chile. London Jour. Bot. 2: 199–200. 1843.
14. ———. Description, with a figure, of a new species of Thuja, the Alerse of Chile. London Jour. Bot. **3**: 144–149. 1844.
15. HOOKER, J. D. Handbook of the New Zealand Flora. London. 1867.
16. HU, H. H. and W. C. CHENG. On the new family Metasequoiaceae and on Metasequoia glyptostroboides, a living species of the genus Metasequoia found in Szechuan and Hupeh. Bull. Fan Mem. Inst. Biol. N. S. **1**: 151–163. 1948.
17. JANCHEN, E. Das System der Coniferen. Sitzungsber. Oest. Akad. Wiss. Math.-Nat. Kl. Abt. I. 1949(3): 155–162. 1950.
18. KNOWLTON, F. H. A catalogue of the Mesozoic and Cenozoic plants of North America. U. S. Geol. Surv. Bull. 696. 1919.
19. KOCH, K. Dendrologie, 3 vol. Erlangen. 1869–73.
20. KURZ, S. On a few new plants from Yunan [sic!]. Jour. Bot. Brit. & For. **11**: 193–196. 1873.
21. LAMBERT, A. B. A Description of the Genus Pinus. 1803–24. ed. 2, 3 vol. 1828–39. London.

22. LAMOTTE, R. S. Supplement to catalogue of Mesozoic and Cenozoic plants of North America 1919–37. U. S. Geol. Surv. Bull. 924. 1944.
23. LAUTERBACH, C. Neue Pinaceae Papuaseins. Bot. Jahrb. **50:** 46–53. 1913.
24. MOSELEY, JR., M. F. Contribution to the life history, morphology, and phylogeny of Widdringtonia cupressoides. Lloydia **6:** 109–132. 1943.
25. MUELLER, F. VON. Records of observations of Sir William Macregor's highland plants from New Guinea. Trans. Roy. Soc. Vict. N. S. **1:** 1–45. 1889.
26. NEGER, F .W. Die Nadelhölzer (Koniferen) und übrigen Gymnospermen. Sammlung Goschen **355:** 1–185. 1907.
27. PEIRCE, A. S. Systematic anatomy of the woods of the Cupressaceae. Trop. Woods **49:** 5–21. 1937.
28. PILGER, R. Coniferae. In Engler and Prantl, Nat. Pflanzenfam. ed. 2. **13:** 121–407. 1926.
29. RADFORTH, N. W. Robert Boyd Thomson's morphological and phylogenetical studies bearing on Gymnosperm taxonomy. Bot. Gaz. **110:** 39–47. 1948.
30. SAXTON, W. T. Contributions to the life history of Callitris. Ann. Bot. **24:** 557–569. 1910.
31. ———. Contributions to the life history of Tetraclinis articulata, Masters, with some notes on the phylogeny of the Callitroideae. Ann. Bot. **27:** 577–606. 1913.
32. ———. The classification of conifers. New Phytol. **12:** 242–262. 1913.
33. STERLING, C. Some features in the morphology of Metasequoia. Am. Jour. Bot. **36:** 461–470. 1949.
34. THOMSON, R. B. "Polyembryogeny": sexual and asexual embryo initiation and food supply. Trans. Roy. Soc. Canad. Ser. 3, Sect. V. **34:** 143–169. 1945.
35. TORREY, J. Plantae Fremontianae. Smithsonian Contr. Knowl. **6:** 1–24. 1853.
36. VOSS, A. Coniferen Nomenklatur Tabelle. Mitteil. Deutsch. Dendrol. Ges. 1907(16): 88–95. 1908.
37. VIERHAPPER, F. Entwurf eines neuen Systems der Coniferen. Abh. Zool. Bot. Ges. Wien V. **4:** 1–56. 1910.
38. GUILLAUMIN, A. Contribution à la flore de la Nouvelle-Calédonie, XCII. Plantes récoltées par M. J. Bernier (complément). Bull. Mus. Hist. Nat. Paris **21:** 453–461. 1949.

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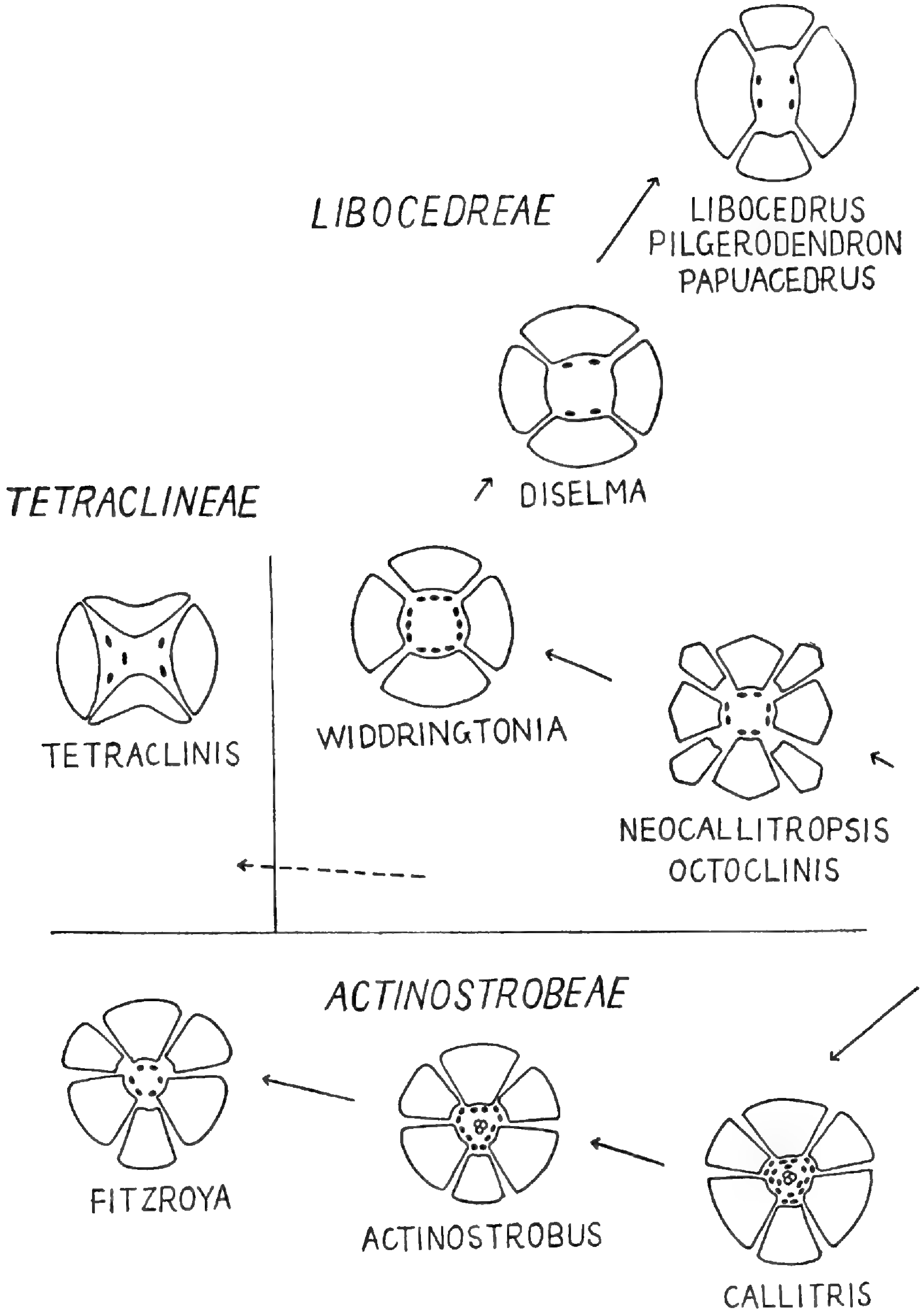
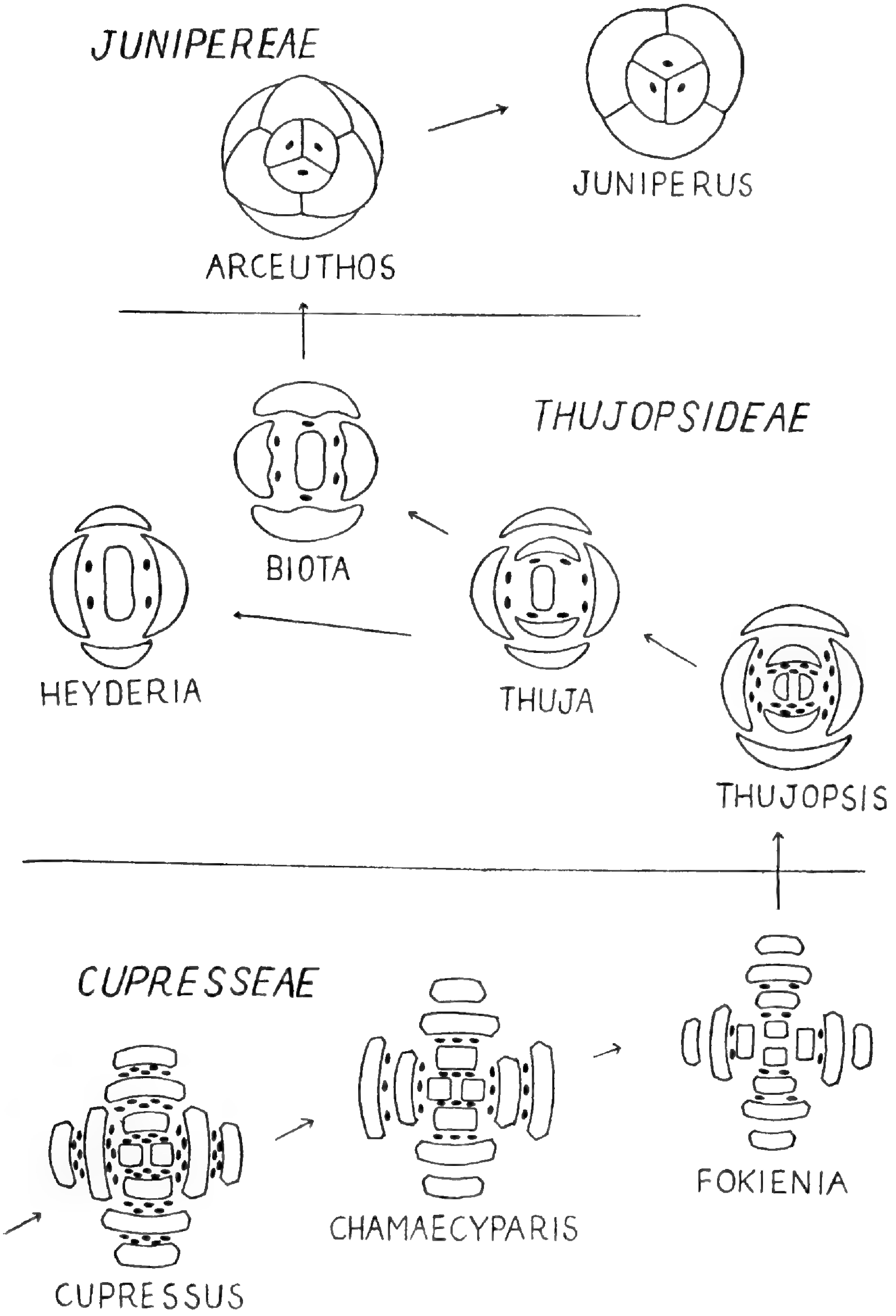
EXPLANATION OF PLATES

PLATE 1. Diagram showing the hypothetical types of cones of the genera of the subfamily Callitroideae and their probable relationships and directions of evolution.

PLATE 2. Diagram showing the hypothetical types of cones of the genera of the subfamily Cupressoideae and their probable relationships and directions of evolution.



LI, LIBOCEDRUS AND CUPRESSACEAE



LI, LIBOCEDRUS AND CUPRESSACEAE

STUDIES OF PACIFIC ISLAND PLANTS, XIV
NOTES ON THE FIJIAN SPECIES OF CYRTANDRA

A. C. Smith

The only revision which treats the vast genus *Cyrtandra* (Gesneriaceae) in its entirety is that of C. B. Clarke (in DC. Monogr. Phan. **5**: 1–303. 1883), and this of course is entirely out of date. In it the 167 recognized species of *Cyrtandra* are arranged in 13 sections, which have seemed to most subsequent students highly artificial. The total number of described species of the genus is now at least double the number known to Clarke. It may prove quite impossible to revise *Cyrtandra* for its entire range, unless some competent student is willing and able to spend many years at this task alone and to supplement his work by intensive field study. Regional solutions, however, are quite feasible, and these may follow the precedent set by J. F. Rock for the Hawaiian species (in Am. Jour. Bot. **4**: 604–623. 1917, **5**: 259–277. 1918, **6**: 47–68, 203–216. 1919), in which Clarke's sections are ignored.

The purpose of the present paper is in no sense revisional; it is intended only to place on record the ten species collected by me in 1947 [1] that appear to be undescribed, and to note pertinent data concerning a few of the older species. With these ten new species, *Cyrtandra* is now represented in Fiji by 45 species, as contrasted with the 20 species of the region known to Clarke. For convenience, the sequence here followed is that of Clarke, but the writer hopes in the near future to revise the Fijian species, and at that time more suitable groupings can be devised. It is not to be supposed that all the Fijian *Cyrtandrae* are now known; on the contrary, further intensive collecting in the wet montane forest is certain to disclose undescribed entities. The genus is second in size only to *Psychotria,* in Fiji, and it definitely includes some of the most beautiful species of undershrubs and low trees to be found in the Melanesian forests. Specimens cited in the present paper are deposited in the herbaria of the Arnold Arboretum (A) and the U. S. National Museum (US).

Cyrtandra victoriae Gillespie in Bishop Mus. Bull. **74**: 25. *fig. 34.* 1930.

Viti Levu: Mba: Mt. Ndelaiyoö, on the escarpment west of Nandarivatu, *Smith 5081* (A, US); upper western slope of Mt. Tomanivi, *Smith 5915, 5916, 5917* (all A, US); Ra: Ridge from Mt. Namama (east of Nandarivatu) toward Mt. Tomanivi, *Smith 5697, 5722* (A, US).

The cited specimens are from shrubs or low trees 2–5 m. high, growing in dense wet forest; the flowers are large and conspicuous, the white corolla

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[1] These collections were made under the auspices of the Arnold Arboretum of Harvard University and the John Simon Guggenheim Memorial Foundation, with the aid of grants from the Penrose Fund of the American Philosophical Society and the Bache Fund of the National Academy of Sciences.

having a pale yellowish pubescence. This very striking species, typified by a Gillespie collection from Mt. Tomanivi, is one of the most beautiful Fijian *Cyrtandrae* and is fairly frequent at elevations of 900–1300 m. in north-central Viti Levu. The leaves vary tremendously in size during their development, the chief vegetative characteristic of the plant being the dense indument of multicellular eglandular hairs (3–8 mm. long) that covers all the young parts and is often long-persistent. A few supplementary notes may be added to Gillespie's description, as follows: Calyx copiously sericeous within toward base with hairs 3–4 mm. long (not glabrous as described), the lobes 4 or 5, lanceolate, up to 2 cm. long, the 2 or 3 upper ones joined by the tips or laterally connate; corolla up to 4 cm. long, 3–5 mm. in diameter at base, broadened at throat to about 15 mm. in diameter, copiously pilose without like the calyx, less densely short-pilose within, the hairs several-celled and usually gland-tipped, interspersed with very short glandular hairs, the lobes 5–6 mm. broad; disk glabrous, about 1.5 mm. high; ovary glabrous, the style stout, copiously glandular-pilose.

Cyrtandra tomentosa A. C. Sm. in Sargentia 1: 116. 1942.

VITI LEVU: Mba: Hills east of Nandala Creek, about 3 miles south of Nandarivatu, alt. 850–970 m., *Smith 6237* (A, US) (shrub 2 m. high, in dense forest; fruit green).

The cited specimen, the second known of the species, agrees excellently with the type, *Degener 14889*, in all respects. Its leaves are slightly larger (petioles up to 6 cm. long; blades up to 35 × 9 cm.). The type locality, Nandrau, falls in the present province of Nandronga & Navosa and is slightly south of the region cited above.

Cyrtandra amicta sp. nov.

Frutex ad 4 m. altus saepe caule simplici, ramulis incrassatis (apicem versus ad 2 cm. diametro) obtuse quadrangularibus juventute obscure pilosis mox glabratis; foliis oppositis apices ramulorum versus congestis magnis, petiolis crassis semiteretibus 4–12 cm. longis fere ad basim alatis inconspicue pilosis glabratisve, laminis in vivo carnosis in sicco papyraceis supra fusco-viridibus subtus pallidioribus, obovatis vel oblanceolatis, 40–70 cm. longis, 12–22 cm. latis, inferne gradatim angustatis et in petiolum longe decurrentibus, apice breviter acuminatis, margine undulatis ac etiam irregulariter et minute calloso-serrulatis, supra glabris vel interdum pilis multiseptatis ad 2 mm. longis subpersistenter pilosis, subtus nervis et interdum facie pilis aureis debilibus 0.1–0.5 (–1) mm. longis molliter pilosis demum subglabratis, costa valida supra elevata subtus prominente, nervis secundariis utrinsecus 15–20 arcuato-adscendentibus copiose anastomosantibus supra inconspicue subtus valde elevatis, nervis tertiariis et rete venularum laxis supra immersis subtus prominulis; inflorescentiis axillaribus multifloris compacte cymosis multibracteatis laxe capitatis ad 10 cm. diametro, bracteis omnino liberis submembranaceis oblongo-lanceolatis, 25–30 mm. longis, 7–10 mm. latis, subacutis, intus basim versus pilis aureis debilibus pluriseptatis 2–3 mm. longis villosis cetera glabris; pedicellis crassis teretibus glabris sub anthesi 6–10 mm. longis; calyce amplo membranaceo campanulato-infundibulari sub anthesi 35–40 mm. longo et basim versus 6–10 mm. diametro, superne latiore, extus glabro, intus basim versus ut bracteis debiliter piloso, inaequaliter 5-lobato, lobis deltoideis vel deltoideo-lanceolatis 5–12 × 3–10 mm.; corolla membranacea inconspicue nervata infundibulari sub anthesi 40–45 mm. longa et basim versus 5–7 mm. diametro, superne ampliata, extus glabra (interdum juvenili tubo pilis ut bracteis floccoso-villosa mox glabrata), intus glabra, lobis 5 leviter inaequalibus semiorbiculari-oblongis in alabastro late imbricatis sub anthesi patentibus 7–10 mm. longis latisque; staminibus glabris tubo corollae supra medium affixis, filamentis crassis leviter complanatis 3–5 mm. longis, antheris oblongis 4–5 mm. longis utroque rotundatis; disco crasse carnoso glabro annulari-cupuliformi 1.5–2 mm. alto apice undulato; ovario graciliter ovoideo glabro vel superne parce piloso, stylo crasso tereti sub anthesi circiter 15 mm. longo pilis patentibus 0.3–0.7 mm. longis pluriseptatis capitato-glandulosis copiose piloso, stigmate subclavato demum bilobato,. lobis complanatis; fructibus juvenilibus (calyce caduco) elongato-ovoideis in sicco rugulosis.

VITI LEVU: Mba: Eastern slopes of Mt. Koroyanitu, Mt. Evans Range, *Smith 4243*, *4244* (A, US); upper western slopes of Mt. Tomanivi [Mt. Victoria], alt. 1100–1150 m., Sept. 6, 1947, *Smith 5914* (A TYPE, US); hills east of Nandala Creek, about 3 miles south of Nandarivatu, *Smith 6223* (A, US); Nandronga & Navosa: Northern portion of Rairaimatuku Plateau, between Nandrau and Rewasau, *Smith 5654* (A, US).

The cited specimens are from often simple-stemmed shrubs 1.5–4 m. high, occurring at elevations of 850–1150 m. in dense forest. The bracts, calyx, and corolla are white, the fruit becoming white at maturity and up to 2.5 cm. in length. The leaves are characteristically congested toward the apex of the plant, concealing the densely clustered axillary inflorescences.

Cyrtandra amicta is strongly characterized by its glabrous flowers and its remarkably long calyx, which approximates the corolla in length and conceals it except for the tip. Its relationship is with *C. vitiensis* Seem. (§ *Decurrentes*), which it resembles closely in having its large leaf-blades gradually narrowed and long-decurrent at base. However, *C. vitiensis* has the calyx only about half as long as that of the new species, while its corolla is sericeous without. I believe that *C. vitiensis* is represented in my 1947 collections by nos. *5103*, *5315*, and *5848*, from Mt. Tomanivi and vicinity; these numbers differ from the new species in the stated floral characters, in having the calyx uniformly long-pilose within, and in their more obvious and persistent foliage-indument.

Cyrtandra occulta sp. nov.

Frutex ad 2 m. altus, caule simplici valido apice ad 2 cm. diametro saepe fistuloso primo debiliter piloso mox glabrato; foliis oppositis magnis, petiolis crassis canaliculatis 2–8 cm. longis ad basim alatis mox glabratis, laminis in vivo carnosis in sicco subcoriaceis vel chartaceis supra fusco-viridibus subtus pallidioribus, obovatis vel oblanceolatis, 30–40 cm. longis, 10–16 cm. latis, basim versus gradatim angustatis et in petiolum longe decurrentibus, apice ut videtur acutis, margine undulato-crenulatis etiam irregulariter calloso-denticulatis, utrinque praecipue nervis pilis aureis debilibus 0.5–2 mm. longis molliter pilosis, supra mox glabratis et minute pustulosis, subtus demum subglabratis, costa valida supra elevata subtus prominente, nervis secundariis utrinsecus 18–22 curvatis obscure anastomosantibus supra subplanis subtus prominentibus, nervis tertiariis et venulis laxis subimmersis; inflorescentiis axillaribus multifloris compacte cymosis subcapitatis 3.5–5 cm. diametro multibracteatis, bracteis extimis in involucrum latum cupuliforme connatis submembranaceis utrinque copiose tomentosis, pilis pallide aureis debilibus pluriseptatis extus 2–3 mm. longis demum caducis intus 5–8 mm. longis densissimis persistentibus, bracteis interioribus numerosis membranaceis oblongis ad 3 × 1.5 cm. similiter pilosis; pedicellis crassis (2–3 mm. diametro) teretibus sub anthesi 5–10 mm. longis persistenter debiliter pilosis (pilis 2–3 mm. longis pluriseptatis); calyce membranaceo campanulato sub anthesi 20–22 mm. longo et basim versus circiter 10 mm. diametro superne latiore, utrinque pilis eis bractearum similibus densissime sericeo, apice in lobos deltoideo-lanceolatos inaequaliter fisso; corolla membranacea infundibulari sub anthesi 30–35 mm. longa et basim versus 5–7 mm. diametro, superne ampliata, extus pilis 5–7 mm. longis septatis copiose et persistenter sericeo-tomentella, intus praeter basim versus ubique copiosissime glanduloso-pilosa (pilis minutis patentibus, stipite ad 0.2 mm. longo vel subnullo plerumque 2–4-septato apice capitato-glanduloso), lobis 5 subaequalibus oblongis rotundatis 5–7 mm. longis latisque; staminibus glabris tubo corollae medium versus affixis, filamentis crassis leviter complanatis circiter 5 mm. longis, antheris oblongis circiter 4 mm. longis utroque rotundatis; disco crasse carnoso glabro annulari-cupuliformi 1.5–2 mm. alto margine integro; ovario graciliter ovoideo glabro, stylo crasso tereti sub anthesi 10–15 mm. longo superne pilis pluriseptatis 0.2–0.5 mm. longis capitato-glandulosis copiose piloso, stigmate subpeltato bilobato; fructibus juvenilibus (calyce caduco) elongato-ovoideis apice acutis.

VITI LEVU: Mba: Upper western slopes of Mt. Tomanivi [Mt. Victoria], alt. 1100–1150 m., Sept. 6, 1947, *Smith 5913* (A TYPE, US) (simple-stemmed shrub 2 m. high, in dense forest; bracts greenish white; corolla and young fruit white); Naitasiri: Northern portion of Rairaimatuku Plateau, between Mt. Tomanivi and Nasonggo, alt. 870–970 m., *Smith 5792* (A, US) (simple-stemmed shrub 1–2 m. high, in dense forest; bracts white).

The species here described closely resembles in foliage *C. vitiensis* Seem. and *C. amicta*, above described, and is probably also referable to § *Decurrentes*. It is readily characterized by its large subcapitate inflorescence surrounded by coalescent and copiously pilose outer bracts, by having its large calyx densely long-sericeous on both sides, and by its copiously sericeous corolla, which is densely glandular-pilose within. An examined isotype of *C. vitiensis* (*Seemann 277*, from the vicinity of Namosi) at the Gray Herbarium has lost the outer bracts of the inflorescence, and so a comparison on this score cannot be made. However, *C. occulta* differs obviously from *C. vitiensis* in its densely pilose calyx. From *C. amicta* the new species is readily separated by its large coalescent bracts, its more copious inflorescence-indument, its shorter calyx, and the glandular indument of the inner surface of its corolla, as well as by obvious differences in leaf-texture, surface, and venation.

Cyrtandra leucantha sp. nov.

Frutex ad 3 m. altus, ramulis gracilibus apices versus subquadrangularibus 3–5 mm. diametro pilis brunneis pluriseptatis 0.5–0.8 mm. longis patentibus copiose indutis demum subglabratis; foliis oppositis apices ramulorum versus subcongestis, petiolis gracilibus leviter canaliculatis vel semiteretibus 3–6 cm. longis ut ramulis juvenilibus pilosis, laminis in sicco papyraceis supra fusco-viridibus subtus pallidioribus, oblanceolatis vel obovatis, 20–37 cm. longis, 7.5–14 cm. latis, inferne gradatim angustatis et in petiolum longe decurrentibus, apice breviter acuminatis vel cuspidatis, margine copiose sed irregulariter calloso-serratis, supra pilis multiseptatis 1–1.5 mm. longis copiose patenti-pilosis, margine pariter ciliatis, subtus etiam copiose pilosis (pilis nervorum similibus, eis facie pallidioribus interdum unicellularibus 0.3–0.5 mm. longis), costa et nervis secundariis utrinsecus 9–13 arcuato-adscendentibus supra subplanis subtus prominentibus vel valde elevatis, nervis tertiariis et rete venularum intricato supra immersis subtus prominulis; inflorescentiis axillaribus cymosis multifloris congestis, bracteis liberis papyraceis ellipticis vel suborbicularibus, 6–8 mm. diametro, apice rotundatis, margine distali undulatis, utrinque glabris vel basim versus obscure pilosis, pedunculo brevi, pedicellis gracilibus sub anthesi 6–9 mm. longis glabris; calyce submembranaceo cylindrico-campanulato, sub anthesi 16–17 mm. longo, basim versus circiter 5 mm. diametro superne ad 8–9 mm. diametro gradatim ampliato, extus praeter basim versus pilis numerosis patentibus 0.5–1 mm. longis (stipitibus 3–6-septatis gracilibus apice capitato-glandulosis raro eglandulosis) praedito, intus glabro basi sericeo excepto, lobis 5 suberectis subaequalibus deltoideis circiter 3 × 4 mm. apice obscure calloso-mucronulatis; corolla membranacea cylindrica sub anthesi circiter 20 mm. longa et basim versus 4 mm. diametro, faucibus paullo ampliata, extus superne ut calyce glanduloso-pilosa, intus glabra, lobis 5 subaequalibus patentibus suborbicularibus circiter 4 mm. diametro; staminibus tubo corollae supra medium affixis, filamentis gracilibus 2–3 mm. longis, antheris ellipsoideis circiter 3 mm. longis; disco glabro breviter tubuloso circiter 1.5 mm. alto; ovario graciliter ovoideo glabro, stylo crasso circiter 8 mm. longo parce glanduloso-piloso, stigmate complanato bifido; fructibus ellipsoideis maturis circiter 15 mm. longis in sicco rugulosis, apice styli basi apiculatis, calycis limbo et disco mox caducis sed pilis calycis basis subpersistentibus.

VITI LEVU: Mba: Western slopes of Mt. Nanggaranambuluta [Lomalangi], east of Nandarivatu, alt. 850–1000 m., *Smith 4767* (A, US) (*mbeta kai:* simple shrub 1–1.5 m. high, in dense forest; fruit white), *6312* (A TYPE, US) (Oct. 2, 1947; shrub 3 m. high, in dense forest; calyx and corolla white); vicinity of Nandarivatu, alt. 800–900 m., *Degener & Ordonez 13523* (A, US) (shrub to 2 m. high, in dark wet forest; calyx and corolla white); Nandala, near Nandarivatu, *Degener 14836* (A, US) (*mbeta;* sparingly branched shrub 2 m. high, in dense forest; bracts white).

The last two specimens cited were originally distributed as *C. glandulosa* Gillespie, a species similar in the indument of its calyx and corolla. Further examination indicates that these plants do not represent *C. glandulosa,* which, however, appears to occur in my present collection in no. *4129* (A, US), from the Mt. Evans Range of northwestern Viti Levu. The new species here described differs from *C. glandulosa* in the much shorter indument of its branchlets and leaves, in having its leaf-blades long-attenuate at base and the petiole comparatively short and slender, in its much smaller inflorescence-bracts, its comparatively small flowers, its white rather than yellow corolla, and its caducous calyx. The fact that the calyx of *C. leucantha* is not saccate and persistent would, in Clarke's system, remove it from the alliance of *C. glandulosa.* A closer relative of the new species is perhaps *C. desvoeuxii* Horne ex Clarke (represented in my present collection by no. *5101* [A, US], from Mt. Tomanivi), which Clarke placed in his § *Aureae. Cyrtandra desvoeuxii* is a very robust species, with flowers approaching those of *C. glandulosa* in size. It is possible that *C. glandulosa* also belongs in § *Aureae* rather than in § *Campanulaceae,* where it was placed by Gillespie.

Cyrtandra chlorantha sp. nov.

Frutex ad 4 m. altus, ramulis gracilibus obscure quadrangularibus apices versus 3–4 mm. diametro pilis patentibus 2–4 mm. longis multiseptatis brunneis eglandulosis (vel interdum capitato-glandulosis) copiose indutis demum subglabratis; foliis oppositis, petiolis gracilibus leviter canaliculatis 3–4 cm. longis ut ramulis juvenilibus pilosis, laminis in sicco papyraceis supra fusco-viridibus subtus pallidioribus, lanceolatis vel anguste ellipticis, 14–19 cm. longis, 5–8 cm. latis, basi attenuatis et in petiolum longe decurrentibus, apice cuspidatis, margine dentibus irregularibus 1 vel 2 per centimetrum calloso-serratis, supra dispersim pilosis (pilis multiseptatis 1.5–3 mm. longis), subtus similiter pilosis vel pilis faciei brevioribus, margine pariter ciliatis, costa supra leviter elevata subtus prominente, nervis secundariis utrinsecus 7–9 adscendentibus supra planis subtus elevatis, rete venularum supra subimmerso subtus prominulo; inflorescentiis axillaribus cymosis paucifloris, pedunculo ad 1 cm. longo subglabrato, bracteis liberis papyraceis ellipticis vel ovatis, 12–16 mm. longis, subacutis, margine undulatis, utrinque pilis multiseptatis 1–2 mm. longis plerumque capitato-glandulosis parce patenti-pilosis, pedicellis gracilibus sub anthesi 5–8 mm. longis superne ut calyce pilosis; calyce submembranaceo campanulato sub anthesi 15–18 mm. longo et basim versus 5 mm. diametro superne ad

10 mm. diametro ampliato, extus pilis 2–3 mm. longis pluriseptatis capitato-glandulosis (glandulis interdum caducis) copiose et uniformiter patenti-piloso, intus similiter sed parcius pilosis, lobis 5 inaequalibus deltoideis 2–5 mm. longis obtusis; corolla membranacea cylindrica viridi sub anthesi circiter 22 mm. longa et basim versus 5 mm. diametro, extus ut calyce copiose et subtiliter glanduloso-pilosa, intus glabra, apice in lobos 5 subaequales late imbricatos suborbiculares circiter 5 mm. diametro abrupte incrassata; staminibus tubo corollae supra medium affixis, filamentis circiter 5 mm. longis, antheris ellipsoideis circiter 3.5 mm. longis; disco cupuliformi glabro circiter 1 mm. alto; ovario ovoideo glabro, stylo circiter 10 mm. longo pilis ad 0.5 mm. longis glanduloso-piloso, stigmate bifido.

VITI LEVU: Naitasiri: Northern portion of Rairaimatuku Plateau, between Mt. Tomanivi [Mt. Victoria] and Nasonggo, alt. 870–970 m., Aug. 21, 1947, *Smith 5789* (A TYPE, US) (shrub 3–4 m. high, in dense forest; bracts and calyx pale green; mature corolla bright green; anthers white; young fruit green).

The new species is of the general relationship of *C. leucantha*, described above, and for the present appears best referred to § *Aureae*. *Cyrtandra chlorantha* is readily distinguished from *C. leucantha* by its longer vegetative indument, smaller leaves, larger and pilose inflorescence-bracts, the markedly longer hairs of its calyx and corolla, and the striking bright green color of the latter. With *C. desvoeuxii* Horne ex Clarke and possibly *C. glandulosa* Gillespie, the two new species here described make up a group readily characterized, among the Fijian species, by their glandular-pilose flowers.

Cyrtandra bracteolosa sp. nov.

Arbor gracilis ad 5 m. alta, habitu partibus juvenilibus minute et evanescenter furfuraceis exceptis glabra, ramulis gracilibus apices versus subquadrangularibus 2–3 mm. diametro inferne subteretibus cinerascentibus, internodiis 1.5–5 cm. longis; foliis oppositis, petiolis gracilibus leviter canaliculatis 1–2.5 cm. longis, laminis chartaceis in sicco viridibus, lanceolatis, (11–) 14–19 cm. longis, (3.5–) 4–6 cm. latis, basi attenuatis et in petiolum decurrentibus, apice gradatim longe acuminatis, margine dentibus 1–2 cm. remotis calloso-apiculatis manifeste undulato-crenatis, costa supra paullo elevata subtus prominente, nervis secundariis utrinsecus 5–8 arcuato-adscendentibus supra subplanis subtus elevatis marginem versus interconnexis, rete venularum laxo supra immerso subtus prominulo; inflorescentiis e nodis defoliatis orientibus cymosis, aliquot dichotome ramulosis, ad 6 cm. longis, paucifloris (floribus plerumque mox caducis), pedunculo ramulisque teretibus gracillimis (0.4–0.7 mm. diametro), pedunculo 10–25 mm. longo, internodiis 7–15 mm. longis; bracteis bracteolisque ad nodos subpersistentibus papyraceis vel submembranaceis oblongo-linearibus, 4–7 mm. longis, 0.8–1.2 mm. latis, obtusis 1-nerviis, distalibus dorso saepe obscure furfuraceis; floribus e nodis apicalibus solitariis, pedicello tereti 3–5 mm. longo; calyce membranaceo cupuliformi 4–5 mm. longo demum subrotato caduco, manifeste nervato, ad medium 5-lobato, lobis subaequalibus late deltoideis subacutis; corolla non visa; fructibus juvenilibus ellipsoideis levibus, stylo crasso circiter 5 mm. longo, stigmate incrassato bilobato.

VITI LEVU: Mba: Hills east of Nandala Creek, about 3 miles south of Nandarivatu, alt. 850–970 m., Sept. 25, 1947, *Smith 6232* (A TYPE, US) (slender tree 5 m. high, in dense forest; young fruit green).

The cited specimen, although lacking corollas, seems definitely to represent a new species related to the species of § *Polynesieae* with freely branching inflorescences; this group in Fiji includes *C. denhamii* Seem., *C. ciliata* Seem., *C. taviunensis* Gillespie, and perhaps *C. montana* Gillespie. The new species differs from all of these in its narrow, linear bracteoles. These bracteoles bear a superficial resemblance to the calyx-lobes of *C. ciliata*, but actually the calyces of the two species are very dissimilar, and foliage differences are also pronounced. In comparison with *C. bracteolosa*, *C. taviunensis* has much larger bracteoles and calyx, while *C. montana* has the leaves and bracteoles considerably smaller and the calyx larger. *Cyrtandra denhamii*, apparently the closest ally of the new species, is very imperfectly known, but it is described as having an elongate peduncle, oblong bracteoles about 1 cm. long, and a subspathaceous calyx.

Cyrtandra trichophylla sp. nov.

Arbor gracilis ad 6 m. alta, ramulis apices versus subteretibus 3–6 mm. diametro pilis pallidis ad 1.5 mm. longis obscure pluriseptatis copiose indutis, demum incrassatis ad 15 mm. diametro glabratis cinereis rugulosis; foliis oppositis, petiolis crassis (3–5 mm. diametro) leviter canaliculatis 1–2.5 cm. longis ut ramulis juvenilibus pilosis glabratisque, laminis in vivo carnosis in sicco subcoriaceis fuscescentibus, obovatis vel obovato-ellipticis, (12–) 14–28 cm. longis, (4–) 5.5–11 cm. latis, basi acutis vel attenuatis et in petiolum decurrentibus, apice breviter acuminatis vel cuspidatis, margine dentibus 1–3 per centimetrum inconspicue calloso-serratis, supra glabris (juventute dispersim sericeis), subtus pilis subtilibus pallidis 0.8–1.5 mm. longis obscure pluriseptatis densissime molli-sericeis, costa supra plana vel leviter elevata subtus prominente, nervis secundariis utrinsecus 7–11 adscendentibus vel erecto-patentibus supra planis subtus valde elevatis, rete venularum utrinque immerso; inflorescentiis trunco vel ramulis infra folia enatis vel interdum axillaribus, simpliciter cymosis, plerumque 3(interdum 2- vel 4-)-floris, pedunculo pedicellisque gracilibus longitudine subaequalibus (vel pedunculo interdum subnullo) sub anthesi 10–15 mm. longis copiose pilosis (pilis subpatentibus pluriseptatis 1–2 mm. longis) demum subglabratis; bracteis apice pedunculi in involucrum papyraceum monophyllum coalitis ad 10 mm. longis latisque, apice obtusis, utrinque ut pedicellis copiose pilosis (indumento intus persistentiore) demum deciduis; calyce subcarnoso campanulato sub anthesi 15–17 mm. longo et basim versus 6–7 mm. diametro superne ad 10–12 mm. ampliato utrinque (intus saepe densius) pilis eis pedicelli similibus copiose sericeo, lobis 5 subaequalibus deltoideo-lanceolatis acutis 5–7 mm. longis; corolla infundibulari sub anthesi circiter 25 mm. longa, tubo subcarnoso basim versus 3–5 mm. diametro faucibus ampliato extus superne ut calyce piloso intus glabro, lobis 5 subaequalibus sub anthesi patentibus submembranaceis oblongo-suborbicularibus 7–8 mm. diametro intus inconspicue pilosis (pilis debilibus 0.3–0.5 mm. longis stipitatis capitato-glandulosis); staminibus apicem tubi corollae versus affixis, filamentis 2–3 mm. longis, antheris ellipsoideis circiter 2 mm. longis; disco carnoso breviter cylindrico glabro 1–2 mm. alto; ovario anguste ellipsoideo glabro, stylo crasso circiter 10 mm. longo superne parce glanduloso-piloso, stigmate complanato obscure bilobato; fructibus ellipsoideis in vivo ad 4 × 2.5 cm. in sicco rugulosis, calyce caduco.

VITI LEVU: Ra: Ridge from Mt. Namama (east of Nandarivatu) toward Mt. Tomanivi [Mt. Victoria], alt. 1050–1120 m., Aug. 18, 1947, *Smith 5698* (A TYPE, US) (tree 5 m. high, in dense forest; corolla and stamens white; fruit when fresh white, ellipsoid, about 4 × 2 cm., greatly shrinking in drying); Mba: Hills east of Nandala Creek, about 3 miles south of Nandarivatu, alt. 850–970 m., *Smith 6246* (A, US) (slender tree 6 m. high, in dense forest; calyx green, with brown pubescence; corolla and anthers white; fruit white, when fresh about 4 × 2.5 cm., greatly shrinking in drying).

A species of § *Polynesieae*, the new species forms, with *C. involucrata* Seem. and *C. gillespieana* A. C. Sm. [*C. monticola* Gillespie], a group characterized by simple inflorescences with the two bracts joined to form a cup-like involucre. *Cyrtandra trichophylla* differs from its relatives in the prevailingly obovate, larger, and thick-textured leaves, of which the lower surface is very densely sericeous with long, pale, obscurely septate hairs, and in its comparatively large calyx and corolla, the former being copiously sericeous on both sides.

Cyrtandra esothrix sp. nov.

Frutex vel arbor gracilis ad 6 m. alta, partibus novellis copiose sed minute brunneo-puberulis, ramulis gracilibus apices versus subquadrangularibus demum glabratis, internodiis 1–2.5 (–4) cm. longis; foliis oppositis, petiolis gracilibus leviter canaliculatis vel semiteretibus 1–3 (–3.5) cm. longis ut ramulis puberulis glabratisque, laminis papyraceis in sicco viridibus vel fusco-viridibus, lanceolatis vel obovato-ellipticis, 10–18 cm. longis, 3–6 cm. latis, basi attenuatis et in petiolum decurrentibus, apice acuminatis et calloso-apiculatis, margine dentibus 1–3 per centimetrum calloso-mucronulatis conspicue serratis, supra glabris vel nervis parce puberulis, subtus nervis (et plerumque facie) primo pilis 0.1–0.3 mm. longis copiose puberulis demum subglabratis, costa supra subplana subtus prominente, nervis secundariis utrinsecus 7 vel 8 adscendentibus supra planis subtus elevatis, rete venularum laxo subtus prominulo; inflorescentiis cymosis axillaribus etiam infra folia enatis breviter pedunculatis plerumque unifloris raro bifloris, bracteis bracteolisque oppositis inconspicuis deltoideis vel oblongis 1.5–2.5 mm. longis obtusis mox caducis, pedicellis gracilibus sub anthesi 5–15 mm. longis cum pedunculo bracteisque ut ramulis juvenilibus puberulis demum glabratis; calyce subcarnoso in alabastro ovoideo et calloso-mucronulato, sub anthesi 8–12 mm. longo in lobos 2 vel 3 ovatos 3–4 mm. longos cuspidatos irregulariter rumpente, extus glabro vel basim versus parce puberulo, intus pilis crassis adscendentibus fulvis subrigidis 3–5-septatis 0.8–1.5 mm. longis copiose sericeo, mox caduco; corolla membranacea cylindrica inconspicue curvata ubique glabra sub anthesi ad 22 mm. longa, basim versus 5–6 mm. diametro superne ampliata, lobis 3 inferioribus rotundato-oblongis 5–6 mm. longis, 2 superioribus paullo minoribus; staminibus glabris tubo supra medium insertis, filamentis circiter 3 mm. longis, antheris oblongis circiter 2 mm. longis utroque rotundatis; disco carnoso annulari glabro circiter 1.5 mm. alto; gynoecio glabro, ovario subcylindrico-ovoideo, stylo crasso sub anthesi circiter 4 mm. longo demum elongato, stigmate subcapitato; fructibus anguste ovoideis ad 2 cm. longis in sicco rugulosis.

VITI LEVU: Naitasiri: Northern portion of Rairaimatuku Plateau, between Mt. Tomanivi [Mt. Victoria] and Nasonggo, alt. 870–970 m., Sept. 18, 1947, *Smith 6134* (A TYPE, US) (slender tree 4–6 m. high, forming dense thickets in forest; calyx white in bud, at length pale green; corolla and young fruit white); Mba: Western and southern slopes of Mt. Tomanivi, alt. 850–1150 m., *Smith 5098*, *5267* (A, US) (shrubs 3–4 m. high, in dense forest; calyx pale green; corolla and fruit white).

A member of § *Polynesieae, C. esothrix* appears to be most closely related to *C. coleoides* Seem., a species with the same type of irregularly splitting calyx and a similar, but sparser, vegetative indument. The new species differs from *C. coleoides* most obviously in having the calyx copiously sericeous within (rather than glabrous), the several-celled hairs conspicuously protruding as soon as the calyx-bud breaks, and in having the flowers usually one per inflorescence (rather than several). *Cyrtandra coleoides* is a not infrequent species in upland Viti Levu, being represented in my present collection by nos. *5259*, *5628*, and *5813*; its leaves are slightly larger than those of the new species and have the margins merely undulate rather than sharply serrate, while the indument of the nerves on the lower surface is evanescent.

Cyrtandra greenwoodiana sp. nov.

Arbor vel frutex ad 6 m. altus, ramulis gracilibus sub anthesi subquadrangularibus 1–3 mm. diametro et pilis fusco-brunneis pluriseptatis 0.1–0.3 mm. longis copiose et arcte indutis, mox glabratis subteretibus, internodiis 1–2 cm. longis; foliis oppositis, petiolis gracilibus semiteretibus (0.7–) 1–3 cm. longis ut ramulis pilosis glabratisque, laminis in sicco chartaceis saepe viridibus subtus pallidioribus, oblongo-ellipticis, (4–) 6–15 cm. longis, (2–) 4–6 cm. latis, basi obtusis, apice abrupte cuspidatis vel breviter acuminatis, margine dentibus irregularibus 1 vel 2 per centimetrum apiculatis manifeste undulato-serratis, supra glabris, subtus costa nervisque secundariis ut petiolis (saepe sparsim) pilosis alioqui glabris, costa et nervis secundariis utrinsecus 5–8 curvatis patentibus supra subplanis subtus valde elevatis, rete venularum subimmerso vel subtus laxe prominulo; inflorescentiis axillaribus unifloris, pedunculo gracili 5–12 mm. longo primo ut ramulis juvenilibus arcte piloso sub fructu subglabrato, bracteis apice pedunculi binis minutis lanceolatis 1–2 mm. longis arcte strigillosis caducis, pedicello pedunculum subaequante vel sub fructu ad 15 mm. longo similiter strigilloso; calyce submembranaceo inaequilateraliter campanulato, in alabastro clauso et conspicue caudato-apiculato, sub anthesi irregulariter fisso saepe subspathaceo, 15–16 mm. longo, 5–7 mm. diametro, utrinque pilis eglandulosis pluriseptatis (extus 0.2–0.3 mm. longis caducis, intus ad 0.7 mm. longis persistentibus) induto, lobis 5 lanceolatis 5–7 mm. longis, saepe omnino ad apicem connatis, interdum 1 vel 2 liberis aliis connatis, calyce e basi mox caduco; corolla membranacea infundibulari sub anthesi lobis inclusis 20–25 mm. longa et basim versus 3–5 mm. diametro superne ampliata, tubo utrinque glabro, lobis 5 subaequalibus oblongo-suborbicularibus circiter 5 mm. longis intus subtiliter et minute glanduloso-pilosis; staminibus in faucibus corollae insertis, filamentis 2–3 mm. longis, antheris ellipsoideis longitudine aequalibus; disco annulari-pulvinato haud 0.5 mm. alto; ovario anguste ellipsoideo glabro, stylo crasso circiter 7 mm. longo obscure glanduloso-piloso, stigmate incrassato bilobato; fructibus ellipsoideis in vivo circiter 2.5 cm. longis in sicco rugulosis, basi styli subpersistente.

VITI LEVU: Mba: Mt. Nairosa, eastern flank of Mt. Evans Range, alt. about 1050 m., May 14, 1947, *Smith 4412* (A TYPE, US) (tree or shrub 4–6 m. high, in crest thickets at base of ultimate pinnacle; corolla and fruit pure white, the mature fruit about 2.5 × 1.5 cm., shrinking in drying); northern portion of Mt. Evans Range, between Mt. Vatuyanitu and Mt. Natondra, alt. 700–900 m., *Smith 4304* (A, US) (slender tree 5 m. high, in dense forest; calyx pale green; corolla and fruit white); Mt. Evans Range, alt. about 970 m., *Greenwood 1260* (US) (shrub 3–4 m. high, in thick forest; flowers white).

Cyrtandra greenwoodiana is characterized by the close (and often sparse) indument of its vegetative parts and inflorescence, its one-flowered inflorescence with minute bracts subtending the solitary pedicel, and its large, unevenly cleft, often one-sided and subspathaceous calyx, which is densely short-pilose within. A member of § *Polynesieae*, its closest ally seems to be *C. pritchardii* Seem., from which it differs in its more obvious indument, its slightly smaller leaves, its consistently one-flowered inflorescence, and its much larger calyx and corolla. The calyx of *C. pritchardii* is only about 7 mm. long and is subequally 5-lobed, and its corolla is about 16 mm. long. It is probable that some of the specimens from central Viti Levu identified as *C. pritchardii* will be better referred to the new species, but a final circumscription of Seemann's species (type from Ovalau) may be delayed until the genus is revised for Fiji. Another species of this relationship, *C. spathacea* A. C. Sm. (type from Kandavu), is essentially glabrous throughout and has much larger, many-nerved leaves. It is a pleasure to name the new species for Mr. William Greenwood, a long-time resident of Fiji, who has collected many unusual species on the Mt. Evans Range of northwestern Viti Levu.

Cyrtandra harveyi Seem. Fl. Vit. 182. 1866; C. B. Clarke in DC. Monogr. Phan. **5**: 281. 1883.

VANUA LEVU: Mathuata: Southern base of Mathuata Range, north of Natua, *Smith 6761* (A, US); slopes of Mt. Numbuiloa, east of Lambasa, *Smith 6343* (A, US), *6529* (A, US).

Cyrtandra harveyi (§ *Polynesieae*) is one of the most frequent species of the genus in Fiji at low elevations, occurring from near sea-level up to 500 m. in the forest undergrowth, especially on Vanua Levu. In addition to the recently collected material above cited it is represented by: Vanua Levu: *Harvey* (type at Kew, isotype at Gray Herbarium), *Smith 367, 1847, Degener & Ordonez 13899, 13969, 14088*; Viti Levu: *B. E. Parham 17, Tabualewa 15596.* The specimens are from shrubs or slender trees 1–4 m. high; the corolla is cream white to pale yellow, and the mature fruit is white and about 2 × 1 cm., with a quickly caducous calyx.

Although the available specimens show some variability in leaf-size and marginal serration, there seems no doubt that they represent the same well circumscribed species. The branchlets, petioles, pedicels, and calyx are copiously and closely sericeous with dark golden subascending (less commonly subspreading) several-celled hairs 0.2–1 mm. long, both leaf-surfaces being similarly pilose but eventually subglabrate; the inflorescence is axillary or lateral below the leaves, openly cymose, pedunculate, inconspicuously bracteate, 2–4-flowered; the calyx is closed and apiculate in bud, eventually 10–12 mm. long and unequally (sometimes deeply) 5-lobed; the corolla is 20–25 mm. long, subequally 5-lobed, copiously to sparsely spreading-pilose with several-celled gland-tipped hairs 0.1–0.5 mm. long; the stamens are highly placed on the corolla; and the style often equals the corolla in length, having scattered glandular hairs distally.

Cyrtandra xanthantha sp. nov.

Frutex ad 4 m. altus, ramulis subteretibus vel obscure quadrangularibus apices versus 1.5–3 mm. diametro et pilis patentibus fusco-brunneis pluriseptatis 0.8–1.5 mm. longis copiose indutis, demum glabratis, internodiis brevibus 5–8 mm. longis, nodis subincrassatis; foliis oppositis, petiolis gracilibus basim versus canaliculatis 5–15 mm. longis ut ramulis juvenilibus patenti-pilosis, laminis chartaceis in sicco fusco-viridibus lanceolatis, (8–) 11–18 cm. longis, (3–) 4–5.5 cm. latis, basi acutis sed haud decurrentibus, apice calloso-acuminatis, margine dentibus circiter 2 per centimetrum calloso-apiculatis inconspicue denticulatis, utrinque pilis pluriseptatis 0.5–1 mm. longis dispersim patenti-pilosis, costa nervisque secundariis utrinsecus 7–9 subadscendentibus supra subplanis subtus valde elevatis, rete venularum supra immerso subtus prominulo; inflorescentiis axillaribus simpliciter cymosis 3–4-floris, pedunculo pedicellisque longitudine subaequalibus 5–10 mm. longis gracilibus ut ramulis juvenilibus copiose pilosis, indumento pedicelli pallido, bracteis mox caducis non visis; calyce membranaceo campanulato sub anthesi 5–6 mm. longo, extus ut pedicellis piloso (pilis pallidis 0.5–1.3 mm. longis multiseptatis eglandulosis), intus glabro, fere ad basim 5-lobato, lobis deltoideis subacutis, 3 interdum altiuscule connatis; corolla membranacea infundibulari sub anthesi lobis inclusis 22–25 mm. longa et basi 4–5 mm. diametro superne leviter ampliata, extus pilis subtilibus pluriseptatis 0.2–0.4 mm. longis capitato-glandulosis copiose sed inconspicue induta, intus glabra, lobis 5 subaequalibus oblongo-suborbicularibus 4–6 mm. longis; staminibus apicem corollae tubi versus insertis, filamentis 2–3 mm. longis, antheris ellipsoideis circiter 2 mm. longis; disco carnoso cupuliformi glabro circiter 1.5 mm. alto; ovario anguste ellipsoideo glabro, stylo 7–10 mm. longo subtiliter glanduloso-piloso, stigmate incrassato bifido; fructibus immaturis ellipsoideis ad 1.5 cm. longis rugulosis styli basi persistente coronatis.

VITI LEVU: Mba: Slopes of the escarpment north of Nandarivatu, alt. 550–800 m., Sept. 29, 1947, *Smith 6277* (A TYPE, US) (shrub 3–4 m. high, in woods along stream; calyx white; corolla pale yellow, the lobes at first greenish, then yellow).

Cyrtandra xanthantha is a species of § *Polynesieae*, characterized by its simple, few-flowered inflorescence with caducous bracts, its comparatively small and deeply 5-lobed calyx being eglandular-pilose without and glabrous within, and its corolla being 22–25 mm. long and finely glandular-pilose without. Its closest relatives seem to be *C. harveyi* Seem. and *C. pritchardii* Seem. From *C. harveyi* it differs in the more obvious and more definitely spreading indument of its vegetative parts and inflorescence, its smaller and comparatively short-petiolate leaves, and its smaller, more deeply lobed calyx. *Cyrtandra pritchardii* is a more distant ally, differing obviously from the new species in its closer and sparser indument (essentially lacking on the flowers) and its longer-petiolate, more conspicuously toothed leaves.

Cyrtandra jugalis sp. nov.

Frutex vel arbor parva ad 5 m. alta, ramulis gracilibus subteretibus vel obscure quadrangularibus apices versus copiose pilosis (pilis patentibus fuscis 0.4–0.7 mm. longis 3–7-septatis) inferne glabratis; foliis oppositis, petiolis leviter canaliculatis (5–) 10–25 (–30) mm. longis ut ramulis juvenilibus pilosis superne angulatis haud alatis, laminis chartaceis in sicco fusco-viridibus subtus saepe pallidioribus, lanceolatis vel lanceolato-ellipticis, (6–) 10–19 cm. longis, (1.5–) 2.5–5 (–6) cm. latis, basi acutis vel subattenuatis, apice gradatim acuminatis et calloso-apiculatis, margine dentibus 2 vel 3 per centimetrum calloso-mucronulatis conspicue et irregulariter serratis, supra glabris, subtus molliter pilosis (pilis fusco-aureis 0.3–0.5 mm. longis inconspicue pluriseptatis saltem nervis longe persistentibus), costa supra subplana subtus prominente, nervis secundariis utrinsecus 5–8 longe adscendentibus supra planis subtus inconspicue elevatis, rete venularum laxo subimmerso; inflorescentiis axillaribus vel ramulis defoliatis enatis simpliciter cymosis plerumque 3-floris pedunculatis, pedunculo gracili 2–6 cm. longo raro subnullo cum pedicellis bracteisque ut ramulis juvenilibus piloso (pilis patentibus vel subadscendentibus 0.2–

0.7 mm. longis); bracteis apice pedunculi binis ovato-lanceolatis, 5–13 mm. longis, 1.5–4 mm. latis, subacutis, basi non vel haud connatis, demum caducis; pedicellis gracilibus sub anthesi et fructu (8–) 15–25 mm. longis; calyce subcarnoso in alabastro ovoideo longe apiculato, sub anthesi campanulato 10–14 mm. longo apice ad 12 mm. diametro utrinque ut pedicello piloso, ad medium 5-lobato, lobis subaequalibus deltoideo-lanceolatis acuminatis 5–8 mm. longis; corolla membranacea infundibulari sub anthesi lobis inclusis 18–24 mm. longa basi 2.5–4 mm. diametro superne ampliata, extus pilis pallidis pluriseptatis 0.4–1 mm. longis molliter patenti-pilosa, tubo intus glabro, lobis 5 subaequalibus suborbicularibus sub anthesi patentibus 5–8 mm. diametro intus copiose glanduloso-pilosis (pilorum stipitibus pluriseptatis 0.1–0.3 mm. longis); staminibus apicem corollae tubi versus insertis, filamentis crassis 1–2 mm. longis, antheris oblongis 2–3 mm. longis utroque rotundatis; disco carnoso glabro pulvinato-cupuliformi 1–1.5 mm. alto apice undulato; ovario elongato-ovoideo glabro, stylo crasso tereti sub anthesi 4–8 mm. longo ut corollae lobis glanduloso-piloso, stigmate subpeltato; fructibus calyce mox caduco in vivo ellipsoideo ad 1.5 × 1 cm. in sicco ruguloso.

VITI LEVU: Mba: Summit of Mt. Nanggaranambuluta [Lomalangi], east of Nandarivatu, *Smith 4878* (A, US); ridge between Mt. Nanggaranambuluta and Mt. Namama, alt. 1050–1120 m., June 30, 1947, *Smith 4994* (A TYPE, US); western slopes of Mt. Tomanivi [Mt. Victoria], *Smith 5319* (A, US); Ra: Ridge from Mt. Namama toward Mt. Tomanivi, *Smith 5695, 5696, 5709, 5715* (all A, US); Nandronga & Navosa: Vicinity of Nandrau, *Degener 14904* (A); northern portion of Rairaimatuku Plateau, between Nandrau and Nanga, *Smith 5569* (A, US).

The cited specimens are from shrubs or slender, freely branching trees 2–5 m. in height, occurring in dense forest at elevations of 725–1120 m. The corolla, stamens, and style are pure white to cream-white, and the mature fruit is white. Recorded local names are *mindra* (*Smith 4994*) and *mbetambeta* (*Degener 14904*).

The described species, of § *Polynesieae,* is quite frequent on the long ridge that curves from Nanggaranambuluta to Tomanivi and dominates north-central Viti Levu. It seems strange that Gillespie did not obtain material of the species, or at least that he did not describe it. I have examined type material of most of his species, and all are well described and figured; the only one that suggests *C. jugalis* is *C. prattii,* a species with larger and more copiously nerved leaves, an elongate inflorescence with solitary lateral flowers, pedicels only about 4 mm. long, and a somewhat larger, unequally lobed calyx.

Closer relatives of the new species are *C. anthropophagorum* Seem. and *C. hornei* Clarke, both of which have comparatively small flowers. This group of species is characterized by its indument of several-celled eglandular hairs and its few-flowered inflorescence with free, opposite, rather small bracts. In characters of indument, *C. jugalis* is intermediate between *C. anthropophagorum* and *C. hornei*, the former having more copious and softer pubescence on both vegetative and inflorescence parts and the leaves less obviously serrate, the latter being soon essentially glabrate on vegetative parts, calyx, and corolla.

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A NEW FIJIAN SPECIES OF CALYPTOSEPALUM

I. W. BAILEY AND A. C. SMITH

With two plates

AMONG THE PHANEROGAMS collected in Fiji by the junior author in 1947 [1], one specimen from upland central Viti Levu could not, upon preliminary study, be referred to any family known to occur in the region. Of the plant in question, *Smith 5339*, several duplicate herbarium specimens and a wood sample from the trunk are available. The herbarium material bears foliage and essentially mature fruits, but one sheet shows very young fruits, with the carpel scarcely developed beyond its flowering condition and with the perianth and disk intact, and also young flower buds. The plant being apparently dioecious, no staminate flowers are available, and there is no trace of stamens or staminodes in the pistillate flower.

The specimen clearly represents a genus not previously recorded from Fiji or the adjacent archipelagos. The desirability of applying a name to it has led us to consider all plausible systematic positions for this Fijian plant, and we have reached the conclusion that it is best placed as a congener of *Calyptosepalum sumatranum* S. Moore. Reasons for this conclusion and a discussion of the position of the genus follow a formal description of our new species and an analysis of its salient characters.

Calyptosepalum pacificum sp. nov.

Arbor dioica ad 12 m. alta, ramulis cinereis subteretibus praeter partes novellissimas minute et fugaciter sericeas glabris valde corticeo-lenticellatis; stipulis binis basi petiolorum lateralibus deltoideis acutis circiter 1 mm. longis latisque extus minute fulvo-sericeis mox caducis, cicatricibus minutis; foliis simplicibus alternatis, petiolis nigrescentibus leviter canaliculatis in sicco rugulosis crassis (1.5–2 mm. diametro) 1–1.5 cm. longis; foliorum laminis coriaceis siccitate brunneis vel fusco-olivaceis, ovato-oblongis vel late ellipticis, (6–) 7–12 cm. longis, (3–) 3.5–7 cm. latis, basi late obtusis vel subtruncatis et saepe paullo inaequilateralibus, in petiolum subito breviter decurrentibus, apice obtusis vel subacutis, margine integris et leviter incrassatis, utrinque glabris vel interdum pilos paucos dispersos subpersistentes (eis carpelli similes) subtus nervis gerentibus, pinnatinerviis, costa valida utrinque prominente et rotundata, nervis secundariis utrinsecus 5–8 irregulariter arcuato-adscendentibus et copiose anastomosantibus utrinque valde elevatis, basalibus confertis, rete venularum copioso utrinque

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[1] Under the auspices of the Arnold Arboretum of Harvard University and the John Simon Guggenheim Memorial Foundation, with the aid of grants from the Penrose Fund of the American Philosophical Society and the Bache Fund of the National Academy of Sciences.

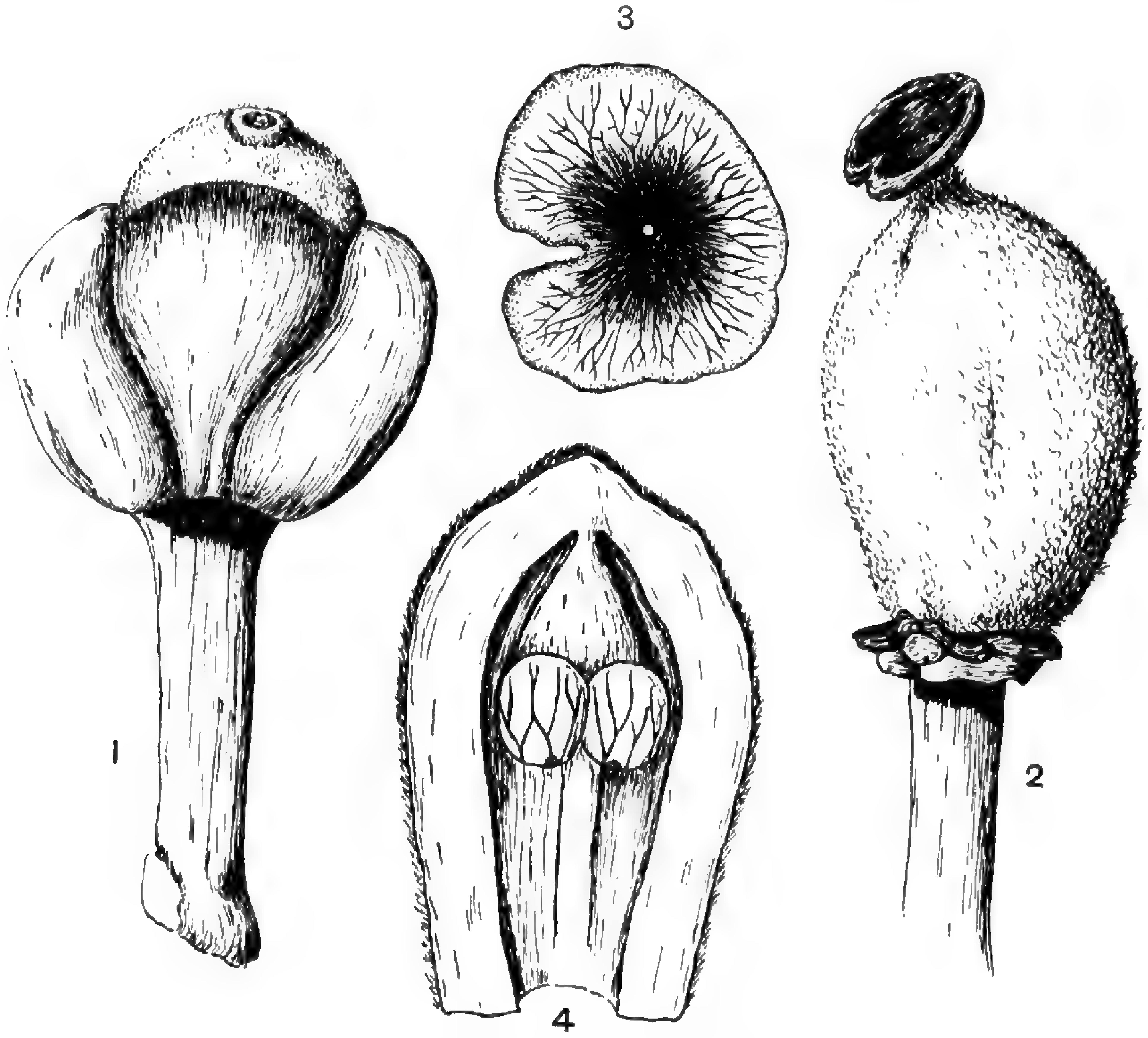
prominulo; floribus (♀ solis visis) pluribus (plerumque 2–5, interdum cum aliis abortivis), e glomerulis parvis irregularibus natis, glomerulis axillaribus vel supra cicatrices in ramulis defoliatis dispositis; bracteolis sub floribus paucis (videtur 2 basi pedicelli oppositis) late reniformibus, circiter 0.5 mm. longis, 1.5–2 mm. latis, extus obscure sericeis, margine rotundato minute ciliolatis; pedicellis rectis teretibus in sicco rugulosis paullo post anthesin 4–6 mm. longis, parce strigilloso-puberulis demum glabratis, apice in receptaculum complanatum 2–3 mm. diametro subito incrassatis, sub fructu ad 2 mm. diametro et 8 mm. longis; perianthio tepalis 4 decussatis composito, tepalis reniformi-ovatis apice rotundatis, 2.5–3 mm. longis, 3–3.5 mm. latis, e basi plurinervatis, glabris, 2 exterioribus papyraceis, 2 interioribus membranaceis, omnino evanescentibus, cicatricibus linearibus vel transverse ellipticis inconspicuis; disco annulari carnoso glabro, primo subpatente haud 0.5 mm. alto apice truncato, demum rotato et margine irregulariter sinuato; staminibus et staminodiis nullis; ovario supero ellipsoideo vel obovoideo uniloculari, extus minute papilloso et copiose piloso (pilis pallide fuscis simplicibus pluriseptatis ad 0.5 mm. longis subadscendentibus vel subappressis, apicem ovarii versus reflexis); stigmate subsessili terminali carnoso peltato leviter infundibulari 2–3 mm. diametro, margine ventraliter inciso, mox caduco (raro subpersistente), cicatrice parva rotundata; ovarii loculo solitario, placenta ventrali superne valde incrassata, ovulis 2 collateralibus anatropis, e parte incrassata placentae pendulis; fructibus ellipsoideis vel obovoideis maturitate ad 3 cm. longis et 1.5 cm. latis, basi et apice rotundatis, raro stigmate coronatis, apice plerumque inconspicue cicatricosis, pericarpio coriaceo persistenter piloso, semine solitario (ovulo altero abortivo) in sicco valde contracto, in vivo videtur magno carnoso elongato-obovoideo apicem versus connecto, testa tenui, endospermo copioso, embryone magno.

FIJI: VITI LEVU: Mba: Valley of Nggaliwana Creek, north of the sawmill at Navai, alt. 725–850 m., July 21, 1947, *Smith 5339* (TYPE at Arnold Arboretum, 2 sheets, duplicates at U. S. National Museum, etc.) (*ndonggau*; tree 12 m. high, on edge of dense forest; tepals dull yellow; mature fruit orange).

The new species differs from *C. sumatranum* S. Moore, the type and only previously known species of *Calyptosepalum*, in several obvious characters, although the known flowers, being staminate in one case and pistillate in the other, cannot be too critically compared. The Fijian plant has comparatively long petioles and leaf-blades that are thicker in texture, proportionately broader, obtuse to subtruncate at base, and obtuse or subacute at apex. In contrast, *C. sumatranum* has its leaf-blades narrowed at base and short-acuminate at apex, with nerves and veinlets less obvious than those of *C. pacificum*. As regards floral characters which presumably are specific in nature, it may be noted that the disk in *C. sumatranum* is pilose and the ovary-rudiment (in ♂ flowers) glabrous, whereas in the new species the disk is glabrous and the ovary copiously pubescent.

THE FLOWER

The several duplicate specimens of the single collection of this Fijian tree bear mature or nearly mature fruits. The type specimen has, in addition, small immature fruits and a few flower buds in early stages of enlargement. A detailed study of the exomorphic and endomorphic characters of the flower buds and of the youngest fruits enables one to visualize the general form of the flower at anthesis. It consists of two pairs of fleshy decussate tepals, a glandular-appearing, annular disk, and a single carpel which contains two pendent anatropous ovules and terminates in a broad, funnel-shaped stigma, TEXT-FIGS. *1–4*. There are no rudiments of stamens or staminodes and no structures that might be interpreted as vestiges of petals. It should be noted in this connection, however, that subsequent to anthesis and during the enlargement of the torus and of the young fruit,



TEXT-FIGURES 1–4. FIG. 1. Young fruit, showing retention of the decussate tepals at an unusually late stage of development. There is a corky scar at the apex of the carpel left by the abscission of the stigma, × 12. FIG. 2. Young fruit, showing retention of the stigma, also disk and corky scars left by the abscission of the tepals, × 8. FIG. 3. Cleared stigma, showing complex vasculature, × 12. FIG. 4. Longitudinal section of carpel, showing two pendent anatropous ovules, × 10.

the disk becomes distorted and broken and gives at times a false impression of being the bases of additional appendages. Abscission of the tepals and stigma appears to occur shortly subsequent to anthesis, leaving four corky scars at the base of the enlarging carpel and a circular embossed one at its apex. In exceptional cases only are the tepals and stigma retained for a time during subsequent stages of development, TEXT-FIGS. *1* and *2*.

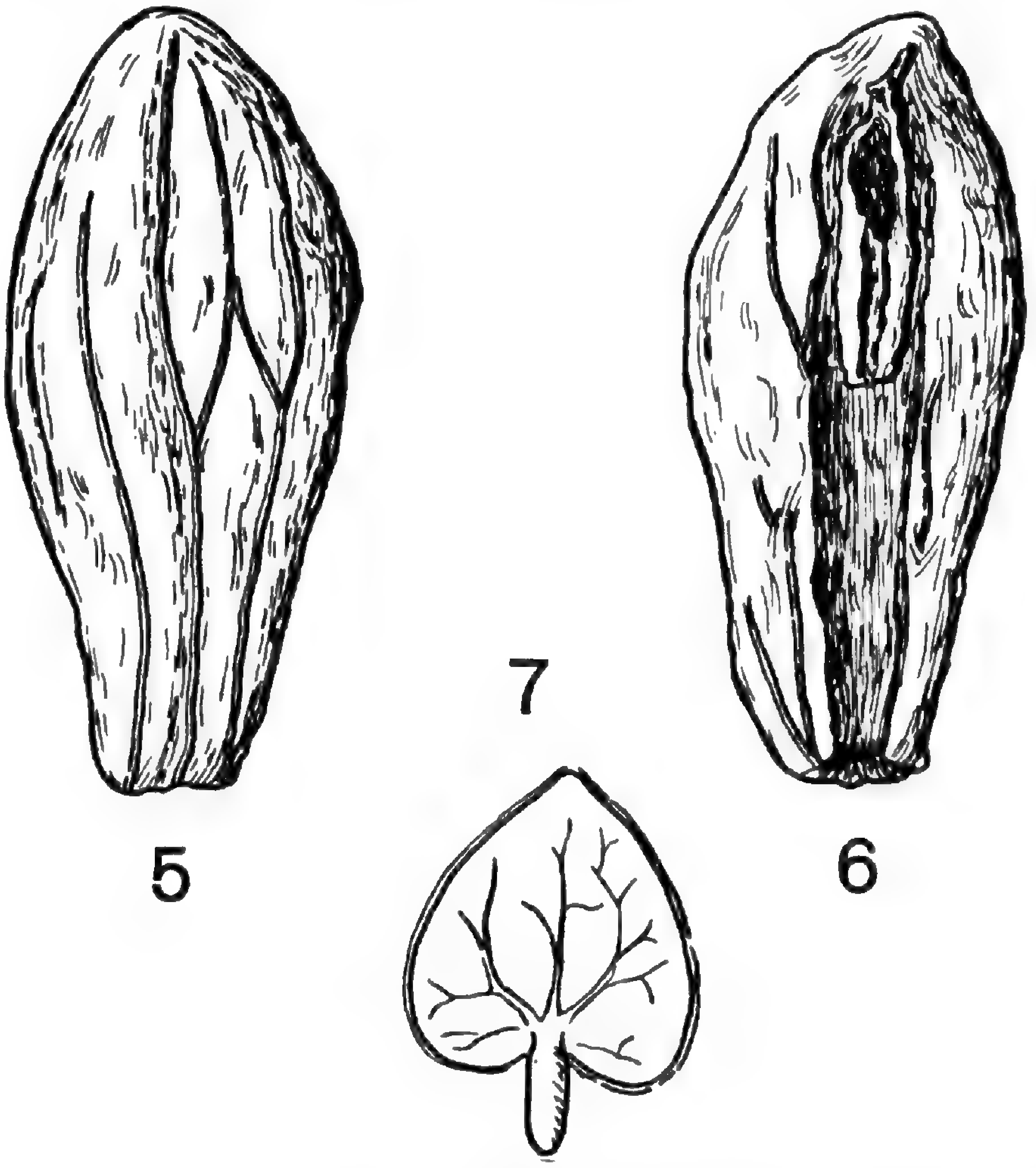
Each of the four decussate tepals has a branching reticulate venation derived in most cases from three principal, independent vascular strands or traces. The disk is unvascularized, but the carpel in its somewhat enlarged form in the youngest available fruits has a strikingly complex and highly specialized vasculature. In transverse sections cut at the base of such a carpel, there is an outer ring of numerous, small, precociously branching vascular strands, a small, compact, more or less centrally located eustele, and a single, large, detached bundle. The outer bundles extend upward in the wall of the carpel, branching repeatedly and forming a basket-like venation of much complexity. The central eustele is in continuity at lower levels with the eustele of the pedicel. It extends upward in the ventral side of the carpel to the level of attachment of the ovules, where it dissociates into a number of principal strands. Two of these curve abruptly downward and ramify in the integuments of the ovules, two extend upward and ramify in the stigma, and four to six curve upward and then downward in the wall of the carpel. The large detached bundle extends upward as a discrete strand in the dorsal side of the carpel. It branches at higher levels and has an extension into the stigma. Evidence from a young flower bud indicates that the differentiation of the ventral eustele and of the discrete dorsal strand is initiated during early stages of the ontogenetic development of the flower, whereas that of the peripheral bundles occurs during subsequent stages of the enlargement of the torus and carpel. There are no vestiges of a suture in the ventral side of the older carpels, but the stigma has a deep cleft in its ventral side, TEXT-FIGS. *2* and *3*.

THE FRUIT

One ovule aborts, at least in a majority of cases, and the mature fruit contains a single elongated seed, TEXT-FIGS. *5* and *6*.

The older fruits have no clearly defined outer epidermal layer, but instead are clothed externally by a dense mat of short, multicellular papillae. This papillose surface appears to be derived during development of the carpel and the young fruit by repeated periclinal and anticlinal divisions of all of the cells of an originally unicellular epidermal layer. Among the papillose projections are elongated hairs which become more widely spaced as the fruit matures. Both the papillae and the hairs vary considerably in size and form. Among the former are conspicuously capitate and glandular-appearing ones. The hairs are multicellular and frequently are internally septate. They may be thick-walled or thin-walled, straight or markedly undulate, or recurved parallel to the surface which bears them.

As seen in sectional view, PLATE-FIG. *1*, the pericarp consists of five more or less clearly defined layers. Passing from without toward the locule these are: (1) the papillose layer referred to in the preceding paragraph, (2) a zone of small, thin-walled parenchymatous cells, (3) a zone composed largely of stone cells, (4) a broad central zone of large, thin-walled parenchymatous cells and (5) a compact zone of thin-walled parenchyma whose cells tend to become elongated or oriented parallel to the inner surface of the pericarp. The vascular bundles are distributed within the broad central layer and have numerous branches which extend outward toward the sclerenchymatous zone. The proportions and the detailed configurations of these layers change during successive stages of the enlargement of the fruit. In particular, the layer of stone cells becomes broader and denser. Furthermore, the vasculature of the pericarp becomes increasingly complex and massive.



TEXT-FIGURES 5–7. FIG. 5. Seed, showing vasculature, × 3.3. FIG. 6. Seed, showing extensive hilum, × 3.3. FIG. 7. Embryo, × 3.3.

THE SEED

The seed, even in apparently mature fruits, contracts so extensively in drying and becomes so deformed that it appears to have aborted. However, it re-expands upon soaking and resumes its original plump, elongated form, TEXT-FIG. *5*. It contains a well-formed, normal-appearing embryo with pseudo-palmately veined, basally auriculate cotyledons, TEXT-FIG. *7*. The embryo is embedded in a massive endosperm whose thin-walled cells contain no visible accumulations of starch, fat or oil. It is the excessive contraction and re-expansion of these large, delicate cells which produces the pronounced changes in volume of the seed during drying and wetting. The testa is thin and soft and contains an externally conspicuous vasculature which resembles that of the ovules in greatly expanded form, compare TEXT-FIGS. *4* and *5*.

THE LEAF

The simple, entire, pinnately veined leaf is coriaceous and glabrous appearing when fully expanded. However, a few hairs tend to persist, from the early juvenile stages, upon the lower surface of the leaf and to be scattered along the principal veins. These hairs resemble the thicker-walled, recurved ones that occur on the carpel and fruit. The base of the young leaf is flanked by a pair of small, triangular, caducous stipules which leave corky scars following abscission.

The lower epidermis is composed of angular cells of relatively uniform size. The stomata have no special subsidiary cells, and the guard cells are not extensively subtended by the surrounding epidermal cells. There is a conspicuously differentiated layer of large hypodermal cells which becomes discontinuous at times. The palisade layer consists of several rows of relatively short elements, and the thin-walled spongy mesophyll contains large intercellular spaces. The venation is massive and conspicuous, even the smaller veinlets being jacketed by sclerenchyma and in turn by thin-walled crystal-bearing cells, PLATE-FIG. *4*.

Three traces, related to a trilacunar node of the stem, enter the base of the petiole, where they quickly become associated in a vascular cylinder or eustele, PLATE-FIG. *2*, which extends throughout the petiole and the mid-rib of the lamina. Within the pith of this vascular cylinder, in its course through the petiole, there are one to three, commonly two, amphivasal bundles. The cells of the parenchyma of the petiole, particularly many of the cortical cells and the rays of the secondary phloem, contain crystals of calcium oxalate. Small druses predominate in the phloem and large, single, rhombohedral crystals in the cells of the cortex. The vascular cylinder is jacketed by large, very thick-walled fibers.

THE STEM

The pith and the eustele in the internodal parts of the stem have a symmetrically four-lobed form as seen in transverse sections, the configuration of the tissues being correlated with an approximately one-half phyllotaxy. The median traces of the leaves are situated in two opposite lobes and the lateral traces in the two intervening lobes. The median trace of each leaf consists of two widely separated halves in the subtending internodal part of the stem, but commonly divides forming three or four independent strands at the nodal level. Further divisions of these strands, as also of the lateral traces, occur precociously in the base of the leaf, where orientation into a foliar eustele takes place.

The pith is homogeneous and composed of relatively short cells, many of which contain single rhombohedral crystals of calcium oxalate. The secondary xylem is formed by a primitive type of cambium having elongated fusiform initials with extensively overlapping ends. The wood parenchyma is apotracheal in distribution, PLATE-FIG. *3*, varying from diffuse to loosely aggregated tangentially. The relatively thin-walled, angular vessels occur singly and in small radial clusters. The long, slender vessel members have numerous scalariform perforations in their extensively overlapping ends. The intervascular pitting in the tangential facets of adjoining vessels is minute, closely crowded and multiseriate, and exhibits numerous transitions between opposite and alternating seriations. Vestiges of scalariform pitting are of not infrequent occurrence, particularly in the smaller vessels. The pitting between vessels and wood parenchyma or rays is of essentially similar size and form, with, however, numerous evidences of unconformity. The imperforate tracheary elements or "fibers" have such excessively thickened walls that the lumina are occluded and the pits are few in number with minute vestigial borders. The first-formed secondary xylem has vertically extensive uniseriate rays composed of tall erect cells. In addition, there are more or less numerous biseriate and triseriate rays composed of more nearly cubical cells or slightly procumbent ones. The wood from the outer part of old stems resembles the secondary xylem of twigs taken from herbarium specimens, but exhibits the usual increase in cell size that occurs during enlargement of stems. The rays, PLATE-FIG. *5*, are lower, the multiseriate (2- to 4-seriate) ones being proportionally more numerous and composed of radially more extensive procumbent cells. Many of the parenchymatous cells of both the earlier and the later formed wood contain crystals of calcium oxalate, the rhombohedral form predominating.

Prior to the initiation of cambial activity, each bundle of the eustele — as seen in transverse sections of the stem — is capped externally by thick-walled fibers. Subsequently, the entire vascular cylinder becomes enclosed in a composite ring of sclerenchyma, formed in part by the original fibers and in part by stone cells derived from tangentially intervening, thin-walled parenchyma. The secondary phloem, when first formed, is soft and is composed of parenchyma, sieve tubes and rays, no fibers being formed among the derivatives of the cambium. As the zone of phloem widens in enlarging stems more or less extensive sclerification of parenchyma occurs in its outer part. The form of these secondary changes in the older phloem varies considerably in different parts of the tree. Successive rings of sclerenchyma are formed in the bark of the main stem of the tree. These rings are comparatively widely spaced and are composed of sclereids. The soft intervening tissue contains more or less numerous patches of such sclerenchyma derived in part from phloem parenchyma and in part by the sclerification of ray cells. At least in certain of the upper branches of the tree, all of the vertically oriented parenchyma tends to develop lignified secondary walls, whereas most of the cells of the rays do not.

The crystals of calcium oxalate differ markedly in form in different parts of the phloem. Druses occur abundantly and characteristically in the unmodified parts of the rays. On the contrary, the zones and patches of stone cells have numerous cells which contain single crystals of rhombohedral form.

DISCUSSION

The summation of reproductive and vegetative characters, in the case of this Fijian tree, is peculiar and unusual, and the problem of determining the true relationships of the plant is a difficult one. When all of its salient exomorphic and endomorphic characters are taken into consideration, it does not fit readily into any existing family of the dicotyledons. However, it closely resembles a Sumatran tree collected by H. O. Forbes in 1880–82, subsequently described and placed in the monotypic genus, *Calyptosepalum*, by S. Moore (3) in 1925.

The species, *Calyptosepalum sumatranum* S. Moore, is based upon two collections, *Forbes 2847* and *2862*. Both sets of herbarium specimens bear male flowers only, but a few detached fruits were included under *Forbes 2862*. Unfortunately, these fruits are of two entirely different kinds. Therefore, it is essential to determine which of them actually belongs to *Calyptosepalum*.

Both of the Forbes collections, *2847* (isotype) and *2862*, are represented in the Gray Herbarium, and our observations are based upon these specimens, supplemented by examination of a fruit from *Forbes 2862* at the British Museum. Sections of the stems of *Forbes 2847* and *2862*, made by Swamy (5) in connection with his anatomical investigation of the Santalaceae, were available for detailed study.

Significant similarities and differences between the vegetative parts of the Fijian and the Sumatran plants are the following:

The buds of both trees are naked with a ½ phyllotaxy and precociously developing triangular stipules. Those of the Fijian plant are less conspicuously hairy except at their apex, and the stipules are more massive and leave more evident scars following their earlier abscission. The stems of both plants have a characteristically 4-lobed pith and eustele as seen in transverse sections, a morphological feature that is correlated with a ½ phyllotaxy and a trilacunar nodel anatomy. The cellular structure of the pith, xylem, cambium, phloem, and cortex is fundamentally similar in both cases, the only conspicuous histological difference being the occurrence of porous, as well as of scalariform, perforation plates in the vessels of the Sumatran plant. The major patterns and the minor details of the vascularization of the petiole and lamina of the simple entire leaves are strikingly similar. The petioles of both plants have cylindrical eusteles, surrounding a pith which contains from one to three vascular strands, the medullary bundles of the Fijian plant being more extensively amphivasal than those of the Sumatran species. The venation of the lamina, as revealed in cleared specimens, is massive and conspicuous, even the smaller veins being jacketed by sclerenchyma and in turn by crystal-bearing cells. The stomata of the Sumatran plant are more extensively subtended by surrounding epidermal cells, and hairs and bases of hairs are more numerous on the under surface of fully matured leaves. In addition, there are more numerous small druses in the palisade layer.

Both plants are characterized by having hairs of a similar structural type, viz. multicellular and unbranched, but commonly recurved parallel to the surface which bears them. Furthermore, both are characterized by forming two types of crystals, viz. druses and single rhombohedral crystals.

A summation of exomorphic and endomorphic evidence from the vegetative organs indicates that the Fijian tree and the Sumatran one are closely related. Such differences as occur in the leaves and stems are of no greater magnitude than may be anticipated in related, but geographically widely separated, species. In fact, without convincing evidence from the reproductive organs, there are no valid arguments for placing the two trees even in separate genera.

It is unfortunate that the female flower of the Sumatran plant and the male flower of the Fijian tree are not available, and that one is forced at present to depend upon comparisons between flowers of different sexes.

The size, external form, and axillary distribution of the flowers are similar in both cases. Both kinds of flowers have a perianth consisting of two pairs of fleshy, deeply concave, decussate tepals. Both have a conspicuous disk whose form is determined by internal pressures and spacial relationships within the developing flower bud. At anthesis, the expanded disk of the male flower bears the imprints of the four stamens that are crowded inward and downward upon it in the closed bud. That of the female flower, being confined to the space between the base of the carpel and the tepals, expands outwardly rather than inwardly and has an undulating contour in conformity with the fleshy bases of the tepals. The disk of the male flower is pilose, whereas that of the female flower is glabrous and glandular appearing. The carpel of the female flower is conspicuously pilose during the earlier stages of its ontogeny, whereas its sterile homologue in the male flower is nearly glabrous. However, the hairs of both flowers are of a fundamentally similar structural type.

As noted earlier, the detached fruits included under *Forbes 2862* are of two different morphological kinds. In the case of the specimen at the Gray Herbarium, the fruit obviously does not belong to *Calyptosepalum* as indicated by the character of the persistent gamosepalous calyx which subtends it. The angularities in the outer contour of the calyx demonstrate that it is composed of five concrescent members. Furthermore, the hairs on its external surface are unicellular and aggregated in clusters, in marked contrast to the multicellular (i.e. internally septate) and diffusely distributed ones of *Calyptosepalum*. The fruit is broadly ovoid, with a massive pericarp and a persistent, fleshy, 4-lobed and 4-ridged stigma. It has four locules, each of which contains a seed with conspicuously sclerenchymatous testa.

The fruit from *Forbes 2862* at the British Museum is detached from its pedicel and has a corky scar at its apex, formed by the abscission of its stigma. It is of more ellipsoidal form and evidently is the kind of fruit that was figured and described by Moore (3). It is derived from a single enlarged carpel and contains a single seed which is attached at a relatively low level of its ventral side. As in the case of the Fijian fruits, the seed contracts and expands extraordinarily during drying and soaking. It has a thin soft testa with coarsely conspicuous vasculature, and a massive endosperm which is lobed internally. No embryo is visible.

Although the fruit and seed of *Forbes 2862* from the British Museum closely resemble those of the Fijian plant in their salient exomorphic characters and in the cellular structure of the testa and endosperm, there are obvious anatomical differences in the pericarp. The outer surface of the Sumatran fruit is glabrous, with a thick cuticle which projects inwards between the epidermal cells. Thus in surface view, the epidermis has a reticulate pattern superficially resembling that which occurs on the under side of the leaves of certain Sapotaceae. The sclerenchymatous layer is internal, instead of external, to the vasculature. The stone cells, many of which are of irregular size and form, occur in closely adjacent patches and give to the internal surface of the pericarp an appearance of being composed of a miniature mosaic.

Forbes' field notes indicate that fruits of *Calyptosepalum sumatranum* were collected. It seems likely, therefore, that the fruit from *Forbes 2862* at the British Museum is one of these, and that the fruit on the corresponding specimen at the Gray Herbarium was added to that sheet by mistake.

Evidence from the flowers, fruits, and seeds supports anatomical data from the vegetative parts and indicates that the Fijian tree is closely related to *Calyptosepalum.* The question whether the two plants should be included in the same genus or should be placed in two separate, but closely allied, genera is one that may not be finally answered until more extensive collections of the reproductive parts are made. However, on the basis of material now available, we find no valid reason to separate the two plants generically. Differences between them are of a sort to be anticipated in any angiosperm genus of reasonable circumscription, and so we refer the new Fijian species to *Calyptosepalum* with a fair degree of confidence.

Moore (3) concluded that the affinity of *Calyptosepalum* is with *Henslowia,* and therefore placed the Sumatran tree in the Osyrideae of the Santalaceae. It is listed under that family by Pilger (4) who considered it to be a genus of uncertain affinities. As shown by Swamy (5), *Calyptosepalum* cannot be included in the Santalaceae, even as a primitive and structurally less specialized representative of that family. Furthermore, the genus has a number of salient characteristics which exclude it from the Olacaceae. Indeed, a summation of evidence from both the vegetative and reproductive parts suggests that *Calyptosepalum* and its

Fijian relative do not belong in any previously described family. Should they be placed in a new family?

This raises a question of major taxonomic significance and one upon which general agreement should be attained. If *Casuarina, Leitneria, Myzodendron, Grubbia, Octoknema, Lactoris, Cercidiphyllum, Eupomatia, Gomortega,* and other isolated end-products of morphological specialization are to be segregated in independent small families, then it obviously is consistent to deal with *Amborella, Trimenia, Euptelea, Trochodendron,* and many other genera in a similar manner. Although such a procedure leads to a multiplication of small families — to which many systematic botanists object — it is preferable to loading truly homogeneous families with discordant elements which prove upon thorough study to be out of place. Classification should be determined not by an inherently and rigidly "conservative" or "radical" concept of families, but by the character of the plants under consideration.

In this connection, we may well remember that modern concepts of family delimitation were evolved by botanists familiar, for the most part, with the floras of the Northern Hemisphere. In the regions best known to them, the students who outlined our angiosperm families found many large and obviously closely related groups of genera. Because of the apparently natural composition of such groups as the Compositae, Rosaceae, Orchidaceae, Gramineae, etc., it is probable that the taxonomists of a century ago became inured to a concept of large and comparatively few families, and that they subconsciously acquired an aversion to "splitting" at the family level. This aversion, as is well known, persists among the curatorial staffs of modern herbaria. Every change in family delimitation and every proposal of a new family means, to the curator of a herbarium, a change in his system, accompanied by a shift of specimens, the preparation of new covers, case-labels, index-cards — in short, such a change means more work for a small and often already harassed staff. It is not surprising, therefore, that herbarium botanists with great pertinacity cling to the notion that there are already "enough" families.

However, it is not a function of systematists to decide *a priori* upon the number of families. If the plants of the southeastern Asia-Malaysian area had been as well known to the phylogenists of a century ago as were the plants of Europe and North America, can anyone believe that our traditional families would have their present circumscriptions? Workers in this area and also in tropical Africa are finding that, if they apply to their floras the criteria of family-delimitation that have served for the North Temperate floras, two courses are open to them. First, they may expand current family concepts beyond all degree of usefulness, to the point where relic genera are quite lost in a maze of vague and often contradictory characterizations, or second, they may propose distinct families for such genera. That the second course seems to be increasing in popularity may cause herbarium workers considerable anguish, but one must conclude that it offers the more legitimate solution of a difficult problem. The multiplication of families caused by the application of uniform standards of family-criteria is "unfortunate" only in that it causes inconvenience to those in charge of our large herbaria. If such a development leads to a better comprehension of the interrelationships of genera and families, then it should be welcomed as fortunate, in spite of transient physical and psychological inconveniences.

Another alternative to the proposal of small families, in the case of phanerogams of uncertain affinities, may be the temporary assignment of aberrant genera to a special category, comparable to the Fungi Imperfecti of mycologists. In such a category might be placed plants of uncertain or obscure affinities, the inclusion of which in any existing family would cause an undue expansion of the basic family-characters. This category could also accommodate those plants as yet incompletely known, lacking, for instance, material for adequate cytological, embryological and anatomical investigations. To place such plants in a group of "Phanerogamae Imperfectae" would at least call them to the attention of regional students and would save them from the obscurity of being misplaced in some large and unsuitable family.

As previously stated, available exomorphic and endomorphic evidence makes it difficult to include *Calyptosepalum* in any existing family of the dicotyledons. As demonstrated by Swamy (5), the salient features of *Calyptosepalum* do not fall within the range of anatomical or morphological characters of the Santalaceae, and it may be excluded likewise from the Olacaceae. Furthermore, Dr. R. A. Howard concurs in our conclusion that a summation of evidence from different organs of the plants excludes *Calyptosepalum* from the Icacinaceae. Although the genus exhibits certain similarities, on the one hand, to the Olacales and, on the other hand, to the Celastrales of Hutchinson, there is no convincing summation of evidence to justify placing it with certainty in either of these orders.

We believe that *Calyptosepalum* is another relic genus which will ultimately have to be placed in an independent family. This should not be done, however, until more adequate and extensive material of its two species are available for detailed exomorphic and endomorphic investigations. For the present, it had best be placed in a special category of plants of uncertain affinities, as has been suggested (1,2) in dealing with other relic genera from Austromalayan and Indomalayan regions.

ACKNOWLEDGMENTS

We are much indebted to Dr. George Taylor, of the British Museum (Natural History), for the opportunity of examining a fruit from its sheet of *Forbes 2862*, and to the Gray Herbarium for the privilege of studying its specimens of the Forbes collections.

LITERATURE CITED

1. BAILEY, I. W. The anatomical approach to the study of genera. Chronica Botanica. Ined.
2. ——— AND B. G. L. SWAMY. The morphology and relationships of Idenburgia and Nouhuysia. Jour. Arnold Arb. **34**: 77–87. 1953.
3. MOORE, S. Dr. H. O. Forbes's Malayan Plants. Jour. Bot. **63**: Suppl. 91–92. 1925.
4. PILGER, R. Santalaceae. E. & P. Nat. Pflanzenfam. ed. 2. **16b**: 91. 1935.
5. SWAMY, B. G. L. The comparative morphology of the Santalaceae: node, secondary xylem, and pollen. Amer. Jour. Bot. **36**: 661–673. 1949.

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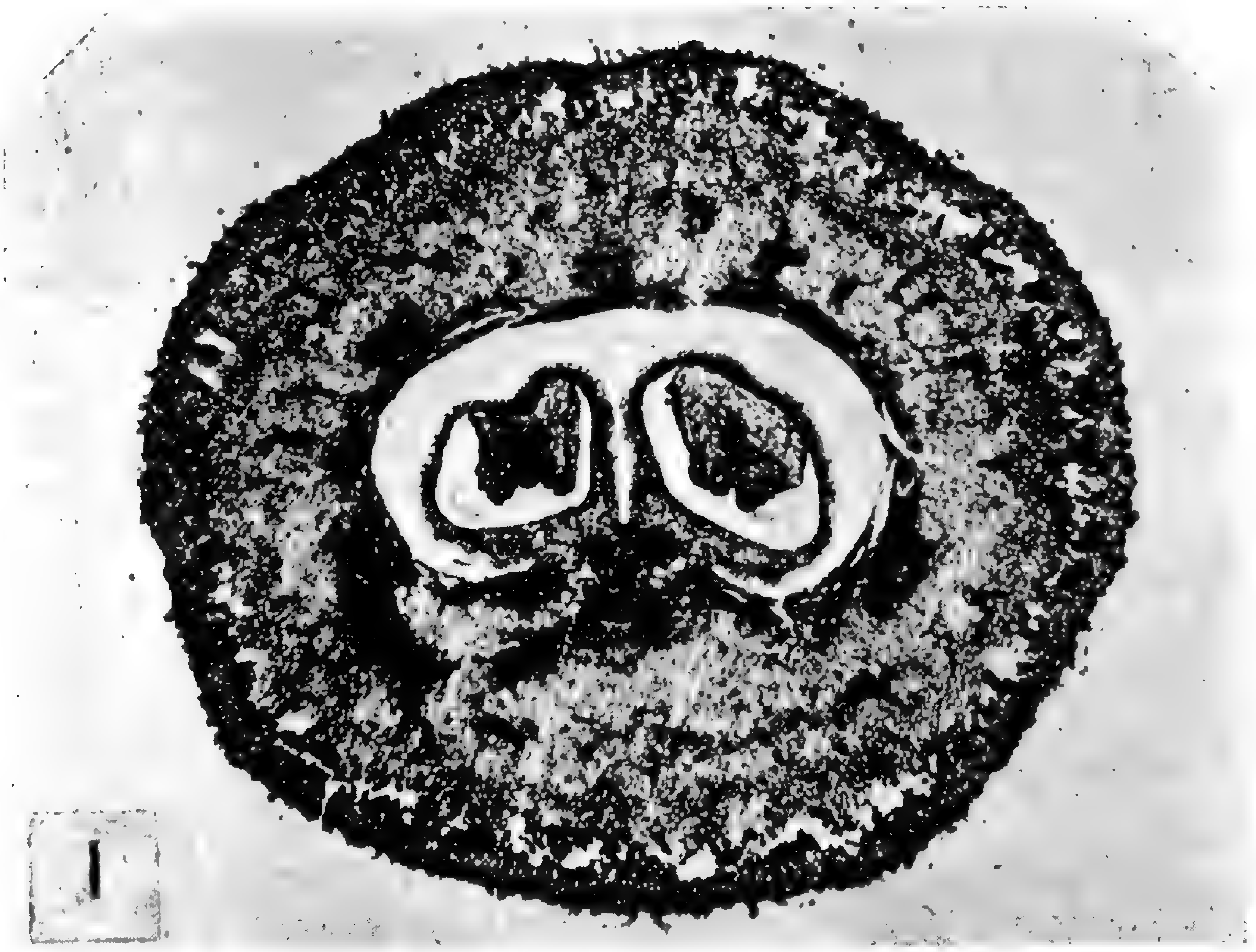
EXPLANATION OF PLATES

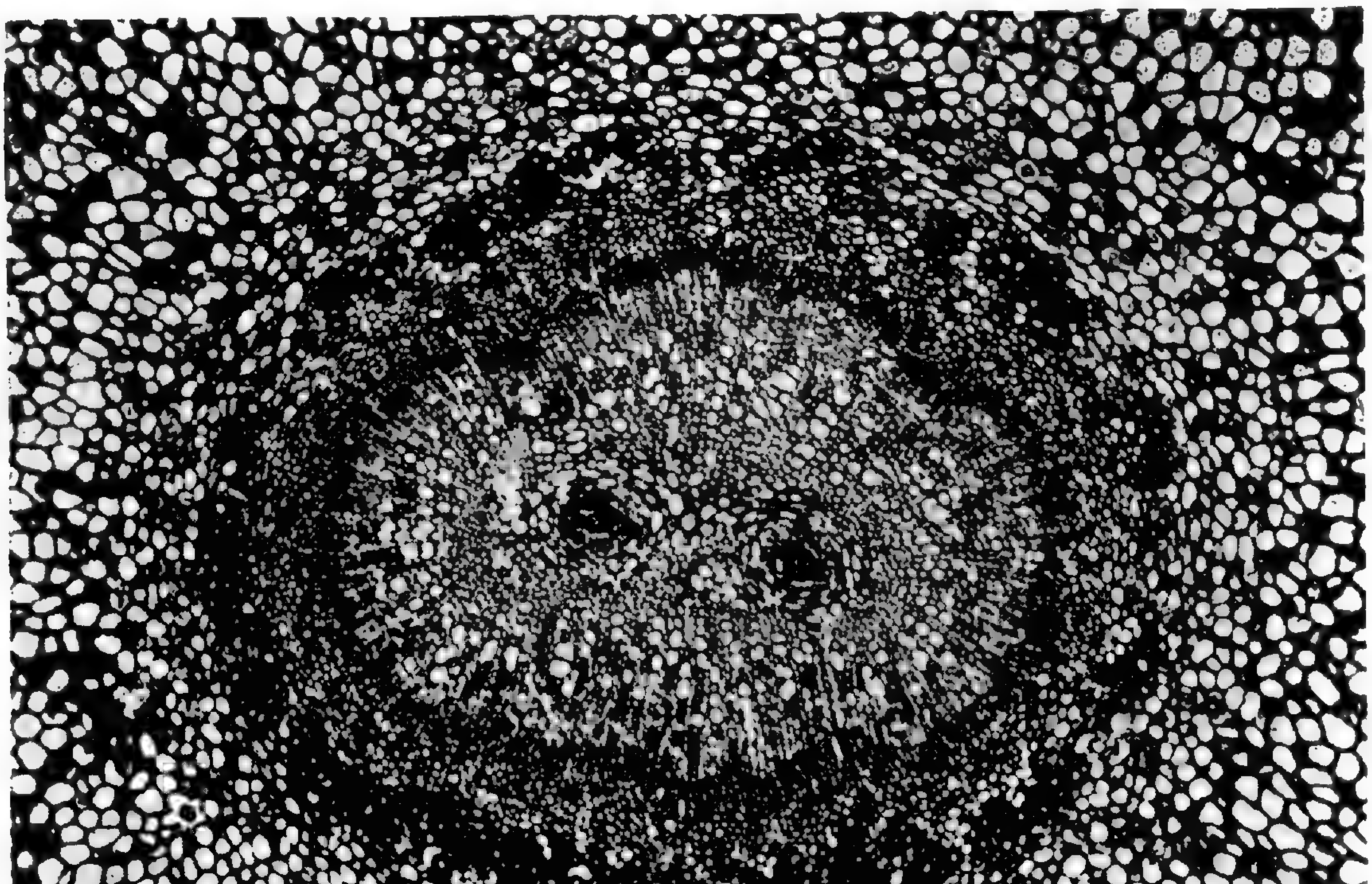
PLATE I

FIG. 1. Transverse section of carpel at the level of the attachment of the two ovules, × 24. FIG. 2. Transverse section of the petiole, showing cylinder of vascular tissues and two included amphivasal bundles, × 50.

PLATE II

FIG. 3. Transverse section of the secondary xylem, × 50. FIG. 4. Cleared leaf, showing characteristic pattern of venation, × 50. FIG. 5. Tangential longitudinal section of the secondary xylem, showing extensively overlapping vessel members and heterogeneous rays, × 107.





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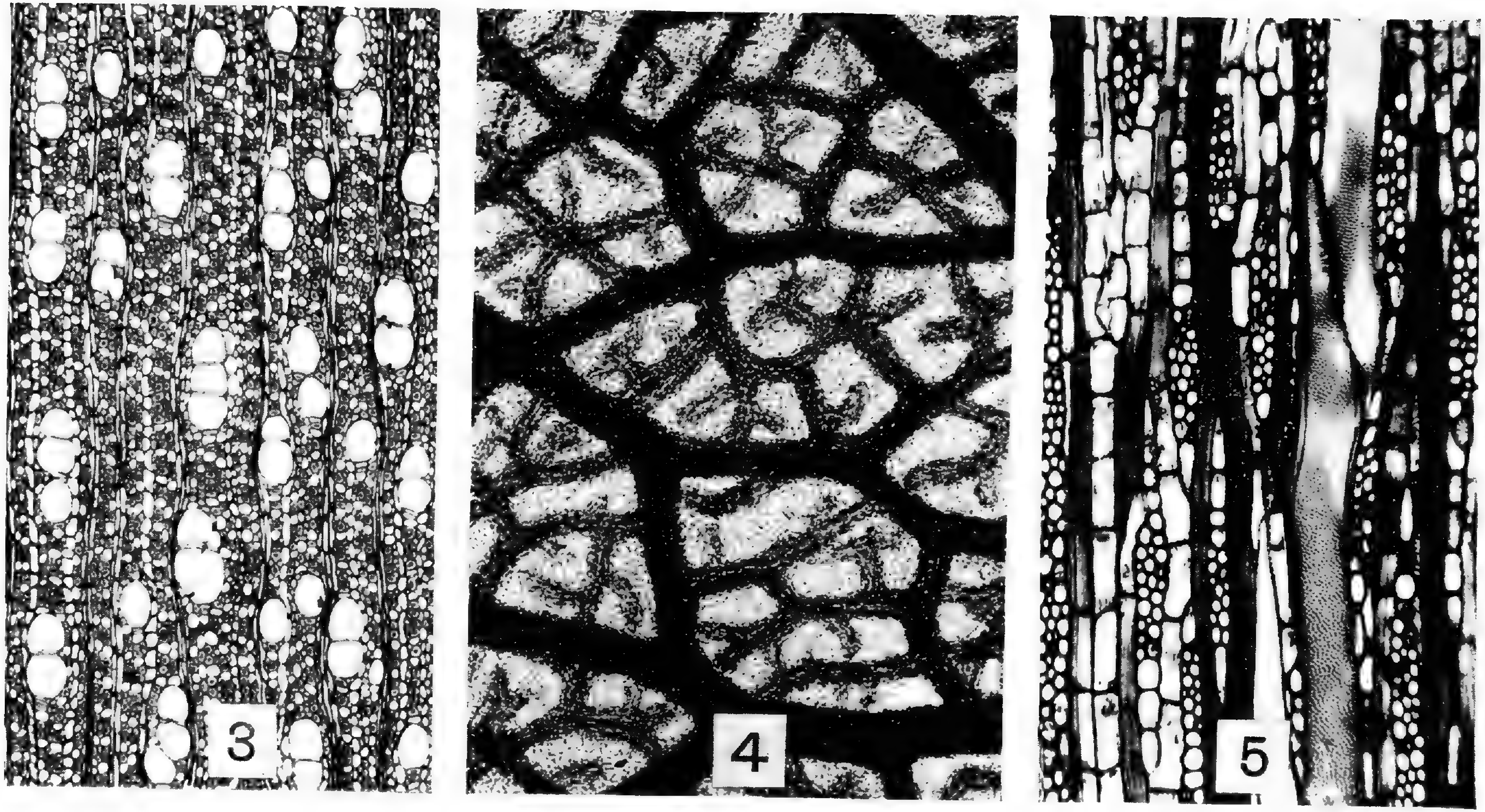

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A TAXONOMIC REVISION OF PODOCARPUS
VII. THE AFRICAN SPECIES OF PODOCARPUS: SECTION AFROCARPUS

NETTA E. GRAY*

THE SECTION *Afrocarpus* was set up as a group distinct from section *Stachycarpus* in the first paper of this series (4). The six species included are *Podocarpus falcatus* (Thunb.) R. Br., *P. gracilior* Pilger, *P. Mannii* Hook., *P. usambarensis* Pilger, *P. gracillimus* Stapf and *P. Dawei* Stapf. They are all located in areas of Africa near and south of the Equator.

Extensive work on the geographic distribution of the species and on the taxonomic details has been done by Stapf (16), Chalk et al. (5) and Robyns (13) representing British and Belgian explorations in their respective territories.

Pilger (12) placed this group of species in the subgenus *Stachycarpus*, part B, and authors since have followed this treatment. However, dissatisfaction with this arrangement has been often voiced, particularly by Florin (7) and Orr (11). These species are distinctly different in their leaf anatomy and female cones, being clearly separated in any key, and are, in themselves, "a compact and morphologically homogenous group" (11). They are mostly large trees providing important lumber in areas of abundance.

The leaves in all species are amphistomatic with about the same number of stomata on the upper and lower surfaces. Abundant hypodermal fibers are found at the margin and midrib and gathered in groups between the stomatal rows on both upper and lower sides of the leaf. The palisade parenchyma may be equally distributed on both sides or may be more abundant on the surface exposed to the sun, whether abaxial or adaxial. Often it is poorly developed. The single vascular bundle has one resin canal below it, and is flanked on either side by wings of transfusion tissue which extend far into the blade of the leaf, sometimes more than half-way to the margin. This latter feature has been noted by Orr (11) and Robyns (13) particularly. The only other group in which a similar arrangement has been found is in the section *Polypodiopsis*, *P. minor* and *P. Rospigliossi*. In the parenchyma, around the vascular bundle and transfusion tissue, are numerous, often very large, conspicuous fibers. There is no accessory trans-

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[*] The author of this paper greatly regrets the loss of her associate in this study, Professor John T. Buchholz, deceased July 1951. She wishes to express her appreciation for his assistance in the preparation of this paper, especially the cleared and mounted whole leaves. Also she gratefully acknowledges the permission and assistance which was given to him to examine and photograph specimens of the section *Afrocarpus* preserved in the herbaria of the Royal Botanic Gardens, Kew, the British Museum and Cambridge University.

fusion tissue, but often large pitted sclereids of similar origin develop in the mesophyll between the end of the transfusion tissue and the margin of the leaf (4, PLATE I, FIG. 3).

The abundance, size and position of these sclereids were noted to vary among the samples. A detailed study of these patterns was made in whole mounts of leaves which had been cleared in NaOH and stained with safranin. It has been found that the sclereids are shortest at the base and tip of a leaf, and largest in the middle. They are usually most abundant in the base of the leaf, less so in the remainder, often decreasing toward the tip or even again increasing in number at the very tip. In addition, the number of sclereids increases with the age of the leaf. Thus, the data of TABLE 1 are of doubtful value in distinguishing species because of the abundance of over-lapping sizes in leaves having sclereids under the maximum and the data are not consistent either as to species or geographical region. In a similar examination of the sclereids in the leaves of the *Podocarpus* species, in section *Stachycarpus* (4) from New Caledonia, New Zealand and Australia, patterns of size and abundance sufficiently different to separate the species lines were found. No such clear criteria seem to be apparent in the case of the African group of species.

TABLE 1. SCLEREID LENGTH IN SECTION *Afrocarpus*

Species	Min.	Max.
P. gracillimus	50μ	95μ
P. falcatus	50μ	230μ
P. gracilior	70μ	265μ
P. Dawei	60μ	310μ
P. usambarensis	65μ	322μ
P. Mannii	50μ	368μ

The following key, adapted from Chalk et al. (5), adding where useful, the characters of leaf anatomy, includes all the species in this group. It is preferable to base a key upon one prepared by individuals familiar with the living trees in the field, where keys are so necessary for identification.

KEY TO SECTION *Afrocarpus*

Leaves small, 1–5 cm. long, 1–4 mm. broad on adult trees; inner woody layer of seed 3 mm. thick or less.

  Leaves 2–5 cm. long, 2–4 mm. broad on adult trees (up to 7 or 10 cm. by 6 mm. on young plants and long shoots).

    Seed glaucous green, globose, 0.6–1.2 cm. diam. on stalk 0.6–1.2 cm. long; outer layer of seed-shell coriaceous, inner layer very hard, woody, about 1 mm. thick. S. Africa: Cape Province, Natal, Transvaal, s. Mozambique. . . . . 1. *P. falcatus*.

    Seed brown, more than 1.5 cm. long, inner woody layer more than 1 mm. thick.

      Seed ellipsoid-globose, purplish-brown and slightly bluish pruinose, 1.6–1.8 cm. long, 1.4–1.6 cm. diam.; outer layer of seed-shell coriaceous;

inner layer very hard woody, up to 2 mm. thick; branchlets angular from the decurrent leaf-bases. Abyssinia, Kenya, Uganda . . . . 2. *P. gracilior.*

Seed subglobose, dark or chestnut-brown, 2–2.2 cm. long by 1.6 cm. diam.; outer layer of seed-shell woody, chestnut-brown, inner layer hard-woody, light colored, 3 mm. thick. Uganda . . . . 3. *P. Dawei.*

Leaves 1.8–2.5 cm. long, 1–1.5 mm. broad, straight or slightly falcate, acute, densely crowded at the ends of the branchlets; seed up to 2 cm. long, woody inner layer of seed-shell 1–2 mm. thick. Transvaal . . . . 4. *P. gracillimus.*

Leaves 7.5–15.0 cm. long, 5–10 mm. wide, tapering to a fine point; seed up to 2.5 cm. long, woody inner layer of seed-shell 4–7 mm. thick.

Leaves very shortly stalked, up to 7.5 cm. long, 4–6 mm. wide; seed globose to ellipsoid-globose, about 2.5 cm. long, on a slender stalk 1.2–2.0 cm. long. Tanganyika, Belgian Congo . . . . 5. *P. usambarensis.*

Leaves sessile, 7.5–15.0 cm. long, 5–12 mm. wide; seed subpyriform, subsessile, about 3.8 cm. long. West Africa . . . . 6. *P. Mannii.*

Podocarpus falcatus (Thunb.) R. Br. ex Mirb. in Mém. Mus. Paris **13**: 75. 1825 (nomen); Endlicher, Syn. Conif. 219. 1847; Parlatore in D C. Prodr. **16** (2): 511. 1868; Pilger in Pflanzenreich IV. **5** (Heft 18): 72. 1903, in Nat. Pflanzenfam. ed. 2, **13**: 245. 1926; Bernard in Beih. Bot. Centralblatt **17**: 275. 1904; Wilson in Jour. Arnold Arb. **9**: 143. 1928; Florin in Svenska Vet.-Akad. Handl. ser. 3, **10**: 262. 1931; Chalk et al., For. trees and timbers of Brit. Emp. **1**: 23. 1932, **3**: 86. 1935; Dallimore & Jackson, Handb. Conif. 44. 1923, 1931, 67. 1948; Stapf in Fl. Cap. **5** (Sect. 2, suppl.): 10. 1933.

Podocarpus Meyeriana Endlicher, Syn. Conif. 218. 1847; Parlatore in DC Prodr. **16** (2): 512. 1868.

Podocarpus elongata Carrière, Traité Conif. ed. 2: 671. 1867, in part; Sim, Forests & For. Fl. 335. 1907; Marloth, Fl. S. Afr. 1: 101. 1931–32.

Taxus falcata Thunb., Prodr. Pl. Cap. 117. 1800, et Fl. Cap. (ed. Shultes) 547. 1823.

This species is a tree, often very large, with minute terminal buds, leaves erect, 2–5 cm. × 3–5 mm., apex shortly acute to almost obtuse (juvenile somewhat larger); male flowers short, solitary or 2–3 together; seed 6–12 mm. diam., globose, with peduncle 6–12 mm. A complete description, including figures, may be found in Chalk et al. (6).

Podocarpus falcatus, from the Cape of Good Hope vicinity, was first described as *Taxus falcata* from a specimen collected by Thunberg in 1773–74, at the same time as *P. elongatus* later to be used as the type for the genus. Both these specimens are in the Botanical Museum at Uppsala. We have seen photographs and examined leaf samples and can designate them as authentic. Toward the latter part of the nineteenth century these two species, with leaves of similar size and shape, became rather hopelessly confused both in the literature and among foresters, and they are still occasionally interchanged in published work. As late as 1943, Smith (15) found it necessary to include these in publishing a verification of the nomenclature of certain African species of *Podocarpus*. In 1867, Carrière published a description under the name of *P. elongata* Carr. which was only partly *P. falcatus*. Parlatore, in 1868, described *P. falcatus* under that name but the description of the female flowers was of another species. In 1874, Bertrand (2) published his detailed anatomy of conifer leaves in which he described *P. falcatus* under the name of *P. elongata* L'Herit. and placed the former name in synonymy. Mahlert, in 1885, using much of Bertrand's work on conifers, described *P. falcatus* in detail under the name of *P. elongatus* L'Herit. Stiles (17) reconsidered this same data and followed the same misconception. In 1891, Van Tieghem (18), in a paper setting up *Stachycarpus* as a genus, did not include any African species, but he placed *P. falcatus* in *Eupodocarpus* and listed *P. elongatus* as a species having palisade parenchyma on both sides of the leaf.

Pilger (12), in 1903, showed in his taxonomic key and description a clear concept of *P. falcatus* R. Br. as different from *P. elongatus* L'Herit. However, in his preliminary discussion of leaf anatomy preceding the taxonomic part, he repeated the errors of Mahlert and others in describing for *P. elongatus* the leaf anatomy of *P. falcatus*. Later authors continued the confusion. Sim (14) and Marloth (10) redescribed this species in its correct position to affirm its place to African investigators, as did Stapf (16) and Chalk et al. (6) in their listings of strictly South African trees. Orr (11), in making a study of the leaf anatomy of the genus, mentioned the confusion in the literature and found that Bernard labelled a text figure of *P. elongatus* as *P. falcatus* which is the reverse of the usual error.

Orr (11) indicated that this species can be differentiated by the leaf anatomy: "hypodermal fibers are much larger than those of any other species and the groups into which they are segregated project more deeply into the underlying mesophyll." We are not able to confirm this observation as statistical treatment of measurements shows no consistent variation from those of the other species. In a study of the size and abundance of sclereids it was found that those of *P. falcatus* were larger than those of *P. gracillimus* and mostly smaller than those of *P. gracilior*, but in this latter case, the largest sclereids of *P. falcatus* overlapped the smaller in *P. gracilior*, making this data of doubtful use in differentiating these species.

Two varieties have been described by Pilger on the basis of leaf size. *Podocarpus falcatus* var. *latifolius* has leaves 2.5–3 cm. long, 5–6 mm. wide, with the apex short-rotundate. It is represented by a single specimen from Kaimansgat, *Drege 6182*. We have examined a specimen, *Drege 6184*, which does not seem to differ from the species. *Podocarpus falcatus* var. *pondoensis* is one with small leaves, up to 2 cm. long and 3 mm. broad, represented by the single specimen *Bachmann 69*. We have seen no specimen comparable to this and it may be referred to *P. gracillimus* which will be discussed later. These varieties have been ignored by Stapf (16) and Chalk (6) in studies of these African trees.

DISTRIBUTION: Southern part of the African continent in the following districts: Cape Province, Natal, Portuguese East Africa, Transvaal and British Bechuanaland.

SPECIMENS EXAMINED:

SOUTH AFRICA: Transvaal: *Burtt-Davy 20248* (A*). Natal: Northern Zululand, *Boocock* in 1923 (A—3 sheets); The Doyle, *Wilson* in Jan. 1922 (A), *Wilson* in Feb. 1922 (A—2 sheets). Transkeian Territory: Mananza Forest, Mt. Ayliff, *Cochrane* in 1920 (K). Griqualand East: Buswayo Forest, Manina, *Merwe* Pret. For. Dept. Herb. 2268 (K), *Merwe* Pret. For. Dept. Herb. 2269 (K); Instubani Forest, *Fraser* Pret. For. Dept. Herb. 62A (K), *Fraser* Pret. For. Dept. Herb. 2226 (K); Emkazeni For. Res., *Household* Pret. For. Dept. Herb. 1956; Waterfall Farm, *Wilmot* Pret. For. Dept. Herb. 2205 (K). Cape Province: East London, *Kuntze* in 1894 (K, NY); Queenstown Dist., Junction Darm., *Galapin 8179* (K); King Williamstown Div., Kaffraria, *Cooper 1297* (†K); Alexandria Forest, *Strauch 4137* (A); Somerset East, Boschberg, *Burchell 3174* (K), *Burchell 3189* (K), *MacOwan 1561* (†F, K, Ph); Albany Dist., *Prior* in 1848 (K), *Dyer 3325* (K); Alicedale, *Pulgram* Pret. For. Dept. Herb. 2609 (K); Uitenhage, Elon River, *Drege 6184* (†Mo), *Drege 1839* (K), Kamaehs, *Long 1280* (K), eastern valley Blauberg, *Smuts 852* (K), Swartkop River, *Prior* in 1847 (K), *Eklon & Zeyher s.n.* (A, †F, †Mo, UC); Humansdorp, Hankey, *Fourcade 3319* (K), Klein River, *Long 1350* (K); Ribeckscastle, Vleermuysdrift, *Thunberg s.n.* (†UPS); Outeniqua Mts., Montagu Pass, *Rehmann 213* (†BM); Knysna, Kaymansgate, *Drege* in 1839 (K), Plattenberg For., *Bowie s.n.* (K), *Wilson* in 1922 (†A—5 sheets, UC), Vandu Wats, *Burchell 5293* (K), *Setchell* in 1927 (UC), *Mund & Maire s.n.* (K), in 1840(?) (K); George Division, Gat River, *Drege s.n.* (K), *Burchell 5761, 6068, 8909* (K). IN CAPE COLONY BUT WITH NO LOCALITY: *Drege s.n.* (†Mo, NY), *Prager 785* (†CAS), *Anon. s.n.* ex Scheidweiler Herb. (†BR), *Burchell 5245* (GH), *Burchell 4652* (GH), *Basil* in 1865 (NY), *Anon.* leg. M. & M. (ex HB. Rg. Br.) (GH, NY), *Anon. s.n.* (GH), *Stewart s.n.* (K). NO LOCALITY: *Anon.* ex Herb. A.N.S. (†Ph), *Anon. 10.9* (†Mo), *Anon.* ex Herb. Jan Gen 840½ ex Bernhardi Herb. (†Mo—4 elements on sheet), *A. Brown* in 1862 (†Mo), *Anon. s.n.* (BR), *Molliana* in 1833 (†BR), *H.S.* in 1834 (†BR), *Anon.* ex Gord. Herb. (K).

CULTIVATED: Cape of Good Hope, "Hort. Daudin" 1851 (†DS in part); Natal, Kirstenbosch, *Bolus* in 1941 (†Ill); France, Riviera, *Schneider* in 1903 (A), "Hort. Monac." (BR in part); Italy, Rome, for Engelmann in 1870 (†Mo), Naples for Engelmann in 1869 (†Mo); Brazil, Rio de Janeiro, *Whitford 27* (†F, GH, †US); Australia, *Bowman* in 1921 (A); China, Hongkong, *Chun 5235* (†UC), Sargent in 1903 (†A).

Podocarpus gracilior Pilger in Pflanzenreich IV. 5 (Heft 18): 71. 1903, in Nat. Pflanzenfam. ed. 2, 13: 245. 1926; Battiscombe, Descr.

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* The following symbols indicate the herbaria having the specimens cited: Academy of Natural Sciences of Philadelphia (Ph), Arnold Arboretum (A), British Museum (BM), Brussels Botanical Garden (BR), University of California at Berkeley (UC), California Academy of Science (CAS), Chicago Natural History Museum (Field Museum) (F), Gray Herbarium (GH), University of Illinois Herbarium (Ill), Kew Herbarium (K), Missouri Botanical Garden (Mo), New York Botanical Garden (NY), Rutgers University Herbarium (NJU), Stanford University Dudley Herbarium (DS), United States National Herbarium (US), Uppsala Botanical Museum (UPS), Yale University Herbarium (YU).

† This symbol preceding the abbreviated name of an herbarium following the specimens examined signifies that the details of the leaves of this specimen have been examined in cross-section.

Cat. of common trees & woody plants of Kenya Colony 1. 1926; Florin in Svenska Vet.-Akad. Handl. ser. 3, **10** (1): 262. 1931; Chalk, Burtt-Davy & Desch, Forest trees and timbers of Brit. Emp. **1**: 23. 1932; Giordano in L'Alpe **24**: 417. 1937; Buchholz in Madroño **6**: 119. 1941; Stapf in Fl. Cap. **5** (Sect. 2, suppl.): 13. 1933.

This species differs from *P. falcatus* chiefly in its more restricted range in the forests of tropical Africa. Pilger differentiated it primarily by the larger male cones, 1.5–3 cm. long, its scales with acute apices (instead of obtuse), the more patent, fairly loosely arranged leaves, and the larger seeds, 12–20 mm. long. Stapf (16) finds the leaves mostly long tapering to a sharp point and narrower. He notes the similarity to *P. falcatus* and suggests that it may be only a geographical variety.

Podocarpus gracilior is cultivated as an evergreen exotic in California and has been distributed widely in tropical-plant houses. The tree has been called *P. elongatus*, an error which was corrected by Buchholz in 1941 (3). At the same time several additional differences from *P. falcatus* were noted. *Podocarpus gracilior* has green twigs, the leaves are longer and wider, and the pollen cones are twice as long.

In the description which Battiscombe (1) included with his listing of this species from Mt. Elgon in Kenya Colony, the small seed must be an error and ½ in. long was meant.

DISTRIBUTION: Eastern Africa, on mountain slopes in tropical regions.

SPECIMENS EXAMINED:

ETHIOPIA: Addis Ababa, *Armbruster* in 1915 (K); Mt. Chillalo, *Scott s.n.* (K); Galla Pass, *Gillett 5132* (K); West Sidamo, *Drake-Brockman 205, Brockman 244* (K); Djem-Djem Forest, *Cooper s.n.* (K); Kena Valley, Alafa, *Cheesman 7445* (K); Chere, *Quartin-Dillon & Petit 105* (K); *Schimper 1160* (TYPE) (K); *Schimper 1539* (†BR); *Mearns 92* (†BR); *Roth s.n.* in 1841 (K); *Stordy s.n.* (K). KENYA: between the Oljoro-o-Nyon and Narok Rivers, *Mearns 373* (†US), *Mearns 382* (CU, †F, GH, NY—2 sheets), *Mearns 1382* (GH, NY); NW Kenya, *Hutchins 400, 598* (K); Laikipia Plains, 20 m. from Kenya, *Hutchins 399* (K); Coles Farm, *Fries 801* (†BR, K); Myeri Dist., *Decie* in 1926 (†BM); Walenso, *A. Donaldson Smith 217* (†BM); Mau escarpment, *Wilson* in Dec. 1921 (A—5 sheets); beyond Londoni, *Wilson* in Dec. 1921 (A—4 sheets); SW Kenya, *Hutchins s.n.* in 1906 (K); Nairobi Dist., *Gardner 1110* (K), *Wilson* in Nov. 1921 (A—4 sheets, 1 seedling), *Wilson* in Jan. 1922 (A—2 sheets); *Fuller 683* (A); *Mettam* in 1928 (DS); *Curtis 901, 1071* (A). UGANDA: Kaburon, Mt. Elgon, *Eggeling 2474* (K), *Eggeling 2479* (†BR); Mt. Elgon, *Lugard 64, 64a* (K), *Jackson 352a* (K); Nandi & Ravine Dists., *Johnston* in 1900 (K); Eldoma Ravine, *Johnston* in 1899 (K), in 1900 (K), *Whyte* in 1898 (K); Mt. Debasien, Karamoja, *Thomas 2953* (K); Masai County, Ty Kipia, *Thomson* in 1884 (K); Ruwenzori Exped., *Scott-Elliott 6959* (K). TANGANYIKA TERRITORY: Mt. Kilimanjaro, Gereragua, *Zimmermann 1783* (K); Mt. Meru, *Greenway 4434* (K); Kondoa Dist., Salanga Hill on Bereku Ridge, *Burtt 1069A* (K—2 sheets), *Burtt 1070* (K—2 sheets), Kinyassi Mtn. *Burtt 910* (K); Mt. Hanang, Nangwa, *Greenway 7602* (K); Bukoba, Minsiro Forest, *Wigg 303* (K). LOCALITY UNKNOWN: *Burtt 1174* (†K in part); ex Scheidweiler Herb. (BR); *Anon. s.n.* (†BR); *Parker s.n.* (A); *Anon. s.n.* (†Mo).

CULTIVATED: Kenya: Nairobi Arboretum, *Eggeling 3570* (K), Kirstenbosch, *Graham* in 1941 (†Ill). Tanganyika; Cons. Forests in 1932 (A, †BR, K, †Mo, NY). Cameroons: *Maclaut 344* (K). Cape of Good Hope: ex Herb. John Miers († BM), Forest Nursery. *Wilson* in 1921 (A-seedlings). India: Dehra Dun, *Raizada 5028* (K). Switzerland: *Schneider* in 1903 (A). England: Kew, Temp. House, *Cook* in 1937 (†Ill). U.S.: California, Rosecroft Gardens, *Buchholz* in 1941 (†Ill—2 sheets); Santa Barbara Bot. Gard. *Moran 2529* (Dearing Herb., †Ill); San Diego, *Wangenheim* in 1941 (Ill); Pasadena, Coolidge Nursery, *Buchholz* in Jan. 1941 (A, Ill), in Feb. 1941 (A, Ill); Berkeley Bot. Gard. *Nelson* in 1941 (Ill—2 sheets); Santa Barbara, *Van Rensselaer 1727* (Ill—2 sheets), *1801* (Ph).

Podocarpus Dawei Stapf in Fl. Trop. Afr. ed. Prain, 6(2): 342. 1917; Florin in Svenska Vet.-Akad. Handl. Ser. 3, **10**: 262. 1931; Chalk, Burtt-Davy & Desch, For. trees & timbers of Brit. Emp. 1: 23. 1932.

A typical member of section *Afrocarpus*, it differs from *P. falcatus, P. gracilior* and *P. gracillimus* by the subglobose, chestnut-brown seed with inner woody layer 3 mm. thick. Chalk (5) also differentiates it from *P. usambarensis*, found in the same area, by the smaller leaves, but this becomes a very doubtful criterion after noting the ecological variations in the latter species seen in the specimens and described in detail by Robyns (13).

DISTRIBUTION: Tropical Africa, Uganda.

SPECIMENS EXAMINED:

Uganda: south Budda, near Kagera River, *Dawe 961* (†K, TYPE); Podo. Mt. Debasien at Mareyo, *Eggeling 2704* (†BR); Masaka, Katua, *Eggeling 5566* (K—3 sheets and seeds in alcohol); Kigezi Dist., Kayonso forest, *Fyffe* in 1928 (K—2 sheets), *Eggeling 4180* (K-seedling). Belgian Congo: near Matemba, between Lubango & Luofu, w. of Lake Edward, *Chapin 264* (†NY).

CULTIVATED: Uganda: Entebbe, *Eggeling 5712* (with seeds in alcohol) (K), *Eggeling 5711* (K). Natal: near Durban, *Wood 3005* (†K).

Podocarpus gracillimus Stapf in Fl. Trop. Afr., ed. Prain, 6 (2): 343. 1917; Chalk, Burtt-Davy & Desch, For. trees and timbers of Brit. Emp. 1: 23. 1932; Stapf in Fl. Cap. 5 (Sect. 2, suppl.): 14. 1933.

This species is represented primarily by a single specimen, *Nelson 423* from Transvaal, with small leaves (1.8–2.5 cm. long by 1–1.5 mm. broad) and a seed 20 mm. in length. The leaf anatomy was inadvertently described by Laurent (8) in connection with his description of *P. rostratus*. We have examined a photograph of this specimen and a leaf from it, which shows, as he described, palisade parenchyma on both sides, sclerified fibers in the parenchyma and hypoderm in discontinuous groups, and indicates that it is amphistomatic. He also described three resin canals under the vascular bundle, but we are unable to verify this observation as we find only one in that position. If three resin canals do occur, it is the only member of *Afrocarpus* having them. Orr (11) says that it has the largest vascular fibers, but these vary so much in size among all the species and even in a single section from a leaf that it is a doubtful diagnostic feature.

In the statistical study of the abundance and form of the sclereids of the accessory transfusion tissue, it was found that these were by far the smallest and shortest, not exceeding 95μ in length.

In Stapf's (16) later esimate of the status of *P. gracillimus*, it is a "very doubtful and incompletely known species. It may represent merely a state of *P. gracilior*, in which the reduction of the leaves and breadth characteristic of the fruiting stage has been carried to excess." Sim (14) had previously suggested this explanation. A similar state was collected by A. Whyte in the Eldama Ravine, Kenya, "along with typical *P. gracilior.*" Stapf adds *Burtt-Davy 5083* as a possible example and we can include several specimens from American herbaria which are listed below.

DISTRIBUTION: South Africa, in Transvaal and Natal.

SPECIMENS EXAMINED:

TRANSVAAL: Houtschberg, *Nelson 423* (†K); NATAL: Zululand, *Ballanden 2925* (A—2 sheets); *Wilson* in 1922 (A).

CULTIVATED: Transvaal, in Helpmakaar Arboretum, *Burtt-Davy 20227* (†A).

Podocarpus usambarensis Pilger in Pflanzenreich VI. **5**(Heft 18): 70. 1903, in Nat. Pflanzenfam. ed. 2, **13**: 245. 1926; Stapf in Fl. Trop. Afr. ed Prain, **6**(2): 341. 1917; Dallimore & Jackson, Handb. Conif. 57. 1931, 84. 1948; Florin in Svenska Vet.-Akad. ser. 3, **10**: 262. 1931; Chalk, Burtt-Davy & Desch, For. trees & timbers of Brit. Emp. **1**: 23. 1932; Robyns in Inst. Roy. Colon. Belge, Bull. **6**(1): 236. 1935, in Flore du Congo Belge et du Ruanda-Urundi **1**: 5–6. 1948.

Podocarpus falcatus Engl. in Pflanzenwelt Ostafr. **C**: 92. 1895.

This species is distinguished by Pilger (12) and Chalk (5) from *P. falcatus* and *P. gracilior* by the thicker inner woody layer of the seed and from *P. Mannii* by the shorter leaves and smaller, more globose seed. However, it closely resembles the two former species and Robyns (13) has given a very pertinent discussion (translated) of the status of this species: "It is true that *P. usambarensis* has an area of distribution more tropical than *P. gracilior*, that it is only described from Abyssinia, Uganda, or Kenya, but it is possible that these groups represent in reality two geographic varieties of one and the same species. We note, moreover, that Stapf has shown that the diagnostic characters of *P. gracilior* and *P. falcatus* are confused and that it is reasonable, also, to consider *P. gracilior* as a geographical variety or the tropical form of *P. falcatus*. A comparative study of the three species in question will lead then, very probably, to their fusion into a single species, which should be called *P. falcatus*, according to the laws of nomenclature."

We would concur with Robyns in this matter and perhaps add *P. gracillimus* and *P. Dawei* to the series. However, we believe that *P.*

usambarensis can be distinguished by the large seeds even though this may not be a character of specific rank. Also the leaves usually seem to be stiffer and more abruptly pointed, not as falcate as *P. gracilior*.

We have tried to confirm Orr's (11) statements that the accessory transfusion sclereids are "more numerous and conspicuous here," and that the hypoderm "has the appearance of being interrupted at greater intervals" and is in an "unbroken layer above and below vascular bundle." We do not find these to be any more true in this than in the other species.

DISTRIBUTION: Tropical Africa, in Belgian Congo and Tanganyika.

SPECIMENS EXAMINED:

BELGIAN CONGO: Lac Mokoto, *Claessens 52* (†BR). RUANDA-URUNDI: Rubongera, *Lestrade 2* (†BR). TANGANYIKA: Kilimanjaro, north side, *Schlieben 5129* (†ex Berlin Herb. Florin, †BR, Ill, †YU); Mt. Usambara, *Holst 2467* (†K); Kondoa Dist., *Burtt 1069* (K—2 sheets), *Burtt 1174* (K).

CULTIVATED: Tanganyika: Runjwa Dist., *Davies*, Dept. Agr. D211 (†K); Jamaica: Cinchona, *Nichols 167* (†F, GH, †Mo, NY, US, YU); *Schwaby* in 1943 (Ill); *Buchholz* in 1946 (†Ill); *Chrysler 1460* (NJU); *Scheidweiler s.n.* (†BR).

Podocarpus Mannii Hook f. in Jour. Linn. Soc. **7**: 218. 1864; Pilger in Pflanzenreich IV. **5** (Heft 18): 70. 1903, in Nat. Pflanzenfam. ed. 2. 13: 245. 1926; Henriques in Biol. Soc. Brot. **5**: 216. 1887; A. Nobre in Boletim da Soc. Brot. **7**: 115. 1889, in Pflanzenwelt Ostafr. **C**: 92. 1895 (not Engl.); Stapf in Fl. Trop. Afr., ed. Prain, **6** (2): 341. 1917; Seybold in Bot. Abh. **6**: 49. 1925; Florin in Svenska Vet.-Akad. Handl. ser. 3, **10**: 262. 1931; Dallimore & Jackson, Handb. Conif. 50. 1931, 74. 1948; Chalk, Burtt-Davy & Desch, For. trees & timbers of Brit. Emp. **1**: 23. 1932; Chevalier in Rev. Bot. Appl. **19**: 411. 1939.

This species has the largest leaves and seeds of any species in the group. The leaves are 12–16 cm. long by 7–11 mm. wide (shorter on flowering shoots), and the seed, narrowed at the base, solitary, is found up to 3.8 cm. long on a peduncle 2–3 cm. long. The auxiliary sclereids also reach the greatest length, 368μ.

Podocarpus Mannii is a rare species found native only on St. Thomas Island, cultivated in the forests of Cameroons and in California in Griffith Park. Herbarium specimens were collected in 1944 from 2 yr. old seedlings raised in this latter place from seeds obtained from Buenos Aires, presumably from cultivated trees.

DISTRIBUTION: Western tropical Africa, north of the Equator.

SPECIMENS EXAMINED:

WEST AFRICA: St. Thomas Island: *Mann 1065* (TYPE) (†GH—2 sheets, †K—2 sheets), *Spangler* in 1897 (†BR), *Exell 339* (†BR).

CULTIVATED: Cameroons: Buea, *Dartel 557* (A), *Maitland 343* (K), *Fairchild SPD74656* (K), *Anon. 345* (K); California: Griffith Park, *Buchholz* in 1944 (†Ill—2 sheets).

LITERATURE CITED

1. Battiscombe, E. A descriptive catalogue of some of the common trees and woody plants of Kenya Colony. London. 1926.
2. Bertrand, C. E. Anatomie comparée des tiges des feuilles chez les Gnétacées et les Conifères. Ann. Sci. Nat. Paris, ser. V. **20:** 5–153. 1874.
3. Buchholz, J. T. *Podocarpus gracilior* in cultivation. Madroño **6:** 119–122. 1941.
4. Buchholz, John T. and Netta E. Gray. A taxonomic revision of *Podocarpus.* I. The sections of the genus and their subdivisions with special reference to leaf anatomy. Jour. Arnold Arb. **29:** 49–63. 1948; V. The South Pacific species of *Podocarpus*: section *Stachycarpus.* ibid. **32:** 82–92. 1951.
5. Chalk, L., J. Burtt-Davy & H. E. Desch. Forest trees and timbers of the British Empire I. Some East African Coniferae & Leguminosae. Clarendon Press, N.Y. 66 pp. 1932.
6. Chalk, L., M. M. Chattaway, J. Burtt-Davy, F. S. Laughton & M. H. Scott. III. Fifteen South African high forest timber trees. Forests & timbers of Brit. Emp. Clarendon Press, N.Y. 1935.
7. Florin, R. Untersuchungen zur Stammesgeschichte der Coniferales u. Cordaitales. Erster teil. Morphologie und Epidermizstrukture der Assimilationsorgane bei den rezenten Koniferen. Svenska Vet.-Akad. Handl. ser. 3, **10:** 1931.
8. Laurent, M. L. Les *Podocarpus* de Madagascar. Ann. Fac. Sci. Marseille **23:** 52–64. 1915.
9. Mahlert, Adolph. Beiträge zur Kenntnis der Anatomie des Laubblatter der Coniferer mit besonderer Berücksichtigung des Staltöffnungs-Apparates. Bot. Centralbl. **24:** 278–282. 1885.
10. Marloth, R. The Flora of South Africa, with synoptic tables of the genera of the higher plants. Vols. **1–4.** Cape Town & London. 1913–1932.
11. Orr, M. Y. The leaf anatomy of *Podocarpus.* Trans. Proc. Bot. Soc. Edinburgh **34:** 1–54. 1944.
12. Pilger, R. Taxaceae. Engler Pflanzenreich IV. **5** (Heft 18): 1–124. 1903.
13. Robyns, W. Sur les espèces de *Podocarpus* du Congo Belge et du Ruanda-Urundi. Inst. Roy. Col. Belge, Bull. **6:** 226–242. 1935.
14. Sim, T. R. The forests and forest flora of the Colony of the Cape of Good Hope. Aberdeen. 1907.
15. Smith, C. A. Nomenclature of *Podocarpus* species. So. Afr. For. Assoc. Pretoria Jour. **10:** 23–28. 1943.
16. Stapf, O. Podocarpaceae. Fl. Cap. **5** (Sect. 2, suppl.): 3–14. Ed. Sir Arthur Hill. 1933.
17. Stiles, W. The Podocarpeae. Ann. Bot. **26:** 442–514. 1912.
18. Van Tieghem, Ph. Structure et affinités des *Stachycarpus*, genre nouveau de la famille des Conifères. Bull. Soc. Bot. Fr. **38:** 162–176. 1891.

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THE MORPHOLOGY AND RELATIONSHIPS OF IDENBURGIA AND NOUHUYSIA

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With two plates

INTRODUCTION

IN A PREVIOUS PAPER (5), we excluded *Idenburgia* and *Scyphostegia* from the Monimiaceae. Since doing so, we have devoted considerable attention to additional investigation of the morphological characteristics of these peculiar genera, and to the problem of determining their relationships. It soon became evident that *Idenburgia* is closely related to, if not actually congeneric with, *Nouhuysia*. In writing to Professor van Steenis for additional material, we learned that he had a paper in press (7), in which he concludes that the two genera are identical and places the combination in a new tribe, the Nouhuysieae of the Guttiferae. He recognizes three distinct species of *Nouhuysia*, *N. papuana* Lauterbach, *N. arfakensis* (Gibbs) van Steenis and *N. pauciflora* (A. C. Sm.) van Steenis; *Idenburgia novoguineensis* Gibbs, *I. pachyphylla* Gilg & Schlechter, and *I. elaeocarpoides* Gilg & Schlechter being reduced to synonymy with *N. papuana* Lauterbach.[1]

Upon the basis of our detailed study of the exomorphic and endomorphic characters of the vegetative and reproductive parts of *Idenburgia* and *Nouhuysia*, we are in agreement with van Steenis regarding the identity of the two genera, but we question whether *Nouhuysia* actually belongs in the Guttiferae. Furthermore, there are questions regarding speciation within the genus that appear to need extensive investigation. It seems desirable accordingly to summarize salient features of the morphological and anatomical data that we have accumulated during the last few years.

MATERIAL

Our observations are based upon the examination of material from the following 25 collections of *Nouhuysia* and *Idenburgia*:

Versteegh 1668 (type of *N. papuana* Lauterbach); *Clemens 3828* (type of *I. pauciflora* A. C. Sm.), *Kostermans 2217* [*N. arfakensis* (Gibbs) v. Steenis], *2198; Clemens 2240, 2422, 3122, 3978, 3978A, 4194A, 5122, 5499b, 7023, 8754, 8835, 11134, 12353; Brass 11078, 12661; Brass & Versteegh 10472; Gibbs 5654;* Neth. Ind. For. Serv. bb *24085*, bb *25014; Pulle 647; Rutten 2240.*

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[1] Since our manuscript went to press, we have learned through Dr. A. C. Smith of a paper by S. Hatusima (Bot. Mag. Tokyo **65:** 107–111, 1952.) in which he likewise reduces *Idenburgia* to *Nouhuysia*. This paper is not available as yet in the libraries of Greater Boston.

STYLOIDS

A significant criterion in all of the collections that we have examined is the occurrence of visible calcium oxalate dominantly in the form of styloids. Although the styloids vary markedly in size, attaining at times a length of 350 microns and a breadth of 30 microns, their characteristic crystallographic form is that illustrated in *Fig. 6.* They are square or rectangular in sectional view, and are formed more or less abundantly in the lamina of the leaves and tepals and in the cortex and secondary phloem of the stem and petiole. Furthermore, they may occur, at least in certain cases, in the pith of the stem, in the connective of the stamens and in the pericarp of the fruit. In leaves and tepals, aberrations of form due to twining or the development of more than one crystal in a single cell are statistically of relatively infrequent occurrence. Transitions to raphides, such as may be observed for example in certain of the Parietales and Rubiales, do not occur. Nor have we been able to detect the presence of mucilage in the crystal-bearing cells. Transitions to aggregates of smaller crystals or to druses do occur, however, at times in the phloem and pith of the stem, e.g. *Brass 11078.*

In the lamina of the leaves and tepals — where the styloids commonly are large and have their major axis oriented parallel to the surfaces of the lamina — they are contained within cells that are markedly different from the surrounding cells and therefore appear to be idioblasts. Their outlines are visible in surface view of herbarium specimens when boiled leaves and tepals are examined under an ordinary binocular microscope with adequately controlled surface illumination. It is significant in this connection that, in clearing dried leaves for detailed study of their internal structure in transmitted light, the styloids tend to disintegrate and may disappear under prolonged treatment in 3% sodium hydroxide at 52°C. Therefore, it is essential to verify observations based on cleared material by the examination of thin sections of tissues that have not been subjected to the action of either acids or alkali.

LEAVES

Although the simple, extipulate leaves with glandular-serrate margins vary considerably in size, in the form of their apex and in hairiness, they are characterized in all collections by having a fundamentally similar pattern of vasculature. Three independent and relatively widely separated vascular strands or traces at the trilacunar nodes of the stem, *Fig. 10,* enter the base of the petiole, where they aggregate in the characteristic vascular configuration illustrated in *Fig. 12.* Thus, throughout most of the petiole and the midrib of the lamina the vascular tissues are distributed in the form of a trough with acutely inturned margins. The venation of the lamina is fundamentally pinnate and arcuate-reticulate in all cases. The veins and veinlets are more or less heavily jacketed with thick-walled fibers, and therefore tend to be embossed and conspicuous in dried specimens. The stomata are of relatively constant size, form and structure, and are surrounded by ordinary epidermal cells, *Figs. 8* and *9*, no special subsidiary cells being formed in relation to them. The cell walls of the lower epidermis, as seen in surface view of the lamina, commonly tend to be conspicuously undulate, *Fig. 9*, but this character is less constant than the preceding ones, *Fig. 8*. A much wider range of variability occurs, however, in the cells of the mesophyll. The upper epidermis is subtended by palisade tissue, no hypodermal layer being formed in any of the leaves that we have examined. The palisade tissue is subtended by a small-celled, relatively compact form of spongy parenchyma, the rest of the mesophyll being composed of larger cells with more extensive intercellular lacunae. The cells of the palisade commonly are distributed in a single layer, but more than one such layer is encountered in certain cases, viz. *Brass 11078* and *Brass & Versteegh 10472*. The cells may be slender and typically elongated (*Kostermans 2198*, *Brass 12661*) or they may be short and poorly differentiated from the subtending compact form of spongy mesophyll (*Clemens 3828*, *3978*). The cells of the spongy mesophyll in comparable parts of the lamina vary in size and form from one collection to another. They may be thin-walled throughout the lamina, thin-walled with occasional sclerotic modification, *Fig. 2*, a mixture of thin-walled and thick-walled, or prevailing thick-walled, *Figs. 1* and *7*. Similarly, the cells that jacket the veins and veinlets may be either thin-walled or thick-walled. The intercellular lacunae also vary markedly in size, compare *Figs. 1* and *7*.

STEMS

The fundamental structures of the stem, viz. pith, xylem, phloem and cortex, are remarkably similar in all collections that we have examined, such minor differences as occur being of a quantitative, rather than of a qualitative, nature. The most significant diagnostic criteria, other than the occurrence of styloids particularly in the phloem, are the primitive structure of the xylem and the character and distribution of the sclerenchymatous cells in the cortex.

The secondary xylem is formed by a primitive type of cambium having long fusiform initials with extensively overlapping ends. The vessels are slender, thin-walled and angular, *Fig. 13*, and are distributed either singly or in occasional radial clusters. The vessel members are long with extensively overlapping ends and with unusually numerous scalariform perforations, *Fig. 14*. The pitting between vessels in lateral contact is scalariform and transitional to opposite, as is that between vessels and parenchymatous cells. The more slender vessel members closely resemble scalariformly pitted tracheids and exhibit transitions between imperforate and perforate scalariform bordered pits. The fiber tracheids have numerous pits with conspicuous borders in both their radial and their tangential walls. The orifice of these pits may be included, slightly extended, or much extended by cracking of the secondary wall. The distribution of the wood parenchyma is apotracheal-diffuse. The rays are conspicuously heterogeneous, the uniseriate ones being composed of very tall erect cells, and the biseriate and triseriate ones of lower cells which tend to become procumbent in the outer wood of older stems, *Fig. 13.*

There is a more or less compact zone of thick-walled fibers in the so-called pericyclic layer of the stem. This is jacketed by a broad zone of cortical sclerenchyma, composed of large cells of somewhat irregular form and orientation. These cells, although of a sclerenchymatous nature, are characterized by having relatively thin, lignified walls and unusually large lumina.

FLOWERS AND FRUITS

The floral morphology of the various species of *Idenburgia* as well as of *Nouhuysia papuana* conforms to a similar plan with little variation. The exomorphic characters of the tepals, stamens, pistil and fruit have been described and adequately illustrated by Gibbs (2), Gilg and Schlechter (3), and van Steenis (7). The chief variable factor appears to be in the number of stamens present in a flower, *I. arfakensis* with six standing at one extreme and *I. elaeocarpoides* with 10–13 representing the other extreme. *Idenburgia pauciflora* has flowers decidedly of smaller size in relation to other species of the genus and is distinctive in the possession of profuse dense tomentum on both its vegetative and reproductive parts.

The vasculature of the flowers also presents a rather stabilized pattern in the two genera. The median vascular strands, *Text-fig. 3, md,* of the two pairs of decussately arranged tepals are derived directly from the axial cylinder; the marginal veins, *mr*, of the adjacent tepals, however, are formed by four commissural strands, *com*. Stamens, *st*, receive a single strand each of which broadens slightly while traversing the connective. The remainder of the vascular tissue of the axis, consisting generally of eight to 12 strands, supplies the gynoecium, *g*. Two of these strands fuse together to form the "ventral" vein which runs vertically in the tissue separating the two locules, *v* in Text-figs. *2* and *3*, and finally bifurcates, each branch supplying one ovule. The other strands of the gynoecium traverse the ovary wall and in the region of the stigma undergo considerable proliferation and anastomosis, *Text-fig. 2.*

The gynoecium in all the species of *Idenburgia* and in *Nouhuysia* examined by us is bilocular, lodging a single anatropous ovule in each locule, *Text-fig. 1.* The funicle is rather massive and characteristically papillose externally. Generally both ovules develop to produce two-seeded fruits. In certain collections, however, single-seeded fruits have been described (3,6). An examination of such specimens has revealed that this condition is due to a failure of one of the ovules to develop to maturity. The seed structure of the two genera under consideration are remarkably alike, the most noteworthy feature being the pronounced centripetal ruminations of the stony layer of the seed, *Fig. 11.*

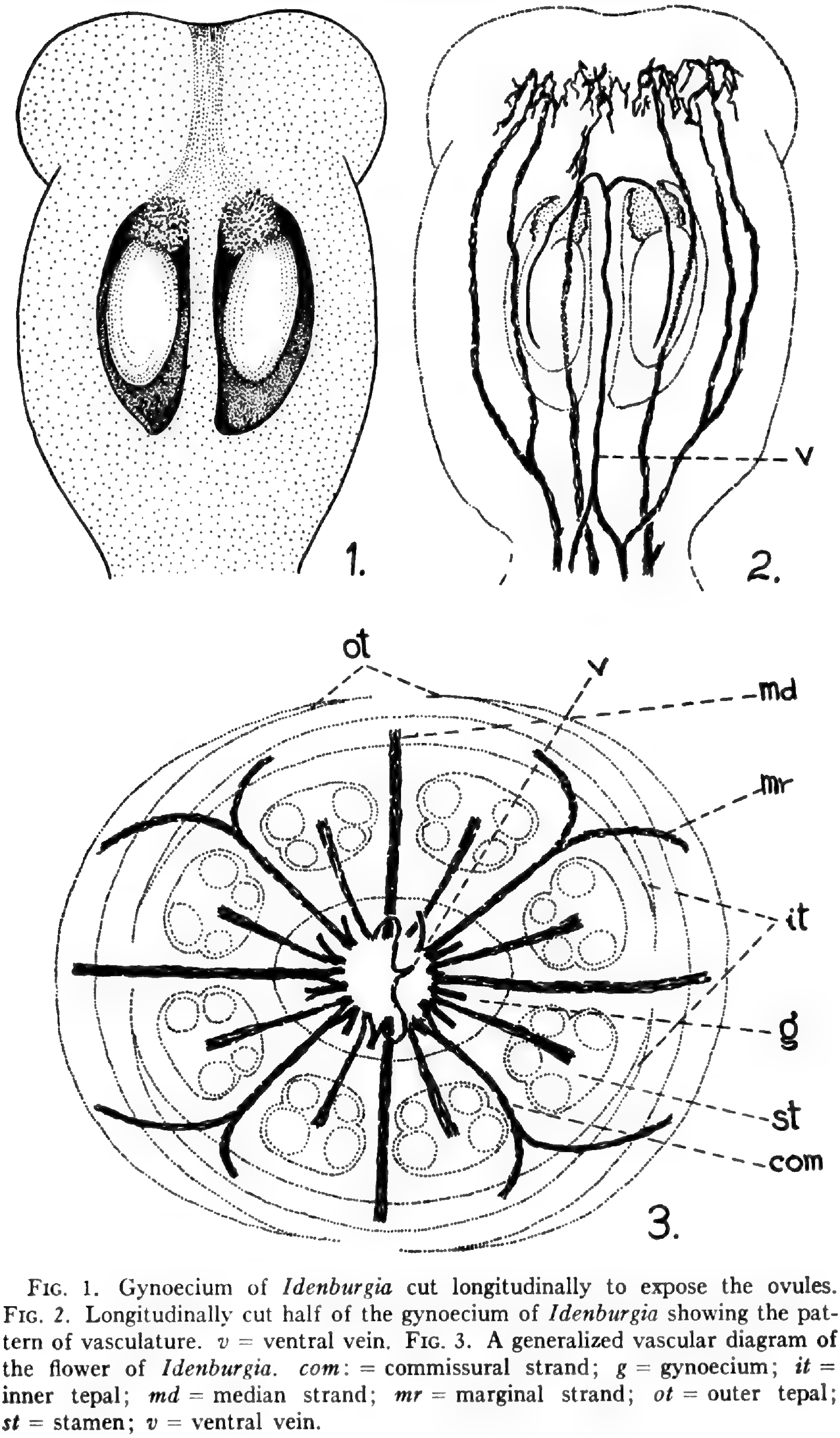

FIG. 1. Gynoecium of *Idenburgia* cut longitudinally to expose the ovules. FIG. 2. Longitudinally cut half of the gynoecium of *Idenburgia* showing the pattern of vasculature. *v* = ventral vein. FIG. 3. A generalized vascular diagram of the flower of *Idenburgia*. *com*: = commissural strand; *g* = gynoecium; *it* = inner tepal; *md* = median strand; *mr* = marginal strand; *ot* = outer tepal; *st* = stamen; *v* = ventral vein.

POLLEN

Erdtman is quoted by van Steenis as stating that the pollen of *Kostermans 2198* is 3-porate, oblate (14.5 × 20.5μ), with an exine 1.5μ in thickness, pattern ± obscure. We have examined the pollen from eight different collections. *Gibbs 5654* and *Kostermans 2198* are characterized by dominantly oblate, 3-porate pollen, *Fig. 3*, with a minor admixture of 4-porate grains. The inner exine is greenish and highly refractive in lactic acid and the outer exine exhibits a barely detectable sculpture in surface view. The pollen of *Rutten 2240* is similar but differs in being dominantly 4-porate with a minor admixture of 5-porate grains. *Clemens 3828* (type of *I. pauciflora* A. C. Sm.) is dominantly 3-porate but differs in its conspicuously smaller size. *Kostermans 2217* (*I. arfakensis* Gibbs) and *Clemens 2422* have a conspicuously granular-reticulate outer exine in surface view, the former being prevailingly 3-porate, and the latter 4-porate and conspicuously smaller, *Fig. 5*. In marked contrast to the pollen of these collections, is that from *Brass 12661* and *Clemens 5499b* which is inaperturate, spherical and much larger, *Fig. 4*. It is significant, however, that all of the various forms of pollen are characterized by having a relatively thick, conspicuously hyaline inner exine.

DISCUSSION

The combination of exomorphic and endomorphic characters of both the reproductive and vegetative parts is closely similar in all collections, and there can be no doubt that *Idenburgia* and *Nouhuysia* are congeneric. Such morphological variations as occur tend to intergrade more or less extensively, *N. pauciflora* (A. C. Sm.) van Steenis being at one extreme of variability, for example in hairiness, and *N. arfakensis* (Gibbs) van Steenis in leaf form. When these specimens are excluded as easily recognizable species, the remaining collections of *Nouhuysia* present a problem of considerable taxonomic difficulty. Should all of them be assigned to one variable species, *N. papuana* Lauterbach, as concluded by van Steenis, or should additional species be segregated as attempted by Gibbs and by Gilg and Schlechter?

Unfortunately, such conspicuous differences in the internal structure of leaves as those illustrated in *Figs. 1, 2* and *7* are at present of questionable utility. The structural differences between sun-leaves and shade-leaves of the same plant and between leaves of plants growing in moist, as contrasted with arid, environments are known to be considerable. Therefore extensive additional collections must be made in order to determine whether such foliar structural differences are due to genetic factors or merely to the effects of varying environmental factors. It is significant in this connection, however, that the differences in pollen morphology, illustrated in *Figs. 3* and *4*, exceed the limits of variability that may be anticipated in a single species. Unfortunately, owing to the limited number of available collections with mature pollen, it is not possible at present to establish valid correlations between differences in pollen morphology and other diagnostic criteria.

Although the available material is inadequate for a satisfactory solution of the problem of speciation within *Nouhuysia*, it provides a summation of evidence that is significant in any discussion of the relationships of the genus. That the genus does not belong in, or in close relationship to, the Trimeniaceae or Monimiaceae is indicated by fundamentally significant morphological and anatomical differences in all of its organs. "Ethereal oil cells," which occur so characteristically throughout the Monimiaceae and the Trimeniaceae, are absent, as are large mucilage cells of the type which are a significant diagnostic criterion in *Trimenia* and *Piptocalyx*. Crystallization of calcium oxalate in the form of styloids, which is so typical of *Nouhuysia*, is alien to the Monimiaceae and allied families. Furthermore, the genus has a dominantly trilacunar nodal anatomy in contrast to the unilacunar structure which occurs throughout the Monimiaceae, Lauraceae, Gomortegaceae, Trimeniaceae, Amborellaceae and Austrobaileyaceae. In addition, the pollen morphology of *Nouhuysia* is fundamentally unlike that of these families. Although *Trimenia*, *Piptocalyx* and many genera of the Monimiaceae have retained a relatively primitive form of secondary xylem, they exhibit a tendency for the elimination of wood parenchyma and for the formation of septate fibers that is absent in *Nouhuysia*. The similarities in the flowers are superficial. The form and particularly the vasculature and other internal structures of the tepals, stamens and pistil of *Nouhuysia* prove upon detailed examination to be fundamentally different from those of *Trimenia* and *Piptocalyx*.

Similarly a summation of available evidence appears to exclude *Nouhuysia* from close relationship to the Guttiferae. The genus lacks the schizogenous secretory receptacles and the subsidiary cells oriented parallel to the guard cells of the stomata that are such characteristic diagnostic features of that family. The xylem is at a conspicuously more primitive level of structural specialization. Furthermore, the trilacunar nodal structure is alien to the Guttiferae which are dominantly unilacunar. In addition, styloids are not known to occur in the Guttiferae whose form of crystallization is of a different type. Nor have outstanding similarities in the reproductive parts been described which might be interpreted as neutralizing such significant differences.

As in the case of *Calyptosepalum*, discussed in another paper (1), *Nouhuysia* exhibits a combination of reproductive and vegetative characters that negates its inclusion at present in any existing family. It appears to be another of the numerous relics of an ancient woody dicotyledonous flora that have survived in New Guinea, New Caledonia, Fiji and adjacent regions. What to do with such genera as they successively come to light is a problem of major taxonomic importance. When thoroughly investigated, they promise to reveal much new evidence regarding the morphological characteristics of primitive angiosperms, and, therefore, should not be relegated to a position where they become lost from view. To refer them at once to existing families not only tends to conceal them, but also is extremely misleading in many cases. Lauterbach's (4) brief description and premature reference of *Nouhuysia* to the Guttiferae is undoubtedly responsible in part for the genus being overlooked and for the description of subsequent collections as species of a new genus, viz. *Idenburgia*.

Past experience with relic genera, e.g. *Casuarina*, *Degeneria*, *Himantandra*, *Amborella*, *Trochodendron*, *Tetracentron*, *Euptelea*, *Illicium*, *Cercidiphyllum*, etc., indicates that many, if not most, of them will have to be placed eventually in separate families, regardless of the results of such a procedure in multiplying the number of small families. This should not be attempted, however, until adequate collections of material are available for detailed and comprehensive investigations of all parts of the plant or until there is a summation of evidence which justifies the exclusion of a genus from existing families and the establishment of a new one. In the meantime, it appears wiser to place such relic genera in a special category of plants of uncertain or undetermined affinities comparable to the Fungi Imperfecti of mycologists rather than to continue to toss them about from one existing family to another as is commonly done at present.

Certain relic genera, when thoroughly studied, prove to be related to existing families, e.g. *Degeneria* and *Himantandra* to the Magnoliaceae or *Amborella, Trimenia, Gomortega* and *Austrobaileya* to the Monimiaceae and Lauraceae, and therefore may justifiably be placed in independent families in close proximity to them. Others, e.g. *Casuarina*, *Cercidiphyllum*, *Euptelea*, *Trochodendron* and *Tetracentron*, appear to be relics of more remotely related plants having no close surviving relatives and had best be retained in a general category of uncertain affinities, at least until their true relationships are revealed by paleobotanical evidence.

The genus *Nouhuysia* belongs for the time being at least in such a category of plants of uncertain or undetermined affinities.

ACKNOWLEDGMENTS

We are indebted to the Arnold Arboretum for the loan of all of its collections of *Idenburgia* and *Nouhuysia*, and to Professor van Steenis for his kindness in sending us pollen-bearing flowers of *Gibbs 5654, Rutten 2240* and *Kostermans 2217*. The junior author wishes to express his keen appreciation of helpful privileges extended to him by the Director and the staff of the herbarium at Kew.

LITERATURE CITED

1. Bailey, I. W. and A. C. Smith. A new Fijian species of Calyptosepalum Jour. Arnold Arb. **34:** 52–66. 1953.
2. Gibbs, L. S. A contribution to the phytogeography and flora of the Arfak Mountains, etc. 135–140. London, Taylor and Frances. 1917.
3. Gilg, E. and R. Schlechter. Die Monimiaceen-Gattung Idenburgia. Engler's Bot. Jahrb. **58:** 244–248. 1923.
4. Lauterbach, C. Guttiferae. In Lorentz's Nova Guinea. **8:** 843. 1912.

5. Money, L. L., I. W. Bailey and B. G. L. Swamy. The morphology and relationships of the Monimiaceae. Jour. Arnold Arb. **31**: 372–404. 1950.
6. Smith, A. C. Studies of Papuasian plants. II. Jour. Arnold Arb. **22**: 231–252. 1941.
7. Van Steenis, C. G. G. J. Reduction of two endemic monotypic Papuan genera. Acta Bot. Neerl. **1**: 93–98. 1952.

EXPLANATION OF PLATES

PLATE I

Fig. 1. *Clemens 5499b.* Cleared leaf, showing large intercellular spaces in the mesophyll and heavy thickening of the walls of its constituent cells, × 150. Fig. 2. *Clemens 12353.* Cleared leaf, showing thin-walled mesophyll and scattered sclereids, × 150. Fig. 3. *Kostermans 2198.* Oblate, triporate pollen, × 440. Fig. 4. *Brass 12661.* Spheroidal, inaperturate pollen, × 440. Fig. 5. *Clemens 2422.* Oblate, tetraporate pollen, × 440. Fig. 6. *N.I.F.S. bb. 25014.* Cleared leaf, showing styloid, × 150. Fig. 7. *Kostermans 2198.* Cleared leaf, showing thick-walled mesophyll and relatively small intercellular spaces, × 150.

PLATE II

Fig. 8. *Kostermans 2198.* Cleared leaf, showing stomata and form of the surrounding epidermal cells, × 310. Fig. 9. *Brass 12661.* Cleared leaf, showing stomata and form of the surrounding epidermal cells, × 310. Fig. 10. *Clemens 3978.* Transverse section of the stem at the level of a trilacunar node, × 11. Fig. 11. *Clemens 2240.* Transverse section of a fruit with two seeds, × 5. Fig. 12. *Clemens 3978.* Transverse section of the mid-vein of the leaf, showing form of vascular tissues, × 19. Fig. 13. *Clemens 2422.* Transverse section of the secondary xylem, × 40. Fig. 14. *Clemens 2422.* Radial longitudinal section of the xylem, showing the scalariform perforations, × 150.

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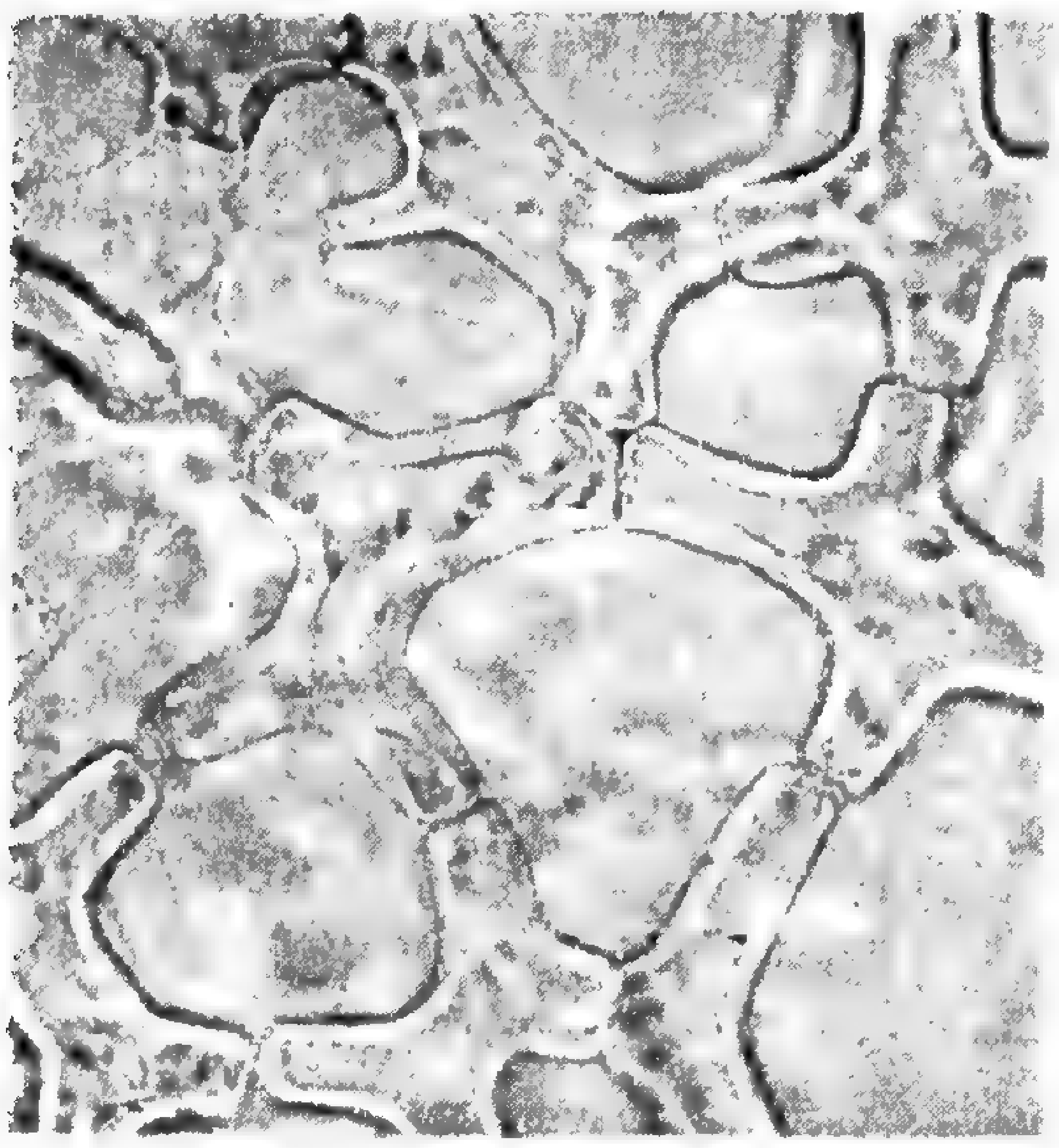
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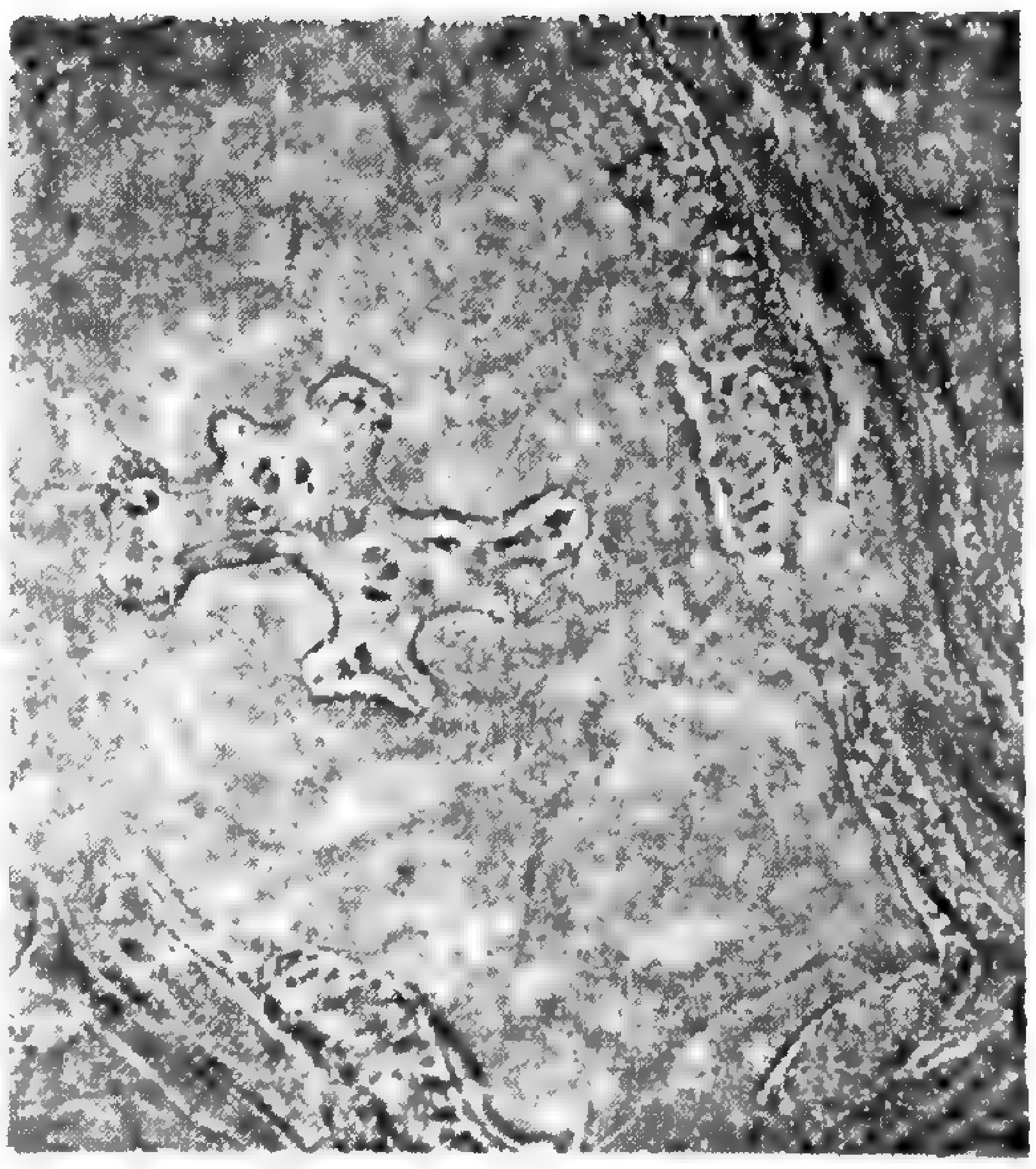
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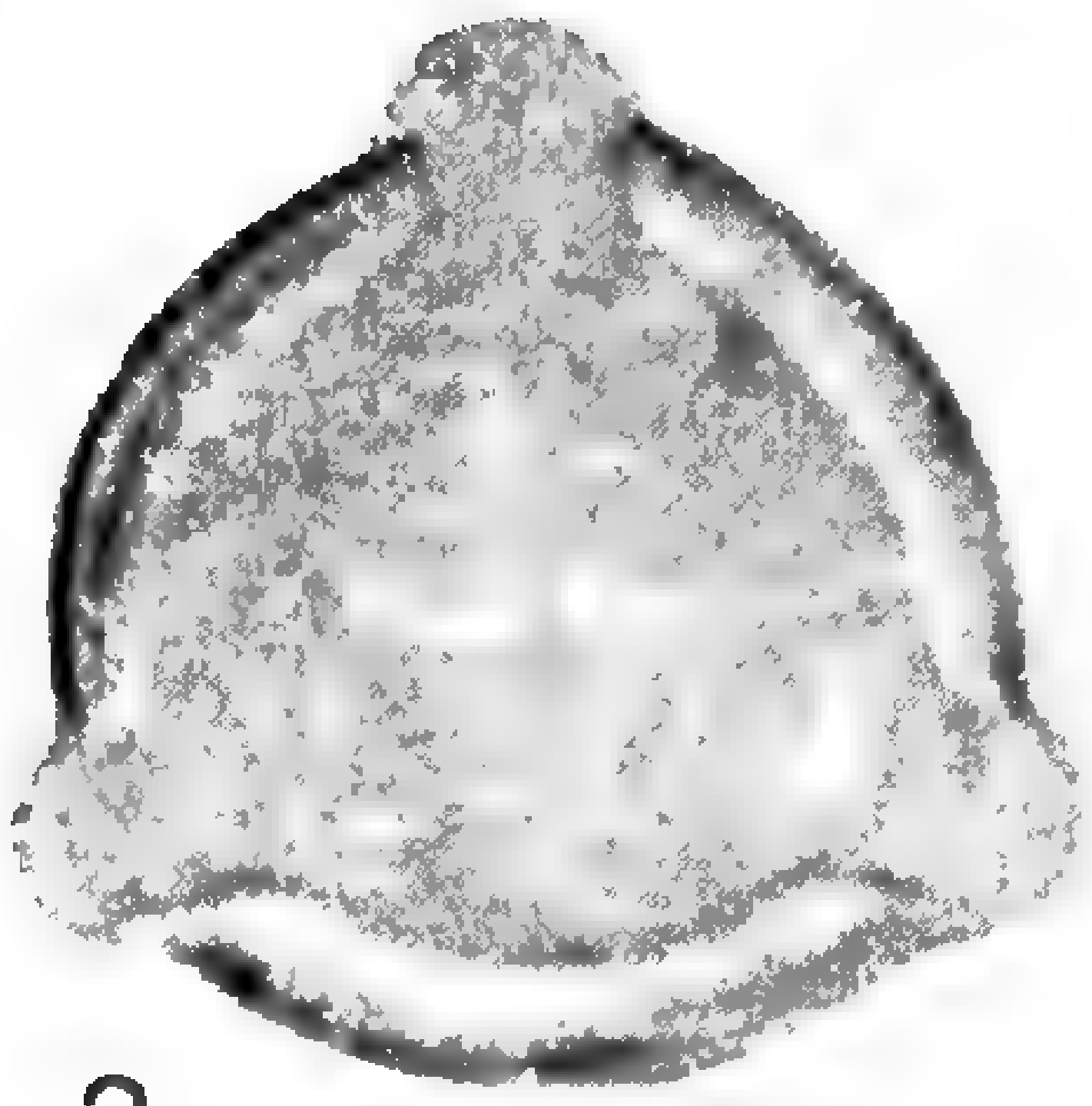
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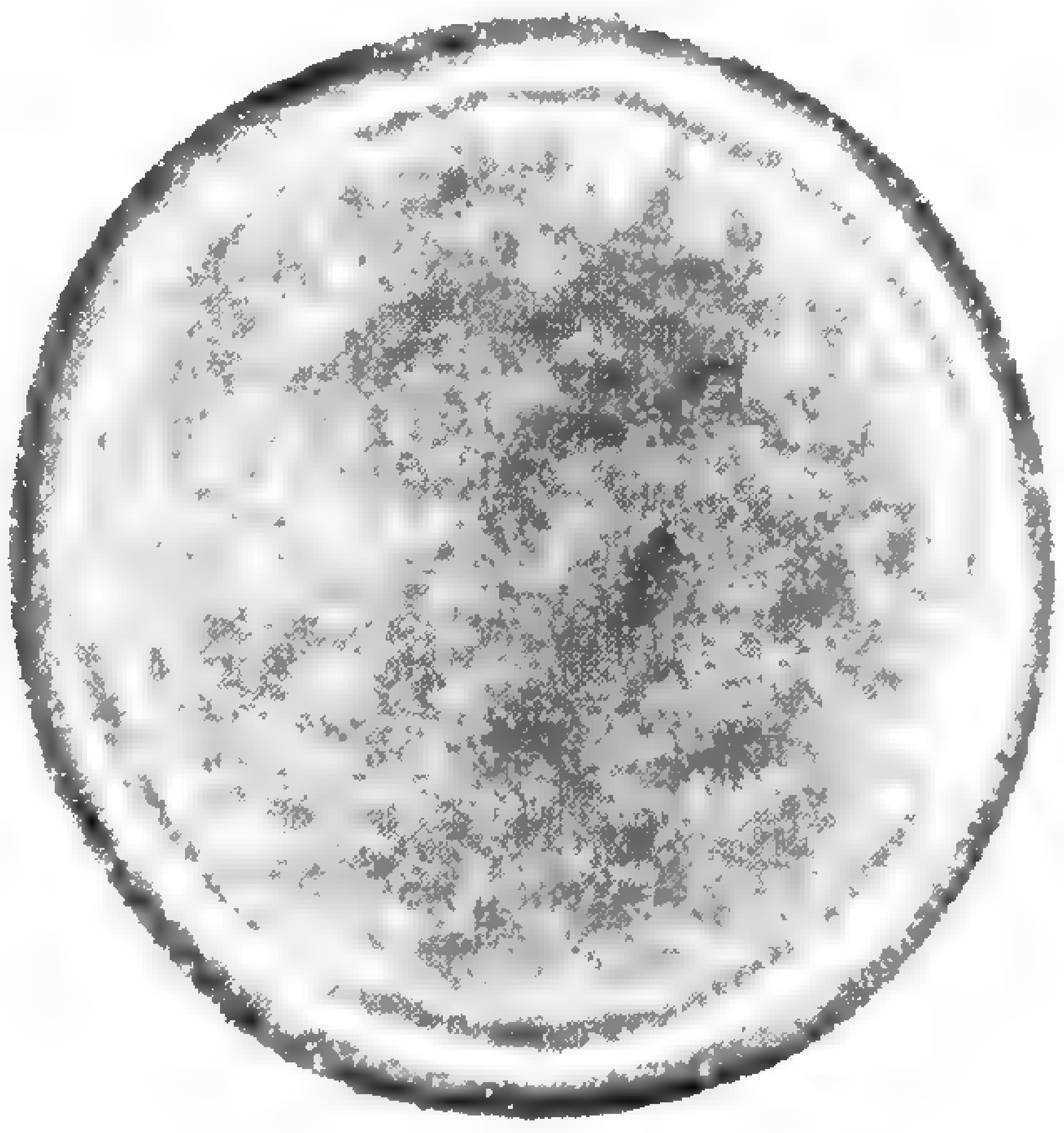
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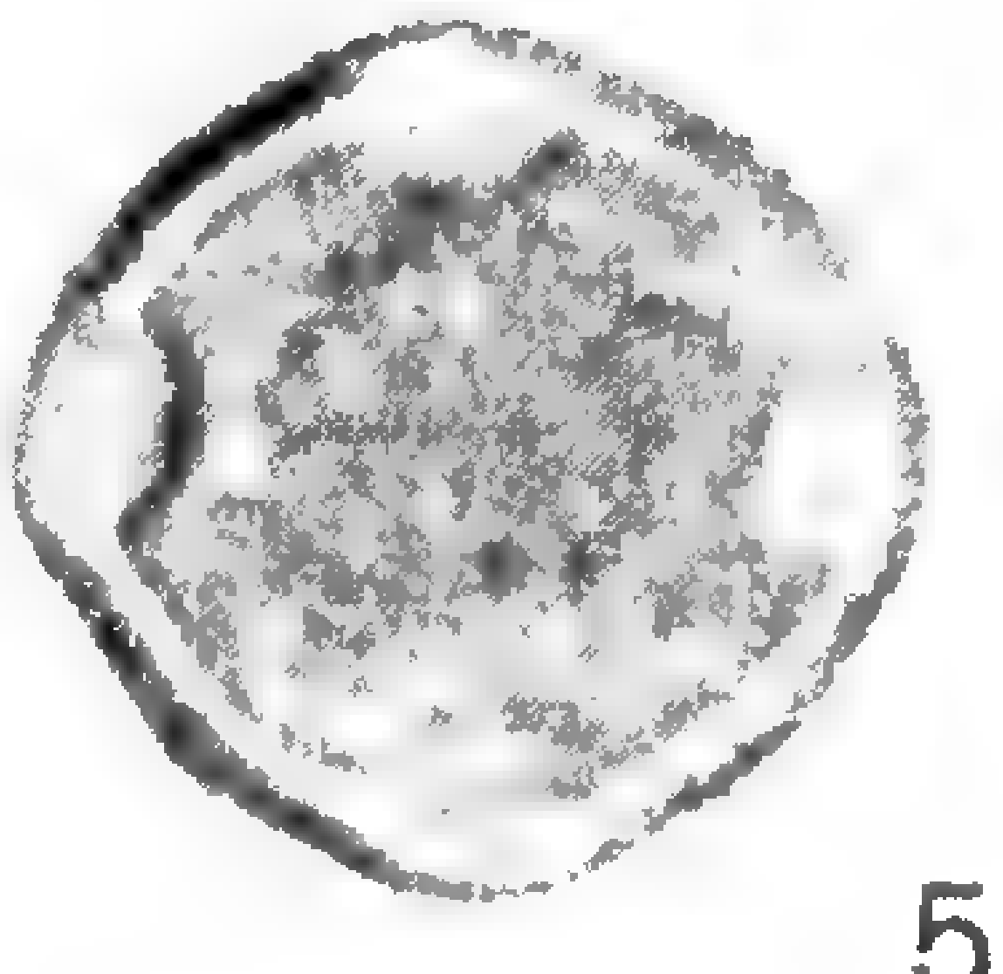
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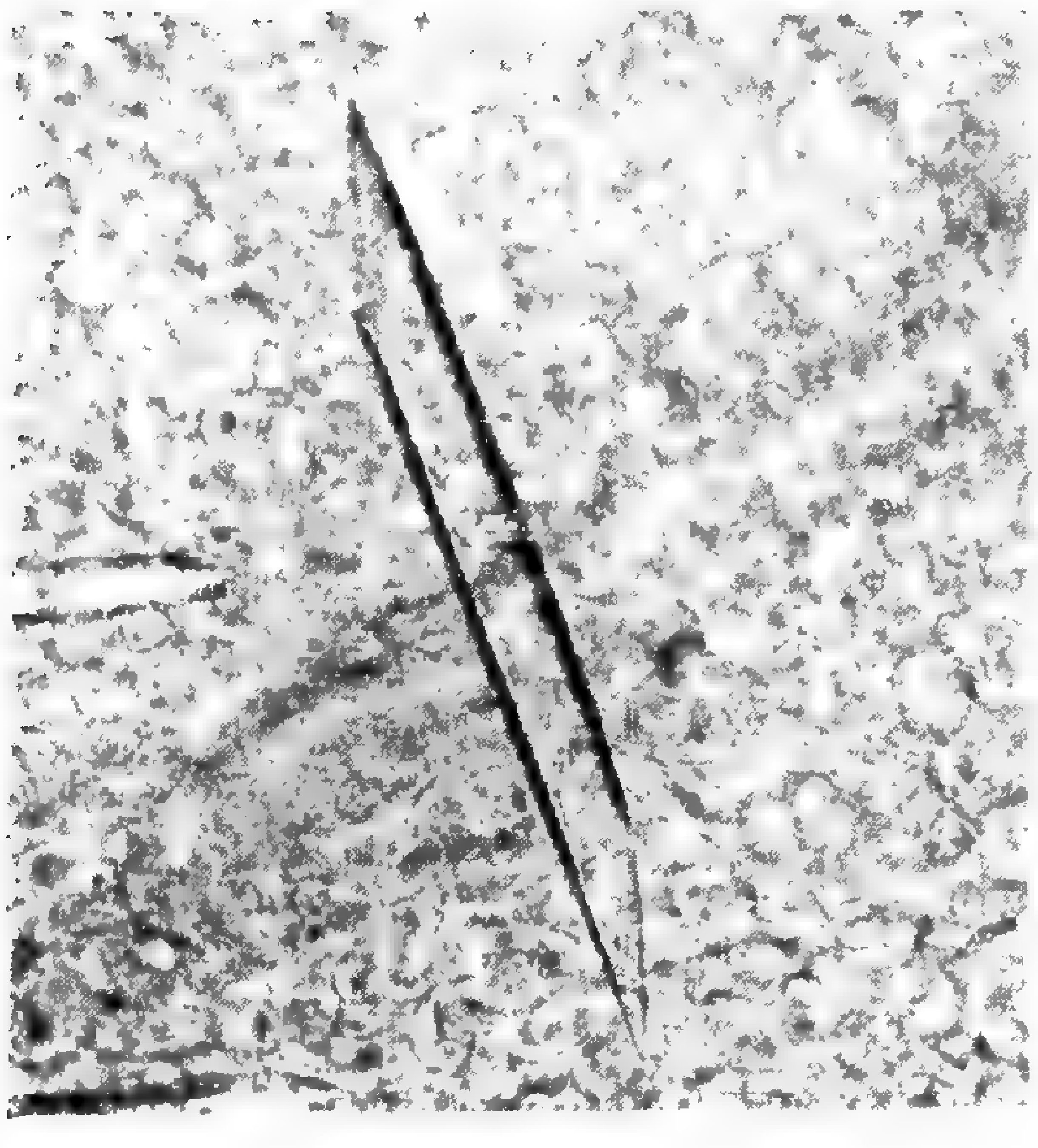
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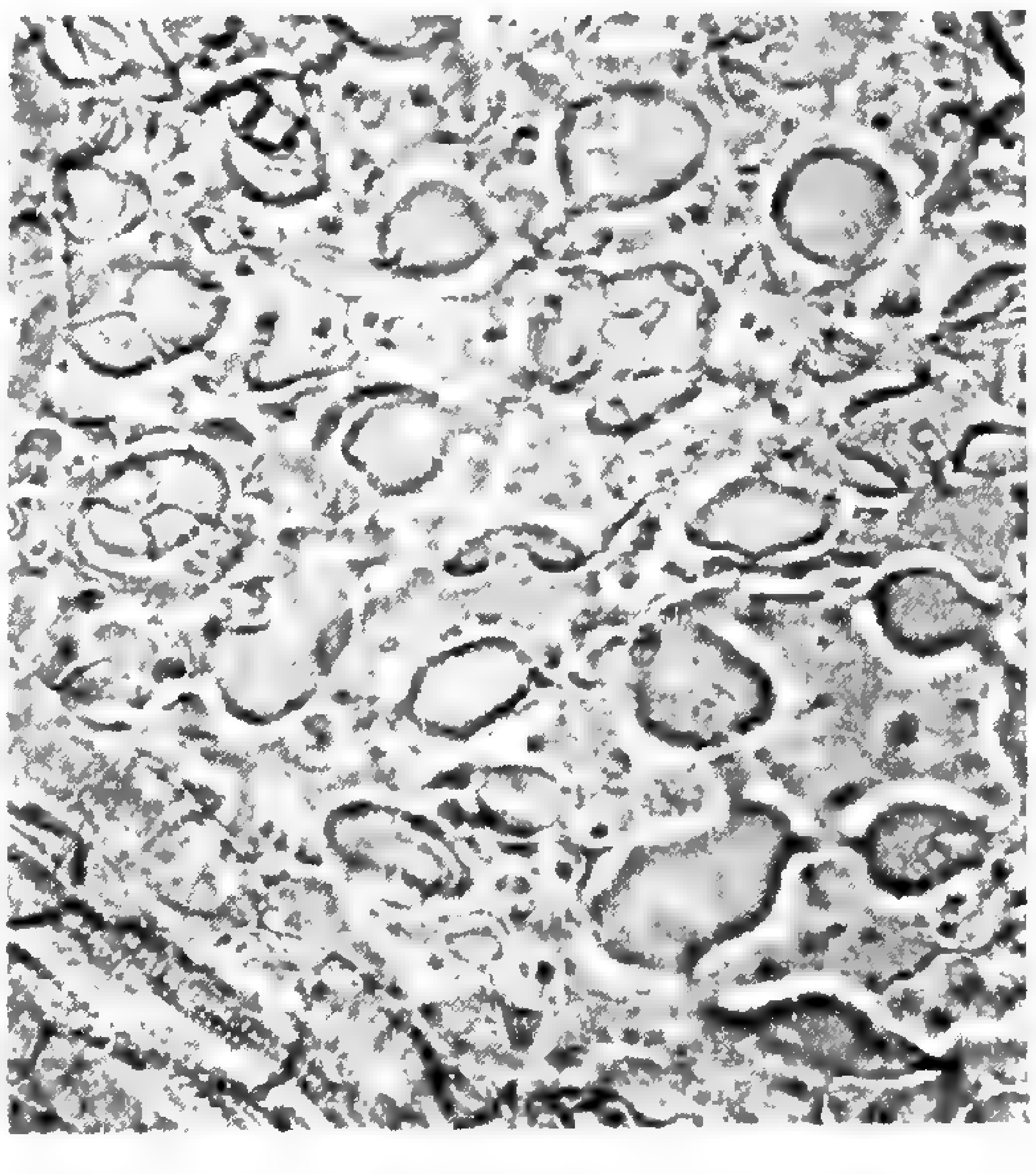
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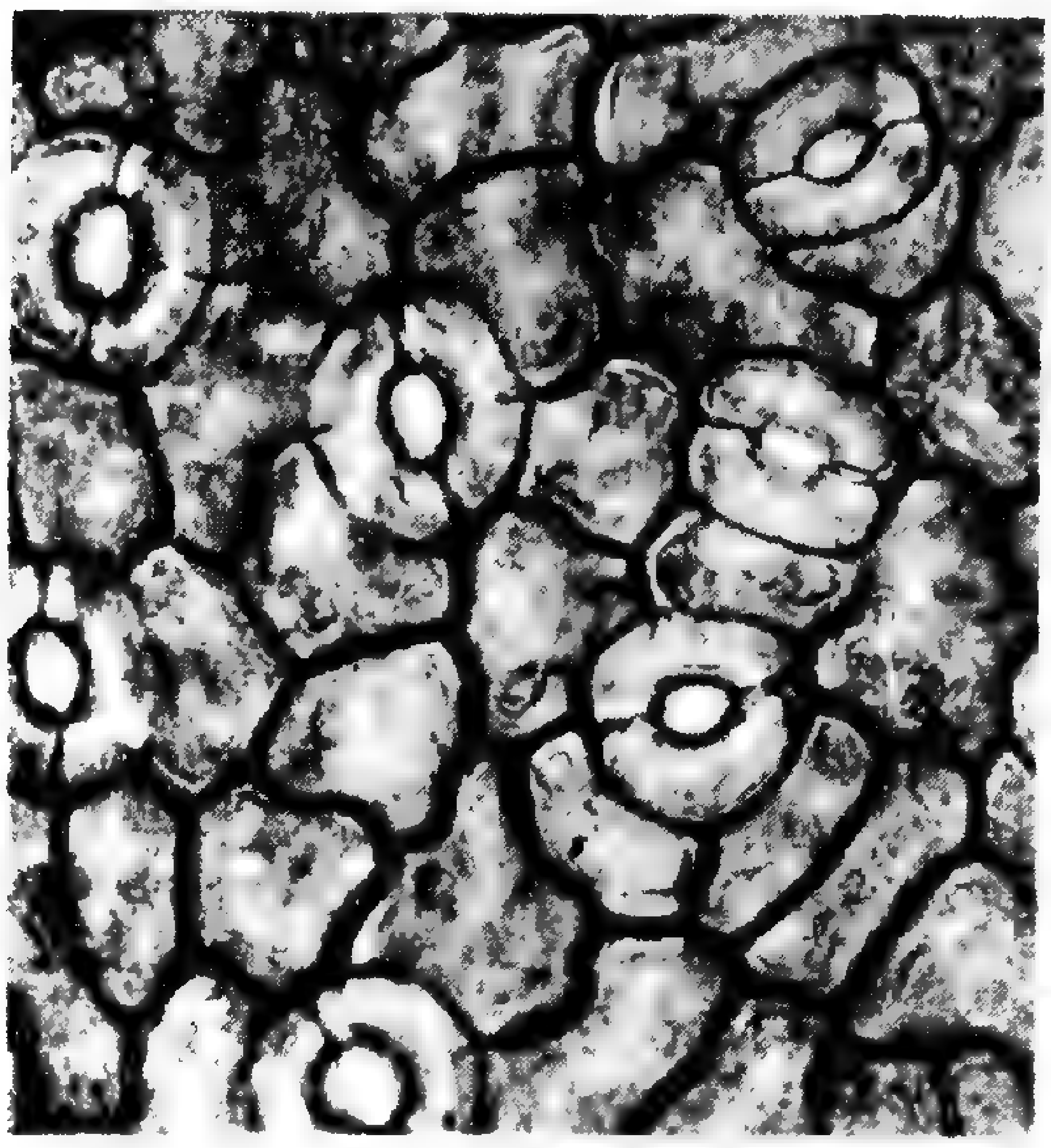
Bailey & Swamy, Idenburgia and Nouhuysia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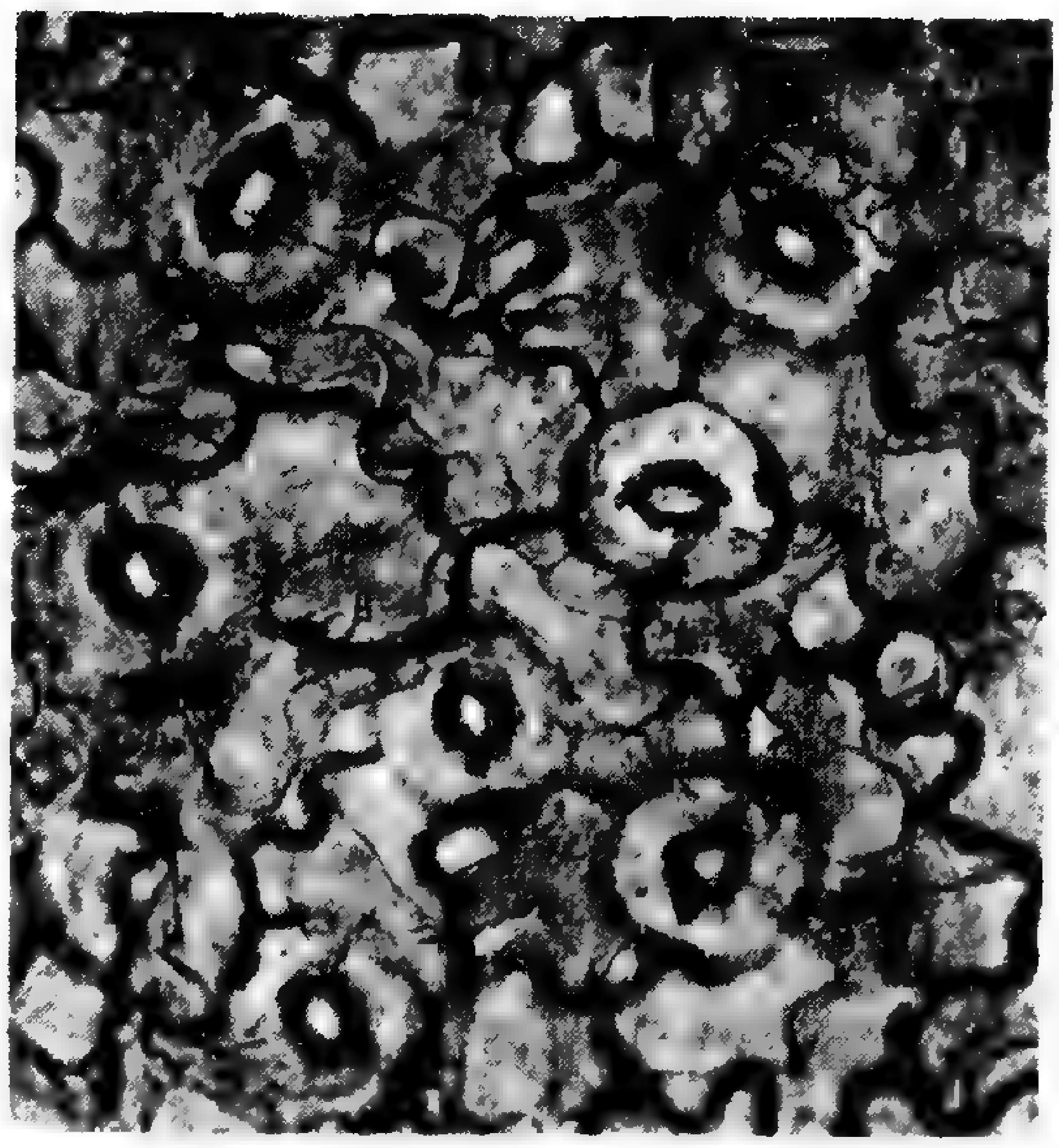
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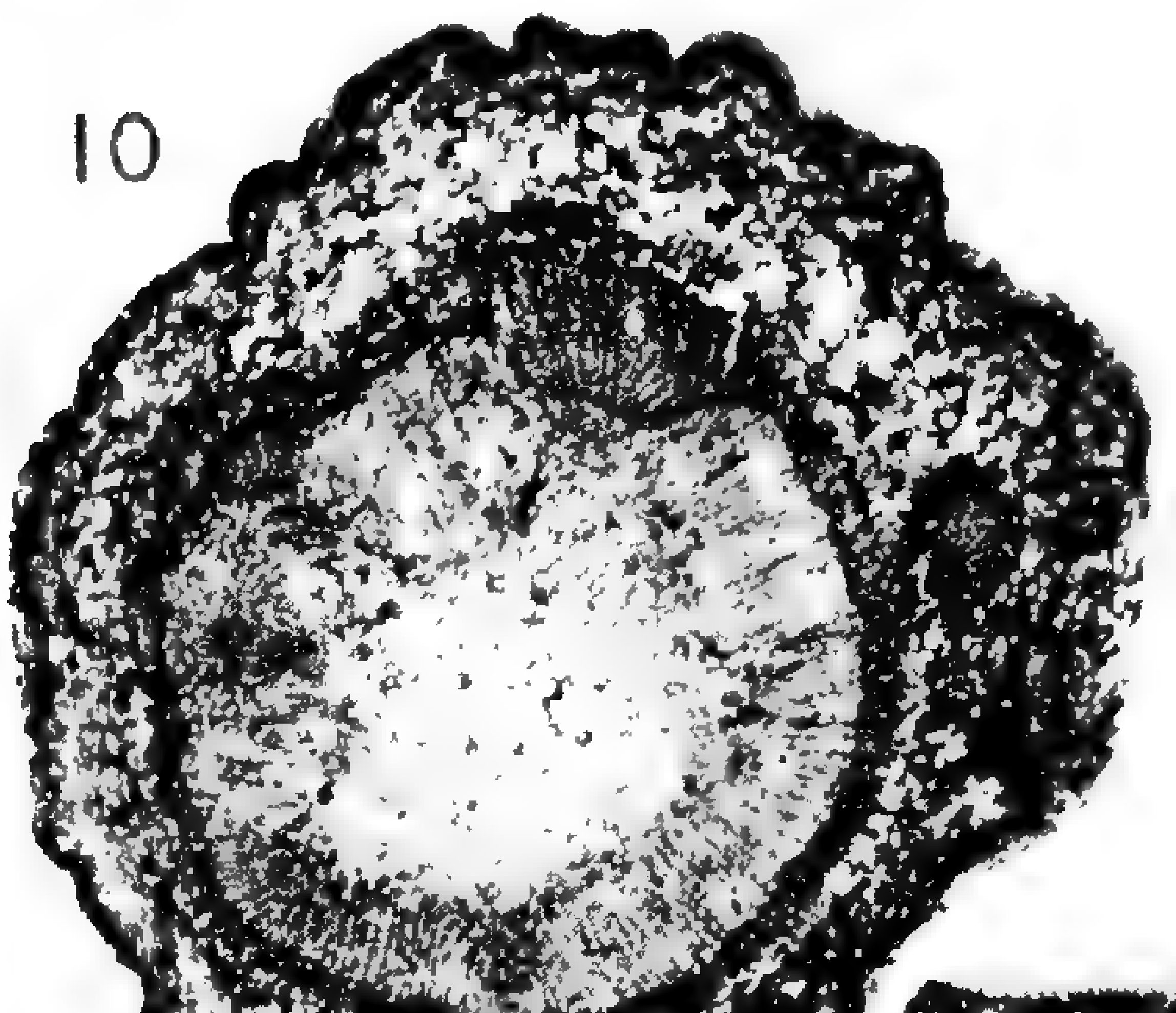

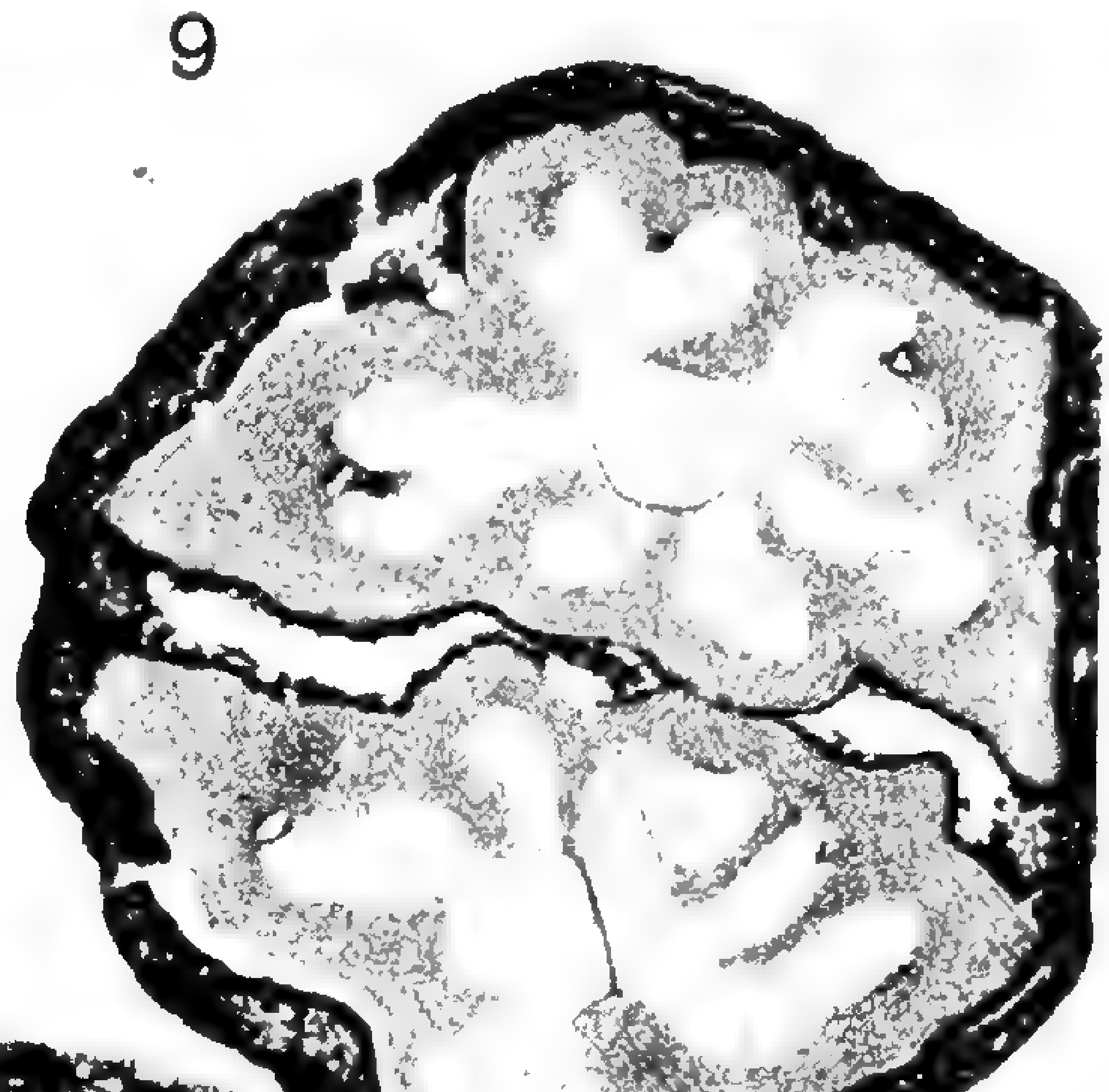
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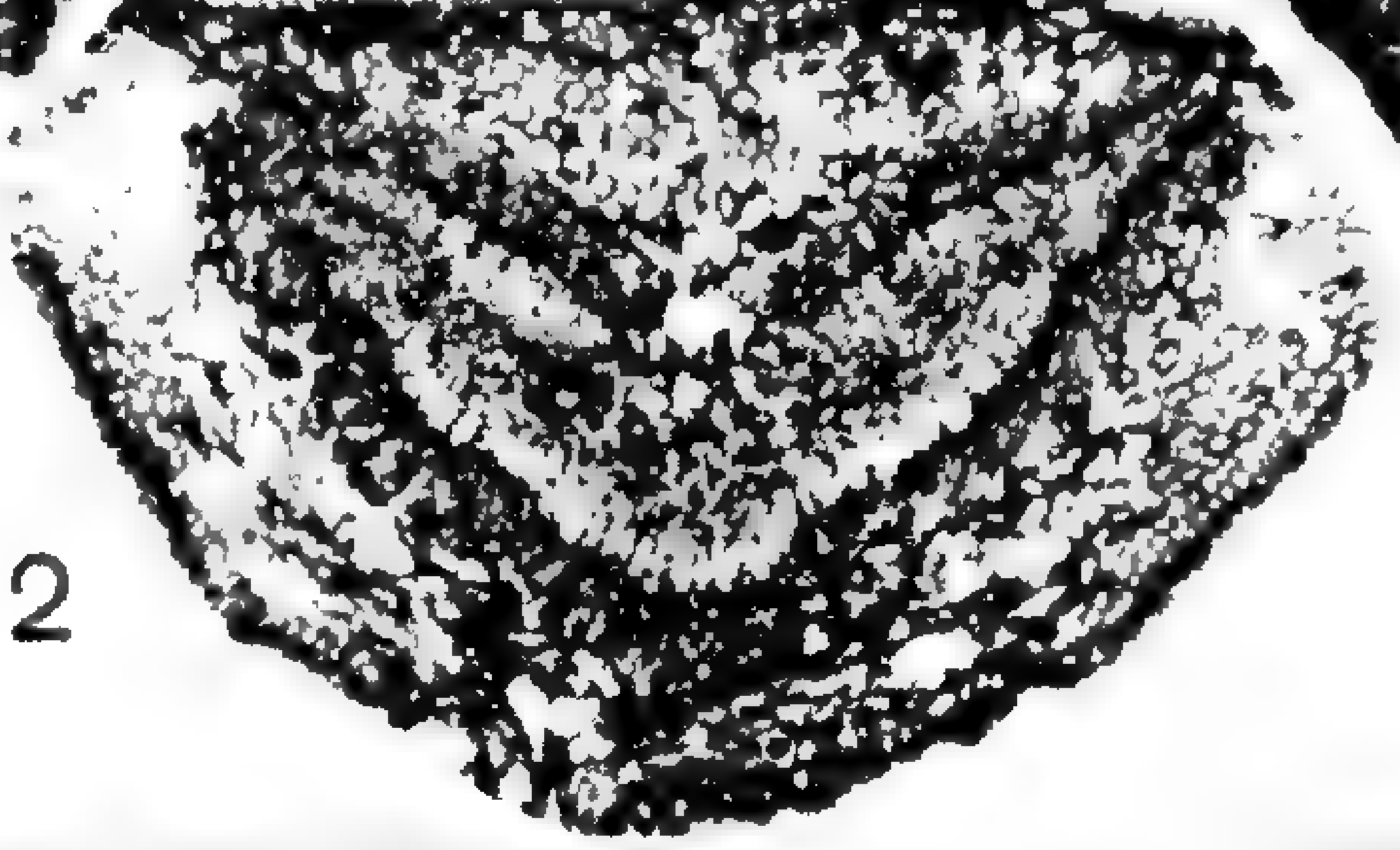

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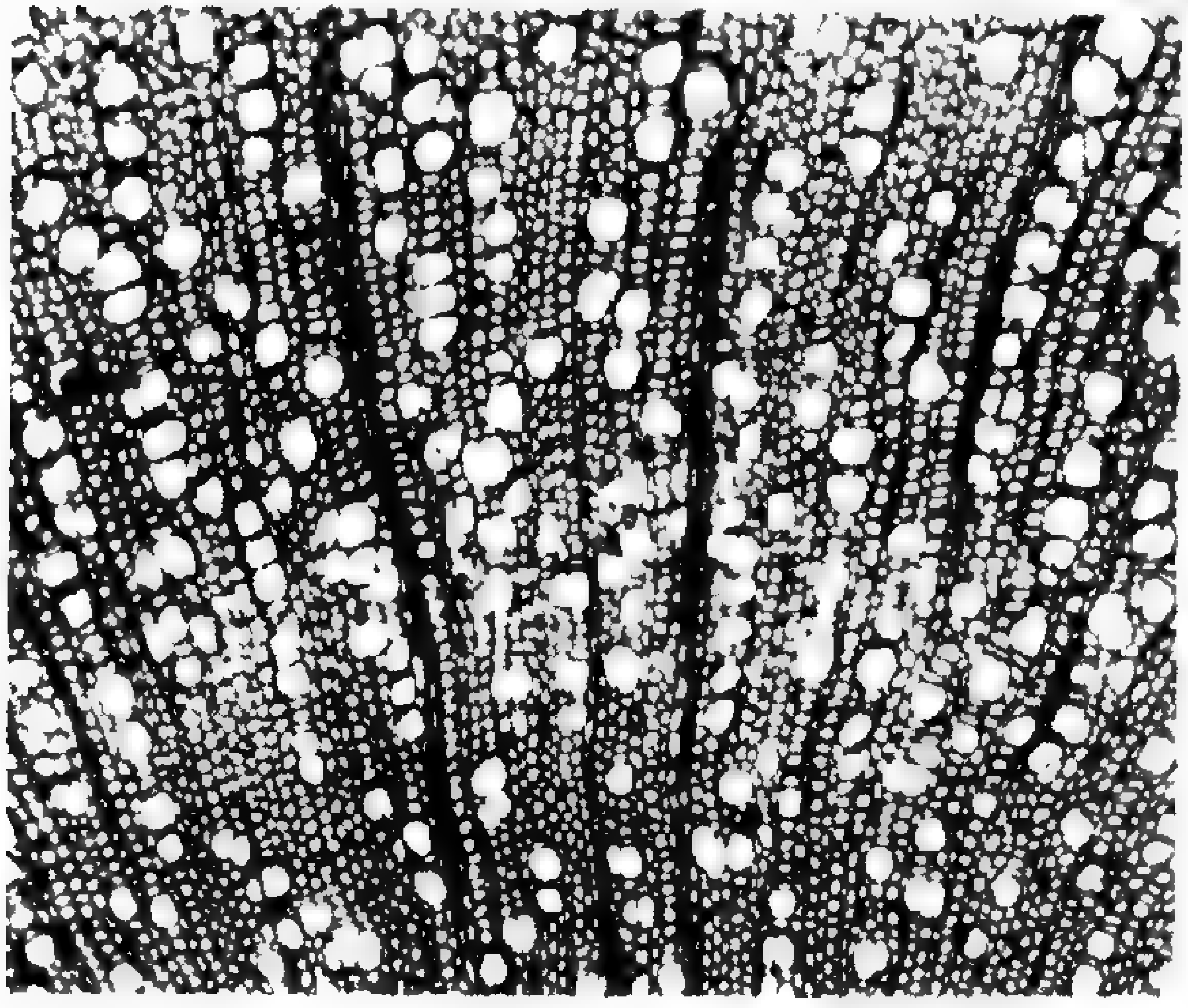

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Bailey & Swamy, Idenburgia and Nouhuysia

THE VEGETATION ON COASTAL DOGTOOTH LIMESTONE IN SOUTHERN CUBA

RICHARD A. HOWARD AND WINSLOW R. BRIGGS

With One Plate

ONE OF THE GEOLOGIC FEATURES of the southern coast of Las Villas province in Central Cuba is an uplifted bench of weathered limestone known in Cuba as diente de perro or dogtooth limestone. The name describes well the lacerated, sharp-edged, hard, metallic-ringing limestone rock (PL. I, FIG. 1). Similar formations exist in a few other spots in Cuba, on the islands off Haiti and the Dominican Republic, and near Ponce in Puerto Rico; but they appear to be found principally on the southern coasts. They are missing in the Lesser Antilles and Jamaica, and are not comparable to the limestone formations of the Bahamas. The formation is covered with a tree and shrub vegetation which has never been described adequately. Gleason and Cook (Scientific Survey of Puerto Rico and the Virgin Islands 7: 158. 1927) describe briefly a "xerophytic forest" on the Ponce limestone. Ekman (Ark. för Botanik **22A**(16) : 4. 1929) lists the components of this vegetation as found on Navassa Island. The senior author has considerable unpublished data for the vegetation of Beata Island, off Hispaniola, which is also growing on dogtooth limestone. These four areas seem comparable in aspect of the vegetation and substratum, but the floristic composition of the vegetation is different in each case. The present paper records the elements comprising the predominantly woody vegetation on the dogtooth limestone in Cuba.

Coastal exposures of dogtooth limestone are found in Las Villas province on either side of the entrance to Cienfuegos Bay. The exposures, paralleling the coast, extend east from Punta Caballos to the mouth of the San Juan river, and west from Castillo de Jagua to the edge of the Cienaga de Zapata. The flora in this area has been collected by several botanists in the past few decades. John George Jack of the Arnold Arboretum collected intensively during the late 1920's in the region discussed in this paper, but he failed to leave any significant notes on the composition of the woodland formation. Combs (Trans. Acad. Sci. St. Louis, 7: 393–491. 1897) studied the area west of Cienfuegos Bay, primarily around Castillo de Jagua, but he too failed to describe the vegetation. Ekman apparently never visited the area during his work in Cuba, and Leon and his associates have not described it.

The area selected for study is a portion of the Gavilan tract owned by the

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Central Soledad. It is west of the Rio Gavilan and east of Punta Lobos and the mouth of Cienfuegos Bay. The specific area is known locally as the Potrero Seboruco and is adjacent to the small Playa de Gavilan.

The south coast of Las Villas province in this area has an undulating shoreline. In a very few of the embayments are sandy beaches. The major portion of the shoreline consists of limestone benches slightly below, at, or slightly (1–3 feet) above sea level. The benches represent a relatively small vertical land adjustment of recent origin. When exposed they are covered with a low shrub growth, littoral in nature, consisting of *Rachicallis americana, Strumpfia maritima,* and *Conocarpus erectus.* Directly behind this coastal formation is a sharply uplifted block of limestone of Miocene age. It is the vegetation of this block that is considered in the present paper. The average uplift appears to be between 15 and 25 feet. The southern edge of the block is wave cut, with a series of erosion caverns indicating that the area, within relatively recent time, was at the sea margin. The uplifted limestone block dips slightly to the north, and ends in an open lateritic plain of reddish soil with a savannah type of vegetation.

The limestone block parallels the coast, and the region studied is approximately one-half mile wide. The formation has been cracked by subsequent land movements. Some of the larger sections are flat-topped, perfectly smooth and show little sign of weathering except at the fractures. At the coastal margins, however, sections of the block are severely cracked and show both large and small chasms, narrow and wide, extending down to sea level. One chasm (Pl. I, Fig. 2) is 150 feet long and 25 feet deep and averages 25 feet in width. In this chasm a shallow lake of brackish water has developed. The bottom of the shallow lake is of soft debris and muck, and it was impossible to walk in it.

The smaller sections of the main block, especially those at the southern edge, are severely weathered with each section rounded to the middle (Pl. I, Fig. 1). The rock is extremely hard and the results of weathering have been peculiar. A matrix of extremely sharp and hard ridges and spines has been developed (Pl. I, Fig. 1). According to Lewis (Amer. Assn. Petr. Geol. Bull. **16**: 533–555. 1932) this weathering is not due to the erosion of a softer rock from a harder matrix, as the rock is essentially homogeneous, but rather due to extremes of temperature, humidity, and rainfall, external physical conditions. Loose fragments of the rock will ring with a characteristic metallic sound when struck. Footing is treacherous on these naked sharp ridges, and the name "dogtooth limestone" for such an area is well deserved. Similar lacerated surfaces are found only on the edges of the larger fracture blocks.

The entire surface in this area can be described as naked rock. The mass is so cracked and weathered into a porous structure that only rarely have very small, cup sized pockets of soil accumulated. The leaves and branches present on the surface are dry and no humus has been formed. However inhospitable the area seems, the limestone block is covered with a shrub and tree vegetation. In most areas this vegetation is open. The trees average 35 feet in height and are unbranched for the first 15 feet. The boles are thick and massive for the heights of the trees, and are generally crooked. The crowns are symmetrical and the effects of the wind have not caused the lopsided growth expected in coastal vegetation. The shrub vegetation is approximately 12 feet in height, usually densely branched and predominantly spiny. Herbaceous vegetation is almost entirely lacking and no ferns were seen. Shade loving plants are conspicuously absent under the thin and open canopy. Epiphytes are relatively abundant but only members of the Bromeliaceae were found. Vines are few but the individual plants are usually extensive.

Root development of all plants found on the dogtooth limestone is conspicuous, perhaps because one is not accustomed to seeing the roots of tropical trees. Unless the plants are growing in or near a rock chasm the roots usually crawled along the surface to a distance greater than the radius of the crown before penetrating into cracks in the rocky substratum. The trees seem to be successful in such an area because the roots are able to penetrate to a depth where moisture is available.

In order to determine accurately the composition of this vegetation we ran a transect through the vegetation on the limestone outcrop. The senior author [1] had surveyed the region several years before in order to determine the most undisturbed locality and to learn the nature of the flora. Several survey trips were made before and after the date of the transect to ascertain the extent to which the transect was typical. It was determined that the area studied was characteristic of the vegetation occurring on the limestone, and that relatively few more species were to be expected than were seen on the transect.

The transect made was 880 yards long and 2 yards wide. Every plant within this strip, the area of which is ⅓ acre, was counted. Stem diameters of all woody species were determined at breast height.

The vegetation of the transect area consists of 74 species and 521 individual plants, excluding only the epiphytes and parasites. The detailed composition is shown in the following table:

Trees:	22 species	29.7%	of total —	231 individuals	44.3%	of total
Shrubs:	35 species	47.2%	of total —	224 individuals	42.9%	of total
Herbs:	9 species	12.1%	of total —	30 individuals	5.7%	of total
Vines:	8 species	10.8%	of total —	36 individuals	6.9%	of total
Total:	74 species	99.8%		521 individuals	99.8%	

While shrubs dominate the area from the standpoint of the number of species involved, the trees are slightly more significant from the standpoint of number of plants. The herbaceous species, vines, and epiphytes make up a relatively unimportant aspect of the vegetation on the dogtooth limestone.

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[1] The authors are grateful for the assistance of the other members of the course in Tropical Botany of Harvard University who helped on this survey. Special appreciation is acknowledged for the suggestions and help of Mr. Earl E. Smith in the recording method used. They also wish to thank the management of Central Soledad for permission to study the area.

SPECIES	LESS THAN 3″	3″	4″	5″	6″	7″	8″	9″	10″	12″	15″	16″	TOTAL
Gymnanthes lucida	31	18	9	2									60
Cordia Gerascanthus	32	7		1									40
Leucaena glauca	26	1	3	1	1								32
Hebestigma cubensis	10	1	4	1	4	1	2	1		2			26
Celtis trinervia	6			3	1								10
Pseudocarpidium Wrightii	5		2					1	1				9
Adelia ricinella	7		1										8
Tabebuia pterophila	5	1		1									7
Torrubia discolor	1	2	1							1	1	1	7
Exostema caribaeum	3				1	1							5
Capparis cynaphallophora	4		1										5
Colubrina reclinata	3		1		1								5
Vitex divaricata	1		1			1							3
Bursera simaruba	1								1				2
Luhea speciosa						1							1
Hypelate trifoliata									1				1
Securinega Acidoton				1									1
Rondeletia pedicellaris		1											1

THE SIGNIFICANT COMPONENTS OF THE VEGETATION ON DOGTOOTH LIMESTONE IN CUBA LISTED BY DIAMETERS OF THE BOLES AND FREQUENCY OF OCCURRENCE.

The trees were tabulated for their frequency and size. All trees with a trunk diameter of less than three inches were considered together. Any plant with an unbranched bole of ten feet was considered to be a tree possessing a potentially useful log. *Casearia sylvestris*, represented by three specimens, and *Forestiera laevigatus* by one specimen, have the necessary length of trunk but none of the specimens exceed three inches in diameter at breast height. One large specimen of *Ficus laevigatus* defied classification in possessing multiple trunks, several of which were eight inches in diameter. A lone specimen of *Ceiba pentandra* towers over the rest of the trees on this limestone and has a trunk diameter of 36 inches; however, the wood of the *Ceiba* is considered worthless. The remaining 18 arboreal species are listed in the following table, in order of their frequency of occurrence. All size figures represent diameters at breast height.

It can be seen from the table that *Hebestigma cubensis* and *Torrubia discolor* are the only potential timber trees in the transect. *Gymnanthes lucida, Cordia Gerascanthus,* and *Leucaena glauca* appear to be the only trees seeding themselves, as indicated in the number of saplings encountered. None of the species in the above list is currently considered valuable as a timber tree.

The shrubs of the transect have trunks less than six feet long to the first branch, or are characteristically bushy in appearance. They comprise the following species. The number of individuals counted in the transect follows each species.

Erythroxylum areolatum	72	*Lantana reticulata*	4
Argythamnia candicans	28	*Leucocroton microphylla*	3
Pithecellobium Hysterix	15	*Capparis flexuosa*	3
Cordia globosa	14	*Schaefferia frutescens*	3
Croton lucidus	14	*Malpighia cubensis*	3
Hyperbaena racemosa	13	*Guettarda elliptica*	3
Acacia farnesiana	10	*Erythroxylum rotundifolium*	3
Duranta repens	7	*Plumiera obtusa*	3
Capparis Grisebachii	5	*Randia spinifex*	2
Boerreria succulenta	4		

Single specimens of the following species were found: *Citharexylum spinosum, Amyris elemifera, Boerreria virgata, Caesalpinia glaucophylla. Phyllanthus neopeltandrus, Guettarda Combsii, Bumelia glomerata, Guaiacum sanctum, Savia sessiliflora, Comocladia dentata, Guettarda calyptrata, Anthacanthus tetrastichus, Pluchea odorata, Rhacoma Crossopetalum. Celtis iguanaea,* and *Morinda Royoc.*

Erythroxylum areolatum dominates the shrubs in the transect area. The plants of this species average eight feet in height and fruit heavily. They usually occur in groups. It is probable that birds are responsible for the dispersal of the red-colored fruits. *Argythamnia candicans*, generally a 3–4′ woody shrub, is represented by hundreds of seedlings. The fruits of this member of the Euphorbiaceae are elastically dehiscent. *Argythamnia* is the only plant that appears to be spreading rapidly. *Comocladia dentata* is more abundant outside of the transect area, particularly in the inland lateritic soil zone. *Celtis iguanaea* is represented by one shrub, rooted far down in one of the larger chasms and climbing on the limestone rocks before scrambling into the tree tops. Some of the branches of this plant are 2″ in diameter and reach a length of 25 feet.

The herbaceous plants and cacti are represented by nine species. *Hibiscus pilosus* is most abundant with individuals counted. *Setaria distantiflorum*, represented by three individuals in the transect area, is growing on very small pockets of soil in the dogtooth limestone. *Ayenia pulsilla*, *Acalypha chamaedrifolia* and *Portulaca pilosa* are all on the limestone, but only single individuals were seen. Sterile plants of *Harrisia*, *Selenicereus*, and *Cephalocereus* were found. *Opuntia Dillenii* is represented by one flowering and fruiting plant which forms an extensive sprawling mass.

Of the eight species of vines in the transect area *Stigmaphyllon Sagraeanum* is the most abundant with fifteen individuals counted. *Serjania subdentata* was found nine times, and *Triopteris rigida* and *Passiflora suberosa* four times for each. Two extensive plants of *Acacia tenuifolia*, a viciously spiny species were found, and single specimens of *Urechites lutea*, *Gouania polygama* and *Tournefortia peruviana*.

One parasite, *Phthirusa purpurea* was found growing on *Tabebuia pterophila*. Three species of *Tillandsia* were the only epiphytes seen. These plants are numerous and were not considered in the transect count. *Tillandsia fasciculata* is the most abundant, while *T. flexuosa* and *T. tenuifolia* are infrequent.

In an area such as the dogtooth limestone, where soil cover is lacking, moisture penetration is high, the canopy thin, and the temperature high, evaporation and transpiration are assumed to be critical factors in the environment. Various morphological specializations are expected in plants capable of living in such an environment. These specializations are generally expressed in reduced total leaf surface, microphyllous leaves which are usually associated with the presence of spines, thick cuticles, and ilicioid leaves. If the leaves are large, they usually have soft laminal tissues and are apt to wilt and droop easily. Of the species found in this area, five of the trees, five of the shrubs, and one of the vines possess microphylls. Such leaves are generally of hard thick tissues. Spines, either modified branches or of stipular origin, are found in one of the trees, seven of the shrubs and one of the vines. Ilicioid leaves occur in one species of the trees and one of the shrubs. The wilting habit was especially obvious. On the hot sunny day when the transect was made nearly 50% of the broad leafed species appeared to be in a wilting condition.

Exact rainfall data for this specific area are not available. The site is to the west of the normal path of rain storms from the Trinidad-San Juan mountains. The rainfall is probably in the range of 30–35 inches, which is commonly regarded as insufficient, in the Caribbean area, to support other than a thorn-shrub type of woodland. The lack of surface accumulation of soil and moisture may account for the lack of herbaceous plants and the deep penetration of the roots of the shrubs and trees.

It is probable that the woody vegetation found on the dogtooth limestone is a fairly stable type for this habitat under existing environmental conditions. While the sea side cliff development indicates former proximity to the Caribbean Sea there is, at present, no indication of the littoral or halophyte shrub vegetation characteristic of the low limestone coastal formations in Cuba.

The current vegetation of the area meets the description of a thorn woodland proposed by Beard (Ecology **25**: 140. 1944) but does not fit into any of the fascies he suggested. In general aspect it agrees with the descriptions published by Ekman for the dogtooth limestone areas of Navassa Island, and by Gleason and Cook for the Ponce limestone. In floristic composition and species dominance, however, it is quite different. Ekman described the forests of the dogtooth limestone of Navassa Island as "low, the trees are stunted, though often with thick trunks. Characteristic of Navassa is the small number of species involved. Only four species of trees could be labelled as common, to wit, *Ficus populnea*, *Sideroxylon foetidissimum*, *Coccoloba laurifolia*, and *Metopium Brownei.* Scatter occur: *Pseudophoenix navassana*, *Bumelia navassana*, while *Fagara martinicensis* and *Colubrina feruginosa* are rare. Shrubs are few, e.g. *Pisonia discolor* var., *Schoepfia obovata*, and *Duranta erecta*, while vines and epiphytes are nearly absent." (Ark. för Botanik, **22A** (16): 4. 1929).

Gleason and Cook (Sci. Surv. Puerto Rico and Virgin Is. **7**: 158. 1927) report the composition of the "xerophytic forest" on the Ponce limestone as follows: "Trees, *Bursera simaruba*, the commonest trees, *Bucida buceras*, *Ficus laevigatus*, *Amyris elemifera, Capparis cynophallophora*, and *Pisonia albida.* Rare or scattered trees of *Guaiacum officinale* and *Tabebuia heterophylla.* The shrub layer comprises a large number of species of which *Lantana involucrata*, *Coccolobis laurifolia*, *Helicteres jamaicensis* seem to be the most abundant. Other common species are *Moluchia tomentosa*, *Croton rigidus*, *Croton lucidus*, *Exostema caribaeum*, *Varronia angustifolia*, *Savia sessiliflora*, *Pithecellobium Unguis-cati*, *Ricinella Ricinella*, *Eugenia ligustrina*, *Eugenia buxifolia*, *Schaefferia frutescens*, *Hypelate trifoliata*, *Reynosia uncinata*, *Samyda dodecandra*, *Citharexylum fruticosum*, *Plumeria alba*, *Adelia Bernardia*, *Krugiodendron ferreum*, *Elaeodendrum xylocarpum*, *Comocladia Dodonea*, *Canella Winteriana*, *Jacquinia Berterii* and *Tournefortia microphylla*."

A comparison of the list of plants found on the Las Villas dogtooth limestone to those listed above by Ekman and by Gleason and Cook emphasizes the similarity of aspect among the dogtooth limestone floras as well as the differences in species and dominants comprising them.

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EXPLANATION OF PLATE

FIG. 1. The face of one of the smaller chasms in the Gavilan dogtooth limestone showing the many cracks and the eroded surface with sharp projections.

FIG. 2. A larger chasm in the limestone block showing a shallow brackish lake.

Plate I

1

2

Howard & Briggs, Vegetation on Dogtooth Limestone

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STUDIES OF PACIFIC ISLAND PLANTS, XVI
NOTES ON FIJIAN RUBIACEAE [1]

A. C. SMITH

THE PRESENT PAPER is intended primarily to place on record the apparently undescribed species of Fijian Rubiaceae collected by the writer in 1947.[2] Twenty species are here described as new, in the genera *Gardenia, Ixora,* and *Psychotria*. No effort is here made toward a revision of the family on a local scale, but field observation inclines me to believe that such a revision will not prove difficult. When all the Fijian types are brought together for comparison with the abundant material now available, it should be possible to delimit and correlate the local species with accuracy. In spite of the fact that it is the largest family of phanerogams in Fiji, the Rubiaceae does not present insurmountable taxonomic problems. Differences of opinion as to the rank of categories may remain for some time, but the taxa appear in general to be well delimited.

The place of deposit of specimens is indicated by: A (Arnold Arboretum), US (U. S. National Museum).

HEDYOTIS L.

Hedyotis tenuifolia Sm. in Rees, Cycl. 17: no. 19. 1811.

Oldenlandia tenuifolia sensu Forst. f. Fl. Ins. Austr. Prodr. 11. 1786; non Burm. Fl. Ind. 37. *pl. 14, fig. 1.* 1768.

VANUA LEVU: Mathuata: Seanggangga Plateau, in drainage of Korovuli River, vicinity of Natua, alt. 100–200 m., *Smith 6886* (A, US) (on edge of pond in open rolling country; corolla white).

I am indebted to Dr. F. R. Fosberg for pointing out the identity of this interesting little plant, which, in my observation, is rare in Fiji; at least

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[1] No. XV of this series was published as vol. 30, part 5 (pages 523–573), of Contributions from the U. S. National Herbarium, 1953.

[2] Under the auspices of the Arnold Arboretum of Harvard University and the John Simon Guggenheim Memorial Foundation, with the aid of grants from the Penrose Fund of the American Philosophical Society and the Bache Fund of the National Academy of Sciences.

I have seen it only in the cited locality. However, Seemann noted the species as "Common on roadsides throughout Viti."

Smith's binomial of 1811 is based upon Forster's interpretation of *Oldenlandia tenuifolia* Burm. and his concept is based entirely upon Forster's specimen from Tanna, in the New Hebrides. *Oldenlandia tenuifolia* Burm. is said by Smith to be a very different plant, which he refers to *Hedyotis herbacea.* Of course, by modern nomenclatural practice, Smith could not have based his binomial upon Forster's interpretation of an earlier name to the exclusion of the actual type of that concept, and therefore Forster cannot be cited as the parenthetical author. However, there is no obstacle to the acceptance of Smith's *Hedyotis tenuifolia* as a new species, dating from 1811 and based entirely upon Forster's Tanna specimen. Previous mention of the occurrence of the species (as *Oldenlandia tenuifolia* Forst. non Burm.) in the New Hebrides and Fiji is to be found also in the following works: DC. Prodr. **4**: 425. 1830; Seem. Fl. Vit. 126. 1866; Drake, Ill. Fl. Ins. Pac. 186. 1886; Guillaumin in Bull. Soc. Bot. Fr. **74**: 698. 1927.

GARDENIA Ellis

Gardenia candida sp. nov.

Arbor ad 7 m. alta, ramulis gracilibus, inferne subteretibus cinereis glabris, internodiis distalibus leviter angulatis 2–3 mm. diametro pilis pallidis 0.1–0.3 mm. longis puberulis; stipulis longe persistentibus in tubum 9–11 mm. longum pilis ad 0.5 mm. longis puberulum vel setulosum apice undulatum connatis; petiolis liberis semiteretibus superne leviter canaliculatis 2.5–3.5 cm. longis ut ramulis juvenilibus puberulis; foliorum laminis chartaceis in sicco viridibus, ellipticis, (12–) 15–20 cm. longis, (5–) 6–9 cm. latis, basi acutis et in petiolum decurrentibus, in acuminem obtusum ad 1 cm. longum apice cuspidatis, margine integris, supra costa nervisque secundariis plus minusve puberulis exceptis glabris, subtus pilis patentibus pallidis 0.2–0.4 mm. longis uniformiter et persistenter puberulis, costa valida supra elevata subtus prominente, nervis secundariis utrinsecus 15–17 patentibus marginem versus curvatis et interconnexis utrinque elevatis, nervis tertiariis numerosis inter secundarios transversis et rete venularum utrinque prominulis; floribus magnis in axillis distalibus solitariis, pedicello crasso subtereti sub anthesi 1–1.5 cm. longo cum calyce pilis pallidis 0.3–0.7 mm. longis copiose patenti-piloso; calyce infundibulari sub anthesi lobis inclusis 3.5–4 mm. longo et apicem versus circiter 2.5 mm. diametro, tubo parvo obconico, limbo chartaceo vel subcoriaceo elongato dorso 4-alato, alis semiobovatis circiter 2.5 cm. longis et 1 cm. latis conspicue nervatis apice rotundatis apicem limbi ipsi scariosum et undulatum 5–10 mm. excedentibus; corolla in vivo subcarnosa hypocrateriformi, tubo 4.5–5 cm. longo et basi circiter 4 mm. diametro faucibus ad 1 cm. ampliato, extus glabro vel obscure puberulo, intus ad lineas staminibus alternatas pilis debilibus adscendentibus 1–2 mm. longis copiose piloso, limbo patenti sub anthesi rotato 9–11 cm. diametro ad basim 8-lobato, lobis late imbricatis oblongis ad 5 cm. longis et 2–2.5 cm. latis apice rotundatis; staminibus 8, antheris sessilibus anguste oblongis circiter 17 mm. longis et 1.5 mm. latis, dorso complanatis, a tubo corollae leviter exsertis; stylo crasso clavato quam tubo corollae paullo breviore demum in stigmata 4 circiter 1 cm. longa dorso minute strigillosos fisso.

VANUA LEVU: Mathuata: Seanggangga Plateau, in drainage of Korovuli River, vicinity of Natua, alt. 100–200 m., Nov. 25, 1947, *Smith 6640* (A TYPE, US) (*ndrenga*; tree 7 m. high, in patches of forest in open rolling country; corolla-lobes pure white, the tube greenish).

Species of *Gardenia* are among the more obvious components of the flora of the Mathuata coast of Vanua Levu. Their abundance in the patches of forest that occur here and there in this comparatively dry region, together with the pervasive fragrance of their flowers, imparts a characteristic charm to the landscape. Species known to occur in Mathuata are *G. vitiensis* Seem., *G. gordonii* Baker, *G. grievei* Horne ex Baker, and *G. hillii* Horne ex Baker. The species here described cannot be confused with any of these nor with the several others known from Viti Levu. Superficially *G. candida* is most like *G. gordonii*, but it differs in the indument of its leaves, pedicels, and calyx, and in its even larger flowers.

MASTIXIODENDRON Melchior

Mastixiodendron pilosum A. C. Sm. in Jour. Arnold Arb. **26**: 109. 1945.

VANUA LEVU: Mathuata: Southern base of Mathuata Range, north of Natua, alt. 100–250 m., *Smith 6781* (A, US) (slender tree 8 m. high, in dense forest; mature fruit dull yellow).

The third known collection of the species agrees very well with the two earlier ones, which are similarly in fruiting condition. Previously the species has been known with certainty only from the province of Mbua, Vanua Levu.

IXORA L.

Ixora pedionoma sp. nov.

Arbor ad 2 m. alta, ramulis gracilibus apices versus complanatis 1–1.5 mm. diametro pilis 0.1–0.3 mm. longis patenti-puberulis, vetustioribus subteretibus cinereis glabratis, internodiis 5–10 mm. longis; stipulis liberis e basi late ovato aristatis 4–5 mm. longis ut ramulis puberulis; foliis glabris subsessilibus, petiolis canaliculatis 1–3 mm. longis, laminis chartaceis siccitate olivaceis lanceolatis, 4–9 cm. longis, 1–2 cm. latis, basi attenuatis et in petiolum decurrentibus, apice in mucronem callosum 0.5–1 mm. longum angustatis, margine integris leviter incrassatis, utrinque levibus, costa supra valde elevata subtus prominente, nervis secundariis utrinsecus 8–12 subadscendentibus utrinque prominulis vel supra planis, rete venularum immerso vel subtus prominulo; inflorescentiis in ramulis brevibus terminalibus 3-floris, basi bracteis binis foliaceis subtentis, bracteis papyraceis ovatis, (15–) 18–25 mm. longis, (10–) 12–15 mm. latis, basi sub-cordatis, apice cuspidatis, reticulato-nervatis; pedicellis teretibus 1–1.5 mm. longis ut calyce copiose pallido-puberulis; calyce sub anthesi circiter 3 mm. longo, limbo erecto, lobis 4 deltoideis obtusis haud 0.5 mm. longis; corolla hypocrateriformi glabra, tubo gracillimo (haud 1 mm. diametro) circiter 25 mm. longo, lobis 4 patentibus oblongis subacutis 8–8.5 mm. longis circiter 3 mm. latis; staminibus exsertis glabris, filamentis ligulatis 1–1.5 mm. longis, antheris anguste oblongis 4–5 mm. longis; stylo gracillimo exserto parte inclusa puberulo, stigmatibus complanatis circiter 2 mm. longis; fructibus ellipsoideis ad 5 mm. diametro persistenter puberulis calycis limbo coronatis.

VANUA LEVU: Mathuata: Seanggangga Plateau, in drainage of Korovuli River, vicinity of Natua, alt. 100–200 m., Nov. 28, 1947, *Smith 6703* (A TYPE, US) (shrub 1–2 m. high, along river in patches of forest in open rolling country; corolla and style white).

The new species (of § *Phylleilema*) is a very close relative of *I. nandarivatensis* Gillespie, in comparison with which it has its branchlets distally and its shorter stipules puberulent, its leaves comparatively short-petioled, proportionately narrower, and smooth rather than bullate in texture, its inflorescence-bracts larger, and its corolla with a very slender, longer tube and larger lobes.

Ixora decora sp. nov.

Arbor ad 4 m. alta, ramulis apices versus gracilibus 1.5–3 mm. diametro complanatis parce puberulis mox glabratis, vetustioribus teretibus cinereis, internodiis plerumque 2–5 cm. longis; stipulis glabris vel minute puberulis in tubum brevem subcoriaceum circiter 2 mm. longum biaristatum (aristis circiter 2 mm. longis) caducum connatis, basi intus pilis circiter 0.7 mm. longis ornatis; foliis glabris, petiolis gracilibus canaliculatis 8–16 mm. longis, laminis rigide chartaceis in sicco fusco-olivaceis, oblongo-lanceolatis, (6–) 9–13 cm. longis, (2–) 2.5–4 cm. latis, basi acutis vel attenuatis et in petiolum decurrentibus, apice rotundatis vel obtusis vel obtuse cuspidatis apice ipso obscure calloso-mucronulato, margine integris, costa supra impressa vel in sulcula elevata subtus prominente, nervis secundariis utrinsecus 12–14 patentibus marginem versus anastomosantibus supra subplanis subtus prominulis, rete venularum plerumque immerso; inflorescentiis terminalibus trichotome corymbosis multifloris ad 9 cm. longis et 13 cm. diametro, radiorum pedunculis gracilibus glabris ad 5 cm. longis, ramulis infimis subtrichotomis haud articulatis minute et sparse puberulis, bracteolis paucis inconspicuis subulatis ad 1 mm. longis; pedicellis sub fructu 0.5–3 mm. longis, bracteolis basi ovarii insertis minutis 0.2–0.3 mm. longis; calyce ovario incluso cupuliformi minute puberulo paullo post anthesin 1–1.5 mm. longo, limbo minuto, lobis 4 rotundatis haud 0.2 mm. longis; corolla in alabastro 4-lobata lobis extus minute puberulis; fructibus globosis in sicco rugulosis glabris ad 7 mm. diametro, calycis limbo minuto coronatis.

VANUA LEVU: Mathuata: Southern slopes of Mt. Numbuiloa, east of Lambasa, alt. 100–350 m., Oct. 27, 1947, *Smith 6376* (A TYPE, US) (tree 4 m. high, in open forest; fruit red).

The new species (§ *Pavettopsis*) is of the general relationship of *I. elegans* Gillespie, having a similar type of inflorescence, stipule, etc. However, it differs from *I. elegans* in its shorter stipules, its oblong-lanceolate leaf-blades that are proportionately narrower and rounded or obtuse at apex (the apices in *I. elegans* being gradually narrowed and predominantly acute), and the very obscure indument of its inflorescences. Another species of this relationship, *I. tubiflora* A. C. Sm., differs from *I. decora* in its more conspicuously aristate stipules, as well as in foliage characters and in its glabrous calyx with comparatively conspicuous lobes.

Ixora myrsinoides sp. nov.

Arbor ad 8 m. alta, ramulis teretibus cinereis glabris apicem versus circiter 2 mm. diametro interdum in internodiis distalibus inconspicue complanatis; stipulis subcoriaceis glabris circiter 5 mm. longis e basi late ovata aristatis, basi lateraliter haud connatis, arista dorsali 2–3 mm. longa; foliis glabris, petiolis gracilibus canaliculatis 1.3–2.3 cm. longis, laminis chartaceis in sicco olivaceis oblongo-ellipticis, (10–) 12–16 cm. longis, (5–) 6–8 cm. latis, basi obtusis sed subito angustatis et in petiolum manifeste decurrentibus, apice acutis et calloso-mucronulatis, margine integris et leviter recurvatis, costa supra paullo impressa subtus prominente, nervis secundariis utrinsecus 8–12 patentibus leviter curvatis marginem versus anastomosantibus supra subplanis subtus elevatis, rete venularum utrinque manifeste prominulo; inflorescentiis terminalibus subsessilibus trichotome corymbosis sub anthesi floribus inclusis ad 5.5 cm. longis et 9 cm. diametro, pedunculo 2–3 mm. longo, bracteis primariis oblongo-lanceolatis vel obovatis 7–15 mm. longis, radiorum pedunculis ad 1.5 cm. longis et ramulis infimis subtrichotomis glabris, bracteolis ad 2 mm. longis infimis subulatis minoribus; pedicellis sub anthesi 2–4 mm. longis vel subnullis, bracteolis basi ovarii insertis 0.3–1 mm. longis; calyce ovario incluso anguste cupuliformi sub anthesi 3.5–4 mm. longo obscurissime puberulo, limbo erecto lobis 4 oblongo-deltoideis obtusis 0.7–0.9 mm. longis inclusis 1.5 mm. longo intus minute strigilloso; corolla subcarnosa glabra hypocrateriformi, tubo circiter 15 mm. longo et basi 1.3 mm. diametro superne paullo ampliato, lobis 4 patentibus oblongis obtusis circiter 9 mm. longis et 4 mm. latis; staminibus exsertis glabris, filamentis gracilibus 2–3 mm. longis, antheris anguste oblongis 7–8 mm. longis; stylo gracillimo exserto medium versus obscure puberulo superne incrassato, stigmatibus circiter 2 mm. longis; fructibus subglobosis in sicco rugulosis glabrescentibus ad 9 mm. diametro calycis limbo coronatis.

VITI LEVU: Mba: Northern slopes of Mt. Namendre, east of Mt. Koromba [Pickering Peak], alt. 750–900 m., May 27, 1947, *Smith 4529* (A TYPE, US) (tree 8 m. high, in dense forest; corolla white, the lobes faintly pink-tinged; fruit at length purple).

The closest relative of *I. myrsinoides* (§ *Pavettopsis*) is apparently *I. tubiflora* A. C. Sm., from which it differs in the shorter aristae of its stipules, its much more compact inflorescence, its puberulent calyx with slightly shorter lobes, and its corolla with a shorter tube but larger lobes. Other related species, *I. elegans* Gillespie and *I. harveyi* (A. Gray) A. C. Sm., are readily distinguished from *I. myrsinoides* in details of leaf-shape, calyx-lobes, and in their comparatively small corollas.

Ixora greenwoodiana sp. nov.

Arbor gracilis ad 10 m. alta vel frutex, ramulis gracilibus cinereis subteretibus apices versus 1.5–2 mm. diametro inconspicue puberulis mox glabrescentibus, internodiis plerumque 1–3 cm. longis; stipulis subcoriaceis mox glabris 3.5–5 mm. longis e basi late ovata aristatis, basi lateraliter breviter connatis, arista 1.5–3 mm. longa; petiolis gracilibus canaliculatis 7–12 mm. longis minute puberulis vel in sulcula glabris; foliorum laminis chartaceis in sicco olivaceis, elliptico- vel obovato-lanceolatis, 9–13 cm. longis, 3.5–5 cm. latis, basi attenuatis et in petiolum decurrentibus, apice cuspidatis et calloso-mucronulatis, margine integris et anguste recurvatis, supra glabris, subtus pilis pallidis haud 0.05 mm. longis persistentibus minute sed dense et uniformiter puberulis, costa supra leviter impressa subtus prominente, nervis secundariis utrinsecus 8–12 erecto-patentibus leviter curvatis inconspicue anastomosantibus supra prominulis subtus elevatis, rete venularum supra prominulo subtus plerumque immerso; inflorescentiis e ramulis brevibus terminalibus trichotome corymbosis sub fructu ad 6 cm. longis et 10 cm. diametro, pedunculo 3–5 mm. longo arcte puberulo, bracteis primariis obovatis foliaceis ad 2 cm. longis, radiorum pedunculis ad 2 cm. longis et ramulis infimis subtrichotomis minute puberulis; pedicellis paullo post anthesin et sub fructu ad 2 mm. longis vel subnullis, bracteolis basi ovarii insertis subulatis 0.3–1 mm. longis puberulis; calyce ovario incluso oblongo-cupuliformi paullo post anthesin 2.5–3 mm. longo dense sed minute puberulo, limbo suberecto lobis 4 deltoideis obtusis 0.5–0.7 mm. longis inclusis circiter 1 mm. longo intus obscure strigilloso; corolla non visa; fructibus subglobosis ad 8 mm. diametro in sicco rugulosis obscure puberulis calycis limbo coronatis.

VITI LEVU: Mba: Eastern slopes of Mt. Koroyanitu, Mt. Evans Range, alt. 950–1050 m., May 2, 1947, *Smith 4249* (A TYPE, US) (slender tree 10 m. high, in dense low forest; fruit becoming pink); Mt. Evans Range, alt. about 1150 m., *Greenwood 939* (A) (shrub, to 3 m. high; young leaves golden-brown, the flower-buds deep red).

The new species (of § *Pavettopsis*) suggests *I. harveyi* (A. Gray) A. C. Sm. in the size and shape of its leaves and their narrowed bases, but it differs in the close but uniform indument of the lower surfaces of leaves (the leaves of *I. harveyi* being strictly glabrous), in its more ample and puberulent inflorescence, and in its pilose calyx with comparatively short lobes. Other Fijian species of § *Pavettopsis* with leaves pilose beneath are *I. maxima* Seem. and *I. pubifolia* A. C. Sm., but both of these have more pronounced foliar and inflorescence indument and substantially larger leaves. *Ixora greenwoodiana* differs from *I. myrsinoides,* described above, not only in the foliage indument, but also in the short petioles, the considerably smaller leaf-blades more gradually narrowed at base, and the smaller calyx-limb.

Ixora bullata Turrill in Jour. Linn. Soc. Bot. 43: 25. 1915.

VANUA LEVU: Mathuata: Summit ridge of Mt. Numbuiloa, east of Lambasa, alt. 500–590 m., *Smith 6414* (A, US) (shrub or slender tree 2–4 m. high, in dense forest; inflorescence compact, deep red).

The extraordinary species described by Turrill bears little resemblance to other Fijian *Ixorae*; our specimens have some of the leaves even more extreme in size (up to 40 × 3 cm.) than those originally described. Apparently the species is otherwise represented only by the type, collected in southeastern Viti Levu (*im Thurn 359,* at Kew).

PSYCHOTRIA L.

Psychotria, the largest genus of phanerogams in Fiji, has had referred to it more than 60 binomials based on material from the archipelago. Some of these have been reduced outright and others are now referred to varietal status, but there remain in Fiji at least 55 described species of *Psychotria* which seem readily distinguishable. Particular efforts were made during my 1947 trip to obtain material of as many *Psychotriae* as possible, with a view to clarifying the status of various inadequately known species. Many, if not most, of the older species were re-collected, and it was gratifying to observe that certain species, hitherto considered rare, are in fact locally quite abundant. Of other species a second or third known collection was obtained, but there still remain several Fijian species known only from the type collection. It is hoped that future collectors will pay particular attention to this complex genus, which, in my opinion, can be locally understood by the examination of all types in connection with abundant new material. Most of the species appear to be sharply delimited, and one may suspect that much of the confusion in herbaria is due to misinterpretation of types or attempts to expand species concepts beyond reasonable limits. In the present treatment I describe 15 species as new; thus the genus now includes approximately 70 Fijian species, a number which will almost certainly be substantially increased by future collecting.

Careful consideration of all the Fijian species of *Psychotria* with various types of enlarged calyces inclines me at present to agree with Fosberg's reduction of my genera *Calycodendron* and *Eumorphanthus* (cf. Sargentia 1: 125. 1942). The calyx appears to be a highly variable feature in *Psychotria,* although it is reasonably constant within species. The Fijian species that have the calyx-limb much exceeding the tube show several trends of development, but these are not necessarily stages along one line of evolution, and consequently the single character of a showy calyx-limb probably does not justify generic segregation. An extreme development of the calyx-limb is found in *P. eumorphanthus* and approached in *P. confertiloba*, these species also being characterized by very large, 4-angled fruits. To this group two new species are added in the present paper. Species with a large calyx-limb abruptly flattened, or essentially rotate nearly from the base, are very striking on the basis of this character; this group ("*Calycodendron*") includes *P. glabra, P. magnifica, P. fragrans,* and *P. rufocalyx.* A somewhat similar calyx-limb, but campanulate or crateriform rather than subrotate, occurs in *P. pubiflora, P. milnei,* and *P. gibbsiae.* Species which resemble the latter group in this character but have the calyx smaller are *P. neurocalyx, P. calycosa,* and *P. gillespieana. Psychotria vitiensis* must also be associated with this group, although its calyx-limb is erect and fusiform, abruptly flaring only at the apex. The species here mentioned, together with several novelties of this relationship, would have to be associated in *Calycodendron* if that genus were maintained, but I think that Fosberg is probably correct in implying that no sharp line can be drawn between this group and *Psychotria* proper. In the following treatment the species of the "*Calycodendron-Eumorphanthus*" alliance are discussed toward the end.

Psychotria broweri Seem. Fl. Vit. 135 (as *P. browerii*). 1866.

VITI LEVU: Nandronga & Navosa: Northern portion of Rairaimatuku Plateau, between Nandrau and Nanga, alt. 725–825 m., *Smith 5483* (A, US) (tree 4–5 m. high, in dense forest; fruit red).

The cited specimen is the only one of my 1947 collection that represents *P. broweri*, a species too broadly interpreted in herbaria. Seemann originally cited as representing this species his numbers *244* and *254*, both from the island of Moturiki and both represented in the Gray Herbarium. The description agrees with no. *254*, which Gillespie has indicated as an isotype. Number *244* represents a different species and has been so indicated by Gillespie; it has a single pedunculate inflorescence and small leaves.

Psychotria broweri is characterized by its glabrous foliage and infructescence; its leaves are narrowly elliptic, up to 25 × 9 cm., acute to attenuate at both ends. Its cymes are strictly sessile, with several (up to 6) short radiating branches, and its fruits are turbinate, up to 12 mm. long and sharply several-carinate when dried. My no. *172*, from Kandavu, is also typical of this species, while my no. *1023* (from Koro) and *Gillespie 3476* and *Degener 15335* (both from Viti Levu) probably represent it. In herbaria, identifications of this species and of the related *P. brackenridgei* A. Gray, *P. turbinata* A. Gray, and *P. pritchardii* Seem. are often questionable. However, study of the types of these and of certain more recently described species will permit adequate circumscriptions.

Psychotria brackenridgei A. Gray in Proc. Am. Acad. 4: 44 (as *P. brackenridgii*). 1860.

VITI LEVU: Mba: Northern slopes of Mt. Namendre, east of Mt. Koromba [Pickering Peak], *Smith 4548*; western and southern slopes of Mt. Tomanivi, *Smith 5137, 5266, 5305, 5748*; Nandronga & Navosa: Northern portion of Rairaimatuku Plateau, between Nandrau and Rewasau, *Smith 5616.*

The cited specimens (all A, US) are from shrubs or slender trees 2–5 m. high, occurring in dense forest at 725–1150 m. altitude, and all bear fruits that are at first pale green and eventually orange to red. These specimens may confidently be referred to Gray's concept, as represented by the type at the Gray Herbarium (no Exploring Expedition material of this species is in the U. S. National Herbarium). In foliage the species is very similar to *P. broweri* Seem., like which it has strictly sessile cymes. In comparison with Seemann's species, *P. brackenridgei* has a more ample inflorescence with persistently pilose branchlets and calyces. This species has been misidentified (by the writer and others) as *P. storckii* Seem. and *P. pritchardii* Seem.; older collections from Vanua Levu and Taveuni, as well as Viti Levu, fall into a reasonable concept of *P. brackenridgei.* Further study is needed to analyze the differences between this species and the very closely related *P. turbinata* A. Gray.

Psychotria pritchardii Seem. Fl. Vit. 135. 1866.

VANUA LEVU: Mathuata: Seangganggа Plateau, in drainage of Korovuli River, vicinity of Natua, alt. 100–200 m., *Smith 6744* (A, US) (slender tree 4 m. high, in patches of forest in open rolling country; corolla-bud white).

The cited collection is the only one of the species obtained by me in 1947. *Psychotria pritchardii,* as represented by *Seemann 259* (isotype, Gray Herb.), from Taveuni, is readily characterized by its essentially glabrous habit, its large, fleshy, auriculate, subpersistent stipules, its lanceolate-elliptic leaves with blades up to 17 × 6 cm., its elongate inflorescence with a reflexed peduncle up to 18 cm. long, its slender pedicels 6–10 mm. long, and its shallowly undulate calyx-limb. Also representing the species are *Gillespie 4826* and *Smith 743,* from Taveuni, and *Degener & Ordonez, 13820, 14015,* and *14097* and *Smith 1606* and *1617,* all from Vanua Levu. Certain specimens from Viti Levu so identified are in need of further study before they can be definitely referred here.

Psychotria furcans Fosberg in Sargentia 1: 133. 1942.

VITI LEVU: Mba: Mt. Evans Range, *Smith 4091, 4277, 4354. 4372*; upper slopes of Mt. Koromba [Pickering Peak], *Smith 4660, 4661*; northern slopes of Mt. Namendre, east of Mt. Koromba, *Smith 4550*; slopes of the escarpment north of Nandarivatu, *Smith 6038, 6270*; Nandronga & Navosa: Northern portion of Rairaimatuku Plateau, *Smith 5477, 5608.*

The cited specimens (all A, US), collected in dense forest or hillside thickets at altitudes of 550–1075 m., were from shrubs or slender trees 2–10 m. high; the corolla is white or distally pale pink, and the fruit is red to bright orange. The species is typified by *Degener 14450,* from the Nandarivatu region, and Fosberg has questionably referred to it another specimen from lowland Vanua Levu. It now seems that *P. furcans* is one of the more abundant *Psychotriae* in upland Viti Levu, and I would also refer here *Degener 14369, 14625,* and *14637,* which were otherwise identified by Fosberg. The type is among the smaller-leaved specimens, but no differences of consequence are noted, except that the indument of the inflorescence is persistent to a varying degree. The petioles vary in length up to 7 cm., the leaf-blades may rarely be as large as 23 × 8 cm., and the peduncle, usually sharply reflexed, is up to 6 cm. in length. I doubt if this species is as closely related to my *P. edentata* and *P. pachyantha* as implied by Fosberg, and I should rather relate it to *P. pritchardii* Seem., from which stipular characters and the shorter inflorescence distinguish it. The forked stipules indicate a relationship of *P. furcans* to *P. broweri, P. brackenridgei,* and their more immediate relatives, from which the pedunculate inflorescence readily separates it.

Psychotria chrysophylla Fosberg in Bull. Torr. Bot. Cl. 67: 423. 1940.

VITI LEVU: Mba: Slopes and summit of Mt. Ndelaiyoö, on the escarpment west of Nandarivatu, *Smith 5078*; southern slopes of Mt. Ndelainathovu, on same escarpment, *Smith 4931*; western and southern slopes of Mt. Tomanivi, *Smith 5296*; Ra: Ridge from Mt. Namama (east of Nandarivatu) toward Mt. Tomanivi, *Smith 5702;* Naitasiri: Northern portion of Rairaimatuku Plateau, between Mt. Tomanivi and Nasonggo, *Smith 6130*; Nandronga & Navosa: Northern portion of Rairaimatuku Plateau, between Nandrau and Nanga, *Smith 5545, 5593.*

The cited specimens (all A, US) agree very closely with the original description, based only on the type, *St. John 18344,* collected in the upper Wainimala drainage near the center of Viti Levu. The type locality falls into the present Province of Naitasiri and lies about eight miles south of the last locality listed above. My specimens were from trees or shrubs 4–5 m. high, occurring in dense forest at elevations of 725–1150 m.; the corolla is pure white and in one case a fragrance of the flowers was noted. The only recorded local name (no. *5545*) was *kau simbala.* Slightly to amplify the original description, it may be noted that the petioles vary in length from 0.5 to 3 cm., the leaf-blades are sometimes as much as 15 cm. long and 5.5 cm. broad, and the peduncle may be as long as 6 cm. The variation is no more than normal for a species of *Psychotria,* and in fact this is a very well-marked species, distinguished as originally noted by the uniform pubescence of the inflorescence and the rather regularly oblong leaf-blades which dry a characteristic yellow-green, at least on the upper surface.

Psychotria st.-johnii Fosberg in Bull. Torr. Bot. Cl. 67: 423. 1940.

VITI LEVU: Mba: Slopes of Mt. Nairosa, eastern flank of Mt. Evans Range, *Smith 4025, 4049*; hills east of Nandala Creek, about 3 miles south of Nandarivatu, *Smith 5927*; hills between Nggaliwana and Nandala Creeks, *Smith 5839*; hills between Nggaliwana and Tumbeindreketi Creeks, *Smith 5890, 5991*; Nandronga & Navosa: Northern portion of Rairaimatuku Plateau, between Nandrau and Rewasau, *Smith 5648.*

The cited specimens (all A, US) are from shrubs or slender trees 1–8 m. high, occurring in dense forest at elevations of 725–1050 m.; the calyx and corolla at anthesis are pure white and the fruit is red to bright orange. This material agrees very closely with the two specimens previously known of the species, both collected by St. John near the center of Viti Levu, about 10 miles south of the last locality listed above and in the present Province of Naitasiri. The species is very sharply marked by the short reddish indument of its long, calyptrate stipules and lower leaf-surfaces, by its acuminate, pale-nerved leaves, and by its white flowers with the calyx very inconspicuously lobed. Although the flowers are usually glabrous without, the reddish indument of the inflorescence-branches sometimes (as in my no. *5890*) extends to the calyx-tube.

Psychotria degeneri Fosberg in Sargentia 1: 134. 1942.

VITI LEVU: Mba: Western slopes of Mt. Nanggaranambuluta [Lomalangi], east of Nandarivatu, *Smith 4771, 4773*; western and southern slopes of Mt. Tomanivi [Mt. Victoria], *Smith 5246, 5301*; Nandronga & Navosa: Northern portion of Rairaimatuku Plateau, between Nandrau and Nanga, *Smith 5540.*

The cited specimens (all A, US) agree very well with the type and the three other collections originally cited; they were taken from shrubs or low trees 2–5 m. high, growing in dense forest at 725–1150 m. elevation. The inflorescences (branches, pedicels, calyx, and corolla) are white, or the pedicel and calyx may be faintly pink-tinged, and the fruit is red to orange. This recently described species, like *P. st.-johnii* (discussed above), proves to be fairly common in the undergrowth of the rain-forest of upland Viti Levu. It resembles *P. st.-johnii* in its strongly veined leaves and its delicate, sessile inflorescences, but it is most readily distinguished by its longer indument, which extends to the calyx and corolla, the individual hairs being reddish and several-celled.

Psychotria diffusiflora sp. nov.

Arbor vel frutex ad 4 m. altus, praeter corollam et interdum costam foliorum ubique glaber, ramulis gracilibus teretibus apices versus ut petiolis luteo-glanduloso-lineolatis, internodiis distalibus 5–15 mm. longis; stipulis papyraceis maturitate 17–25 mm. longis in vaginam connatis superne in tubum brevem haud 1 mm. longum contractis, apice minute liberis recurvatis inconspicue bifidis, caducis, vagina ellipsoidea inflorescentiam juvenilem obtengente ad 12 mm. lata uno latere erumpente; petiolis leviter canaliculatis vel semiteretibus in sicco rugulosis 1–2 (–2.5) cm. longis, laminis foliorum papyraceis vel subcoriaceis copiose immerso-glanduloso-punctatis vel -lineolatis siccitate fusco-olivaceis, ellipticis vel elliptico-oblanceolatis, (6–) 7–12.5 cm. longis, (2.5–) 3–5 cm. latis, basi acutis et in petiolum manifeste decurrentibus, apice cuspidatis vel breviter acuminatis (apice ipso gracili 5–15 mm. longo calloso obtuso), margine integris vel undulatis leviter recurvatis, costa supra paullo elevata subtus prominente et interdum pilis rubellis multiseptatis circiter 1 mm. longis patenti-pilosa, nervis secundariis utrinsecus 10–13 patentibus curvatis pallidis marginem versus inconspicue anastomosantibus supra prominulis vel subplanis subtus valde elevatis, rete venularum intricato utrinque subimmerso vel plano; inflorescentia terminali cymosa copiose ramulosa multiflora ad 10 cm. longa et lata epedunculata vel pedunculo ad 8 mm. longo, ramulis plerumque 5 divaricatis, pedunculis secundariis gracilibus ad 7 cm. longis, bracteis bracteolisque lanceolatis 0.5–2 mm. longis caducis, pedicellis gracilibus sub anthesi 7–9 mm. longis; calyce obconico-cupuliformi sub anthesi 1.5–2 mm. longo et apice diametro, tubo brevi, limbo suberecto membranaceo 0.5–0.8 mm. longo inconspicue nervato truncato vel obscure 5-denticulato; corolla membranacea infundibulari sub anthesi lobis inclusis 6–7 mm. longa faucibus pilis circiter 0.5 mm. longis copiose barbellatis exceptis glabra, tubo brevi haud 2 mm. longo, lobis 5 patentibus vel reflexis oblongis obtusis circiter 4 mm. longis et 1.5 mm. latis; staminibus 5 faucibus affixis exsertis, filamentis gracilibus circiter 3 mm. longis, antheris oblongis circiter 1.5 mm. longis; disco conspicuo annulari-pulvinato circiter 0.7 mm. alto; stylo gracili quam corolla breviore apice bifido; fructibus ovoideis circiter 7 mm. longis et 5 mm. latis, in sicco 4-angulatis et leviter complanatis, calycis limbo persistente coronatis, pyrenis hastatis circiter 6.5 × 4.5 × 2.5 mm., basi obtusis, medium versus abrupte contractis, superne angustatis, ventre levibus, dorso basi levi excepto unicarinatis.

VITI LEVU: Mba: Southern slopes of Mt. Tomanivi [Mt. Victoria], alt. 850–1150 m., *Smith 5247* (A, US) (tree 4 m. high, in dense forest; pedicel, calyx, and corolla pure white), *6087* (A TYPE, US) (Sept. 18, 1947; shrub 3 m. high, in dense forest; stipules greenish white; calyx and corolla white).

A representative of Gray's subgenus *Piptilema,* the new species is characterized by its glabrous habit, its large calyptrate stipules with very minute free portions, and its ample and many-flowered, spreading inflorescence. Its only close ally seems to be *P. filipes* A. Gray, from which it differs in its shorter petioles, in having its leaf-blades acute and decurrent at base (rather than narrowly but obviously cordate) and with more numerous secondary nerves, and in its long-pedicellate flowers, which are considerably larger, especially as to the corolla-lobes. My understanding of *P. filipes* is based entirely upon the type (US 62336), which was redescribed and discussed by Fosberg in Sargentia 1: 129. 1942.

Psychotria tetragona Seem. Fl. Vit. 137. 1866.

VITI LEVU: Mba: Slopes and summit of Mt. Ndelaiyoö, on the escarpment west of Nandarivatu, alt. 900–1053 m., *Smith 5057, 5058* (A, US).

The cited specimens agree very well with an isotype in the Gray Herbarium, *Seemann 252,* from Ovalau. The species is characterized by its glabrous habit, lanceolate leaves, forking stipules which are basally connate around the inflorescence-bud, very compact inflorescence, small calyx, conspicuous and pulvinate disk, and clavate corolla about 15 mm.

long. Also to be placed here are *Degener 14611, 15057,* and *15167* (all A, US), from Viti Levu.

Similar to *P. tetragona,* but differing in its broader leaf-blades (3–6 cm. broad) is *Smith 4352* (A, US) (Viti Levu: Mba: Northern portion of Mt. Evans Range, between Mt. Vatuyanitu and Mt. Natondra, alt. 700–900 m.). My no. *4551* (A, US) (Viti Levu: Mba: Northern slopes of Mt. Namendre, east of Mt. Koromba, alt. 750–900 m.) is similar to no. *4352* except that the costa of the lower leaf-surface is copiously hispidulous with hairs 0.5–0.8 mm. long. In inflorescence characters these two specimens are hardly distinguishable from typical *P. tetragona,* and at present I am inclined to consider them extreme representatives of this species; it may be noted that both occur on isolated forested hills rising from the grassland of western Viti Levu.

Psychotria tetragonoides Fosberg, a species of this alliance somewhat suggested by the last two numbers discussed above, is clearly separable from *P. tetragona* by the indument of its foliage and flowers; it is not represented in my collection.

Psychotria ampullacea sp. nov.

Arbor gracilis ad 5 m. alta, ramulis subteretibus gracilibus praeter cicatrices stipularum hispidulas glabris, internodiis distalibus 6–10 mm. longis; stipulis glabris papyraceis 2–2.5 cm. longis in vaginam ampullaceam connatis, vagina basi ventricosa inflorescentiam juvenilem obtegente superne in tubum circiter 1 cm. longum valde contracta, stipularum partibus liberis circiter 3 mm. longis bifidis; petiolis gracilibus glabris 1–3 cm. longis subteretibus rugulosis; foliorum laminis chartaceis in sicco fusco-olivaceis, lanceolatis vel oblanceolatis, (9–) 12–17 cm. longis, (2–) 3.5–5 cm. latis, basi longe attenuatis et in petiolum decurrentibus, apice gradatim acuminatis, margine anguste recurvatis, supra glabris, subtus pilis 0.7–1 mm. longis rubellis multiseptatis copiose (demum sparsiore) patenti-pilosis, costa supra elevata subtus prominente, nervis secundariis utrinsecus 11–13 curvatis patentibus inconspicue anastomosantibus supra leviter subtus valde elevatis, rete venularum subimmerso; inflorescentia terminali subcapitata 9–12-flora, floribus pedicellatis, pedicellis teretibus 2–3 mm. longis copiose pilosis (pilis pallidis patentibus 0.5–0.7 mm. longis multiseptatis); calyce campanulato 8–9 mm. longo et apice circiter 4 mm. diametro, tubo brevi haud 1.5 mm. longo ut pedicello piloso, limbo erecto submembranaceo glabro conspicue nervato 5-lobato, lobis deltoideo-lanceolatis suberectis acutis 1–2 mm. longis; corolla submembranacea infundibulari sub anthesi circiter 20 mm. longa, extus lobis inclusis pilis ad 1 mm. longis ut pedicello copiose patenti-pilosa, intus glabra, lobis 5 erectis oblongis 4–5 mm. longis obtusis; staminibus glabris medium corollae versus insertis, filamentis gracilibus 4–5 mm. longis, antheris oblongis 2.5–2.8 mm. longis haud exsertis; disco conspicue pulvinato glabro circiter 1 mm. alto; stylo gracili glabro quam corolla breviore apice bifido.

VITI LEVU: Nandronga & Navosa: Northern portion of Rairaimatuku Plateau, between Nandrau and Rewasau, alt. 725–825 m., Aug. 11, 1947, *Smith 5659* (A TYPE, US) (slender tree 5 m. high, in dense forest; calyx pale green; corolla white).

The species here described, together with the following, seems superficially to be related to *P. tetragona* Seem. and *P. tetragonoides* Fosberg, because of its congested, subcapitate inflorescence. However, the calyces of the two older species are very small, scarcely 1.5 mm. in length, and inconspicuously dentate, whereas the calyces of the two species here described as new are comparatively elongate and obviously lobed. In texture, the calyx-limb of *P. ampullacea* suggests that of some of the species that have been referred to *Calycodendron*, but in those species the inflorescence is ample and freely branched. Probably these two new species belong in the general alliance of *P. tetragona,* but they seem to have no immediate relatives.

Further distinguishing characteristics of *P. ampullacea* are the indument of the leaves, pedicels, calyx-tube, and corolla (the hairs being divided into many short cells by transverse septae), and the form of the stipular sheath, which is flask-shaped, swollen at base to enclose the inflorescence-bud and narrowed to a very slender elongate throat, the stipules being free and bifid only at the extreme apices.

Psychotria tomaniviensis sp. nov.

Frutex ad 4 m. altus, ramulis gracilibus glabris subteretibus vel in sicco angulatis, internodiis distalibus 5–10 mm. longis; stipulis papyraceis 5–8 mm. longis basim versus connatis, superne 3–5 mm. liberis et profunde bifidis, glabris vel apicem versus puberulis; foliis glabris, petiolis canaliculatis 5–10 mm. longis vel subnullis, laminis chartaceis in sicco fusco-viridibus oblanceolatis, (7–) 10–16 cm. longis, (2.5–) 3.5–4.5 cm. latis, basi attenuatis et in petiolum longe decurrentibus, apice obtuse cuspidatis, margine integris et anguste recurvatis, costa supra subplana vel leviter elevata subtus prominente, nervis secundariis utrinsecus 12–15 curvatis patentibus inconspicue anastomosantibus supra subplanis subtus elevatis, rete venularum subimmerso; inflorescentia terminali subcapitata multiflora, bracteolis sub floribus lanceolatis circiter 2 mm. longis ciliolatis caducis, pedicellis teretibus circiter 1 mm. longis glabris; calyce campanulato sub anthesi circiter 10 mm. longo et apice 4 mm. diametro lobis interdum obscure puberulis exceptis glabro, tubo brevi haud 2 mm. longo, limbo erecto submembranaceo manifeste nervato 5-lobato, lobis oblongis 2–3 mm. longis subacutis; corolla submembranacea infundibulari sub anthesi circiter 22 mm. longa, extus glabra vel juventute pilis conicis haud 0.1 mm. longis minute puberula, intus medium versus pilis albidis mollibus copiose tomentella, lobis 5 erectis oblongis circiter 5 mm. longis obtusis; staminibus glabris, antheris subsessilibus apicem tubi corollae versus oblongis circiter 2 mm. longis; disco conspicue pulvinato glabro circiter 0.7 mm. alto; stylo gracili glabro leviter exserto apice bifido; fructibus subglobosis circiter

15 mm. diametro, pericarpio crasse carnoso, pyrenis obovoideo-oblongis circiter 8 × 6 × 5 mm., ventre levibus, dorso superne conspicue 3-carinatis, apice profunde cavatis, basi rotundatis.

VITI LEVU: Mba: Western slopes of Mt. Tomanivi [Mt. Victoria], alt. 850–1150 m., July 17, 1947, *Smith 5294* (A TYPE, US) (shrub 3–4 m. high, in dense forest; calyx green; corolla pure white; fruit red).

The new species differs from the above described *P. ampullacea,* which seems to be its closest ally, in its much smaller stipules that do not form the flask-shaped sheath so noticeable in *P. ampullacea,* in its glabrous leaves and much shorter petioles, in its glabrous pedicels and calyx-tube, in having the external indument of the corolla composed of very minute conical hairs and evanescent, while within the corolla is tomentellous rather than glabrous, and in its subsessile anthers and elongate style. Such characters as length of filament and style, and perhaps internal pubescence of the corolla, may sometimes be correlated with actual or incipient dioecism in *Psychotria.*

Psychotria valleculata sp. nov.

Arbor ad 4 m. alta sub fructu cicatricibus stipularum obscure ferrugineo-setulosis exceptis ubique glabra, ramulis subteretibus crassis, internodiis longitudine diversis; stipulis subcoriaceis deltoideo-lanceolatis 6–7 mm. longis, basi connatis, superne liberis, apice integro minute mucronulatis; petiolis crassis rugulosis semiteretibus 8–18 mm. longis, laminis subcoriaceis in sicco pallide olivaceis, oblongo-obovatis, (6–) 8–10.5 cm. longis, (2.5–) 3.5–5 cm. latis, basi attenuatis et in petiolum longe decurrentibus, apice rotundatis, margine integris et anguste recurvatis, costa utrinque valde elevata, nervis secundariis utrinsecus 8–10 patentibus anastomosantibus utrinque elevatis, rete venularum subimmerso; inflorescentia non visa; infructescentia terminali capitata, receptaculo coriaceo rotundato vel clavato 2–4 mm. alto, fructibus 8–15 confertis radiatis subsessilibus, pedicellis haud 1 mm. longis vel subnullis; fructibus obovoideis in vivo ad 11 mm. longis et 8 mm. latis, in sicco indistincte 4-angulatis, calycis limbo mox caduco non viso, disco pulvinato interdum conspicuo circiter 1 mm. alto, pyrenis subhastato-ovoideis circiter 7 × 4 × 2 mm., ventre complanatis vel basim versus inconspicue costatis, dorso conspicue unicarinatis, basi acutis, paullo supra medium valde contractis, apice rotundatis, parte basali obcordiformi carina excepta complanata, parte apicali conspicue angustiore.

VITI LEVU: Nandronga & Navosa: Southern slopes of Nausori Highlands, in drainage of Namosi Creek above Tumbenasolo, alt. 300–450 m., June 4, 1947, *Smith 4721* (A TYPE, US) (tree 4 m. high, in dense forest of valley; fruit red).

In spite of the lack of flowers, this collection seems patently to represent a new species, characterized by its oblong-obovate, rounded leaves and its strictly capitate infructescences. In the latter character and in its general aspect the new species suggests *P. tetragona* Seem., but its stipules are of another type and its leaves are quite different; it is further characterized by its obovoid fruits, of which the pyrenes are unicarinate, sharply contracted near the middle, and broadly obcordiform in the basal part. It is perhaps referable to Gray's subgenus *Piptilema,* but it is only remotely related to the species of this group discussed by Fosberg (in Sargentia 1: 126. 1942).

Psychotria evansensis sp. nov.

Arbor ad 5 m. alta vel frutex, ramulis crassis subteretibus novellis minute puberulis exceptis glabris, internodiis distalibus 1–3 cm. longis; stipulis papyraceis 3–5 mm. longis deltoideis obtusis, basi in vaginam brevem connatis, superne liberis, mox caducis; foliis magnis, petiolis semiteretibus 2–5.5 cm. longis primo minute puberulis demum glabratis, laminis papyraceis in sicco fusco-viridibus anguste oblongis, 16–26 cm. longis, 5–8.5 cm. latis, basi attenuatis et in petiolum longe decurrentibus, in acuminem 1–2 cm. longum gradatim angustatis, margine integris vel undulatis anguste recurvatis, immerso-luteo-glandulosis, supra glabris, subtus minute puberulis glabratisque, costa supra subplana vel leviter elevata subtus prominente, nervis secundariis utrinsecus 12–18 curvatis patentibus anastomosantibus supra subplanis subtus elevatis, rete venularum intricato supra immerso subtus prominulo; inflorescentia non visa; infructescentia terminali cymosa fructibus inclusis 5–9 cm. diametro pedunculata, pedunculo gracili 2–4 cm. longo et ramulis primariis 4 vel 5 divaricatis 1–2.5 cm. longis pedicellisque minute puberulis, fructibus apices ramulorum versus pluribus, pedicellis gracilibus 1–3 mm. longis; fructibus in vivo obovoideis 11–12 mm. longis 9–10 mm. latis, in sicco valde 6–10-costatis, basi obtusis, apice rotundatis vel paullo depressis, calycis limbo persistente inconspicuo circiter 1 mm. longo submembranaceo fere ad basim 5-lobato lobis subacutis, pericarpio carnoso copiose immerso-luteo-glanduloso, pyrenis semi-obovoideis circiter 10 × 7.5 × 5 mm., basi rotundatis, apice truncatis, ventre complanatis rugulosis basim versus costatis, dorso conspicue 3-carinatis, carinis crista rotundatis rugulosis, sulcis profundis, marginibus incrassatis interdum carinis similibus.

VITI LEVU: Mba: Slopes of Mt. Nairosa, eastern flank of Mt. Evans Range, alt. 700–1050 m., in dense forest, *Smith 4024* (A, US) (shrub 3 m. high), *4072* (A TYPE, US) (Apr. 28, 1947; slender tree 5 m. high; fruit red).

Although it lacks flowers, the species here described is evidently a relative of *P. forsteriana* A. Gray, which it resembles in general appearance, leaf-shape and -texture, and the obovoid fruits with a very short calyx-limb, immersed-glandular pericarp, and 3-carinate pyrenes. The new species differs from *P. forsteriana* in its larger leaves, obviously pedunculate infructescences, and much larger fruits. The mature fruits of *P. forsteriana* are 6–7 mm. long and 5–6 mm. broad, while the pyrenes do not exceed 6 × 5 ×3.5 mm. In the typical (Samoan) variety, the pyrenes are dorsally nearly smooth but somewhat rugulose with three incipient carinae, while in var. *vitiense* A. Gray the pyrenes are obviously 3-carinate and marginally thickened so that they appear 5-carinate, the carinae being rounded and the sulcae deep, as in the new species.

While *P. evansensis* bears a resemblance to the common *P. carnea* (Forst. f.) A. C. Sm. in its foliage and in the size and shape of its mature fruits, the relationship is remote. *Psychotria carnea* has the persistent calyx-limb obvious, 3–6 mm. in length, and the pericarp only inconspicuously glandular. The pyrenes of *P. carnea* are fundamentally unicarinate, although the carina may be flattened on its crest or variously interrupted, while subsidiary protuberances may give the dorsal surface of the pyrene an irregularly rugulose appearance.

Psychotria amoena sp. nov.

Arbor compacta vel gracilis ad 8 m. alta vel frutex, ramulis gracilibus teretibus glabris; stipulis papyraceis lanceolato-oblongis maturitate 8–11 mm. longis in vaginam spathaceam connatis, acuminatis, margine scariosis, extus glabris, intus pilis debilibus subadscendentibus 0.3–0.6 mm. longis pubescentibus, mox caducis, basibus pilosis interdum subpersistentibus; foliis glabris, petiolis gracilibus 0.5–2 cm. longis fere ad basim saepe anguste alatis, laminis papyraceis in sicco pallide viridibus, ovato-ellipticis vel lanceolatis, (2.5–) 3–5.5 cm. longis, (1–) 1.5–2.8 cm. latis, basi acutis vel attenuatis et in petiolum longe decurrentibus, apice cuspidatis et calloso-apiculatis, margine integris et anguste recurvatis, costa utrinque elevata, nervis secundariis utrinsecus 4–8 patentibus curvatis marginem versus anastomosantibus utrinque prominulis, rete venularum inconspicuo; inflorescentia terminali cymosa sub anthesi et fructu 2–4 cm. longa e basi 3-partita vel pedunculata, pedunculo raro ad 1 cm. longo, ramulis gracilibus ad 2.5 cm. longis glabris vel obscure puberulis; floribus praeter corollam intus glabris 3–10 apice ramulorum irregulariter aggregatis, pedicellis gracilibus sub anthesi 2–5 mm. sub fructu ad 9 mm. longis; calyce turbinato limbo incluso 2–2.5 mm. longo et apice diametro, limbo tenui suberecto 1–1.5 mm. longo inconspicue nervato integro vel obscure 5-denticulato; corolla subcarnosa breviter tubulosa vel campanulata sub anthesi 3–4 mm. longa, tubo brevi apice pilis pallidis circiter 0.5 mm. longis copiose barbellato, lobis 5 vel 6 oblongis circiter 2 mm. longis apice cucullatis sub anthesi reflexis; disco annulari-pulvinato circiter 0.5 mm. alto; staminibus 5 vel 6, filamentis gracilibus ad 0.5 mm. longis, antheris oblongis 0.8–1 mm. longis utroque obtusis; stylo quam corolla breviore in lobos complanatos profunde bifido; fructibus in vivo obovoideis in sicco inconspicue 6–10-costatis 7–8 mm. longis 6–7 mm. latis calycis limbo brevi persistente coronatis, pericarpio copiose immerso-luteo-glanduloso, pyrenis semi-obovoideis circiter 5.5 × 4.5 × 3 mm., basi obtusis, apice rotundatis, ventre levibus, dorso 3-carinatis, carinis obtusis, sulcis brevibus, margine leviter incrassatis.

VITI LEVU: Mba: Slopes of Mt. Nairosa, eastern flank of Mt. Evans Range, alt. 700–1050 m., *Smith 4090* (A, US) (slender tree 8 m. high, in dense forest; corolla white; fruit deep red); hills east of Nandala Creek, about 3 miles south of Nandarivatu, alt. 850–970 m., Sept. 9, 1947, *Smith 5949* (A TYPE, US) (compact tree 4 m. high, in mossy forest on ridge; calyx and disk pink-tinged; corolla, stamens, and style white; fruit green, at length dull orange); Nandronga & Navosa: Northern portion of Rairaimatuku Plateau, alt. 725–825 m., between Nandrau and Rewasau, *Smith 5402* (A, US) (shrub 3 m. high, in dense forest; fruit becoming red), between Nandrau and Nanga, *Smith 5562* (A, US) (*ndengendenge*; compact tree 5 m. high, in dense forest; ripe fruit red). All the cited specimens are in fruit, and the first two bear flowers as well.

The close relationship of this graceful little plant to *P. forsteriana* A. Gray is shown by the similarity of their stipules, leaf-texture, fruits, and small flowers (with truncate calyx-limb and barbellate corolla-throat). However, the new species is more delicate in every respect, having leaves less than half as large and fewer-flowered inflorescences. Also of this general alliance is *P. setchellii* Gillespie, which, as compared with *P. amoena*, has the leaves longer and proportionately narrower, acuminate, and with more numerous secondaries, the inflorescence larger, and the corolla nearly twice as long.

Psychotria incompta sp. nov.

Arbor compacta ad 4 m. alta praeter calycis limbum sub fructu ubique glabra, ramulis rectis teretibus, internodiis distalibus plerumque 1–2.5 cm. longis; stipulis papyraceis 12–15 mm. longis primo in vaginam gracilem fere ad apices connatis, apicibus minutis simplicibus calloso-acutis, vagina mox irregulariter erumpente, basi breviter persistente; petiolis semiteretibus vel supra costatis gracilibus 0.5–2 cm. longis, laminis chartaceis vel subcoriaceis in sicco viridi-olivaceis, lanceolatis vel anguste ellipticis, 6–8.5 cm. longis, 2–3.5 cm. latis, basi attenuatis et in petiolum longe decurrentibus, apice cuspidatis vel in acuminem calloso-apiculatum ad 1 cm. longum gradatim angustatis, margine integris vel undulatis, costa supra elevata subtus prominente, nervis secundariis utrinsecus 8–10 patentibus curvatis anastomosantibus utrinque elevatis vel supra subplanis, rete venularum supra immerso subtus prominulo; inflorescentia desiderata; infructescentia terminali congesta simplici sessili, receptaculo parvo, pedunculis raro evolutis denique videtur 3-floris, pedicellis sub fructu gracilibus 6–15 mm. longis raro (apice pedunculi brevis binis) brevioribus basi bracteis evanescentibus subtentis; fructibus 4–9 per infructescentiam obovoideis maturitate ad 14 mm. longis et 8.5 mm. latis in vivo levibus in sicco obscure costatis, basi acutis, apice calycis limbo persistente coronatis, limbo papyraceo erecto 2.5–4 mm. longo utrinque obscure puberulo vel glabrato 4-lobato, lobis oblongis rotundatis 2–3 mm. longis, disco pulvinato carnoso, pericarpio crasse carnoso eglanduloso, pyrenis semi-obovoideis circiter 10 × 6.5 × 4 mm., basi acutis, apice irregulariter truncatis, ventre levibus, dorso rotundatis et obscure unicarinatis, carina obtusa marginibus incrassatis simili.

VITI LEVU: Mba: Upper western slopes of Mt. Tomanivi [Mt. Victoria], alt. about 1200 m., July 10, 1947, *Smith 5208* (A TYPE, US) (compact tree 4 m. high, in dense mossy forest); summit of Mt. Nanggaranambuluta [Lomalangi], east of Nandarivatu, alt. 1100–1120 m., *Smith 5672* (A, US) (compact tree 4 m. high, in dense forest).

Although flowers are not known for the species described above, its relationship to *P. carnea* (Forst. f.) A. C. Sm. and *P. archboldiana* Fosberg is indicated by the type of stipule, the leaf-texture, the large obovoid fruit with a conspicuous and persistent calyx-limb, and the shape of the pyrenes. From both of these species (§ *Eumachia*), however, *P. incompta* is readily distinguished by its simple inflorescence, the elongate pedicels being borne directly upon a small capitate receptacle. Rarely a short peduncle supports a pair of fruits, whereas in the two allied species the inflorescence is compound and obviously pedunculate. The new species further differs from *P. archboldiana* in its more robust habit, larger fruit, and dorsally comparatively smooth (rather than irregularly tuberculate) pyrenes, and from *P. carnea* in its narrower leaves and shorter calyx-limb.

Psychotria leucocalyx sp. nov.

Arbor ad 4 m. alta praeter corollam intus pilosam ubique glabra, ramulis teretibus, novellis petiolisque luteo-glanduloso-lineolatis, internodiis distalibus plerumque 2–3.5 cm. longis, stipulis papyraceis 7–10 mm. longis inferne in vaginam tubulosam connatis, partibus liberis 3–6 mm. longis laminaribus profunde bilobatis; petiolis gracilibus semiteretibus 1.5–2.2 cm. longis, laminis subcoriaceis vel chartaceis in sicco fusco-olivaceis, oblongo-ellipticis, (8–) 12–17 cm. longis, (3–) 5–7.5 cm. latis, basi obtusis vel subacutis et in petiolum breviter decurrentibus, apice obtusis vel obtuse cuspidatis, margine integris et anguste recurvatis, utrinque immerso-luteo-lineolatis, costa supra leviter elevata et sulcata subtus prominente, nervis secundariis utrinsecus 12–14 patentibus curvatis marginem versus anastomosantibus supra paullo subtus valde elevatis, rete venularum intricato subimmerso vel utrinque subprominulo; inflorescentia terminali pedunculata 3–4-plo divisa sub anthesi ad 13 cm. longa, pedunculo subtereti crasso 3.5–4.5 cm. longo, ramulis 4 vel 5, pedunculis secundariis 2–3 cm. longis; bracteis sub ramulis submembranaceis glabris obovatis ad 10 mm. longis in lobos lanceolatos 3–5 acutos profunde fissis, bracteolis similibus, ultimis circiter 2 mm. longis, omnino caducis; pedicellis gracilibus sub anthesi 4–7 mm. longis; calyce magno, tubo turbinato sub anthesi 1.5–2 mm. longo et circiter 3 mm. diametro apice contracto, limbo membranaceo conspicue reticulato-nervoso breviter adscendente deinde patente subrotato 15–17 mm. diametro profunde 4- vel 5-lobato, lobis oblongo-deltoideis ad 7 mm. longis latisque obtusis margine undulatis; corolla tenuiter carnosa tubulosa sub anthesi 23–30 mm. longa et medium versus circiter 3 mm. diametro superne paullo ampliata, extus glabra, intus omnino copiose puberula etiam medium versus pilis pallidis ad 1 mm. longis molliter tomentella, lobis 4 vel 5 oblongis 3–5 mm. longis suberectis vel demum reflexis apice rotundatis et cucullatis; staminibus 4 vel 5 faucibus affixis, antheris subsessilibus oblongis circiter 3.5 mm. longis basi sagittatis apice obtusis; disco conspicuo hemisphaerico-pulvinato circiter 0.8 mm. alto, stylo filiformi leviter exserto, stigmatis lobis complanatis; fructibus juvenilibus turbinatis in sicco leviter costatis, calycis limbo mox caduco.

VITI LEVU: Naitasiri: Northern portion of Rairaimatuku Plateau, between Mt. Tomanivi [Mt. Victoria] and Nasonggo, alt. 870–970 m., Sept. 18, 1947, *Smith 6103* (A TYPE, US) (tree 4 m. high, in dense forest; calyx and corolla white).

This striking species, characterized by its large, spreading, membranaceous calyx-limb, is closely allied only to *P. magnifica* (Gillespie) Fosberg, from which it differs in having its leaf-blades proportionately slightly broader and predominantly obtuse at base and in having its inflorescence glabrous except for the inner surface of the corolla. *Psychotria magnifica* has the inflorescence-branches, pedicels, calyx-tube (and base of limb), and outer surface of corolla copiously puberulent. Other species of this immediate relationship, *P. glabra* (Turrill) Fosberg and *P. fragrans* (Gillespie) Fosberg, differ from *P. leucocalyx* more sharply, the first in its elongate calyx-tube and even larger calyx-limb and corolla, the second in its smaller leaves, comparatively small and conspicuously glandular-lineate calyx, and hispidulous corolla.

Psychotria jugalis sp. nov.

Arbor compacta ad 4 m. alta, ramulis crassis teretibus glabris, nodis distalibus plerumque 1–2 cm. longis obscure luteo-glanduloso-lineolatis; stipulis papyraceis 10–15 mm. longis dorso pilis rubellis 0.5–1 mm. longis furfuraceo-setosis, inferne in vaginam cupuliformem 4–5 mm. longam connatis, partibus liberis oblongis in segmentos 2 deltoideos acutos profunde bifidis; foliis glabris, petiolis crassis semiteretibus 1.5–3 cm. longis, laminis subcoriaceis in sicco fusco-olivaceis oblongo-ellipticis, (8–) 11–15 cm. longis, (3.5–) 5–7 cm. latis, basi acutis et in petiolum decurrentibus, apice cuspidatis et calloso-obtusis, margine integris et anguste recurvatis, costa supra valde elevata subtus prominente, nervis secundariis utrinsecus 10–13 patentibus leviter curvatis marginem versus anastomosantibus supra subplanis subtus elevatis, rete venularum subimmerso; inflorescentia terminali sub anthesi ad 9 cm. longa pedunculata multiflora plerumque 3-plo divisa bracteis bracteolisque et corolla exceptis glabra, pedunculo crasso tereti 2.5–3 cm. longo, ramulis 4 vel 5 patentibus, pedunculis secundariis ad 3 cm. longis; bracteis sub ramulis papyraceis lanceolatis 7–10 mm. longis ut stipulis dorso copiose rufo-pilosis (pilis 0.2–0.5 mm. longis), profunde 3–5-lobatis, lobo medio elongato acuto, caducis, cicatricibus pilis rufidis copiosis ornatis, bracteolis similibus, ultimis 1–3 mm. longis; pedicellis teretibus paullo ante anthesin circiter 4 mm. longis; calyce magno, tubo turbinato 1.5–2 mm. longo et circiter 3 mm. diametro, limbo membranaceo conspicue reticulato-nervoso breviter adscendente deinde patente subrotato 10–12 mm. diametro profunde 5-lobato, lobis oblongo-deltoideis ad 3 mm. longis et 4 mm. latis obtusis; corolla carnosa tubulosa ante anthesin ad 13 mm. longa et medium versus circiter 3 mm. diametro superne paullo ampliata, extus marginibus loborum leviter pilosis exceptis glabra, intus inferne glabra medium versus pilis pallidis circiter 1 mm. longis copiose molliter induta, lobis 5 oblongis in alabastro circiter 2.5 mm. longis intus puberulis apice rotundatis et cucullatis; staminibus 5 faucibus affixis, antheris subsessilibus oblongis circiter 3 mm. longis basi sagittatis apice obtusis; disco hemisphaerico-pulvinato circiter 0.6 mm. alto; stylo tereti in alabastro quam corolla breviore, stigmatis lobis complanatis.

VITI LEVU: Mba: Ridge between Mt. Nanggaranambuluta [Lomalangi] and Mt. Namama, east of Nandarivatu, alt. 1050–1120 m., Aug. 18, 1947, *Smith 5681* (A TYPE, US) (compact tree 4 m. high, in dense forest; calyx white).

The species here described is evidently closely related to the preceding (*P. leucocalyx*), like which it has a membranaceous, subrotate calyx-limb and an externally glabrous corolla. It differs from *P. leucocalyx* in its copiously reddish-pilose stipules, bracts, and bracteoles, in its smaller calyx, and presumably in having its inflorescence more compact, although *P. jugalis* is not known at full anthesis.

Psychotria gibbsiae S. Moore in Jour. Linn. Soc. Bot. 39: 152. 1909.

VITI LEVU: Mba: Slopes and summit of Mt. Ndelaiyoö, on the escarpment west of Nandarivatu, alt. 900–1053 m., *Smith 5068* (A, US) (freely branching tree 5 m. high, in dense forest; calyx-limb and corolla white).

Among the specimens of this relationship available to me, the cited number is the only one that appears in every respect to agree with Moore's description. The original collections, *Gibbs 664* and *734*, came from "Nadarivatu, 2700 [ft.], edge of N. W. escarpment," which may be the precise locality of my no. *5068*. Mt. Ndelaiyoö is one of the eminences surmounting the escarpment west of Nandarivatu, and an old trail from Nandarivatu toward Mba passes near it; consequently it is a locality almost certainly visited by Gibbs. The species, as I interpret it, is characterized not only by its small leaves and compact cymes, but by the close and uniform puberulence of its inflorescence (including branches, pedicels, bracts, bracteoles, calyx, and corolla, the hairs being very dense and 0.1–0.2 mm. long), by having its campanulate (not subrotate) calyx-limb about 8 mm. long, and by having its puberulent stipules connate below into a campanulate (not tubular) base 3–5 mm. long, the free portions being about 5 mm. long and deeply bifid into lanceolate lobes.

Psychotria nandarivatensis sp. nov.

Arbor ad 4 m. alta, ramulis subteretibus, novellis et petiolis interdum patenti-pilosis (pilis rubellis ad 0.3 mm. longis) mox glabratis, nodis distalibus plerumque 5–15 mm. longis; stipulis papyraceis glabris 10–18 mm. longis glandulis minutis luteis linearibus copiose ornatis in vaginam tubulosam vel ampulliformem connatis, partibus liberis 2–3 mm. longis profunde bifidis; petiolis semiteretibus 1–2 cm. longis, laminis subcoriaceis in sicco olivaceis, lanceolatis vel anguste ellipticis, (5–) 7–13 cm. longis, (2–) 3–5.5 cm. latis, basi attenuatis et in petiolum decurrentibus, apice subacutis vel obtuse calloso-cuspidatis, margine integris et anguste recurvatis, supra glabris, subtus pilis rubellis multiseptatis fastigantibus 0.5–1 mm. longis patentibus ornatis demum glabratis, costa supra elevata subtus prominente, nervis secundariis utrinsecus 9–12 erecto-patentibus marginem versus leviter curvatis et anastomosantibus supra subplanis subtus elevatis vel prominulis, rete venularum immerso; inflorescentia compacta cymosa epedunculata pauciflora simplici (floribus receptaculo parvo enatis) vel e basi inconspicue 3-ramulosa raro 2-plo divisa, ramulis brevibus ut pedicellis patenti-pilosis (pilis multiseptatis rufidis 0.3–0.7 mm. longis) vel mox glabratis; bracteolis membranaceis deltoideis vel lanceolatis 1–4 mm. longis saepe irregulariter pauci-fissis, margine ciliolato excepto glabris, lobis calloso-apiculatis; pedicellis teretibus sub anthesi 8–14 mm. longis raro longioribus; calyce campanulato sub anthesi circiter 12 mm. longo et 10 mm. diametro ut pedicellis extus piloso vel glabrato vel glabro, tubo inconspicuo sub anthesi haud 1.5 mm. longo superne non contracto, limbo papyraceo in 5–6 mm. basalibus erecto tubuloso 3–4 mm. diametro deinde patente, lobis 5 oblongis 3–5 mm. longis 4–5 mm. latis manifeste nervatis apice obtusis; corolla submembranacea infundibulari sub anthesi lobis inclusis 17–20 mm. longa et basim versus circiter 2 mm. diametro superne ampliata, primo ut calyce extus copiose pilosa (pilis pallidioribus ad 1 mm. longis) inferne saepe subglabrata, tubo intus supra medium similiter piloso, lobis 5 oblongis circiter 4 × 2 mm. apice rotundatis demum reflexis; staminibus 5 in faucibus affixis, filamentis glabris brevibus, antheris oblongis circiter 2.5 mm. longis apice obtusis, loculis basi saepe divergentibus; disco conspicuo hemisphaerico-pulvinato circiter 1.5 mm. alto luteo-glanduloso-lineolato; stylo filiformi, stigmatis lobis complanatis.

VITI LEVU: Mba: Immediate vicinity of Nandarivatu, alt. 800–900 m., *Smith 5031* (A TYPE, US) (July 2, 1947; tree 4 m. high, in dense forest along stream; corolla white), *Degener & Ordonez 13598* (A, US, etc.) (tree, in rain-forest); western slopes of Mt. Nanggaranambuluta [Lomalangi], east of Nandarivatu, alt. 850–1000 m., *Smith 6303* (A, US) (compact tree 4 m. high in dense forest).

The new species differs from its closest ally, *P. gibbsiae* S. Moore (discussed above), in having its stipules connate into a tubular or flask-shaped sheath, with the free tips comparatively minute, in having its inflorescence-branches, pedicels, and calyx spreading-pilose with comparatively long, reddish, multiseptate hairs (or glabrate, but not closely puberulent), in having its bracteoles glabrous except for the ciliolate margins, and in having its calyx campanulate from the base, whereas in *P. gibbsiae* it is slightly contracted at the apex of the tube and then flaring slightly into the campanulate limb. It should be noticed that no. *6303*, identical with no. *5031* in every other respect, has its calyx glabrous, indicating that the degree of indument is not as dependable as its type.

Psychotria vaughanii sp. nov.

Frutex, ramulis crassis teretibus apicem versus pilis haud 0.1 mm. longis copiose sed minute cinereo-puberulis, nodis distalibus 1–3 cm. longis; stipulis papyraceis 3–4 mm. longis (immaturis?) dorso parce puberulis inferne in vaginam brevem connatis, partibus liberis circiter 2 mm. longis bifidis; petiolis crassis semiteretibus 0.7–1.4 cm. longis ut ramulis juvenilibus dense puberulis, laminis coriaceis in sicco luteo-viridibus, oblanceolatis vel anguste ellipticis, 12–19 cm. longis, 4–7 cm. latis, basi acutis et in petiolum decurrentibus, apice obtuse cuspidatis, margine undulatis et anguste recurvatis, supra glabris, subtus minute sed copiose puberulis, costa valida supra leviter elevata et obscure sulcata subtus prominente, nervis secundariis utrinsecus 12–14 patentibus curvatis marginem versus obscure anastomosantibus utrinque inconspicue elevatis, rete venularum immerso; inflorescentia terminali epedunculata e basi 3-ramulosa multiflora plerumque 4-plo divisa, ramulis pedicellisque copiose puberulis (pilis fulvis circiter 0.1 mm. longis), bracteolis papyraceis lanceolatis ad 1 mm. longis margine ciliolato et irregulariter fisso excepto glabris caducis; floribus e nodis ultimis plerumque 3, pedicellis gracilibus sub anthesi 3–5 mm. longis; calyce sub anthesi circiter 5 mm. longo et apice diametro extus copiose puberulo vel superne demum glabrato, tubo minuto cupuliformi, limbo campanulato inferne erecto breviter tubuloso circiter 3 mm. diametro apice subito patente, lobis 5 deltoideis rotundatis circiter 1.5 × 2 mm.; corolla submembranacea infundibulari sub anthesi 11–12 mm. longa et basim versus circiter 1.5 mm. diametro superne ampliata, extus inconspicue sed copiose puberula, intus inferne glabra medium versus pilis pallidis circiter 0.5 mm. longis copiose tomentella superne puberula, lobis 5 erectis oblongis circiter 1.5 mm. longis apice rotundatis et cucullatis; staminibus 5 apicem tubi corollae versus insertis glabris, filamentis gracilibus circiter 1 mm. longis, antheris oblongis circiter 2 mm. longis; disco pulvinato circiter 0.6 mm. alto; stylo gracili quam corolla breviore, stigmatis lobis complanatis.

VITI LEVU: Naitasiri: Prince's Road, mile 7 [approximate vicinity of Tholo-i-suva], alt. about 150 m., Nov. 10, 1946, *J. H. Vaughan 3323* (TYPE in herbarium of British Museum) (common shrub, with terminal clusters of tubular white flowers).

The species here described suggests *P. fragrans* (Gillespie) Fosberg in the size and spreading apex of its calyx-limb. However, the calyx-limb of *P. fragrans* is subrotate from its base, rather than campanulate, and is conspicuously glandular-lineate, while the plant is essentially glabrous in habit, has comparatively small leaves, a pedunculate inflorescence, and a longer corolla. Actually *P. vaughanii* in calycine characters more nearly approximates *P. gibbsiae* S. Moore, a species with much smaller leaves and a more compact and fewer-flowered inflorescence. The new species is further distinguished by the uniform puberulence of its vegetative parts and inflorescence and by having its narrowly campanulate calyx-limb flaring only at the apex.

Psychotria mundula sp. nov.

Frutex ad 2 m. altus ubique praeter corollam glaber vel partibus novellis minute puberulis, ramulis gracilibus teretibus in sicco rugulosis, internodiis distalibus 2–6 mm. longis; stipulis papyraceis ovato-oblongis 3.5–6 mm. longis in vaginam inferne connatis, superne liberis saepe scarioso-marginatis, dorso brevi-calcaratis vel in apicem subacutum vel acuminatum interdum puberulum productis; foliis apices ramulorum versus confertis parvis, petiolis gracilibus semiteretibus 2–7 mm. longis, laminis subcoriaceis obscure immerso-glandulosis in sicco viridi-olivaceis, lanceolatis vel ellipticis, (2–) 3–5.5 cm. longis, (0.5–) 1–2 cm. latis, basi attenuatis et in petiolum decurrentibus, apice acutis vel breviter acuminatis et calloso-apiculatis, margine integris anguste recurvatis, costa supra subplana subtus elevata, nervis secundariis utrinsecus 7–10 inconspicuis patentibus vel subadscendentibus curvatis anastomosantibus supra planis subtus prominulis, rete venularum immerso; inflorescentia terminali cymosa compacta pauciflora epedunculata vel pedunculo ad 2 mm. longo, sub anthesi floribus inclusis 2–3 mm. longa, ramulis plerumque 3 patentibus ad 1.5 cm. longis saepe 3-floris, floribus sessilibus, lateralibus apice ramulorum secundariorum ortis, bracteolis sub floribus 1–2 mm. longis deltoideis acutis vel interdum apice trifidis; calyce infundibulari sub anthesi limbo incluso 5–7 mm. longo et apice 3–4 mm. diametro, tubo brevi, limbo papyraceo erecto lobis inclusis 3–4 mm. longo, lobis 5 vel 6 deltoideo-lanceolatis 1–1.5 mm. longis incrassatis acutis interdum apice patentibus; corolla tenuiter carnosa gracili infundibulari sub anthesi lobis inclusis 13–15 mm. longa, extus glabra, intus faucibus et lobis pallide puberula, lobis 5 vel 6 oblongis obtusis 3–4 mm. longis sub anthesi patentibus; staminibus 5 vel 6, filamentis gracilibus ad 1 mm. longis vel subnullis, antheris oblongis 2–2.3 mm. longis utroque obtusis; disco annulari-pulvinato 0.6–0.8 mm. alto; stylo filiformi interdum corollam subaequante, apice bifido.

VANUA LEVU: Mathuata: Northwestern slopes of Mt. Numbuiloa, east of Lambasa, alt. 500–590 m. [also noted on summit], Nov. 6, 1947, *Smith 6533* (A TYPE, US) (shrub 2 m. high, in wind-swept thickets; corolla white). VITI LEVU: Mba: Mountains near Lautoka, alt. 480–550 m., *Greenwood 1226, 1227, 1270, 1271* (all US) (shrubs about 50 cm. high, on dry open hillsides; flowers white).

The very distinct species described above is characterized by its compact habit, the crowded leaves nearly concealing the small, few-flowered inflorescences. Each branch of the 3-parted inflorescence usually bears three sessile flowers, but the lateral flowers, borne on short secondary branchlets, are sometimes flanked by additional and mostly undeveloped flowers. The erect calyx-limb, with longitudinal thickenings terminating in the lobes, and the slender corolla with the throat puberulent also characterize the species. In its basic floral characters, the new species seems most closely related to *P. gillespieana* A. C. Sm. [*Calycosia laxiflora* Gillespie] (represented in my present collection by nos. *5180* and *5184*, from Mt. Tomanivi, the type-locality), a species with much larger stipules which have laminar forked apices, larger and longer-petiolate leaves, a much more ample and freely divided inflorescence, and larger flowers. Greenwood's specimens were taken from two plants, his nos. *1227* and *1270* representing one and nos. *1226* and *1271* the other, the second of these having slightly the narrower leaves.

Psychotria leptocalyx sp. nov.

Arbor ad 5 m. alta, ramulis gracilibus subteretibus et petiolis minute sed dense puberulis (pilis griseis ad 0.05 mm. longis), internodiis distalibus 8–15 mm. longis; stipulis papyraceis 15–17 mm. longis extus copiose puberulis, basim versus in vaginam connatis, partibus liberis laminaribus 10–12 mm. longis conspicue bifidis; petiolis gracilibus semiteretibus 1–2 cm. longis, laminis subcoriaceis in sicco fuscis, oblanceolatis vel elliptico-obovatis, 9–16 cm. longis, 3–6.5 cm. latis, basi attenuatis et in petiolum longe decurrentibus, apice obtusis vel obtuse cuspidatis, margine integris et anguste recurvatis, supra glabris, subtus minute sed uniformiter griseo-puberulis, costa supra leviter elevata et sulcata subtus prominente, nervis secundariis utrinsecus 11–13 arcuato-adscendentibus marginem versus anastomosantibus supra paullo subtus valde elevatis, rete venularum immerso; inflorescentia terminali sub anthesi ad 12 cm. longa multiflora plerumque 4-plo divisa manifeste pedunculata, pedunculo gracili ad 4 cm. longo et ramulis inflorescentiae pedicellisque copiose puberulis, pedunculis secundariis 3 radiatis 2–3.5 cm. longis; bracteolis papyraceis oblongis 1–1.5 mm. longis in lobos 3 plerumque fissis, dorso puberulis, margine ciliolatis, bracteis similibus 3–4 mm. longis mox glabratis et caducis; pedicellis sub anthesi gracilibus ad 6 mm. longis; calyce sub anthesi 6–7 mm. longo et apice 4–5 mm. diametro extus copiose puberulo, tubo pyriformi circiter 1.5 mm. longo et 2.5 mm. diametro, apice constricto, limbo papyraceo obscure nervato, parte basali fusiformi erecta 3–4 mm. longa et circiter 2.5 mm. diametro superne leviter contracta deinde subito patente, lobis 5 oblongis rotundatis circiter 1.5 × 2 mm.; corolla submembranacea infundibulari circiter 20 mm. longa (vel ultra?) et basim versus 2 mm. diametro superne ampliata, extus basi excepta cinereo-puberula, intus medium versus pilis ad 0.6 mm. longis dense tomentella, lobis 5 erectis oblongis 3–4 mm. longis apice obtusis cucullatis; staminibus 5 faucibus affixis glabris, filamentis gracilibus 1–2 mm. longis, antheris oblongis circiter 3 mm. longis; disco pulvinato circiter 0.5 mm. alto; stylo gracili quam corolla breviore, stigmatis lobis complanatis.

VITI LEVU: Mba: Hills east of Nandala Creek, about 3 miles south of Nandarivatu, alt. 850–970 m., Sept. 25, 1947, *Smith 6215* (A TYPE, US) (tree 5 m. high, in dense forest; pedicel and calyx-tube greenish white, the lobes white; corolla white).

In its comparatively narrow, fusiform calyx-limb, *P. leptocalyx* suggests *P. vitiensis* Fosberg [*Calycosia monticola* Gillespie], which, as Fosberg has pointed out (in Sargentia 1: 127. 1942), is distinct from *P. calycosa* A. Gray. From *P. vitiensis,* however, the new species is readily distinguished by the dense, although minute, puberulence of its vegetative and inflorescence parts, and by its larger leaves and more freely branching inflorescence. Also suggestive of the new species and resembling it in indument is *P.*

vaughanii, described above, which has the inflorescence epedunculate, the calyx proportionately broader, with the basal part of the limb campanulate rather than fusiform, and the corolla apparently shorter.

Psychotria eumorphanthus Fosberg in Sargentia 1: 127. 1942.

VITI LEVU: Mba: Western slopes of Mt. Tomanivi [Mt. Victoria], alt. 850–1000 m., *Smith 5091* (A, US) (tree 6 m. high, in dense forest; calyx-limb green).

This species (*Eumorphanthus fragrans* A. C. Sm. in Bishop Mus. Bull. 141: 158. *fig. 81.* 1936) has previously been known only from the type collection, from Taveuni. The cited Viti Levu specimen, in fruit, agrees in all respects with the type and similarly has a subpersistent calyx-limb about 2 cm. long; the only apparent difference is that no. *5091* has the secondary nerves of the leaves slightly closer, 12–15 per side rather than 9–13. Unless the discovery of flowers should prove otherwise, I think that the range of the species may safely be extended to include Viti Levu.

Psychotria leptantha sp. nov.

Arbor ad 12 m. alta, ramulis gracilibus subteretibus glabris (vel novellis interdum parce puberulis) apices versus 1.5–2 mm. diametro, internodiis distalibus 5–10 mm. longis; stipulis lanceolatis 6–8 mm. longis obscure puberulis vel glabris, basim versus lateraliter cohaerentibus, apice subacutis, mox caducis; foliis patentibus glabris, petiolis semiteretibus gracilibus 1–3 cm. longis, laminis papyraceis in sicco viridibus, interdum ut ramulis stipulisque cystolithis circiter 0.2 mm. longis ornatis, ellipticis vel oblanceolatis, 7–12 cm. longis, 3–5 cm. latis, basi acutis vel attenuatis et in petiolum decurrentibus, apice cuspidatis (apice ipso ad 5 mm. longo obtuso vel subacuto), margine integris, costa supra leviter elevata et basim versus anguste canaliculata subtus prominente, nervis secundariis utrinsecus 6–9 arcuato-patentibus marginem versus anastomosantibus supra subplanis subtus elevatis, rete venularum laxo utrinque prominulo vel supra immerso; inflorescentia terminali pauciflora compacte cymosa sub anthesi corolla inclusa ad 9 cm. longa et lata plerumque e basi 3-partita bracteis pluribus deltoideis obtusis 2–3 mm. longis caducis subtenta, ramulis gracilibus laxe pilosis (pilis pallidis 0.1–0.3 mm. longis obscure pluriseptatis), lateralibus 1–1.5 cm. longis apice 2- vel 3-floris, ramulo centrali semel vel bis partito plurifloro; bracteis sub floribus minutis circiter 1 mm. longis caducis, pedicellis teretibus sub anthesi 5–9 mm. longis ut ramulis pilosis in calycem gradatim crassatis; calyce graciliter infundibulari sub anthesi 1.5–2 cm. longo basim versus piloso vel puberulo alioqui glabro, tubo minuto, limbo magno erecto submembranaceo conspicue longitudinaliter nervato apice circiter 5 mm. diametro inconspicue 5-lobato, lobis inaequalibus deltoideis acutis haud 1 mm. longis; corolla hypocrateriformi submembranacea, tubo graciliter cylindrico sub anthesi 3.5–4 cm. longo et circiter 1.5 mm. diametro faucibus paullo ampliato superne extus puberulo et intus subtiliter arachnoideo-tomentello cetera glabro, lobis 5 patentibus anguste oblongis vel obovatis 13–15 mm. longis circiter 4 mm. latis manifeste nervatis apice obtusis extus puberulis intus glabris; staminibus 5 tubi apicem versus insertis et leviter exsertis, filamentis membranaceis ligulatis ad 5 mm. longis vel omnino tubum adnatis, antheris anguste oblongis circiter 3.5 mm. longis obtusis; disco annulari-pulvinato glabro circiter 0.8 mm. alto et 1.5 mm. diametro; stylo gracili glabro circiter 2 cm. longo in stigmata circiter 2 mm. longa fisso; floribus post anthesin saepe caducis, fructibus 1 vel 2 per inflorescentiam, pedicellis sub fructu 1–1.5 cm. longis persistenter patenti-pilosis; fructibus in vivo carnosis et ellipsoideis ad 23 × 15 mm. (maturis?) in sicco 4-angularibus, basim versus et basi persistente calycis limbi puberulis, parte majore calycis limbi mox caduca, pyrenis (maturis?) triquetro-ovoideis circiter 1 cm. longis latisque, basi rotundatis, apice subacutis, ventre complanatis levibus, dorso unicarinatis.

VITI LEVU: Mba: Slopes of Mt. Nairosa, eastern flank of Mt. Evans Range, alt. 700–1050 m., in dense forest, *Smith 4048* (A TYPE, US) (April 26, 1947; tree 8 m. high; calyx and corolla pure white), *4423* (A, US) (tree 12 m. high, in fruit).

Psychotria leptantha is a sharply marked and very attractive species, characterized by its long, narrow calyx-limb and its very slender, elongate corolla-tube. It is closely allied only to *P. eumorphanthus* Fosberg, from which it obviously differs in being more delicate and slender throughout, in its much smaller leaves, slightly smaller and more slender calyx-limb, corolla with a slightly shorter tube and much smaller lobes, and shorter style. Fosberg (in Sargentia 1: 125, 127. 1942), in reducing my genus *Eumorphanthus* to *Psychotria,* allies its single species to *P. confertiloba* A. C. Sm. [*P. umbraticola* Gillespie]. This is perhaps the correct disposition, since the two species concerned are quite similar in basic corolla and fruit characters. However, the calyx-limb of *P. confertiloba* does not exceed 7 mm. in length, whereas in both *P. eumorphanthus* and *P. leptantha* it approaches or exceeds 2 cm. *Psychotria confertiloba* proves to be a very common species in upland Viti Levu, being represented in my present collection by nos. *4542, 4800, 5011, 5129, 5252, 5313, 5560,* and *5790,* and also by *Degener 13567, 14280, 14610, 14754,* and *14830.* To the Vanua Levu specimens cited by me as *P. confertiloba* (in Bishop Mus. Bull. 141: 152. 1936) may be added *Smith 6470, 6650,* and *Degener & Ordonez 14010.*

Psychotria gracilior sp. nov.

Arbor ad 10 m. alta sub fructu ubique glabra, partibus novellis, stipulis, petiolis inflorescentiae ramulisque cystolithis 0.1–0.3 mm. longis saepe copiose ornatis; ramulis gracilibus subteretibus apices versus 1.5–2 mm. diametro, internodiis distalibus 5–7 mm. longis; stipulis lanceolatis 1–1.5 cm. longis infra medium lateraliter connatis apice liberis et calloso-acuminatis mox caducis; foliis patentibus, petiolis gracilibus semiteretibus 1–2 cm. longis, laminis papyraceis in sicco viridibus oblanceolatis, 8–11 cm. longis, 2.5–4 cm. latis, basi attenuatis et in petiolum longe decurrentibus, apice in acuminem gracilem 5–10 mm. longum obtusum angustatis, margine integris et leviter recurvatis, supra cystolithis dispersim ornatis, costa supra leviter elevata subtus prominente, nervis secundariis utrinsecus 7–9 marginem versus obscure anastomosantibus supra subplanis subtus elevatis, rete venularum laxo supra plano subtus prominulo; infructescentia terminali compacte cymosa fructibus inclusis ad 4 cm. longa et 6 cm. lata e basi 3-partita bracteis caducis subtenta, ramulis lateralibus (interdum caducis cicatricibus indicatis) 8–12 mm. longis fructus 2 vel 3 gerentibus, ramulo centrali plerumque semel partito; fructibus pluribus per infructescentiam, pedicellis gracilibus 6–12 mm. longis, fructibus in vivo carnosis ellipsoideis maturitate ad 2 × 1.5 cm. in sicco 4-angularibus, utroque obtusis vel subacutis, calycis limbo subpersistente cylindrico papyraceo erecto 4–5 mm. longo longitudinaliter nervato coronatis, limbo apice irregulariter erosulo vel inconspicue 5-lobato, lobis deltoideis obtusis circiter 0.5 mm. longis; pyrenis triquetro-oblongo-ellipsoideis, 11–12 mm. longis, 6.5–8 mm. latis, 3.5–4 mm. crassis, basi rotundatis, apice cuspidatis, ventre complanatis levibus vel obscure sulcatis, dorso unicarinatis.

VITI LEVU: Mba: Hills between Nandala and Nukunuku Creeks, along trail from Nandarivatu toward Lewa, alt. 750–850 m., Sept. 22, 1947, *Smith 6186* (A TYPE, US) (tree 5–10 m. high, in dense forest; fruit at length deep red).

Although the specimen cited above lacks flowers, it clearly represents a new species of the general alliance of *P. leptantha,* above described, from which it differs most obviously in its comparatively short calyx-limb. *Psychotria gracilior* further differs from *P. leptantha* in its completely glabrous habit, its comparatively narrow leaves, and its apparently smaller fruits, of which the pyrenes are differently proportioned. In spite of the general similarity of these two species in foliage, perhaps a closer alliance of *P. gracilior* is with *P. confertiloba* A. C. Sm., as indicated by the similarity in size of the calyx-limb. However, *P. confertiloba* is comparatively coarse in habit, with broader leaves generally obtuse at apex and with spreading secondaries, and with larger fruits.

DEPARTMENT OF BOTANY,
U. S. NATIONAL MUSEUM,
SMITHSONIAN INSTITUTION.

STUDIES IN THE THEACEAE, XXVII
MISCELLANEOUS NEW SPECIES IN THEACEAE

Clarence E. Kobuski

Study and work on a single genus is never truly completed. The publication of such a work often incites an interest for even further study, as the author begins receiving unexpected material for identification — material which often changes his opinion of his own work supposedly completed. Such is the case in the genus *Adinandra*. Shortly after the publication of a review of the genus more than seven hundred additional specimens were received, mostly from Indonesia. These were sent primarily for my studies to be included in the *Flora Malesiana*. Several new species have been discovered among these specimens, and these are being included here, since considerable time will elapse before their descriptions will appear in the *Flora*. Also included are a few new entities in *Eurya* and *Freziera*. All are oriental except a single species of *Freziera* from Colombia.

Adinandra anisobasis, sp. nov.

Arbor magna, 20–30 m. alta; trunco 30–60 cm. diametro; ramulis juvenilibus rubris, teretibus, adpresso-pubescentibus; ramulis maturis glabris, teretibus, brunneo-rubris; gemmis terminalibus conicis, dense aureo-adpresso-pubescentibus. Folia coriacea, late ovata vel elliptica, 8–14 cm. longa, 5–7 cm. lata, supra nitida, glabra, subtus pallidora, pubescentia, punctata, apice obtusa, late acuminata vel rotundata, basi inaequalia, subrotundata, rare obtusa, margine integra, venis 10–12 paribus, undique elevatis, marginem intra anastomosantibus arcuantibusque, petiolis brevibus, ca. 2 mm. longis vel subsessilibus. Flores axillares, solitarii; pedicellis teretibus, ca. 1.5 cm. longis, brevi-adpresso-pubescentibus; bracteolis 2, persistentibus, oppositis vel suboppositis, late ovatis vel deltoideis, subaequalibus, ca. 2.5 cm. longis latisque, adpresso-pubescentibus; sepalis 5, imbricatis, late ovatis vel subrotundatis, duobus exterioribus ca. 5 mm. longis et 4 mm. latis, margine integris, dorso ad marginem dense adpresso-pubescentibus, tribus interioribus ca. 7 mm. longis et 5 mm. latis, margine scariosis, integris, dorso medio adpresso-pubescentibus; petalis 5, cremeo-albis basi connatis, obovatis, ca. 15 mm. longis, 5.5–7 mm. latis, integris, apice rotundatis, exteriore medio adpresso-pubescentibus; staminibus ca. 35, 3-vel 4-seriatis, filamentis ad basim corollae adnatis, 5–7 mm. longis, supra pubescentibus, ad basim glabris, antheris ca. 5 (–6) mm. longis, dense brunneo-pubescentibus; ovario globoso, glabro, ca. 4 mm. diametro, 5-loculari, mutiovulato, apice abrupte in stylum attenuato, stylo integro, glabro, ca. 10 mm. longo, stigmate punctiformi. Fructus maturus non visus.

BRITISH NORTH BORNEO: Mt. Kinabalu: Penataran river basin, Penataran river, in jungle near Lobang, alt. 3500 ft., *J. & M. S. Clemens 34154* (Bogor, TYPE; AA, fragment), July 25, 1933 (tree 70 ft.; diam. 1–2 ft.; flowers cream, the anthers brown). — Penataran river basin, Wusser River, alt. 3500 ft., *J. & M. S. Clemens 34035* (Bogor), July 22, 1933 (tree 80 ft. high., diam. 2 ft.; flowers cream-white, the anthers brown).

The outstanding characteristic of this species is the unequal base of the shining subsessile leaves. In this character it resembles *A. cordata*, also found on Mt. Kinabalu. However, the latter species can be separated by (1) the truly cordate leaf-base; (2) larger (20 × 10 mm.) glabrous corolla-lobes; and (3) larger calyx-lobes (12 × 18 mm.), broader than long.

Cited here may be a third specimen, unnumbered, collected by J. & M. S. Clemens at Penibukan, 4000 ft. altitude, on Mt. Kinabalu. This specimen is sterile but agrees with the species in foliage and branch characters.

Adinandra endertii, sp. nov.

Arbor; ramis rubro-griseis, teretibus glabris (innovationibus leviter pubescentibus), gemmis terminalibus longo-conicis pubescentibus. Folia membranacea vel chartacea, elliptica, glabra, subtus punctata, 4–5 cm. longa, 1.3–1.7 (–2) cm. lata, apice acuta, basi cuneata decurrentiaque, margine integra vel subintegra, venis 7–9 paribus, petiolis circiter 3 mm. longis, subtus pubescentibus. Flores axillares, solitarii; pedicellis teretibus, tenuibus, circiter 2 cm. longis, glabris (basi saepe leviter adpresso-pubescentibus); bracteolis 2, oppositis, late ovatis vel subrotundatis, inaequalibus, 1.5–2.5 mm. longis, 2.5–3.5 mm. latis, persistentibus, in medio crassioribus, ut videtur glabris (sub magnificatione leviter adpresso-pubescentibus); sepalis 5, imbricatis, glabris (sub magnificatione leviter adpresso-pubescentibus), late ovatis, apice rotundatis, subaequalibus, ca. 7 mm. longis, 5–8 mm. latis; petalis 5, ovatis, ca. 6 mm. longis (in gemmis), dorso medio dense pubescentibus; staminibus numerosis, 3-seriatis ?, filamentis glabris, ad basim corollae adnatis, antheris dense hirsutis; ovario subplano, glabro, 5-angulato, apice in stylum abrupte attenuato, 5-loculari, multiovulato. Fructus non visus.

EAST BORNEO: W. Koetai: near Kemoel, forest in very mountainous country, alt. 1600 m., *F. H. Endert 4135* (Arnold Arboretum, TYPE; Bogor, ISOTYPE), Oct. 14, 1925 (tree with greyish green buds).

In general characters this species resembles the Philippine species more closely than the Indonesian species. The smaller chartaceous elliptic leaves and the smaller, less robust flowers and floral parts remind one of *A. apoensis* Elmer of Mindanao. The Philippine species, however, can be separated by the coriaceous leaves, broadly rounded at the apex, with the margin serrate along the upper half. The filaments in *A. apoensis* are very hirsute — as hirsute as the anthers.

Adinandra laronensis, sp. nov.

Arbor ?; ramulis maturis teretibus, griseis, glabris; ramulis juvenilibus teretibus, rubris, adpresso-pubescentibus; gemmis terminalibus conicis, dense aureo-adpresso-pubescentibus. Folia coriacea, elliptica vel subelliptica, 7–13 cm. longa, 2.5–4 cm. lata, supra glabra, subtus glabrescentia, apice late acuta vel obtusa, basi cuneata, margine integra vel minute glanduloso-denticulata, venis ca. 12 paribus, marginem intra anastomosantibus arcuantibusque, petiolis brevibus, 2–3 mm. longis, glabris. Flores ignoti. Fructus immaturi axillares, solitarii; pedicellis teretibus, 1.5–2 cm. longis, glabris; bracteolis 2, oppositis, persistentibus, glabris, rotundatis vel subrotundatis, ca. 3 mm. longis latisque; sepalis 5, imbricatis, glabrescentibus (juvenilibus adpresso-pubescentibus), rotundatis, 5–7 mm. longis latisque; petalis non visis; fructibus immaturis globosis vel subglobosis, glabris, 5-locularibus, multiseminatis; seminibus nigris, nitidis, 2 mm. longis, reticulatis.

CELEBES: Gouvt. Celebes en Onderh.: Malili, near Larona, *"Mantri Boschwezen" bb.2399* (Bogor, TYPE), Oct. 13, 1922. — Same locality, *"Mantri Boschwezen" 1875* (Bogor).

This species owes its proposed status to its very distinct leaves. Ordinarily one would not suggest a new species on such sparse material, since only a single attached immature fruit is to be found. However, the rather thick coriaceous elliptic leaves make it stand out from the other species on the island. A third specimen (*bb.3225*) collected at the same locality and by the same collector, "*Mantri Boschwezen*," obviously an unknown assistant, might be cited here. The leaves in this third specimen are wider.

Adinandra loerzingiana, sp. nov.

Arbor 25 m. alta; ramis griseis, teretibus, glabris, cicatricibus magnis, ca. 4 × 3 mm., ramulis novellis rubris, leviter adpresso-pubescentibus; gemmis terminalibus longis, adpresso-fulvo-pubescentibus. Folia sessilia, crasso-coriacea, glabra, elliptica vel subelliptica, 10–15 cm. longa, 5–7 cm. lata, apice obtusa, subtiliter late acuminata, basi late cuneata, margine integra, venis prominentibus, primariis 20 (vel plus) paribus, marginem intra anastomosantibus, venis secundariis inter primarias frequentibus. Flores axillares, solitarii; pedicellis glabris, curvatis, teretibus, 2–2.5 cm. longis; bracteolis 2, supoppositis, persistentibus, glabris, deltoideis, inaequalibus, ca. 2 mm. longis latisque; sepalis 5, imbricatis, glabris, subrotundatis, inaequalibus, exterioribus duobus minoribus, ca. 5 mm. longis et 7 mm. latis, interioribus tribus ca. 5 mm. longis et 12–13 mm. latis, margine late scariosis; petalis 5, basi connatis, glabris, cremeis, obovatis, inaequalibus, exterioribus ca. 15 mm. longis et 9 mm. latis, interioribus ca. 15 mm. longis et 12–13 mm. latis; staminibus ca. 40, ut videtur 4-seriatis, inaequalibus, 10, 11, 12 et 13 mm. longis, filamentis 4–5 mm. longis basi connatis, glabris vel apice leviter pubescentibus, antheris inaequalibus, 6, 7, 8, et 9 mm. longis, dense setiferis; ovario late conico, ca. 3 mm. longo, 5 mm. diam., ad apicem adpresso-pubescente, 2-loculari, pauci-ovulato, stylo glabro, integro, ca. 1.5 cm. longo. Fructus globosus vel subglobosus, glabrescens vel apice leviter adpresso-pubescens, 1.5–2 cm. diam., 2-locularis, pauci-seminatus, seminibus 2–10 (rare uno semine in quoque loculo), subplanis, hippocrepiformibus, 7–8 mm. longis, nitidis.

SUMATRA: Gouvt. Oostkust Sumatra: Afd. Sibolangit, near Bandar baroe, rare in primary forest, alt. 850 m., *J. A. Lörzing 6862* (Bogor, TYPE), Sept. 7, 1919 (tree 15 m. with hard wood; flowers fragrant, cream-colored); same general locality, *J. A. Lörzing 7040* (Bogor), Jan. 7, 1920 (tree 25 m. high).

This species is characterized by the sessile, thickly coriaceous, many-veined leaves, the persistent bracteoles, the two-celled ovary and fruit, and the few ovules and seeds. In some dissections a single seed was found in each locule of the fruit. The leaf-scars are unusually large, measuring as much as 5 mm. in diameter. This large scar is due to the unusually thickened base of the sessile leaves.

The only other two species known to have two-celled ovary and fruit are *A. nunkokensis* Kob. from Mt. Kinabalu, British North Borneo and *A. subsessilis* Airy-Shaw of Sarawak. In both *A. nunkokensis* and *A. subsessilis* the flowers are briefly pedicellate, longer (5 mm.) in the former species and subsessile in the latter. In both species the leaves are long-acuminate and the veins are fewer in number (6–8 pairs in *A. nunkokensis* and 12–14 pairs in *A. subsessilis*).

Adinandra kjellbergii, sp. nov.

Arbor (immatura) 6 m. alta; ramulis multis, teretibus, glabris, innovationibus leve adpresso-pubescentibus, gemmis terminalibus parvis, conicis, dense adpresso-pubescentibus. Folia coriacea, obovata, 5–9 cm. longa, 2–4 cm. lata, apice obtusa vel rotundata, late acuminata, basi cuneata, supra nitida glabra, subtus pallidiora, sparse adpresso-pubescentia, margine integra vel glanduloso-denticulata, venis undique obscuris, ca. 8 paribus, petiolis 7–10 mm. longis. Flores axillares, solitarii; pedicellis tenuibus, 1.5–2 cm. longis, sparse adpresso-pubescentibus vel glabrescentibus; bracteolis 2, oppositis, adpresso-pubescentibus, inaequalibus, una late rotundata, 2.5 mm. longa et 4 mm. lata et altera late ovata, 2.5 mm longa et 3 mm. lata, apiculata; sepalis 5, imbricatis, rotundatis, 7–9 mm. longis, ca. 8 mm. latis, dense adpresso-pubescentibus; petalis 5, albis, basi connatis, obovatis, ca. 12 mm. longis, 6–8 mm. latis, exteriore medio aureo-adpresso-pubescentibus; staminibus ca. 40, bi-seriatis ut videtur, ca. 7 mm. longis, filamentis ad basim corollae adnatis, connatis, ca. 3 mm. longis, dense pubescentibus, antheris ca. 4 mm. longis, dense pubescentibus; ovario globoso, glabro, ca. 3 mm. diametro, apice subtruncato, 5-loculari, multiseminato. Fructus non visi.

CELEBES: Gouvt. Celebes en Onderh.: Makale, Rantepao, near Doa, alt. 1000 m., *J. van Ziyl de Jong 29/vz* (Bogor *bb.20268*), Feb. 9, 1936 (young tree 6 m. high with white flowers). — Todjamboe, rare in rain forest, alt. 800 m., *G. Kjellberg 2281* (Mus. Bot. Stockholm, TYPE; Bogor, ISOTYPE), Aug. 12, 1929 (tree ca. 15 m.).

In this species all the floral parts with the exception of the style and ovary are densely appressed-pubescent. In the stamens both the anthers and the filaments (except the portion touching the corolla) are densely pubescent. The ovary is unusual in that the apex is quite truncate rather than tapering, so that the style rises abruptly rather than gradually as is usually the case.

As the flowering material of the type was very sparse, only a single floral dissection was possible. However, the abundant pubescence on the floral parts is distinctive for any *Adinandra* in the region.

Adinandra masambensis, sp. nov.

Arbor nondum adulta 25 m. alta; ramulis teretibus, robustis, rigidis, rubro-brunneis, partibus juvenilibus pubescentibus. Folia crasso-coriacea, elliptica vel ovato-elliptica, 7–12 cm. longa et 4–6.5 cm. lata, apice obtusa vel rotundata, subemarginata, basi rotundata vel subcordata, supra glabra subtus juventute pubescentia, glabrescentia, costa supra canaliculata, subtus elevata, margine integra, venis undique obscuris, petiolis crassis, teretibus, ca. 5 mm. longis. Flores non visi. Fructus (juvenes) axillares, solitarii; pedicellis ca. 2.5 cm. longis, apice 3 mm. crassis; bracteolis 2, oppositis, persistentibus, adpresso-pubescentibus, latissimis, sublunatis, basi crassibus, inaequalibus, 5 mm. longis × 9 mm. latis et 4 mm. longis × 7 mm. latis, adpresso-pubescentibus, margine subciliatis; sepalis 5, imbricatis, crassis, subrotundatis, adpresso-pubescentibus subaequalibus, 9–10 mm. longis et 11–12 mm. latis; ovario globoso, ca. 5 mm. diametro, glabro, 5-loculari, multiovulato; stylo fracto.

CELEBES: Gouvt. Celebes en Onderh.: Masamba, near Rato, rare, alt. ca. 1000 m., *F. Grot 6* (Bogor, *bb. 26298*, TYPE), Sept. 11, 1938 (young tree 25 m., diameter 30 cm.; flowers white).

Outstanding characteristics of this new species are (1) the thick coriaceous pubescent leaves, almost elliptic in shape, subretuse at the apex, rounded or subcordate at the base, *not* decurrent into the petiole, with obscure veining; (2) the persistent bracteoles, much broader (9 mm.) than long (5 mm).

Its closest relative appears to be *A. cordata* from British North Borneo. This latter species can be separated by its glabrous leaves, sharply oblique-cordate at the base, obtusely acuminate at the apex, with ten to twelve conspicuous pairs of veins, and its sericeous ovary.

Neither flowers nor mature fruit were available for this study. However, the glabrous, five-celled fruit, although immature, and the unusual leaves show the species to be distinct from its nearest relatives and so worthy of description.

Adinandra rantepaoensis, sp. nov.

Arbor ca. 15 m. alta; ramulis paucis, teretibus, glabris; gemmis terminalibus glabris. Folia crasso-coriacea, elliptica vel ovato-elliptica, 13–19 cm. longa, 5.5–8 cm. lata, apice late ovata vel obtusa, subacuminata, basi cuneata in petiolum decurrentia, margine integra, venis 8–10 paribus, undique conspicuis, adscendentibus, ad marginem anastomosantibus, petiolis ca. 1.5 cm. longis, glabris. Flores solitarii, axillares; pedicellis glabris, teretibus, 2.5–3.5 cm. longis, 2.5–3 mm. crassis, apice curvatis; bracteolis 2, oppositis, crassis, glabris, subaequalibus, latioribus quam longis, semirotundatis, 4–5 mm. longis, 7–9 mm. latis, integris; sepalis 5, imbricatis, glabris, crassis, subrotundatis, exterioribus duobus 12 mm. longis et 14 mm. latis, interioribus tribus 9 mm. longis et 11 mm. latis; petalis (immaturis) 5, obovatis, ca. 15 mm. longis et 12 mm. latis, apice subacutis, dorso dense pubescentibus (margine excepto); staminibus ca 60, ut videtur 3-seriatis, ca. 10 mm. longis, dense pubescentibus, filamentis connatis, ca. 7 mm. longis, basi ad corollam adnatis, antheris ca. 3 mm. longis; ovario globoso vel subgloboso, 6–7 mm. diametro, dense luteo-pubescente, 5-loculari, multiovulato, pericarpio crasso; stylo 7 mm. longo, glabris basi excepto; stigmate punctato. Fructus non visi.

CELEBES: Gouvt. Celebes en Onderh.: Rantepao, Bala, Balambang, alt. 1600 m., *J. K. Thenu 19* (*bb. 11857*) (TYPE, Bogor), Sept. 6, 1927 (tree ca. 15 m.). — Same locality, *J. K. Thenu 8* (*bb. 11846*) (Bogor).

This distinctive species is characterized by large heavy-coriaceous glabrous leaves with eight to ten widely spaced primary veins. The leaf-base is cuneate and decurs into the petiole, nearly to its base. The floral parts are all large. A single stamen adhering to the lobe of the calyx shows that at maturity the longer stamens may measure up to ten mm. The corolla, which was described above from a bud, may be considerably extended at anthesis. The cell cavity of the ovary is rather small and appears to be confined to a small area near the base of the ovary. It measures only ca. 2 mm. in diameter. The pericarp is very thick, measuring about 2 mm. thick at the base. The upper two thirds of the ovary is dense and of the same texture as the pericarp, with no cell structure obvious.

Adinandra rubiginosa, sp. nov.

Arbor 25 m. alta, trunco angulatissimo, 40 cm. diametro; ramulis teretibus, rubro-brunneis, pubescentibus; gemmis terminalibus dense hirsutis. Folia coriacea, oblongo-ovata, 10–15 cm. longa, 3.5–4 cm lata, supra glabra, rubiginosa, subtus dense rubro-brunnea hirsuta, apice acuta, basi cuneata, margine integra, venis obscuris, petiolis crassis, ca. 5 mm. longis et ca. 3 mm. diametro. Flores axillares, solitarii; pedicellis crassis, recurvatis, teretibus, 5 mm. longis, 3 mm. diametro; bracteolis 2, oppositis, persistentibus, crassis, semi-rotundatis, inaequalibus ca. 3 mm. longis × 4 mm. latis et 2 mm longis × 4 mm. latis, dorso pubescentibus, margine ciliatis; sepalis 5, imbricatis, inaequalibus, duobus exterioribus rotundato-ovatis, 5 mm. longis, basi 5 mm. latis, pubescentibus, tribus interioribus subrotundatis, glabris, ca. 7 mm. longis, 5 mm. latis, margine scariosis; petalis (immaturis) 5, dorso glabro; staminibus (immaturis) ca 30, 3-seriatis ?, filamentis basi connatis, ad basim corollae adnatis, subtus, glabris, super hirsutis, antheris elongatis, ca. 3 mm. longis, dense hirsutis, apice apiculatis; ovario semi-globoso, 5-loculari, multiovulato, apice abrupte in stylum attenuato, stylo glabro, integro, stigmate punctiformi. Fructus (immaturus) globosus, glaber, 5-locularis, multiseminatus, stylo 13 mm. longo.

BORNEO: Subdiv. W. Koetai: near Kemoel, in forest on steep ravine wall, alt. 1100 m., *F. H. Endert 3869* (AA, TYPE; Bogor, ISOTYPE), Oct. 10, 1925 (tree 25 m. high, 25 cm. diam.; trunk very angular; flowers white).

This species is characterized by dark red, coriaceous, oblong-ovate leaves glabrous on the upper surface (even in the terminal bud) and densely hirsute on the lower surface, becoming glabrescent. The pubescence on the younger leaves is striking in that it appears to be densely distributed in distinct longitudinal striae. Although not an unusual occurrence in other pubescent species of the family, this character is unusual in *Adinandra*. Also characteristic is the short thick pedicel.

Although both flowers and fruit were available for this study, it is unfortunate that neither was mature. The petals and stamens were described from a bud, making accurate measurements quite impossible. However, the diagnostic characters were discernible, showing this species to be distinct.

Adinandra steenisii, sp. nov.

Arbor parva, ad 5 m. alta; ramulis multis, congestis, glabris, juventute adpresso-pubescentibus; gemmis terminalibus luteo-adpresso-pubescentibus. Folia coriacea, rotundata, parva, 1–2 cm. longa, 0.8–1.5 cm. lata, apice rotundata, subretusa, basi cuneata, supra glabra, subtus cito glabrescentia, margine integra vel rare crenulata, venis 5–7 paribus, supra obscuris, subtus conspicuis, adscendentibus ad marginem anastomosantibus, petiolis teretibus, glabris, 1–1.5 mm. longis. Flores non visi. Fructus axillares, solitarii; pedunculis teretibus, ca. 1 cm. longis, glabris; bracteolis 2, oppositis, subaequalibus, latioribus quam longis, semi-rotundatis, 1.7–1.8 mm. longis, ca. 3 mm. latis, glabris; sepalis 5, imbricatis, glabris, subaequalibus, rotundatis, 6–8 mm. longis, ca. 8 mm. latis. Fructus globosus, glaber, 8–10 mm. diametro, 5-locularis, multiseminatus, stylo glabro, ca. 10 mm. longo, stigmate punctato.

CELEBES: Gouvt. Celebes en Onderh: Route Rante Lemo-Angin Angin via Poka Pindjang, alt. 2500 m., *C. G. G. J. van Steenis 10303* (TYPE, Bogor), June 19, 1937 (small tree ± 5 m. high).

This species is very distinctive and can be easily recognized by its small habit (tree to 5 m. high), the very small rotund leaves (1–2 cm.

long), with the petiole measuring only 1–2 mm., and the small fruit. In general, all the parts seem to be in miniature.

The flowers were not seen, and the fruit as described above probably was immature. However, the species should be easily recognized in the future.

This species is named after C. G. G. J. van Steenis, the collector.

Adinandra subauriculata, sp. nov.

Arbor ad 22 m.; ramis griseis, teretibus, crassis, glabris; gemmis terminalibus ignotis. Folia crasso-coriacea, ovata, glabra, 10–17 cm. longa, 5–6 cm. lata, apice obtusa, basi rotundata, subauriculata, margine minute glanduloso-denticulata, costa subtus conspicua, venis lateralibus ca. 20 primariis paribus, gracilibus ad marginem anastomosantibus, venis secundariis inter primarias frequentibus, petiolo brevi, crasso, ca. 5 mm. longo. Flores non visi. Fructus axillares, ut videtur solitarii; pedicellis glabris, teretibus, brevibus, 0.5–1.5 cm. longis, crassis, ca. 2–3 mm. diam.; bracteolis caducis; sepalis 5, imbricatis, persistentibus, ovatis vel late ovatis, ca. 1 cm. longis et 7 mm. latis, leviter adpresso-pubescentibus. Fructus globosi vel subglobosi, leve pubescentes vel glabrescentes, ca. 2 cm. diam., 3-loculares, multiseminati, seminibus subplanis hippocrepiformibus, nigris, nitidis, ca. 5 mm. longis, 3–4 mm. latis.

SUMATRA: Res. Sumatra's Westkust: Soeliki, in old forest, alt. 1300 m., *Neth. Ind. For. Serv. bb. 6538* (TYPE, Bogor; ISOTYPE, Arnold Arboretum), Feb. 16, 1924 (tree 22 m. high, 8 m. to first branch, 40 cm. diam. breast high; fruit green, malodorous, bitter).

The outstanding characters of this species are (1) the thick-coriaceous leaf with a rounded subauriculate base and a short thick petiole; (2) a pubescent three-celled fruit with many (up to eighty) flattened hippocrepiform shiny seeds. The latter character is unusual in the genus in that most species with three-celled fruits are known to possess very few (not more than twenty) large seeds, usually thicker than those found in this species. Several fruits were carefully dissected and all showed at least sixty well-developed seeds.

The closest relative appears to be *A. cordifolia* Ridley, found in Sarawak and British North Borneo. In this species the fruit is five-celled, the leaves are distinctly cordate (unequally so) at the base, subsessile or with a very brief petiole.

Adinandra subunguiculata, sp. nov.

Arbor ad 15 m. alta; ramulis maturis innovationibusque glabris, teretibus; gemmis terminalibus conicis, aureo-adpresso-pubescentibus. Folia coriacea, glabra, obovata vel subelliptica, 9–12 cm. longa, 4–6 cm. lata, apice late acuminata vel obtusa, basi cuneata, margine integra vel minute denticulata, venis 12 paribus vel plus, obscuris, petiolis 4–5 mm. longis. Flores axillares, solitarii; pedicellis glabris, 3.5–4.5 cm. longis, ad apicem accrescentibus; bracteolis 2, alternatis vel suboppositis, inaequalibus, bracteola superiore rotundata, ca. 2 mm. longa et 3 mm. lata, glabra, bracteola inferiore deltoidea, ca. 1.5 mm. longa et basi 1.5 mm. lata, glabra; sepalis 5, imbricatis, subrotundatis, subaequalibus, 5–6 mm longis, 6–8 mm. latis, glabris, interioribus rare exceptis, dorso medio minutissime adpresso-puberulentis, cito glabrescentibus; petalis 5, glabris, inaequalibus, exterioribus obovatis, 14 mm. longis, 11 mm. latis, interioribus subunguiculatis, 11 mm. longis, 8 mm. latis; staminibus 40–45, 4-seriatis ut videtur, 4–7 mm. longis, filamentis connatis, glabris, ad basim corollae adnatis, 2–3.5 mm. longis, antheris setosis, 2–3.5 mm. longis; ovario conico vel subgloboso, glabro, 5-loculari, multiovulato, stylo glabro, ca. 1 cm. longo. Fructus globosus, glaber, ca. 1 cm. diametro, 5-locularis, multiseminatus; seminibus nigris, nitidis, reticulatis.

CELEBES: Gouvt. Celebes en Onderh.: MALILI: near Tabaramo, alt. 600 m., *A. Hoornstra 32* (Bogor *bb.9710*), Apr. 9, 1926 (tree 17 m., with white flowers). KENDARI: N. Kendari, rain-forest, alt. 150–300 m., *G. K. Kjellberg 641* (Bogor, TYPE), March 3, 1929. — Poehara, rain-forest, alt. 100 m., *G. K. Kjellberg 698* (Bogor), March 6, 1929. — Peninsula, southeast of Lepo-Lepo, *O. Beccari 1190, 1190A, 1190B* (Firenze), July 1874. — "BOETON EIL MOENA": Laboenti, alt. 15m., *C. P. Burghaut 85* (Bogor *bb.5860*), July 28, 1923 (tree 14 m. with white flowers). MOENA: Labouti, *A. G. Waturandang 250* (Bogor, *bb.21788*), January 22, 1937 (tree 15 m. with white flowers).

This species is one which cannot be placed in close association with any other species of the genus, yet has no truly outstanding characteristics of its own to separate it from all others! The bracteoles are usually subalternate. All the floral parts except the setose anthers are glabrous, the terminal bud is tawny appressed-pubescent, yet the early leaves and the young branchlets are glabrous or quickly become so. The ovary is five-celled with very many characteristic small ovules.

From the label of Bogor *5860* I cannot be certain of the place of collection — whether from Moena or the near-by island of Boeton. However, I am inclined to feel that it was collected on Moena, considering the almost duplicate label of *Bogor 21788*.

Adinandra dubia, sp. nov.

Frutex; ramulis juvenilibus teretibus, sericeis; ramulis maturis glabris vel glabrescentibus, griseis, teretibus; gemmis terminalibus conicis, dense aureo-sericeis. Folia coriacea, ovata vel elliptico-ovata, 6–11 cm. longa, 2–3.5 cm. lata, supra nitida, glabra, subtus pallidiora, pubescentia, apice acuminata, basi cuneata, margine denticulata (juventute glanduloso-denticulata), venis ca. 10 paribus, undique leve elevatis, marginem intra anastomosantibus arcuantibusque, petiolis 7–10 mm. longis, subtus pubescentibus. Flores axillares, solitarii; pedicellis teretibus, 5–8 mm. longis, recurvatis, sericeis; bracteolis 2, suboppositis, longo-triangularibus, 6–6.5 mm. longis, basi 3–4 mm. latis, adpresso-sericeis, margine glanduloso-denticulatis, cito caducis; sepalis 5, imbricatis, inaequalibus, dense sericeis, late ovatis, exterioribus 6–7 mm. longis, 5–6 mm. latis, interioribus 4–5 mm. longis, 2.5–4 mm. latis; petalis 5, dorso medio adpresso-sericeis, oblongo-ovatis, 3–5 mm. longis, ca. 2 mm. latis; staminibus ut videtur 1-seriatis, paucis (ca. 20) ad 2.25 mm. longis, filamentis 0.5 mm. longis, connatis, ad basim corollae adnatis, glabris, antheris 0.5–1.5 mm. longis, apice retusis, interiore dense hirsutis; ovario minuto, 1.5 mm. diametro, 5-loculato, multiovulato, glabro vel minute pubescente, stylo ca. 2.5–3 mm. longo, glabro vel minute adpresso-pubescente. Fructus ignotus.

SUMATRA: Res. Sumatra's Westkust: Ophir District, northwest slope of Talamau, alt. 2100 m., *H. A. B. Bünnemeijer 910* (Bogor, TYPE), May 28, 1917 (shrub).

Adinandra dubia, as the specific name intimates, is a provocative species. Every so often a worker is confronted with a specimen which seems to conform to a certain genus in all respects, yet instinctively a doubt persists as to its real position. Such is the case with *A. dubia*. The flowers are very small, with the corolla measuring only three to five millimeters long and two millimeters wide. The bracteoles are nearly petaloid and are actually larger (ca. 6 mm. long) than the petals, a most unusual feature in this genus. Minute are the stamens, the longest ones measuring only 2.5 mm. in length. They are also very few in number yet so closely joined together in the specimens dissected that an accurate count could not be obtained. The copious pubescence usually found on the anthers in most species of the genus is sometimes so sparse and scattered in *A. dubia* as to be almost negligible.

Closely allied and perhaps belonging here is a specimen collected by *Mareman* [Forest Res. Inst. *6216*] at the Hoogvlakte area near Lake Toba in the Tapanoeli Res. Collected at a lower altitude [900 m.], the habit is that of a tree 21 meters high, which in itself is not unusual. However, the immature fruit is quite conical in shape and densely sericeous. So also is the style. This very noticeable difference in pubescence, especially since the Mareman specimen was collected in fruit, cannot be overlooked. A reversed situation would be quite understandable.

Eurya perserrata, sp. nov.

Frutex 3 m. (fide collectori) altus, ramulis teretibus, innovationibus rufo-pilosis. Folia subcoriacea, oblongo-elliptica vel oblongo-ovata, 14–18 cm. longa et 4.0–6.5 cm. lata, apice acuminata, basi late cuneata, subtus pilosa, venis utrinque conspicuis, margine acre glanduloso-serrata, serrationibus inaequalibus ad 2 mm. longis, sessilia vel subsessilia. Flores ♂ 2–3 in axillis foliorum, albi; pedicellis 1.5–2 mm. longis; bracteolis minutis, sepaloideis, ca. 1 mm. longis; sepala 5, imbricata, inaequalia, subrotundata, concava, 3–3.5 mm. longa et 2–2.5 mm. lata, extus intusque strigosa, margine scariosa, ciliata; petala 5, imbricata, inaequalia, oblongo-obovata, 5–6 mm. longa et 2.5–3 mm. lata, obtusa; stamina ca. 15, filamentis ca. 2.5 mm. longis, antheris ca. 1 mm. longis. Flores ♀ et fructus ignoti.

CHINA: Yunnan: Muchielung, Salwin-Kiukiang Divide, in dense mixed forest, alt. 2500 m., *T. T. Yü 21035* (Arnold Arboretum, TYPE), Nov. 21, 1938, shrub 3 m. with white flowers.

Unfortunately, neither pistillate flowers nor fruit are available for study in this species. However, the serration on the leaves in the staminate plants is so outstanding that when the pistillate specimens are found they will be easily recognized. The serrations are approximately 2 mm. long (or more), surely the most conspicuous feature on the specimen. No other species in the genus approaches *E. perserrata* in this character. The rufous pilose terminal buds, the sessile or near-sessile leaves, and the large flowers are other outstanding characters.

Eurya pseudocerasifera, sp. nov.

Arbor magna (30 m., fide Tsai), ramulis teretibus, innovationibus pubescentibus. Folia oblongo-elliptica, coriacea, decurrentia, 9–13 cm. longa et 3–5 cm. lata, apice acuminata, basi cuneata, supra nitida, subtus opaca, margine integerrima, glabra, basi costae excepta, venis elevatis subtus conspicuis, petiolis ca. 5 mm. longis, pubescentibus. Flores ♀ axillares, 3-fasciculati, albi; pedicellis ca. 3 mm. longis, pubescentibus; bracteolis minutis, sepaloideis, pubescentibus; sepalis 5, imbricatis, inaequalibus, concavis, subrotundatis, ca. 2 mm. longis et 2 mm. latis, pubescentibus, marginibus scariosis ciliatisque; petalis 5, imbricatis, inaequalibus, ca. 3 mm. longis et 2 mm. latis, obtusis, apice rotundatis vel subemarginatis; ovario globoso, piloso, ca. 2 mm. diametro, 3-loculari, multiovulato, stylo 3- vel 4-partito, ca. 5 mm. longo, glabro, 1/2 libero; flores ♂ ignoti. Fructus (*T. T. Yü 17251*) baccatus, globosus, 4–5 mm. diametro, glabrescens, multiseminatus; semina minuta, nigro-nitida, reticulata, ca. 1 mm. diametro.

CHINA: Yunnan: Lung-ling Hsien, in woods, alt. 2300 m., *H. T. Tsai 55002* (Arnold Arboretum), Jan. 7, 1934 (tree 20 ft. high with white flowers). — Mong-ka, in forest, alt. 1750 m., *H. T. Tsai 56882* (Arnold Arboretum, TYPE), Feb. 9, 1934 (large tree 100 ft. high with yellow fruit). — Chenkang, Snow Range, Tapingchang, common in ravine among forest trees, alt. 2350 m., *T. T. Yü 17251* (Arnold Arboretum), Aug. 6, 1938 (tree 20–25 ft. high). — Taron-Taru Divide, Tangtehwang, in mixed forest, alt. 1800 m., *T. T. Yü 19974* (Arnold Arboretum), Aug. 27, 1938 (tree 30 ft. high).

This species is characterized by the entire leaves, the pubescent ovary, and the long style (five millimeters), three- or four-parted, the branches free for one half the length. Also most unusual is the size, recorded by Tsai (*56882*) as a big tree attaining a height of a hundred feet. None of the three other specimens examined and cited above is recorded as taller than thirty feet.

This species resembles *E. cerasifolia* (D. Don) Kob. superficially in the entire shining leaves and the conspicuous veining. However, in *E. cerasifolia* the leaves are not truly entire. Serration may be found on the upper half of the leaf, and then often confined to a single side. Also in *E. cerasi-*

folia, the ovary is glabrous, the style is shorter (two millimeters) and joined nearly its whole length.

Another species in close relationship is *E. pittosporifolia* Hu. The original author recorded this species as a tree six meters high with glabrous branchlets, oblanceolate leaves, long-acuminate at the apex and narrow-cuneate at the base, entire or crenulate on the upper two thirds. The sepals were reported as glabrous and the fruit densely ferrugineous-sericeous. The styles were listed as five and distinct. In examining the isotype of *E. pittosporifolia* (*C. W. Wang 78362*), one finds also that the terminal buds are distinctly pilose and the sepals strigose.

Freziera cuatrecasasii, sp. nov.

Arbor magna, ramis teretibus, undulatis, crassis, pubescentibus, lenticellatis, lenticellis numerosis, prominentibus, elevatis, subsuberosis, ramulis hornotinis dense fulvo-pilosulis. Folia coriacea, ovata, 18–23 (—33) cm. longa, 7–10 (—14.5) cm. lata, apice abrupte acuminata, basi subrotundata, conspicue inaequalia, margine integra, costa supra canaliculata, subtus basi ad 5 mm. elevata, supra glabra (juventate fulvo-pubescens, cito glabrescens), subtus pubescens, venis lateralibus 30–37 paribus undique prominentibus, reticulatis, petiolis ca. 1 cm. longis, pubescentibus, alatis. Flores axillares et cauliflori in axillis defoliatis pedicellati in fasciculum pedunculatum aggregati; pedicellis 3 mm. longis vel minus, curvatis, crassis, pubescentibus; bracteolis 2, oppositis, subrotundatis, ca. 3 mm. longis latisque, dense fulvo-pubescentibus; sepalis 5, imbricatis, adpresso-pubescentibus, rotundatis, ca. 4 mm. longis et 5 mm. latis, margine anguste scariosis, integris; petalis 5, albis, inaequalibus, 6–7 mm. longis, ca. 4.5 mm. latis, exterioribus duobus ovatis, non apiculatis, interioribus tribus apice acutis; staminibus (♀ fl.) ca. 15, uniseriatis, ca. 3 mm. longis, filamentis ca. 1 mm. longis, paucis claviformibus, antheris ca. 2 mm. longis; ovario glabro, conico, ca. 2 mm. diametro basi, apice attenuatis per stylum ca. 3 mm. in stigmate, 5-loculari, multiovulato. Fructus ca. 7 mm. diametro, glaber, 5-locularis, multiseminatus.

COLOMBIA: Dept. del Valle, Cordillera Occidental, Hoya del río Dígua, Río San Juan, 1300–1500 m. alt., abajo de Queremal a la derecha del río entre km. 52–53, *J. Cuatrecasas 23985* (Arnold Arboretum, TYPE; Chicago Nat. Hist. Mus., ISOTYPE), Mar. 27, 1947 (gran árbol; hoja coriácea rigida, verde oscura brillante haz, verde pálida enves; sépalos verdes; pétalos blancos).

This species is most closely allied to *F. guatemalensis* in its pedunculate, fasciculate flowers, and to *F. Smithiana* in its large multiveined leaves and dense fulvous pubescence. It may be separated from the latter species by the pedunculate flowers, the shorter pedicels and petioles, the entire margin of the leaves, the presence in quantity of the conspicuous lenticels, and the somewhat undulate branches.

The outstanding features for this species are the huge coriaceous leaves measuring as much as 33 cm. long and 14.5 cm. wide, conspicuously veined, the pedunculate flowers (with the scales of former flowers below) both in the axils of the leaves and on the stem in the defoliated axils. The large leaf-scars, along with the so-called cauline flowers, give to the older branches a somewhat undulate appearance which is missing in the younger branches and branchlets.

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ILEX IN TAIWAN AND THE LIUKIU ISLANDS

SHIU-YING HU

INTRODUCTION

IN PREPARING A FLORA OF OKINAWA, Dr. E. H. Walker, Associate Curator, Department of Botany, Smithsonian Institution, asked me to comment on the portion of his manuscript devoted to *Ilex*. Although in my studies of the Chinese species of that genus I included some Taiwan forms, chiefly those occurring on both the island and the mainland of China, my study of the insular material was not exhaustive. As I possessed even less knowledge of the Liukiu Islands species I scarcely felt competent to accept his invitation. Yet my knowledge of the Chinese species of *Ilex* enabled me to assure him that the two Chinese species included in his manuscript do not occur in the Liukiu Islands. As to the other species I was uncertain and requested him to send me as much Okinawan material as possible. In the identification of these specimens I was naturally forced to consider all the known species of Taiwan and the Liukiu Islands. The results of this study are included in this paper.

This paper is supplementary in nature to my publications on THE GENUS ILEX IN CHINA.[1] Descriptions, synonyms, and the citations of literature and specimens relating to the species treated therein are not repeated here; however, references to that former work have been included. The specimens marked US are deposited in the United States National Herbarium, and those marked G are in the Gray Herbarium. All other cited specimens, whether designated by A or not, are in the Herbarium of the Arnold Arboretum.

Through Professor E. D. Merrill I have been able to obtain photographs and fragments of types from Dr. Siro Kitamura, Director of the Botanical Institute, Kyoto University, Kyoto, Japan, and Dr. H. Hara of the Botanical Institute, Tokyo University, Tokyo, Japan. To both of these men and to the Curators of the above-mentioned institutions I should like to express my deep appreciation for their help in clarifying certain nomenclatural problems in my study of the *Ilex* of Taiwan and the Liukiu Islands.

PHYTOGEOGRAPHICAL SIGNIFICANCES

The geographic distribution of the Taiwan and Liukiu Islands species of *Ilex* reflects the floristic relationships of the areas covered, and to a certain extent it also illustrates the affinity of the floras of these islands to those of the Chinese mainland and Japan, as well as that of the Philippine Islands.

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[1] Journal of the Arnold Arboretum **30**: 233–344, 348–387, 1949; **31**: 39–80, 214–240, and 241–263, 1950.

In Taiwan twenty-two valid species occur. Twelve of these occur also on the Chinese mainland. Six of the twelve are confined to China and Taiwan, while four, *I. goshiensis* Hayata, *I. micrococca* Maxim., *I. pedunculosa* Miq., and *I. rotunda* Thunb., are widely spread in China, occurring also in Japan and, in some cases, in Korea or Indo-China. Two other species, *I. asprella* (Hook. & Arn.) Champ. and *I. formosana* Maxim., occur also in the Philippines. Among the species confined to Taiwan and China (and closely adjacent regions), two, *I. bioritsensis* Hayata and *I. yunnanensis* Franch., are restricted to the higher altitudes of western China and central Taiwan, and the others, *I. cochinchinensis* Lour., *I. ficoidea* Hemsl., *I. pubescens* Hook & Arn., and *I. triflora* Blume var. *kanehirai* (Yamamoto) S. Y. Hu, are subtropical species which occur in the coastal provinces on the mainland and in the southern part of Taiwan. Some of these also occur in Hainan and in northern Indo-China. It is worthy of note that, although there are four widely spread species that Taiwan shares with Japan and China, there is only a single taxon, *Ilex sugeroki* Maxim. var. *brevipedunculata* (Maxim.) S. Y. Hu, that is confined to Taiwan and Japan. There is no species that is confined to Taiwan and the Philippines. It is also interesting to note that six species, *I. buergeri* Miq., *I. chinensis* Sims, *I. crenata* Thunb., *I. latifolia* Thunb., *I. macropoda* Miq., and *I. serrata* Thunb., which are common in Japan and eastern China, have not been found in either Taiwan or the Liukiu Islands.

Thus for the *Ilex* species of Taiwan, approximately 54% are Chinese elements, 23% are endemic, 18% are shared with the flora of the Liukius, and a very minor percentage are Japanese elements. The genus is strongly marked and easily recognizable and comprises an extraordinary number of distinct species, both deciduous and evergreen. They are in general very specific in their association with different types of vegetation. For example, *I. bioritsensis* Hayata is associated with plants constituting the broadleaved forests of the secondary order, while *I. yunnanensis* Franch. var. *parvifolia* (Hayata) S. Y. Hu is found only along the edge of the coniferous forests. Due to this fact certain species can be used to a considerable extent as indicators of the type of vegetation in their native habitats. Therefore it may perhaps be a legitimate assumption that the proportion of Chinese, Japanese, and endemic elements existing in the *Ilex* flora of Taiwan is likely to prevail in other genera. As illustrated by the species of *Ilex*, the Taiwan flora is strongly affiliated with that of the China mainland, while the affinity between the flora of Taiwan and that of Japan is weak. The chief Philippine Islands elements are not found in Taiwan proper at all, but are limited to Botel Tobago.

There are twelve valid species of *Ilex* in the Liukiu Islands, four of which are endemic. Four species are limited to Taiwan and the southern Liukiu Islands, and one occurs only in Japan and the northern Liukiu Islands. *Ilex goshiensis* Hayata has a range extending from the Liukius and Taiwan north to Japan and south to Hainan Island. There is also in the Liukiu group one widely spread Chinese subtropical element, *I. ficoidea* Hemsl., and another widely spread Sino-Japanese species, *I. rotunda* Thunb.

If the genus *Ilex* may be taken as a criterion, the flora of the Liukiu Islands is characterized by a rather high degree of endemism.

Binomials like *Ilex mertensii* Maxim. and *Ilex matanoana* Makino, which are species endemic to the Bonin Islands, appear repeatedly in literature concerning the floras of Taiwan and the Liukiu Islands. As a matter of fact, however, the Bonin Islands species are morphologically very different, and their affinities with the plants of the group of small islands extending southward toward the Micronesias and the Caroline Islands seem to be closer than with the plants of Taiwan and the Liukiu Islands. At least it appears to me that none of the Taiwan and Liukiu material should carry the names applied to the species of the Bonin Islands.

KEY TO SUBGENERA, SECTIONS, AND SPECIES

A. Leaves deciduous, branchlets with abbreviated shoots, each bearing a fascicle of leaves and flowers; lenticels conspicuous on the current year's growth. . . . . Subgen. PRINOS.

  B. Inflorescence a trichotomously branched cyme bearing 15 or more flowers; fruit small, with smooth pyrenes, each longitudinally canaliculate on the back. . . . . Sect. **Micrococca.** 1. *I. micrococca.*

  BB. Inflorescence a solitary flower or a simple 3-flowered cyme, often fasciculated with the leaves at the end of an abbreviated shoot; fruit medium-sized, with striate and sulcate pyrenes; endocarp woody or stony. . . . . Sect. **Prinoides.**

    C. Leaves ovate, entirely glabrous, obtuse or shortly and broadly acuminate at the apex; ovary with no evident style; pyrenes woody, striate. . . . . .2. *I. kusanoi.*

    CC. Leaves ovate-elliptic, hirsute on the nerves above, acuminate, the acumen up to 12 mm. long; style evident; pyrenes stony, striate and deeply sulcate. . . . . .3. *I. asprella.*

AA. Leaves evergreen; branchlets without abbreviated leafy shoots; lenticels usually absent on the current year's growth. . . . . Subgen. EUILEX.

  B. Pistillate and staminate inflorescences both solitary in the axils of leaves on the current year's growth; pyrenes smooth, with coriaceous or sublignescent endocarps, slightly concave, unicanaliculate or 3-striate and 2-sulcate on the back. . . . . Sect. **Lioprinus.**

    C. Inflorescence cymose; pyrenes concave or unicanaliculate at the back.

      D. Fruit ovoid-globose, 5–7 mm. in diameter; pyrenes 4–5 mm. long, dorsally concave; pedicels slender; leaves pubescent on both surfaces (except var. *hakkuensis*). . . . .4. *I. lonicerifolia.*

      DD. Fruit ellipsoid, 8–10 mm. in diameter; pyrenes 8 mm. long, deeply unicanaliculate on the back; pedicels stout; leaves glabrous. . . . . .5. *I. matudai.*

    CC. Inflorescence umbelliform; pyrenes 3-striate and 2-sulcate at the back; leaves entire. . . . . .6. *I. rotunda.*

    CCC. Inflorescence subcapitate; the pyrenes smooth, slightly concave on the back; the fruit ellipsoid-globose, 5–7 mm. in diameter. . . . . .7. *I. tugitakayamensis.*

BB. Pistillate flowers solitary, axillary in the scales or leaves on the current year's growth, very rarely fasciculate; staminate flowers fasciculate on the second year's growth, rarely solitary and axillary in the scales or leaves at the base of current year's growth; pyrenes smooth or slightly roughened; the endocarp coriaceous. . . . . Sect. **Paltoria.**

C. Leaves not punctate beneath.

D. Petioles 8–17 mm. long, up to one third the length of the lamina; leaves usually entire, rarely serrate, the midribs plane or slightly impressed above. . . . . 8. *I. pedunculosa.*

DD. Petioles 2–7 mm. long, up to one seventh the length of the lamina; leaves usually serrate, the midrib elevated and pubescent above.

E. Pyrenes 4; branchlets thickly ferruginous-pubescent; leaves aristately serrate, extending almost to the base. . . . . 9. *I. yunnanensis* var. *parvifolia.*

EE. Pyrenes 4, 5, or 6; branchlets puberulous; leaves serrate or crenate only near the apex, the basal half entire. . . . . 10. *I. sugeroki* var. *brevipedunculata.*

CC. Leaves punctate beneath.

D. Pistillate flowers and fruit solitary; leaves elliptic or oblanceolate, apex acute or shortly acuminate.

E. Leaves elliptic, the apex acute; petioles 7–10 mm. long; ca. one third the length of the lamina. . . . . 11. *I. maximowicziana.*

EE. Leaves oblanceolate; broadly acuminate; petioles 3–6 mm. long, ca. one eighth the length of the lamina. . . . . 12. *I. mutchagara.*

DD. Pistillate flowers and fruit fasciculate; leaves obovate or oblong, the apex rounded. . . . 13. *Ilex triflora* var. *kanehirai.*

BBB. Pistillate and staminate inflorescences both fasciculate, axillary on the second year's growth; pyrenes rugose, pitted or striate with elevated striae; endocarp woody or stony.

C. Pyrenes 4 or 2; endocarp woody or stony; individual branches of the inflorescence uniflorous. . . . . Sect. **Aquifolium.**

D. Leaves entire or spiny margined.

E. Fruit large, 9–12 mm. in diameter; pyrenes stony, irregularly wrinkled and pitted; leaves entire, acuminate, (4–) 6–7 (–8) cm. long.

F. Fruiting pedicels 4–9 mm. long. . . . . . 14. *I. integra.*

FF. Fruiting pedicels 1–3 mm. long. . 15. *I. brachypoda.*

EE. Fruit small, 4–8 mm. in diameter; pyrenes striate and sulcate; leaves rigid, spiny, when entire rounded at the apex or rarely short acuminate, 1–4 cm. long.

F. Leaves ovate or quadrangular, those on the fruiting branchlets with 2 or 3 strong spines on each side; fruiting pedicels 2 mm. long; pyrenes 2. . . . . 16. *I. bioritsensis.*

FF. Leaves obovate or elliptic; entire or dimorphous; fruiting pedicels 4–5 mm. long; pyrenes 4.

G. Leaves dimorphous, those on the fruiting branchlets entire and those on the sprouts sinuate and spiny, the entire ones obovate, rounded at the apex. . . . . 17. *I. dimorphophylla.*

GG. Leaves entire, elliptic, obtuse or shortly acuminate at the apex. . . . . 18. *I. suzukii.*

DD. Leaves serrate or crenate.

E. Fruiting pedicels 2–3 mm. long.

F. Petioles 4–9 mm. long, 12–22 times shorter than the length of the lamina. . . . . 19. *I. formosana.*

FF. Petioles 8–16 mm. long, 5–12 times shorter than the lamina. . . . . 20. *I. ficoidea.*

EE. Fruiting pedicels (4–) 6–8 (–14) mm. long.

F. Leaves obovate, rarely elliptic, obtuse, rounded, retuse, rarely broadly and shortly acuminate at the apex; fruiting pedicels 9–14 mm. long. . . 21. *I. liukiuensis.*

FF. Leaves oblong-elliptic, elliptic or obovate-elliptic, apex acuminate; fruiting pedicels (4–) 6–8 mm. long.

G. Fruit 10–11 mm. in diameter; leaves shortly and abruptly acuminate, the lateral nerves prominent on both surfaces. . . . . 22. *I. uraiensis.*

GG. Fruit 5–6 mm. in diameter; leaves caudate, the lateral nerves obscure on both surfaces. . . . . 23. *I. warburgii.*

CC. Pyrenes 4, 5, or 6, the endocarp coriaceous or sublignescent; individual branches of the fascicles of the staminate plant usually cymose or umbelliform. . . . . Sect. **Pseudoaquifolium.**

D. Branchlets ridged, in cross-section appearing quadrangular; pyrenes 6, 3-striate and 2-sulcate, the endocarp sublignescent; leaves chartaceous or membranaceous, serrate or subentire, pubescent on both surfaces. . . . . 24. *I. pubescens.*

DD. Branchlets subterete; pyrenes 4 or 5, smooth, the endocarp coriaceous; leaves entire, coriaceous, glabrous.

E. Leaves 9–16 cm. long, punctate beneath; fruit with a columnar-mammiform stigma; pyrenes smooth. . . . . 25. *I. cochinchinensis.*

EE. Leaves 2–5 cm. long, epunctate, fruit with a capitate or discoid stigma; pyrenes 3-striate.

F. Leaves suborbicular or broad-elliptic, the apex shortly produced, usually retuse; individual branches of the inflorescence 1- or 3-flowered. . . . . 26. *I. goshiensis.*

FF. Leaves ovate-elliptic or elliptic, acuminate; individual branches of the inflorescence uniflorous. . . . . 27. *I. hayataiana.*

1. **Ilex micrococca** Maxim. in Mém. Acad. Sci. St. Pétersb. VII. **29** (3): 39, *pl. 1, fig. 6.* 1881. — S. Y. Hu in Jour. Arnold Arb. **30**: 261. 1949.

Ilex micrococca var. *longifolia* Hayata, Ic. Pl. Form. **3**: 55, *pl. 9.* 1913, et Ic. Pl. Form. **6** (Suppl.): 13. (Gen. Ind. Fl. Form. 13). 1917. — Ito, Taiwan Shokub. Zus. *fig. 488.* 1928. — Sasaki, Cat. Gov. Herb. 317. 1930. — Suzuki in Masamune, Short Fl. Form. 125. 1936.

Hayata differentiated his variety by the “much narrower leaves with acute or obtuse base which is never rounded as is the case with the type.”

The base of the leaf in this species varies according to the position of the leaf on the branchlet. The leaves on the lower part of the branchlet have a broader base, which appears rounded, and those on the apical portions have a narrower base which is obtuse or acute. Such variations occur on specimens collected in Japan and China as well as on those from Taiwan. Moreover, the Taiwan specimens that I have examined appear to be identical with Hayata's type (photograph) of this variety, *N. Konishi*, Aug. 1906, from Uraisha. All these specimens agree with the Chinese and Japanese material in the size, texture, and margin of the leaves, in the inflorescence, and in the characters relating to the fruit and pyrenes. I see no reason for maintaining this Taiwan variety.

In Taiwan, *Ilex micrococca* occurs only in the northern and west-central parts of the island. It has been recorded from Sozan, Toyen, Uraisha, the mountains Daiton, Taihei and Gosi, and Lake Jitugetutan. It is a common tree in the woods, growing to a considerable height (up to 23 meters). In the whole family there is no species that equals *I. micrococca* in the length of its fruiting peduncles and in the large number of fruits in each infructescence. For this reason, this species is well worthy of introduction into southern American gardens for the fruiting branches.

The chartaceous leaves, the conspicuous lenticels on the current year's growth, and the occasional occurrence of abbreviated shoots in this species suggests its relationship with *I. macrocarpa* Oliv., a deciduous species. Of all the specimens that I have examined, I have not seen any with leaves on the second year's growth. For this reason I have placed the species in the subgenus *Prinos*. Field data for the winter habit of the species are needed. When such data are available, it may prove necessary to change the subgeneric status of this species.

2. **Ilex kusanoi** Hayata in Jour. Coll. Sci. Tokyo **30**: 55 (Mat. Fl. Form. 55). 1911; Ic. Pl. Form. **1**: 132. 1911, et **6** (Suppl.): 13 (Gen. Ind. Fl. Form. 13). 1917. — Kanehira, Form. Trees 123. 1917, rev. ed. 375, *fig. 331*. 1936. — Sasaki in Trans. Nat. Hist. Soc. Form. **18**: 330, 1928, et Cat. Gov. Herb. 317. 1930. — Suzuki in Masamune, Short Fl. Form. 125. 1936. — Sonohara et al., Fl. Okinawa 92. 1952.

Ilex taiwaniana Hayata in Jour. Coll. Sci. Univ. Tokyo **30**: 58 (Mat. Fl. Form. 58). 1911; Ic. Pl. Form. **1**: 135. 1911, et **6** (Suppl.): 13 (Gen. Ind. Fl. Form. 13). 1917. — Kanehira, Form. Trees 127. 1917.

Ilex poneantha Koidzumi, Pl. Nov. Amami-Ohsim. 13. 1928, syn. nov.

Deciduous tree (?), entirely glabrous, with both elongated and abbreviated shoots; second year's growth of the elongated shoot 3–5 mm. in diameter, when dry castaneous, shiny, with conspicuous lenticels, the current year's growth subterete, up to 20 cm. long, 2 mm. in diameter; abbreviated shoots 1 cm. long, 2.5 mm. in diameter, rugose with leaf-scars and scars of the pedicels, bearing 1–4 leaves, 3–13 flowers. Leaves 6–15 mm. apart on elongated shoots, fasciculate at the end of abbreviated shoots; stipules minute, broadly deltoid; petioles 5–8, rarely up to 10 mm. long, one tenth up to one sixth the length of the lamina, the distal portion winged with decurrent leaf-base, canaliculate above; lamina chartaceous, olivaceous, ovate, 4–6.5 cm. long, 2.5–4 cm. wide, acute at the base, obtuse or shortly broad-acuminate at the apex, remotely crenulate-serrate, the midrib slightly impressed above, prominent beneath, the lateral nerves 5–7 pairs, obscure above, evident beneath, with reticulation obvious beneath. Inflorescence fasciculate, in the axils of scales or small leaves at the base of the elongated shoots or at the apex of the abbreviated ones. Staminate flowers solitary or in a simple 3-flowered cyme, peduncles 3 mm. long, pedicels 3–4 mm. long, prophyllus basal, ciliate; calyx patelliform, 4- up to 6-lobed, the lobes ovate, erose, ciliate; corolla 10 mm. across, the petals oblong, 4 mm. long, 2.5 mm. wide, connate at the base; stamens shorter than the petals, the anthers oblong; rudimentary ovary pulvinate, depressed at the center. Pistillate flowers 3 in each fascicle, the pedicels 12–17 mm. long; calyx patelliform, 2.5 mm. across, with 5 or 6 lobes, the lobes rounded and ciliate; corolla rotate, 5 mm. across, connate at the base, the lobes ovate, 2 mm. long, 1.5 mm. wide; staminodes two thirds the length of the corolla, the sterile anthers sagittate; ovary globose, 1 mm. in diameter, the stigma mammiform. Fruit not seen.

TAIWAN: Taito, *S. Kusano 8*, July 1908 (photograph of the TYPE); Kashioto [Kwasyoto], *G. Nakahara 1025* (photograph of TYPE of *Ilex taiwaniana* Hayata). BOTEL TOBAGO: Kotosyo [Kotosho], *S. Sasaki*, Feb. 7, 1920.

LIUKIU ISLANDS: Amami-Oshima, *J. Ohba 171* (LECTOTYPE of *Ilex poneantha* Koidz., photograph and fragments).

Ilex kusanoi Hayata is closely related to *Ilex macropoda* Miq., but the latter species has relatively longer petioles, puberulent leaves, solitary pistillate flowers with the pedicels 6–7 mm. long, and uniflorous individual staminate flowers in small fascicles. Hayata distinguished this species from his *I. taiwaniana* by its "much thinner" leaves, but in his descriptions for both species he used the same term, "chartaceo-mebranacea." As the types of these two binomials were collected at different seasons, there may be a reason for the difference in the texture of the leaves. The fragment of the type of *Ilex poneantha* Koidz., kindly supplied by Dr. S. Kitamura of Kyoto, Japan, represents a staminate plant of *Ilex kusanoi* Hayata.

3. **Ilex asprella** (Hook & Arn.) Champ. ex Benth. in Hook Jour. Bot. Kew Gard. Misc. **4**: 329. 1852. — Henry in Trans. As. Soc. Jap. **24** (Suppl.): 26 (List Pl. Form. 26). 1896. — Mat. & Hayata, Enum. Pl. Form. 81. 1906. — Ito, Taiwan Shokub. Zus. *fig. 486.* 1928. — Sasaki, Cat. Gov. Herb. 316. 1930. — Suzuki in Masamune, Short Fl. Form. 124. 1936. — S. Y. Hu in Jour. Arnold Arb. **30**: 269. 1949.

TAIWAN: Taipei, *H. Keng 1024*.

This species is widely distributed in the warm temperate, subtropical, and tropical regions on the mainland of China and on Taiwan, and extends southward to northern Luzon in the Philippines. In Taiwan it has been reported from the mountains Daiton, Gosizan and Sozan, and from Toyen of Taihoku prefecture in the north, Nanto of Taichu prefecture in the west, Karenko [Kwarenko] and Taito of the east coast, South Cape at the southern extremity, and Mt. Niitaka in the center of the island. It is a common shrub about three meters high with a trunk up to 6 cm. in diameter, occurring in thickets and along roadsides from sea level up to 1000 meters altitude. Its white flowers appear in early March or April. The fasciculate staminate flowers, the solitary long-pedicellate pistillate flower, the globose fruit with evident style and capitate stigma, and the striate pyrenes suggest close relationship with *Ilex longipes* Chapm. of southeastern North America, which ranges from Florida to Alabama and Tennessee. These species of *Ilex* provide another proof of the affinities of the floras of eastern Asia and eastern North America.

4. **Ilex lonicerifolia** Hayata, Icon. Pl. Form. **3**: 54, *pl. 8*. 1913, et 6 (Suppl.): 13 (Gen. Ind. Fl. Form. 13). 1917. — Sasaki, Cat. Gov. Herb. 317. 1930. — Suzuki in Masamune, Short Fl. Form. 125. 1936. — S. Y. Hu in Jour. Arnold Arb. **30**: 290. 1949.

The range of this species is limited to a narrow band across the center of Taiwan, Lat. 23° 50′–24° 20′ N. The type material was collected from Pokupokusha, Kwarenko, on the east coast. Additional specimens have been collected from Mt. Daisetu and from Nanto and Lake Candidius (Jitugetutan) of Taichu prefecture, at an altitude of 750 meters. The plant has been reported as a tree up to 17 meters high. It flowers in May. The mature fruits are red. It can be readily recognized by its pubescent entire leaves, cymose inflorescences, medium-sized ovoid-globose fruits, and smooth pyrenes which are shallowly concave on the back.

4a. **Ilex lonicerifolia** var. **hakkuensis** (Yamamoto) S. Y. Hu in Jour. Arnold Arb. **30**: 291. 1949.

Ilex hakkuensis Yamamoto Suppl. Ic. Pl. Form. **1**: 32, *fig. 14*. 1925. — Sasaki, Cat. Gov. Herb. 316. 1930. — Suzuki in Masamune, Short Fl. Form. 125. 1936.

This glabrous variety was first collected at Hakku by B. Hayata in April 1916. Material of this variety has also been collected from Rengeti and Lake Jitugetutan of Taichu prefecture.

5. **Ilex matsudai** Yamamoto Suppl. Ic. Pl. Form. 1: 37, *fig. 17*. 1925. — Sasaki, Cat. Gov. Herb. 317. 1930. — Kanehira, Form. Trees 377, *fig. 333*. 1936.

Ilex lonicerifolia Hayata var. *matsudai* Yamamoto in Jour. Trop. Agr. **5**: 55. 1933. Syn. nov.

An evergreen tree, entirely glabrous; the third and second years' growth 3–4 mm. in diameter, more or less rugose with numerous conspicuous lenticels, the current year's growth 2 mm. in diameter, longitudinally striate, the terminal buds ovoid, with glabrous and ciliate scales. Leaves occurring even on the third year's growth, 1–2 cm. apart, the stipules obscure; petioles 8–15 mm. long, rugose, canaliculate above; lamina subcoriaceous, olivaceous and brown, slightly shiny above, opaque beneath, oblong-elliptic, the lower ones often broad-elliptic or suborbicular, 4–9.5 cm. long, 2.5–4 cm. wide, acute or rarely obtuse at the base, very shortly broad-acuminate, rarely obtuse at the apex, the acumen 3–5 mm. long, almost as wide; margin entire, more or less recurved when dry; midrib plane above, elevated beneath, the principal lateral nerves 9–11 pairs, obscure above, elevated beneath, reticulate near the margin. Flowers not known. Infructescence cymose, solitary, in the axils of the leaves on the current year's growth, with 3 fruits, the peduncles 3–11 mm. long, dorsoventrally compressed, glabrous; pedicels 5 mm. long, very minutely puberulent at the base. Fruit ellipsoid, 8–10 mm. long, 6–8 mm. in diameter, the persistent calyx explanate, 4 mm. in diameter, with 5 or 6 rounded, ciliate lobes, the stigma discoid. Pyrenes 4 or 5, smooth, 8 mm. long, 2–5 mm. wide on the back, dorsally deeply and widely unicanaliculate, in cross-section U-shaped, the endocarp sublignescent.

TAIWAN: Koshun [Kosyun], Mt. Hiiran, *E. Matsuda* in 1919 (photo and fragment of TYPE); same locality, *K. Yamada 47.*

The evergreen entire leaves, the cymose infructescence, and the deeply unicanaliculate pyrenes of this species suggest a close relationship with *Ilex maclurei* Merr. of Kwangtung and northern Indo-China. Both of them are tropical species, but the latter can be distinguished by its large and thicker leaves and the compound cymose inflorescence.

6. **Ilex rotunda** Thunb., Fl. Jap. 77. 1784. — Henry in Trans. As. Soc. Jap. **24** (Suppl.): 27 (List Pl. Form 27). 1896. — Mat. & Hayata, Enum. Pl. Form. 82. 1906. — Sasaki, Cat. Gov. Herb. 318. 1930. — Ito, Taiwan Shokub. Zus. *fig. 487.* 1928. — Suzuki in Masamune, Short Fl. Form. 126. 1936. — S. Y. Hu in Jour. Arnold Arb. **30**: 308. 1949.

Ilex koshunensis Yamamoto, Suppl. Ic. Pl. Form. **1**: 36, *fig. 16.* 1925. — Suzuki in Masamune, Short Fl. Form. 125. 1936.

Ilex sasakii Yamamoto, op. cit. **1**: 39, *fig. 19.* 1925. — Sasaki, Cat. Gov. Herb. 318. 1930. — Suzuki, op. cit. 126. 1936.

TAIWAN: Toyen, Kayahara, *Hayata & Sasaki* (photograph of TYPE of *Ilex sasakii* Yamamoto); Koshun, Botansha, *Nakahara 941* (photograph of TYPE of *Ilex koshunensis* Yamamoto).

LIUKIU ISLANDS: Amami-Oshima, *Y. Hosoyamada*, July 29, 1927; without precise locality, *C. Wright 184* (G).

This is the most widely distributed species of *Ilex* in eastern Asia, ranging from Korea and Japan southward to the Liukiu Islands, Taiwan, and the mainland of China and Indo-China. In Taiwan it occurs on the mountains of Horan, Sitisei, and Taihei, and at Toyen, Sirin, and Sitiku of the

Taihoku prefecture, at Suwo of the Giran prefecture, Nanto, Mt. Noko, and Lake Candidius of the Taichu prefecture, Daibu of the Taito prefecture, and Koshun (Kosyun) of Tainan prefecture. It has been reported as a bush three meters high, as well as a tree of ten meters. The scarlet fruit matures in November.

The differences in the climatic and edaphic conditions prevailing in the large area covered by the wide range of the species naturally induce variations in the size, shape, and texture of the leaves. As to the Taiwan material, several binomials have been given to the various collections. As the types of these species are compared with a very large number of specimens from the extensive range of the species, many intergrades are noted. Thus with specimens from widely separated regions, the characters employed to separate Thunberg's from the more recently published species become insignificant and cease to be of value even for distinguishing varieties.

6a. **Ilex rotunda** Thunb. var. **microcarpa** (Lindl. ex Paxt.) S. Y. Hu in Jour. Arnold Arb. **30**: 310. 1949.

Ilex microcarpa Lindl. ex Paxt. in Fl. Gard. **1**: 43. 1850.

In Taiwan this variety occurs in the northern and west-central parts of the island. It differs from typical *Ilex rotunda* Thunb. in the puberulous inflorescence. The fruit of this variety is red. Masamune in 1935 described a yellow-fruited variety, *Ilex rotunda* Thunb. var. *sinensis* (Trans. Nat. Hist. Soc. Form **25**: 13) from Hongkong and Nanhoi district in Kwangtung province. As it also has puberulous inflorescences, its relationship is probably closer to this variety than to the typical *Ilex rotunda* Thunb. There is a possibility that Masamune may have observed immature fruits.

7. **Ilex tugitakayamensis** Sasaki in Trans. Nat. Hist. Soc. Form. **21**: 153, *fig. 3.* 1931. — Suzuki in Masamune, Short Fl. Form. 126. 1936. — S. Y. Hu in Jour. Arnold Arb. **30**: 288. 1949.

This unique species with its subcapitate umbelliform infructescence is known only from the type collection. It grows on Mt. Tugitaka. It has a peculiar position in the classification of the units of the section to which it belongs. As the fruiting pedicels all originate from the enlarged end of the peduncle, the inflorescence is umbelliform, and the species should belong to the Series *Umbelliformes* (Loes.) S. Y. Hu. But species of that series all possess three striate and two sulcate pyrenes, while the pyrenes of this species are smooth, coriaceous, and flattened or slightly concave on the back. In this section such pyrenes are found only in representatives of the Series *Chinenses* S. Y. Hu. More material is needed for the clarification of the taxonomic position of this species. Its coriaceous entire leaves and the much reduced fruiting pedicels suggest a relationship with *Ilex lancilimba* Merr. of Hainan Island. Future students may find it desirable to segregate these species in a distinct series of the Section ***Lioprinus*** (Loes.) S. Y. Hu.

8. **Ilex pedunculosa** Miq. in Versl. Med. Kon. Akad. Wet. II, **2**: 83. 1868 [1866] (Repr. 19. 1866), et in Ann. Mus. Bot. Lugd.-Bat. **3**: 106. 1867. — S. Y. Hu in Jour. Arnold Arb. **30**: 334. 1949.

Ilex morii Yamamoto, Suppl. Ic. Pl. Form. **1**: 38, *fig. 18*. 1925. — Suzuki in Masamune, Short Fl. Form. 125. 1936.

Ilex impressivena Yamamoto, l.c. 34, *fig. 15*. 1925. — Sasaki, Cat. Gov. Herb. 317. 1930. — Suzuki, l.c.

TAIWAN: The Central Mountain Range, *U. Mori*, Dec. 1908 (photograph of TYPE of *I. morii* Yamamoto); Taichu, Nanto, Saramao, *E. Matsuda*, Aug. 11, 1919 (photograph of TYPE of *I. impressivena* Yamamoto).

Yamamoto published two species from central Taiwan. He distinguished *I. morii* from *I. pedunculosa* Miq. by its smaller leaves and *I. impressivena* by the impressed midribs of the leaves. These variations also occur in specimens collected in China and Japan. After a comparative study of the Taiwan, Chinese, and Japanese specimens, I can only conclude that the two Formosan forms are conspecific with Miquel's species. In Taiwan, the species occurs in the west-central part of the island. The white flowers appear in August.

8a. **Ilex pedunculosa** Miq. var. **taiwanensis** S. Y. Hu in Jour. Arnold Arb. **30**: 336. 1949.

This is a small-leaved form endemic to northern Taiwan. The small white flowers appear in July. The small size and the brunneous-nigrescent color of the dried leaves of this variety remind one of *Ilex sugeroki* Maxim. var. *brevipedunculata* (Maxim.) S. Y. Hu, but the latter has much shorter petioles.

9. **Ilex yunnanensis** Franch. var. **parvifolia** (Hayata) S. Y. Hu in Jour. Arnold Arb. **30**: 341. 1949.

Ilex parvifolia Hayata in Jour. Coll. Sci. Univ. Tokyo **30**: 57 (Mat. Fl. Form. 57). 1911; Ic. Pl. Form. **1**: 134, *fig. 19*. 1911, et **6** (Suppl.): 13 (Gen. Ind. Fl. Form. 13). 1917. — Sasaki, Cat. Gov. Herb. 318. 1930. — Suzuki in Masamune, Short Fl. Form. 125. 1936.

Ilex transarisanensis Hayata ex Kanehira, For. Trees 127. 1917.

This is a high mountain form. In Taiwan it occurs at altitudes of 2500–3300 meters in the central and southwestern parts of the island. It is common along the edges of the forests between Mt. Arisan and Mt. Niitaka. A compact shrub, 1.5–5 meters high, with shiny dark green foliage, it bears white flowers in June and bright red berries from November to February. It should be an excellent species for foundation plantings, low screens, or hedges.

10. **Ilex sugeroki** Maxim. var. **brevipedunculata** (Maxim.) S. Y. Hu in Jour. Arnold Arb. **30**: 343. 1949.

Ilex sugeroki Maxim. forma *brevipedunculata* Maxim. in Mém. Acad. Sci. St. Pétersb. VII, **29** (3): 36, *pl. 1, fig. d*. 1881.

Ilex taisanensis Hayata in Jour. Coll. Sci. Univ. Tokyo **30**: 57 (Mat. Fl. Form. 57). 1911; in Ic. Pl. Form. **1**: 134. 1911, et **6** (Suppl.): 13 (Gen. Ind. Fl. Form. 13). 1917. — Sasaki, Cat. Gov. Herb. 318. 1930. — Suzuki in Masamune, Short Fl. Form. 126. 1936.

This variety occurs on the northwestern slopes of the Central Mountain Range, at Hori and Bioritu [Byoritu]. The few specimens that I have examined do not have the characteristic olivaceous or brown shiny leaves of the dried Japanese material. This may be due to the technique used in their preparation.

11. **Ilex maximowicziana** Loes. in Nov. Act. Acad. Caes. Leop.-Carol. Nat. Cur. **78**: 339 (Monog. Aquif. 1: 339). 1901. — Sonohara et al., Fl. Okinawa 92. 1952.

Ilex crenata sensu Ito & Matsum. in Jour. Coll. Sci. Tokyo **13**: 367 (Tent. Fl. Lutch. 367). 1900, non Thunb. 1784.

Ilex crenata Thunb. var. *scoriatum* Yamamoto, Suppl. Ic. Form. **1**: 31. 1925, non var. *scoriarum* W. W. Smith. 1917.

Ilex scoriatulum Koidzumi in Bot. Mag. Tokyo **43**: 389. 1929. — Sasaki, Cat. Gov. Herb. 318. 1930. — Kanehira, Form. Trees, rev. ed. 381, *fig. 338.* 1936 (*I. scoriatum*). — Suzuki in Masamune, Short Fl. Form. 126. 1936.

An evergreen tree 3 m. high with a trunk 4 cm. in diameter; branchlets longitudinally ridged, the third year's growth 3 mm. in diameter, the lenticels obscure, the current year's growth 1.5 mm. in diameter, subquadrangular, very minutely puberulous, the terminal buds usually well developed, subconic, puberulent. Leaves occurring also on the second year's growth, 3–10 mm. apart, the stipules aciculate, 0.7 mm. long, persistent; petioles 7–10 mm. long, one third or one fourth the length of the lamina, puberulous, deeply grooved above; lamina coriaceous, olivaceous, shiny above, opaque and punctate beneath, elliptic or broad-elliptic, 2–4.5 cm. long, 1.3–2.3 cm. wide (up to 8 cm. long and 3.4 cm. wide, according to Loesener), acute at both ends, rarely the lower ones obtuse or rounded at the apex; evenly crenulate-serrate at the margin; midrib impressed above, elevated beneath, the lateral nerves obscure on both surfaces. Staminate inflorescences fasciculate, the individual branches 1- or 3-flowered, the flowers white, 4-merous; the calyx patelliform, the corolla rotate, the stamens shorter than the petals, with oblong anthers, the rudimentary ovary subglobose, with a rostellate center. Pistillate inflorescence solitary in the axils of small leaves or scales on the lower portion of the current year's growth; pedicels 7 mm. long, the flowers not known. Fruit globose, 8 mm. in diameter, the persistent calyx 3.5 mm. in diameter, 4-lobed, the lobes rounded, ciliate; the stigma discoid. Pyrenes 4 in number, 5 mm. long, 4 mm. wide, the endocarp coriaceous, smooth, 5-striate, the striae impressed.

TAIWAN: Taito, Taririku-sya, *S. Sasaki* in May 1924 (photograph).

LIUKIU ISLANDS: Ishigaki, *J. L. Gressitt 608* (TOPOTYPE). Irumuti, *S. Kawagoe* on July 27, 1919.

Ilex maximowicziana was based on the collections of Warburg and Tashiro from Ishigaki. The species has been overlooked by botanists interested in the flora of Taiwan and the Liukiu Islands. In 1925 Yamamoto interpreted the collections of Soma, Matsuda, and Sasaki from Taiwan, and Tashiro's collection (type material for *Ilex maximowicziana* Loes.) from Liukiu as *Ilex crenata* Thunb. var. *scoriarum* (*scoriatum*) W. W. Smith. In 1929 Koidzumi, presumably on the basis of the same collections cited by Yamamoto, raised the variety to specific rank, and not realizing that there was an earlier valid name for the Liukiu plant, called it *Ilex scoriatulum*.

This species is very closely related to *Ilex viridis* Champ. ex Benth. The differences between them rest on very minute and technical characters. In *I. maximowicziana* the petioles are relatively longer, equalling one third or one fourth the length of the lamina, and the pyrenes are smooth with impressed striae, while in *Ilex viridis* the petioles are relatively shorter, being one thirteenth to one sixth the length of the lamina, and the pyrenes are rugose with slightly elevated striae. The insular taxon is not well known. More material from Taiwan and the Liukiu Islands may prove it to be conspecific with the mainland form. In Taiwan, this species occurs at the southern end of the island.

12. **Ilex mutchagara** Makino, in Bot. Mag. Tokyo 27: 75. 1913. — Sasaki, Cat. Gov. Herb. 318. 1930, pro parte. — Sonohara et al., Fl. Okinawa 92. 1952.

An evergreen shrub up to 3 m. high, glabrous, the branchlets subquadrangular, deeply grooved, the third year's growth 1.5–2 mm. in diameter, the lenticels lacking, the leaf-scars semicircular, very slightly elevated; current year's growth 1 mm. in diameter, the terminal buds weakly developed. Leaves occurring also on the second year's growth, 2–5 mm. apart; the stipules callose, deltoid, 0.5 mm. long; petioles 3–6 mm. long, up to one eighth the length of the lamina, deeply narrow-grooved above. Lamina subcoriaceous, olivaceous, shiny above, opaque and punctate beneath, oblanceolate or obovate-elliptic, (2–) 4–5 cm. long, 1–1.5 cm (rarely up to 1.8 cm.) wide, cuneate at the base, shortly and broadly acuminate or rarely rounded at the apex, the acumen obtuse at the tip, remotely crenulate-serrate on the anterior half; midrib impressed above, elevated beneath, the lateral nerves obscure on both surfaces. Staminate inflorescence fasciculate, the individual branches 3- or 1-flowered, the peduncles 3–7 mm. long, minutely puberulent, the pedicels 2–3.5 mm. long, subpuberulent, the flowers 4-merous; calyx patelliform, the lobes suborbicular, ciliate; corolla rotate, the petals broad-elliptic, the stamens with ellipsoid anthers; the rudimentary ovary minute. Pistillate flowers not known. Fruit solitary, in the axils of the bracts at the base of the current year's growth, the pedicels with 2 prophylla at the middle, the berries globose, 7–8 mm. in diameter, the persistent calyx explanate, 3 mm. across, the lobes rounded, sparsely ciliate, the stigma thickly discoid. Pyrenes 4, smooth, 5 mm. long, the endocarp coriaceous.

LIUKIU ISLANDS: Okinawa, Nago, *E. H. Wilson 8071.*

Makino based his description chiefly on material collected from Okinawa, principally from Nago. Wilson's collection appears to have come from the type locality. Makino also cited material from Kume and Iriomote. Specimens from these islands belonging to this species have not been available for my examination.

As Makino observed, this species is closely allied to *Ilex crenata* Thunb. The oblanceolate, loosely arranged leaves and glabrous branchlets are very distinct. It is endemic to the Liukiu Islands, where it is rare even at the type locality. Its white flowers appear in February.

13. **Ilex triflora** Blume var. **kanehirai** (Yamamoto) S. Y. Hu in Jour. Arnold Arb. **30**: 332. 1949.

Ilex crenata Thunb. var. *kanehirai* Yamamoto, Suppl. Ic. Pl. Form. **1**: 31, *fig. 11.* 1925.

Ilex kanehirai (Yamamoto) Koidz. in Bot. Mag. Tokyo **43**: 389. 1929. — Sasaki, Cat. Gov. Herb. 317. 1930. — Kanehira, Form. Trees, rev. ed. 375. 1936. — Suzuki in Masamune, Short Fl. Form. 125. 1936.

Ilex mutchagara Makino var. *kanehirai* (Yamamoto) Masamune in Trans. Nat. Hist. Soc. Form. **25**: 253. 1935. — Kanehira & Hatusima in Trans. Nat. Hist. Soc. Form. **29**: 156. 1939. — Sonohara et al., Fl. Okinawa 92. 1952.

Regarding the status of this taxon, there is considerable controversy among botanists. Yamamoto first placed it as a variety of *Ilex crenata* Thunb. Koidzumi in 1929 raised it to specific rank, and both Kanehira and Sasaki agreed with him. Masamune maintained it as a variety of *Ilex mutchagara* Makino. Kanehira also adopted this concept. *Ilex mutchagara* Makino is characterized by oblanceolate leaves with a shortly acuminate apex and solitary fruits. The present species has fasciculate fruits and obovate leaves with rounded apex. Its relationship should be closer to *Ilex triflora* Blume, a species with fasciculate fruits, which is widely spread in China.

This variety was first described from Giran in northeastern Taiwan. Additional material has since been collected from Kosyun at the southern extremity of the island. It also occurs on the island of Hainan and in Fukien Province of the Chinese mainland.

14. **Ilex integra** Thunb., Fl. Jap. 77. 1784. — Sieb. & Zucc. in Abh. Bay. Ak. Wiss. Math. Phys. **4** (2): 148 (Fl. Jap. **1**: 40). 1845. — Maxim. in Mém. Acad. Sci. St. Pétersb. VII, **29** (3): 28, 41, *pl. 1, fig. 3.* 1881. — Forbes & Hemsl. in Jour. Linn. Soc. Bot. **23**: 116. 1886. — Ito & Matsum. in Jour. Coll. Sci. Univ. Tokyo **12**: 368. 1900. — Loes. in Nov. Act. Acad. Caes. Leop.-Carol. Nat. Cur. **78**: 270 (Monog. Aquif. **1**: 270). 1901. — Matsum. & Hayata, Enum. Pl. Form. 82. 1906. — Sasaki, Cat. Gov. Herb. Form. 317. 1930. — Suzuki in Masamune, Short Fl. Form. 125. 1936. — Rehder, Man. Cult. Trees and Shrubs,

ed. 2, 548. 1940; Bibliogr. Cult. Trees and Shrubs 400. 1949. — Sonohara et al., Fl. Okinawa 92. 1952.

Othera japonica Thunb. (praes., resp. Lodin), Nov. Gen. Pl. 56. 1783.

Ilex othera Sprengel, Syst. Veg. 1: 496. 1826.

Ilex asiatica Sprengel, l.c.

Prinos integra Hook. & Arn. in Bot. Beechey Voy. 261. 1853.

Small evergreen trees 5–8 m. high, the trunk 12–20 cm. in diameter, glabrous; branchlets subterete, striate, the third year's growth 3–4 mm. in diameter, the lenticels lacking, the leaf-scars suborbicular, conspicuous, the current year's growth 2–3 mm. in diameter, the terminal buds well developed, conic, glabrous. Leaves occurring also on second year's growth, 3–15 mm. apart, the stipules obscure; petioles 1–1.5 cm. long, up to one third the length of the lamina, narrowly canaliculate above; lamina coriaceous, olivaceous and brunneous, obovate to obovate-elliptic, rarely oblanceolate, 4–7 cm. long, 1.5–2.5 cm. wide, cuneate, rarely obtuse at the base, abruptly short-acuminate, the acumen 5 mm. long, entire, the midrib plane above, evident beneath, the lateral nerves 6–9 pairs, obscure, rarely evident on both surfaces. Inflorescence fasciculate, the flowers 4-merous, the individual branches of the fascicles uniflorous. Staminate inflorescence: pedicels 4–5 mm. long, glabrous, bracts ovate, glabrous, ciliate, the prophylla basal, ciliate; calyx patelliform, 4 mm. across, the lobes ovate, 1.75 mm. long, obtuse and ciliate; corolla rotate, 10–11 mm. across, the petals oblong, 5 mm. long, 2 mm. wide, connate at the base; stamens shorter than the petals, the anthers oblong; rudimentary ovary globose, slightly depressed, often 4-lobed at the apex. Pistillate inflorescence: pedicels 6–8 mm. long, bracts ovate, the prophylla 2, basal, ciliate; calyx patelliform, 3 mm. across, the lobes rounded; corolla erect, the petals obovate, 5 mm. long, 3.5 mm. wide, the apex rounded, ciliate; staminodes shorter than the petals, the sterile anthers minute, cordate; ovary ovoid, 4 mm. long, 3.5 mm. wide, the apex flat with discoid stigma. Fruit large, globose or oblong-ellipsoid, 9–19 mm. long, 10 mm. in diameter, the exocarp thick, the stigma discoid. Pyrenes rugose, striate and sulcate, the back oblong in outline, 7–10 mm. long, 4 mm. wide, slightly depressed along the middle, the endocarp stony.

LIUKIU ISLANDS: Okinawa, Kunigami, *E. H. Walker, S. Sonohara, S. Tawada & T. Amano 7005*; same locality, *S. Sonohara, S. Tawada & T. Amano 6309*. Nakano-shima, Linshoten Isl. Group, *S. Kawagoe*, Aug. 20, 1912.

JAPAN: Hondo: Tokyo, *E. Elliott 7*; *M. Mizushima 1088*. Sagami, *M. & U. Mizushima 911*; *K. Miyabe*, April 1882; *K. Sakurai*, April 12, 1906. Mino, *K. Shiota 70, 6542*. Yokohama, *Maximowicz* in 1862 (G); *E. H. Wilson 6415*. Kamakura, *E. H. Wilson 6608, 6609*. Nagasaki, *Oldham*. Without precise locality, Herb. Thunberg, fragment of type material; *Siebold* ex Herb. Lugduno-Batavo 101570 (A, G); *Zollinger*. Kyushu: Tanega-shima, *E. H. Wilson 6134*. Kago-shima, *E. H. Wilson 6167*.

KOREA: Quelpaert, *U. Faurie 1638, 1639, 1647*; *T. Taquet 622, 623, 2718, 2719, 4146*; *E. H. Wilson 9513*. Oo-ryong-too, *E. H. Wilson 8540*. Port Hamilton, *C. Wilford* in 1859 (G).

I have also examined material cultivated in Japan, the Royal Botanic Gardens at Kew, the Golden Gate Park, San Francisco, and in gardens in Augusta, Ga., and Federal Point, Fla. In Japan the tree is widely cultivated for ornamental purposes. The young leaves are eaten as greens. The bark is ground to obtain a sticky substance which is used for bird-lime. Loesener recorded this species from China, as represented by *Fortune 57*. Among all the Chinese material of *Ilex* that I have examined, there is no element that is close to this species, and it appears that any occurrence of it in China is not spontaneous.

There exists a great variation in leaf-shape and pedicel-length. The pedicels of all the Liukiu material that I have examined are on the short end of the normal curve. They are 6–7 mm. long. Among the Japanese and Korean elements there is a long-pedicellate form. The fruiting pedicels are as long as 10–15 mm. In such cases the prophylla are inserted on the pedicels, about one third of the way from the base.

15. **Ilex brachypoda** sp. nov.

Frutex sempervirens, usque 3 m. altus, ramulis glaberrimis, bienniis 4 mm. diametro, teretis, rugosis, lenticellis obsoletis; foliis coriaceis, integerrimis, obovatis, vel oblongo-obovatis, 3–8 cm. longis, 1.5–4.5 cm. latis, basi acutis vel cuneatis, apice obtusis vel breviter acuminatis, costa supra plana, subtus prominula, nervis lateralibus utrinque 5 vel 6, obscuris; inflorescentiis paucifasciculatis, floribus 4-meris; ♂ ignotis; ♀ unifloris, pedicellis 2–3 mm. longis, prophyllis basalibus, ciliatis; calycibus patelliformibus, 4 mm. diametro, lobis ciliatis; corolla erecto-patenti, petalis liberis, ovatis, 4 mm. longis, 3 mm. latis; staminodiis petalis brevioribus, antheris parvis, cordiformibus, ovario magno, ovoideo, 4–5 mm. longo, 3–4 mm. diametro, stigmate discoideo. Fructus globosus, 10 mm. diametro, stigmate umbilicato; pyrenis 4, rugosis et lapidosis, dorso 8 mm. longis et 4 mm. latis, leviter depressis.

LIUKIU ISLANDS: Okinawa, Genka, Mt. Kunchon, *E. H. Wilson 8118*. Oosima, *C. Wright*, US 15798 (US, TYPE).

According to Wilson this is a common shrub in Okinawa. Its white flowers appear in early March. It is closely related to *Ilex integra* Thunb., from which it can be distinguished at once by its subsessile fruits.

16. **Ilex bioritsensis** Hayata in Jour. Coll. Sci. Univ. Tokyo **30**: 53. 1911. — Sasaki, Cat. Gov. Herb. 316. 1930. — Suzuki in Masamune, Short Fl. Form. 124. 1936. — S. Y. Hu in Jour. Arnold Arb. **30**: 366. 1949.

This species is characterized by its small spinose leaves and paired fruits, each with two pyrenes. It was first recorded from Bioritsu [Byoritu], on Mt. Tokuzyo-taizan. Additional material has been collected from Tonbara of Nanto in Taichu prefecture and Mt. Noko of Taito prefecture. It is now also known from central and western China in mixed forests at altitudes of 1700–3960 meters. In Taiwan it grows to be a small tree up to seven meters high. As a result of repeated cutting for firewood, it is often seen as a shrub about two meters high. Its compact shiny evergreen foliage and its brilliant red fruits make it a good garden specimen.

17. **Ilex dimorphophylla** Koidzumi, Pl. Nov. Amami-Ohsim. 12. 1928.

An evergreen shrub, the old twigs light gray, slightly rugose, the current year's growth pilose. Leaves occurring also on the third year's growth, 4–12 mm. apart, the petioles 0.5–3 mm. long, canaliculate and puberulous above; lamina coriaceous, olivaceous, glabrous, entire or on young shoots 3- to 6-sinuate-dentate on each side, spiny, obovate, obovate-elliptic or broad-elliptic, 1–3.5 cm. long, 7–17 mm. wide, obtuse or rounded at the base, mucronulate-acute to rounded at the apex, the midrib plane above, slightly elevated beneath, the lateral nerves 4 or 5 pairs, obscure on both surfaces. Flowers not known. Infructescence fasciculate, axillary on the second year's growth; pedicels 5 mm. long, puberulous, the prophylla 2, basal, ovate, ciliate; young fruit globose, 3 mm. in diameter, 4-loculate, the stigma 4-lobed discoid, the persistent calyx 2.5 mm. across, 4-lobed, the lobes ovate, rounded at the apex, ciliate. Pyrenes not known.

LIUKIU ISLANDS: Amami-Oshima: Mt. Yuwandake, *S. Tashiro* in March 1924 (Herb. Univ. Kyoto, LECTOTYPE, photograph and fragment in A); same locality, *G. Koidzumi* in April 1923 (Herb. Univ. Kyoto, PARATYPE; photograph and fragment in A).

When Koidzumi published this species, he cited three specimens (*Z. Tashiro* in 1924, *H. Ohba* in 1925, and *G. Koidzumi* in 1923), not designating the type. Tashiro's collection represents a four-year-old shoot. The leaves are elliptic, all spiny, and with extremely short petioles. Its appearance reminds one of the Taiwan species *Ilex bioritsensis* Hayata. Koidzumi's collection is a fruiting specimen. Its leaves are all entire and the petioles are 3 mm. long. It resembles a Hongkong species, *Ilex championii* Loes. As leaf-dimorphism is a common feature in many species of *Ilex* (as in the case of *Ilex cornuta* Lindl., where both spiny and entire leaves occur on the same plant), I think that Koidzumi was probably justified in maintaining these heterogeneous elements with entirely different aspects as conspecific. Regarding the typification of this species Dr. S. Kitamura of the Botanical Institute of Kyoto wrote, "I selected the specimens collected by S. Tashiro as the lectotypus. This specimen is sterile. There is Koidzumi's handwriting . . . greater part of his original description coincides well with this specimen. I selected the specimen collected by G. Koidzumi as paratypus."

This species appears to be close to *Ilex goshiensis* Hayata, which has abruptly short-acuminate, retuse, entire leaves 2.8–4.8 cm. long and 1.5–2.5 cm. wide.

18. **Ilex suzukii** S. Y. Hu in Jour. Arnold Arb. **30**: 376. 1949.

TAIWAN: Mt. Taiheizan, *S. Suzuki*, Aug. 7, 1928 (US).

This species is endemic to Mt. Taiheizan, Taihoku, Taiwan. It has a superficial resemblance to *Ilex goshiensis* Hayata because both species have small entire leaves. But the nerves on the leaves of Hayata's species are obscure beneath, the fruits have thick discoid stigmata, and the endocarps of the pyrenes are coriaceous, while the leaves of this species are prominently reticulate beneath, the stigmata of the fruits are navel-like, and the endocarps of the pyrenes are woody. According to the characters presented in the fruit and pyrenes, this species should be placed in Series *Denticulatae* S. Y. Hu of the Section *Aquifolium* Gray. But all the other species in this series have denticulate leaves, while this one has entire ones. More material is awaited for the clarification of its taxonomic position.

19. **Ilex formosana** Maxim in Mém. Acad. Sci. St. Pétersb. VII 29 (3): 46. 1881. — Henry in Trans. As. Soc. Jap. **24** (Suppl.): 27 (List Pl. Form. 27). 1896. — Matsum. & Hayata, Enum. Pl. Form. 81. 1906. — Hayata in Jour. Coll. Sci. Univ. Tokyo **30**: 54 (Mat. Fl. Form. 54). 1911, et in Ic. Pl. Form. **1**: 131. 1911. — Sasaki, Cat. Gov. Herb. 316. 1930. — Suzuki in Masamune, Short Fl. Form. 125. 1936. — S. Y. Hu in Jour. Arnold Arb. **31**: 68. 1950.

This species was based on material collected by Oldham in Taiwan. It has been considered endemic to that island by some botanists, among them Kanehira. The type material has elliptic-lanceolate leaves with obscure reticulation on the lower surface and an acuminate apex, and small fruits on very short (2–3 mm. long) pedicels. As our knowledge of the flora of mainland China increases, we know that a species so characterized is widespread in the warmer regions of China. In Taiwan it occurs in forests at altitudes of 600–700 meters, where it grows to a tree up to twelve meters high. The red fruits remain on the tree throughout the winter, from December to March.

20. **Ilex ficoidea** Hemsl. in Jour. Linn. Soc. Bot. **23**: 116. 1886. — S. Y. Hu in Jour. Arnold Arb. **31**: 72. 1950.

Ilex buergeri Miq. var. *glabra* Loes. in Nov. Act. Acad. Caes. Leop.-Carol. Nat. Cur. **89**: 286 (Monog. Aquif. **2**: 286). 1908.

Ilex glomeratiflora Hayata, Ic. Pl. Form. **3**: 53. 1911; **5**: 15, *fig. 6.* 1915, et **6** (Suppl.): 13 (Gen. Ind. Fl. Form. 13). 1917. — Yamamoto, Suppl. Ic. Pl. Form. **1**: 32. 1925, pro parte. — Sasaki, Cat. Gov. Herb. 316. 1930. — Suzuki in Masamune Short Fl. Form. 125. 1936.

Ilex arisanensis Yamamoto Suppl. Ic. Pl. Form. **1**: 30, fig. *10.* 1925. — Sasaki, Cat. Gov. Herb. 316. 1930. — Kanehira, Form. Trees, rev. ed. 370. 1936. — Suzuki in Masamune, Short Fl. Form. 124. 1936.

Ilex warburgii sensu Yamamoto, Suppl. Ic. Pl. Form. **1**: 40. 1925, non Loes., 1901.

Ilex buergeri Miq. var. *glabra* Loes. was based on *Faurie 39* from Taiwan. In the herbarium of the Arnold Arboretum there are two sheets of this number. Their glabrous stems, caudate leaves, and very short fruiting pedicels are characteristic of *Ilex ficoidea* Hemsl. In making this variety a synonym of *Ilex warburgii,* Yamamoto misinterpreted the latter species.

The type of *Ilex glomeratiflora* Hayata represents a staminate plant of *Ilex ficoidea* Hemsl., which has very short pedicels, 1.5 mm. long. Yamamoto wrongly identified the long pedicellate fruiting material of *Ilex uraiensis* Yamamoto as the female plant of *I. glomeratiflora*, and at the same time determined *U. Faurie 186* as *Ilex arisanensis.* This last taxon represents a plant with short fruiting pedicels. Both Sasaki's and Faurie's collections were from Arisan. They represent the staminate and pistillate plants of the same species, *Ilex ficoidea* Hemsl.

21. **Ilex liukiuensis** Loes. in Nov. Act. Acad. Caes. Leop.-Carol. Nat. Cur. **78**: 336 (Monog. Aquif. **1**: 336). 1901. — Sasaki, Cat. Gov. Herb. 317. 1930. — Masamune & Suzuki in Ann. Rep. Taihoku Bot. Gard. **3**: 61. 1933. — Sonohara et al., Fl. Okinawa 92. 1952.

Ilex mertensii sensu Ito & Matsum. in Jour. Coll. Sci. Univ. Tokyo **12**: 369 (Tent. Flor. Lutch. 369). 1900. — sensu Sonohara et al., Fl. Okinawa 92. 1952, non Maxim., 1888.

Evergreen trees up to 8 m. high, entirely glabrous; branchlets of the third year's growth 3 mm. in diameter, rugose with large, slightly elevated leaf-scars and scars of the inflorescences, the lenticels lacking, the current year's growth 1.7 mm. in diameter, striate. Leaves occurring also on the third year's growth, 3–10 mm. apart, the stipules minute, often obsolete; petioles 10–16 mm. long, up to one third the length of the lamina, narrowly canaliculate above; lamina coriaceous, brunneous, rarely olivaceo-brunneous, obovate, or oblong-elliptic, those near the apex sometimes elliptic, 3–7.5 cm. long, 1.8–3.5 cm. wide, acute at the base, obtuse, rounded, retuse or broadly short-acuminate at the apex, the margin recurved and obviously thickened, subentire or remotely crenulate, the midrib plane above, elevated beneath, the lateral nerves 5 or 6, obscure above, prominent and noticeably reticulate beneath. Staminate inflorescence unknown. Pistillate inflorescence fasciculate, 2–4-flowered, the pedicels 9–14 mm. long, each with two prophylla inserted 1–2 mm. above the base; calyx patelliform, 2 mm. across, 4- or 5-lobed, the lobes rounded, ciliate; corolla rotate, 8 mm. across, the petals more or less free, oblong, 3.5 mm. long, ciliate at the apex; staminodes half the length of the petals, the anthers sagittate, ovary ovoid, 1.5 mm. long, the stigma discoid. Fruit globose, 6 mm. in diameter, the persistent calyx explanate, the stigma navel-like, 4-lobed. Pyrenes 4, the back oblong in outline, 4.5 mm. long, 3 mm. wide, the middle longitudinally depressed, rugose and obliquely striate, the endocarp woody.

LIUKIU ISLANDS: Iriomotto [Iriomote], *Warburg* in 1887 (fragment of the TYPE, A); same island, between Shira-hama and Sonai, *E. H. Walker & S.*

Tawada 6528. Ishigaki Island, *E. H. Walker & S. Tawada 727*. Okinawa, Nago-Dake, *T. Kanashiro 1697* (US), *1812*.

I have also seen some sterile material from Yokohama Nursery.

The woody, rugose, dorsally impressed pyrenes, the relatively long-petiolate, obovate or oblong-elliptic leaves, the fasciculate fruit, and the absence of lenticels on the third year's growth of *Ilex liukiuensis* all suggest a close relation with *I. graciliflora* Champ. of Hongkong. Besides the geographical separation, the latter species differs in having sparsely puberulous branchlets, pedicels 4–6 mm. long, and thickly coriaceous leaves.

In Liukiu the plant occurs on forest ridges. The fruit begins to turn red in middle August.

22. **Ilex uraiensis** Yamamoto in Jour. Soc. Trop. Agr. Taiwan **4**: 486. 1932. — Suzuki in Masamune, Short Fl. Form. 126. 1936. — S. Y. Hu in Jour. Arnold Arb. **30**: 382. 1949.

Ilex mutchagara sensu Sasaki, Cat. Gov. Herb. 318. 1930. — sensu Kanehira, Form. Trees, rev. ed. 378, *fig. 335*. 1936, non Makino, 1913.

Ilex uraiana Hayata in sched. ex Kanehira, l.c., in syn.

Ilex kelungensis sensu Kanehira & Hatusima in Trans. Nat. Hist. Soc. Form. **29**: 156. 1939, non Loes. 1901.

TAIWAN: without precise locality, *W. R. Price 262* (fragment).

Ilex uraiensis Yamamoto was based on material collected from Uraisha and Sozan of northern Taiwan, with the type from Sozan. This material was interpreted as *Ilex mutchagara* by Sasaki, as indicated by his citations, in 1930, and by Kanehira in 1936. As Kanehira was the Director of the Department of Forestry, Government Research Institute, and Sasaki the Curator of the Herbarium of the same department, it was natural for them to base their misinterpretation on the same material of *I. mutchagara* Makino. Sasaki cited no synonyms. Kanehira overlooked Yamamoto's publication and credited the binomial to Hayata as *Ilex uraiana* Hayata in sched. Both Kanehira and Sasaki were mistaken in maintaining that the Uraisha and the Sozan specimens were conspecific with the Liukiu *I. mutchagara* Makino. Kanehira's illustration, based on northern Taiwan material, was certainly not Makino's Liukiu species. In the Arnold Arboretum we have several collections with both flowering and fruiting specimens from Sozan, the type locality of *Ilex uraiensis* Yamamoto. *Wilson 10288*, a staminate plant in full bloom, matches Kanehira's figure in every respect. The leaves of this specimen appear similar in size and shape to those of *I. mutchagara* Makino. But the lower surface of Makino's species is "brownish-puncticulate" and that of the Sozan material is not. Moreover, the endocarp of the pyrenes of the Liukiu species is "smooth, thin, coriaceous," while that of the Sozan species is "irregularly striate, wrinkled . . . and stony." The punctate leaves, black fruits, and smooth coriaceous endocarps of *Ilex mutchagara* Makino place it in the section *Paltoria*, while the crenulate-serrate leaves, the fasciculate red fruits and the irregularly striate, wrinkled and stony endocarps of *Ilex uraiensis* Yamamoto place it in the *Denticulatae* series of the section *Aquifolium*. The resemblance in size and shape of the leaves in these two species is very superficial.

Again, in 1939, Kanehira and Hatusima interpreted *Ilex uraiensis* Yamamoto as conspecific with *Ilex kelungensis* Loes. The latter species was based on Warburg's collection made in November 1895 at Kelung, a port in the northeastern part of Taihoku. Its elliptic-lanceolate leaves with obscure reticulate veinlets on the lower leaf-surface, and the small fruits on very short pedicels (2–3 mm. long), are characteristic of *Ilex formosana* Maxim., to which it belongs. *Ilex uraiensis* Yamamoto, on the other hand, is characterized by its prominently reticulated leaves and larger fruits on pedicels 6–8 mm. long. The size and shape of the smaller leaves of this species appear to resemble those of the isotype of *Ilex kelungensis* Loes., which I interpret to be conspecific with *I. formosana* Maxim. It was probably on account of this superficial resemblance that Kanehira and Hatusima made *I. uraiensis* Yamamoto a synonym of *I. kelungensis* Loes.

22a. **Ilex uraiensis** Yamamoto var. **formosae** (Loes.) S. Y. Hu in Jour. Arnold Arb. **30**: 383. 1949.

This variety differs from the typical *Ilex uraiensis* Yamamoto in its smaller obovate leaves with rounded or obtuse apex.

22b. **Ilex uraiensis** Yamamoto var. **macrophylla** var. nov.

Frutex, ramulis glabris; foliis coriaceis, ellipticis, raro obovato-ellipticis, 7–10.5 cm. longis, 3.5 cm. latis, basi acutis, apice brevi-acuminatis, acumine 5–10 mm. longis; fructibus fasciculatis, pedicellis 6–8 mm. longis.

TAIWAN: Kiirun, *T. Tanaka & Y. Shimada 17797* (TYPE).

This large-leaved variety differs from the typical *Ilex uraiensis* Yamamoto in which the elliptic or obovate-elliptic leaves measure only 3–7 cm. long and 1.5–2.5 cm. wide.

23. **Ilex warburgii** Loes. in Nov. Act. Acad. Caes. Leop.-Carol. Nat. Cur. **78**: 326 (Monog. Aquifol. **1**: 326). 1901. — Yamamoto, Suppl. Ic. Pl. Form. **1**: 40. 1925. — Suzuki in Masamune, Short Fl. Form. 126. 1936.

A small evergreen tree up to 4 m. high; branchlets glabrous, the third year's growth 3–4.5 mm. in diameter, the lenticels obscure, the leaf-scars suborbicular, the current year's growth 1.5–2 mm. in diameter, subterete, the terminal buds conic, pubescent. Leaves 1–2 cm. apart, occurring also on the second year's growth, the stipules obscure, the petioles 8–15 mm. long, up to one fifth the length of the lamina, deeply canaliculate, minutely puberulent or glabrescent above; lamina coriaceous, olivaceous, oblong-elliptic, rarely broad elliptic, 4–8.5 cm. long, 2.4 cm. wide, obtuse or rounded at the base, abruptly caudate at the apex, the acumen 8–15 mm. long, 2–3 mm. wide, the width rather uniform, remotely crenulate-serrate, the midrib impressed above, glabrous or very minutely puberulent, elevated beneath, the lateral nerves 7 to 9 pairs, obscure above, evident beneath, reticulate near the margin. Flowers not known. Infructescence fasciculate or subracemose, the central axis up to 6 mm. long, the pedicels of individual fruits 4–8 mm. long, the prophylla basal or medium, the fruit globose, 5–6 mm. in diameter, the persistent calyx explanate, 2 mm. across, the lobes ciliate, the stigma navel-like. Pyrenes 4, short and robust, rugose, striate and sulcate, the back ovate in outline, 4 mm. long, 3 mm. wide, the endocarp woody.

TAIWAN: Taihoku, Shirin, Taihoku Univ. Herb. no. 11132; Shirin to Sozan, *E. H. Wilson 10298.*

LIUKIU ISLANDS: Ischigaki (Ishigaki), *Warburg* (fragment of TYPE). Yaeyama Gunto, Iriomote, *E. H. Walker & S. Tawada 6665.*

This species is closely related to *Ilex ficoidea* Hemsl., which is characterized by its very short (2–3 mm. long) fruiting pedicels.

24. **Ilex pubescens** Hook. & Arn., Bot. Beechey Voy. 167, *pl. 35.* 1833. — Yamamoto, Suppl. Ic. Pl. Form. **1**: 39. 1925. — Sasaki, Cat. Gov. Herb. 318. 1930. — S. Suzuki in Ann. Rep. Taihoku Bot. Gard. **1**: 154. 1931, et in Masamune, Short Fl. Form. 125. 1936. — S. Y. Hu in Jour. Arnold Arb. **31**: 220. 1950.

TAIWAN: between Goshyo & Suizya, *S. Suzuki 5799*; Taihokuzyu, Bunzangun, *Suzuki-Tokio 8822*; same locality, *S. Suzuki* on April 30, 1933. Baran, *Kudo-Sasaki 15126.*

This species was first published on the basis of material collected from Hongkong. It has a wide range of distribution on the mainland of China, from Chekiang and Anhwei southward to Kwangtung and Kwangsi. In Taiwan it has been reported from Sozan, Heirinbi, Taihei, and Urai in the northern part of the island, from Nanto and Lake Candidius in the central part of the island, and from Kosyun and South Cape at the southern extremity of the island. It is a common shrub in thickets along the roadside at altitudes 600–750 meters. Its pinkish flowers appear in late March and its scarlet fruit lasts on the bush all through the winter.

25. **Ilex cochinchinensis** (Lour.) Loes. in Nov. Act. Acad. Caes. Leop.-Carol. Nat. Cur. **78**: 230 (Monog. Aquif. **1**: 230). 1901. — S. Y. Hu in Jour. Arnold Arb. **31**: 239. 1950.

Ilex ardisioides Loes. op. cit. 359. 1901. — Sasaki, Cat. Gov. Herb. 316. 1930. — Suzuki in Masamune, Short Fl. Form. 124. 1936.

In Taiwan this species occurs only at the southern extremity of the island. It is found also in Hainan and northern Indo-China. Its large entire punctate leaves and its fasciculate fruits are very characteristic. In commenting on *Ilex ardisioides* Loes., Hayata wrote in 1911, "a species imperfectly known to me." Two years later he published *Ilex cleyeroides*, which is a synonym of *Ilex cochinchinensis* (Lour.) Loes.

26. **Ilex goshiensis** Hayata in Jour. Coll. Sci. Univ. Tokyo **30**: 54 (Mat. Fl. Form. 54). 1911, et Ic. Pl. Form. **1**: 131. 1911. — S. Y. Hu in Jour. Arnold Arb. **31**: 248. 1950.

Ilex hanceana sensu Ito & Matsum. in Jour. Coll. Sci. Univ. Tokyo **12**: 367 (Tent. Fl. Lutch. 367). 1900. — sensu Hayata, Ic. Pl. Form. **6** (Suppl.): 13 (Gen. Ind. Fl. Form. 13). 1917. — sensu Sasaki, Cat. Gov. Herb. 317. 1930. — sensu Sonohara et al., Fl. Okinawa 92. 1952, non Maxim., 1881.

LIUKIU ISLANDS: Okinawa, *T. Miyagi* (fragment); Kunigami, Tanyu-dak, *S. Sonohara, S. Tawada & T. Amamo 6308*; Genka Mt., *E. H. Wilson 8091* (A, US).

JAPAN: Kyushu: Hingo, Koonose, *K. Mayebara 320* (fragment); Mt. Kirshima, *Z. Tashiro*, May 8, 1913 (sterile).

This species has been misinterpreted as *Ilex hanceana* Maxim. by many botanists. Through Dr. H. Hara of the Botanical Institute, University of Tokyo, I have obtained fragments of the type material for comparison, accompanied by an excellent photograph. The elongated pedicels, the fasciculate umbelliform inflorescences, with the individual branches 3- to 7-flowered, and the globose fruit with slightly elevated discoid stigmata, are distinct features of this species. It is very different from *Ilex hanceana* Maxim., which has paired fruits on very short (1.5 mm. long) pedicels.

In Taiwan and Liukiu this species appears to be a small tree up to 6 meters high. It is common at altitudes of 100–600 meters. Its fruit turns red in August (fide Gressitt) and remains dull red until March (fide Wilson).

27. **Ilex hayataiana** Loes. in Fedde Rep. Spec. Nov. **55**: 333. 1941. — S. Y. Hu in Jour. Arnold Arb. **31**: 249. 1950.

LIUKIU ISLANDS: Okinawa: Yona, *J. W. Conover 1139, 1840* (US); Kunigami, Nago-dake, *E. H. Walker, S. Sonohara, S. T. Tawada & T. Amano 6192.* Irumuti (Iriomote), *S. Murayama* in 1927.

This species differs from *Ilex goshiensis* Hayata in having narrower leaves with acuminate or caudate apex and fasciculate uniflorous individual branches in the inflorescences. It has been reported to be abundant at altitudes of 230–330 meters, where it grows as a small tree along the banks of streams in the shade of taller trees or steep walls of the valleys.

DOUBTFUL AND EXCLUDED SPECIES

ILEX CINEREA sensu Ito & Matsumura in Jour. Coll. Sci. Univ. Tokyo **12**: 369 (Tent. Fl. Lutch. 369). 1900. — Sonohara et al., Fl. Okin. 92. 1952, non Champ., 1852.

Ilex cinerea Champ. ex Benth. is endemic to Hongkong. Its large oblanceolate leaves with very short (2–4 mm. long) petioles and its very short (2–3 mm. long) pedicellate fruits are very characteristic. Many East Asian specimens belonging to *Ilex ficoidea* Hemsl. or *I. formosana* Maxim.

have been erroneously named *Ilex cinerea* Champ. It is quite likely that authors dealing with the flora of the Liukius may have made similar errors, since I have no evidence, from the material which I have examined, to lead me to believe that the species has ever been collected outside Hongkong.

ILEX MATANOANA sensu Sasaki, Cat. Gov. Herb. 317. 1930. — sensu Masamune & Suzuki in Ann. Rep. Taih. Bot. Gard. 3: 61. 1933, non Makino, 1913.

Ilex matanoana Makino was first published from the Bonin Islands. Its small coriaceous obovate leaves with retuse apex and prominently reticulate nerves are very characteristic. Judging from the material I have studied, the species of *Ilex* in the Bonin Islands are very different from those of Taiwan and the Liukiu Islands. In fact, there is no Bonin Island element of *Ilex* found in the flora of Taiwan and Liukiu. Sasaki ascribed specimens collected from Sozan, Giran, and Kosyun to this species. Masamune & Suzuki recorded it as occurring on Kizan, a small volcanic island northeast of Taiwan. They cited no specimens. As these collections are not available for my examination, I can only question their interpretation.

Ilex nokoensis Hayata in Jour. Coll. Sci. Univ. Tokyo **30**: 56 (Mat. Fl. Form. 56). 1911, et in Ic. Pl. Form. **1**: 133. 1911. — Kanehira, Form. Trees, 1st ed. 125. 1917 = **Symplocos nokoensis** (Hayata) Kanehira, Anat. Charact. Ident. Form. Woods 151. 1921, et Form. Trees, rev. ed. 596, *fig. 553.* 1936.

ILEX EURYAEFOLIA Mori & Yamamoto in Jour. Soc. Trop. Agr. Form. **4**: 485. 1932.

This species was based on *T. Suzuki 7332*, collected from Mt. Taihei in the northeastern part of Taiwan. According to the description of the authors, the plant has "Folia coriacea . . . longe eliptica vel oblongo-oblanceolata vel subspathulata . . . apice [obtusa], . . . margine ad totam crenato-serrata sed raro inferne integra . . . petiolis brevibus 3–5 mm. longis . . . Inflorescentia fructifera axillaris, umbellaeforme fasciculata . . . Fructus globosi, 4 mm. in diametro, apice stigmate rostrati . . . pyrenis 4."

ILEX RARASANENSIS Sasaki in Trans. Nat. Hist. Soc. Form. **21**: 154. 1931.

This species was based on Sasaki's own collection from Mr. Rarasan of Taihoku prefecture. According to his description the plant has "Leaves sempervirens, alternate and fascicules near the top of the branches . . . elliptic or ovate, entire or loose serrate . . . acuminate or caudate . . . Inflorescens [sic] umbellate panicles, terminal axilis [sic] of the branches, peduncles umbell [sic] . . . Drupe . . . 6 mm. in diameter, shining chestnut colour when ripe. Seed [sic] 6 . . . 3–4 mm. long, 2 mm. in diameter."

Kanehira in 1936, without giving any reason, excluded *I. rarasanensis* Sasaki and *I. euryaefolia* Mori & Yamamoto from the Aquifoliaceae in his Formosan Trees. In order to ascertain the status of these taxa, I wrote to Professor W. F. Chu, Head of the Department of Forestry, National Taiwan University, asking him for the photographs and fragments of the type material of these species. He very kindly searched in the Herbarium of the Department of Botany of the same University and also in the Government Herbarium of the Department of Forestry, Government Research Institute, of which Sasaki was curator. Unfortunately no traces of these species could be found. For the present they have to be classified among the doubtful species.

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A TAXONOMIC REVISION OF PODOCARPUS
VIII. THE AFRICAN SPECIES OF SECTION EUPODOCARPUS, SUBSECTIONS A AND E

NETTA E. GRAY *

THE SECTION *Eupodocarpus* of the genus *Podocarpus* is well represented on African mountain slopes from the southernmost coast to well north of the equator in both the eastern and western regions, wherever relatively cool and wet climates are found. In many regions the species are found in pure stands, often of magnificent timber which has been very important economically. In other parts the members are less abundant, interspersed among other trees, but still constituting an item in the lumber industry. The five species on the continent (all in subsection A) are *Podocarpus elongatus* (Ait.) L'Hérit., *P. Henkelii* Stapf, *P. latifolius* (Thunb.) R. Br. and *P. milanjianus* Rendle, which have been compared by Stapf (10) and Chalk et al. (3), and *P. ulugurensis* Pilger, which was subsequently described (7). *Podocarpus madagascariensis* Baker, endemic on the island of Madagascar, is also in subsection A and has been treated separately by Laurent (4). *Podocarpus rostratus* Laurent, also confined to the island of Madagascar, is in the new subsection E. Our studies show that *P. rostratus* has close affinities with section *Eupodocarpus*, but we recommend placing it in a separate monospecific subsection. Details leading to this decision are to be found under the discussion of the species.

The leaf anatomy of the group consisting of *P. elongatus*, *P. latifolius*, *P. Henkelii*, *P. milanjianus* and *P. madagascariensis* is quite similar, displaying only very minor variations. It always shows two marginal resin canals, hypoderm between the stomatal rows on the lower side, the Florin ring in the stomatal subsidiary cells, and toothed or pitted walls in the epidermal cells.

In addition, we find that *P. elongatus* can usually be distinguished from the others of the group by the thicker palisade parenchyma of more than one layer and no auxiliary sclereids in the mesophyll. In most specimens there is only one vascular resin canal. In most leaves the upper hypoderm is occasionally interrupted and it has been found that these interruptions

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* The author wishes to express her greatest appreciation to the late Professor John T. Buchholz for assistance in the preparation of this paper. She wishes to acknowledge the assistance which was given to him, with permission to examine and photograph specimens of section *Eupodocarpus* preserved in the herbaria of the Kew Botanic Gardens, the British Museum and Cambridge University. Also she especially thanks Prof. J. Leandri of the Paris Museum Herbarium and Prof. Carl G. Alm of the Uppsala Botanical Museum for locating certain critical specimens. A special grant from the Emory University Research Committee aided the author in the completion of this part of the problem.

are accompanied by one to six short rows of stomata in the upper epidermis. Thus, *P. elongatus* is differentially amphistomatic, a unique character in the section *Eupodocarpus*. Vascular sclereids or fibers in *P. elongatus* are rare, and the stomatal rows seem closer together than in *P. latifolius* and *P. Henkelii*. Hypodermal fibers average 12–18 μ in diameter, somewhat smaller than those in the other species.

In some specimens of *P. latifolius* and *P. Henkelii* the leaf characters seem to overlap those of *P. elongatus*, but there are generally three vascular resin canals, continuous upper hypoderm, larger hypodermal fibers (15–23 μ average diameter), stomatal rows somewhat farther apart, palisade parenchyma only one cell-layer thick, auxiliary sclereids in the mesophyll, and no stomata on the upper side.

Podocarpus milanjianus, usually having the margins of the leaves revolute, often has the upper hypoderm interrupted at the point of the turn. There is often much increased sclerification, this appearing in auxiliary sclereids in the mesophyll, heavier walls in the accessory transfusion tissue and more abundant upper and lower vascular fibers. *Podocarpus madagascariensis*, however, shows the most extreme sclerification, affecting most of the mesophyll.

The specimen of *P. ulugurensis* which we examined shows the striking difference of five instead of three vascular resin canals. The two extra ones appear in or very close to the transfusion tissue. Externally, this is the only species with a definitely sulcate upper midvein.

KEY TO SECT. EUPODOCARPUS (AFRICAN SPECIES), SUBSECTIONS A AND E

Leaves very small; many marginal resin canals, accessory transfusion tissue absent . . . . Subsection E. *P. rostratus.*
Leaves larger; 2 marginal resin canals, accessory transfusion tissue present.
  Leaves with 5 vascular resin canals; upper midrib sulcate. . . *P. ulugurensis.*
  Leaves with 1–3 vascular resin canals; upper midrib never sulcate.
    Leaves narrowly lanceolate, 3.5–6.5 cm. long, 3.5–4 mm. wide, acute to obtuse at tip. . . . . *P. elongatus.*
    Leaves elongate and broader.
      Adult leaves very large, 7–18 cm. long.
        Male cone very short, 13 mm. long.
          Leaves 8–18 cm. long, 8–18 mm. wide; seed 20 mm. long. . . . . *P. madagascariensis.*
          Leaves smaller, 5–7 cm. long, 6 mm. wide; seed 28 mm. long. . . . . *P. madagascariensis* var. *rotundus.*
        Male cone longer, 20–45 mm. . . . . *P. Henkelii.*
      Adult leaves smaller, juvenile often as large as above.
        Leaves gradually attenuate. . . . . *P. milanjianus.*
        Leaves short rotundate, angustate at tip.
          Leaves 5–11 mm. wide. . . . . *P. latifolius.*
          Leaves 12–17 mm. wide. . . . . . . *P. latifolius* var. *latior.*

Podocarpus elongatus (Ait.) L'Hérit. in Pers. Syn. 2: 580. 1807; L. C. & A. Richard, Comm. Bot. Conif. 13. 1826; Endlicher, Syn. Conif. 218. 1847; Carrière, Traité Conif. ed. 2, 671. 1867; in part; Parlatore in DC. Prodr. **16** (2): 511. 1868; Van Tieghem in Bull. Soc. Bot. France **38**: 169. 1891; Pilger in Pflanzenreich IV. 5 (Heft 18): 89. 1903, in Nat. Pflanzenfam. ed. 2, **13**: 247. 1926; Dallimore & Jackson, Handb. Conif. 44. 1923, 1931, 66. 1948; Florin in Svenska Vet.-Akad. Handl. ser. 3, **10**: 279. 1931; Chalk, Burtt-Davy & Desch, For. Trees & Timbers Brit. Emp. **1**: 24. 1932; Stapf in Fl. Cap. **5** (Sect. 2, suppl.): 8. 1933.

Podocarpus Thunbergii var. *angustifolia* Sim fide Dallimore & Jackson, Handb. Conif. 44. 1923, 1931.

Taxus elongata Aiton, Hort. Kew. 3: 415. 1789; Thunberg, Prodr. Fl. Cap. 117. 1800.

Taxus capensis Lamarck in Encycl. 3: 229. 1789.

Podocarpus elongatus is found on the Cape of Good Hope on Table Mountain above the city of Capetown, and hence was one of the plants early brought from that region. Pilger (6) distinguished it from *P. latifolius* and *P. milanjianus* by its narrow lanceolate-linear leaves. Stapf (10) separated it from *P. Henkelii* by its short straight leaves and fleshy receptacle and from *P. latifolius* by leaves only up to 4 mm. wide. Chalk (3), on the other hand, distinguished it from *P. Henkelii* and *P. latifolius* by its red receptacle (which seems to be in error) and from *P. milanjianus* by leaves shorter and much narrower (2.5–5 cm. × 2–3 mm.). Of the species studied by Laurent (4), *P. elongatus* has the shortest, narrowest leaves, shorter male cones than those of *P. latifolius* and *P. milanjianus*, the shortest peduncle on the female cone, and the smallest seed. According to the descriptions, the twigs of *P. elongatus* are drooping while those of *P. latifolius* are erect with leaves stiff. We would distinguish it from *P. latifolius* by the consistent absence of auxiliary sclereids, the one vascular resin canal (rarely 3), the interrupted upper hypoderm, and the 1–6 upper rows of stomata. The thick leaves show no tendency to be revolute.

The differences from *P. latifolius* seem to be chiefly relative. Many of the sterile specimens referred to *P. elongatus* which show wider leaves and no stomata in the upper epidermis belong probably to *P. latifolius*, which has considerable range in leaf size and also a much wider geographical distribution. Both these species may be found in the same area, often being collected by an explorer on the same day. Their close similarity and the existence of a number of specimens intermediate between the two definitely suggest hybridization. *Podocarpus elongatus* seems to be chiefly a plant of western Cape Province.

MacOwan 1958, in both the Gray and Kew Herbaria, has two elements on it, the portion with larger leaves being *P. latifolius* and that with small leaves being *P. elongatus*. This latter has both a single vascular resin canal and a few stomata on the upper surface.

In all cases it must be borne in mind that for more than fifty years *P. elongatus* (Ait.) L'Hérit. and *P. falcatus* R. Br. (in section *Afrocarpus*) were almost hopelessly confused in the literature, and the identity of the actual material discussed must be checked with greatest care. *Podocarpus elongatus* is the only species in the section *Eupodocarpus* with scattered stomata occurring on the upper side of the leaf. This may have been noted by some earlier workers, giving credence to the incorrect determination *P. falcatus,* a species with leaves always equally amphistomatic.

Since *Podocarpus elongatus* (Ait.) L'Hérit. was used by Persoon as the type species for the genus, a most diligent search was made for the type specimen. An original Thunberg specimen of this species is in the Botanical Museum at Uppsala with other plants he collected in and near Capetown in 1773–1774. It is a male specimen with almost mature pollen cones. A female specimen, with immature ovules, was found in the Paris Museum, collected by Sonnerat (Herb. Jussieu 17135) in 1774 in the company of Thunberg on the occasion of his visit to Capetown and ascent of Table Mountain, the site of the former collection. This specimen was probably collected at a later season than the Thunberg specimen. Confusion arose when it was found that a specimen in the British Museum, indicated as the probable type for Aiton's *Taxus elongatus* in his Hortus Kewensis, was really *P. macrophyllus* var. *Maki* from Japan. This mistaken identity is reasonable as the male specimens of the two entities are very similar to the naked eye although the leaves of *P. elongatus* are usually narrower. In this case, the leaf anatomy carries the proof of identity. No doubt there are other good specimens in the British Museum that we have not seen, as Stapf (10) mentions one by Masson who accompanied Thunberg in his original travels. Nor have we seen the specimen used by L. C. Richard for his drawing of *P. elongatus* with seeds, in the publication of 1826 (9).

We feel that the designation of the *Thunberg* (male) specimen at Uppsala Botanical Museum and the *Sonnerat* (female) specimen at the Paris Museum as lectotypes will make this species better understood by later investigators. In genera composed of dioecious species it is desirable to designate both male and female specimens. It is to be hoped that the misidentified specimen will be removed from a type-folder.

DISTRIBUTION: South Africa, in forested areas in southwestern Cape Province primarily.

SPECIMENS EXAMINED:

SOUTH AFRICA: Cape Province: Clanwilliam Division: Grarsangen Mt., *Pillans 8676* (K); * Oliphant's River, Kradouw Krantz, *Pillans*

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* The following symbols indicate the herbaria having the specimens cited: Academy of Natural Sciences of Philadelphia (Ph), Arnold Arboretum (A), British Museum (BM), Brussels Botanical Garden (BR), University of California at Berkeley (UC) and at Los Angeles (LA), California Academy of Science (CAS), Chicago Natural History Museum (Field Museum) (F), Cornell University (CU), Gray Herbarium (GH), University of Illinois Herbarium (Ill), Royal Botanic Gardens, Kew (K), Missouri Botanical Garden (Mo), New York Botanical Garden (NY), Rutgers University Herbarium (NJU), Stanford University Dudley Herbarium (DS), United States National Herbarium (US), Uppsala Botanical Museum (UPS), Yale University Herbarium (YU).

5297 (K), *Pearson 5328* (†K), *Wilson* in 1922 (A—4 sheets); Krakadow Pass, Cedarburg Mts., *Wilson* in 1922 (†A); Ceres, *Munchen 11764* (†NY), *Pearson 15551* (†LA). Malmesbury: Paarl Berg, *Prior* in 1946 (K), *Drege 1839* (K); Stellenbosch, *Miller s.n.* (K), *Garside 1044* (†K); Robertson, Banks of Breede River, *For. Dept. Pretoria Herb. 1247* (K), *Wilson* in 1923 (†A—5 sheets). Swellendam Division: Breede River, *Burchell 7480* (K), *Schlechter 5652* (K); Table Mtn. *Thunberg s.n.* (†UPS), *Sonnerat* ex Herb. Jussieu 17135 (†P). Albany Division: w. of Grahamstown, *Zeyher 3448* (K), *MacOwan 1958, in part* (†GH, †K); Olijantshoek, *Zeyher s.n.* (†A); Steudel, Eptingee, *Ecklon* in 1834 (†NY); Bain's Kloof, *Hutchinson 1008* (†K); Kaffraria, Dohne, *Sim 19620* (†A). LOCALITY NOT INDICATED: ex Hook. Herb., *Pappe s.n.* (K), *Anon.* in 1906 (A), "Hort. Daudin" in 1851 (†DS), *Prager s.n.* (†CAS), *Ecklon & Zeyher s.n.* (†Mo), *Marloth 11488* (†A), *"EM" 81* (†Mo).

CULTIVATED: Algeria For. Sta., *Wilson* in 1922 (A), Piquetberg, Bosch Kloof, *Compton 9498* (†Ill). U.S., Mass., Arnold Arboretum 482.29, *Judd* in 1930 (A).

Podocarpus latifolius (Thunb.) R. Br. ex Mirb. in Mém. Mus. Nat. Hist. Paris **13**: 75. 1825; Berthold, Vergleichenden Anatomie der Coniferen-Blättern 12, 16. 1875; Zimmerman in Flora **63**: 2. 1880; Pilger in Pflanzenreich IV. **5** (Heft 18): 90. 1903; in Nat. Pflanzenfam., ed. 2, **13**: 247. 1926; Florin in Svenska Vet.-Akad. Handl. ser. 3, **10**: 279. 1931; Stapf in Fl. Cap. **5** (Sect. 2, suppl.): 5. 1933; Dallimore & Jackson, Handb. Conif. 48. 1923, 1931, 72. 1948; Chalk, Burtt-Davy & Desch, For. Trees & Timbers Brit. Emp. **1**: 23. 1932; Chalk et al., For. Trees & Timbers Brit. Emp. **3**: 81. 1935; Adamson in Fl. Cap. Penin. 31. 1950.

Podocarpus Thunbergii Hook. in London Jour. Bot. **1**: 657. 1842; Endlicher, Syn. Conif. 217. 1847; Carrière, Traité Conif. ed. 2, 710. 1867; Mahlert in Bot. Centralbl. **24**: 281. 1885; Parlatore in DC. Prodr. **16** (2): 511. 1868.

Podocarpus Thunbergii var. *latifolia* Sim fide Dallimore & Jackson, Handb. Conif. 48. 1923, 1931; Van Tieghem in Bull. Soc. Bot. France **38**: 169. 1891.

Podocarpus Sweetii C. Presl in Bot. Bemerk. 110. 1844.

Nageia latifolia O. Kuntze in Rev. Gen. **2**: 800. 1891 (not Gordon).

Taxus latifolia Thunb. Prodr. Fl. Cap. 117. 1794–1800 et Fl. Cap. (ed. Schultes) 547. 1823.

This species is very large, often found very abundantly in the southeastern part of Cape Province, and important economically as a lumber tree. Its foliage differs from *P. Henkelii* in the shorter and smaller rigid leaves on erect twigs and fleshy receptacle, and from *P. elongatus* by the wider leaves with three vascular resin canals and no stomata on the upper side.

Podocarpus latifolius shows wide variation in its foliage as would be expected in a species of such wide distribution. It seems to be midway between *P. elongatus* and *P. milanjianus*, with many sterile specimens diffi-

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† This symbol preceding the abbreviated name of an herbarium following the specimens examined signifies that the details of the leaves of this specimen have been examined in cross-section.

cult to classify because of extreme characters. The difference between juvenile and adult foliage, which has already been noted in a number of species, adds to the range of characters involved. A detailed description may be found in Chalk (3) and Stapf (10).

Of the varieties of this species which have been described, Stapf (10) and Chalk (3) disposed of most. However, the variety *P. latifolius* var. *latifolia* still standing deserves comment. With its long narrow leaves it seems that this should be a variety of *P. elongatus*, while the erect leaves around rigid twigs show a relation to *P. latifolius*. However, the leaves "1–2 in. long × 2–3 lin. wide" are long narrow leaves and certainly belie Chalk's and Stapf's suggestion that it is the common form in the Cape Colony with its "short, wide leaves." Robyns (8) says that the green color of the receptacle, which has been given by certain authors as a distinctive character for *P. latifolius*, should not receive consideration. Stapf (10) indicates that, in a mature state, this receptacle is vividly colored red as in *P. milanjianus* and he describes it as resembling a "small dark red cherry in color and shape." It is hard to understand why Chalk (3), after using and quoting Stapf, used a green receptacle for a key character only a year later.

DISTRIBUTION: Limited at present to South Africa, most abundant in the southeastern part, probably ranging farther north but no collections seen.

SPECIMENS EXAMINED:

SOUTH AFRICA: Transvaal: Zautpansberg, *Hutchinson & Gillett 4283* (K—2 sheets), *Houseman 5249* (K), *Obermeyer 1228* (†F); Pietersburg, Houtboschberg, *Burtt-Davy 1194* (K); The Downs, Sabie, *Rogers 21910* (K); Helpmakaar Arboretum, *Burtt-Davy 20252* (†A, †BR), *Leeman 105* (†K); Blauberg, *Smuts 906* (K); Waterberg, *I. B. Pole Evans* in 1933 (K); Nylstroom, *Burtt-Davy 4549* (†K), *Galpin 11663* (†K). Swaziland: Forbes Reef Bush, *Burtt-Davy 2748*; Kaaphe Kloof, *Rogers 21089* (K), *Burtt-Davy 2455* (K). Orange Free State: Drakensburg, *Cooper 1111* (†BM, K, NY). Natal: Zululand, Ngoya Forest, For. Dept. 4266, *Chilvers* (†A), *Wilson* in 1922 (A—2 sheets); Nat'l Park, Drakensburg, *Godman 263* (†BM), *Hutchinson 4488* (K); Champaign Castle, *Meebold 13140* (NY); Durban, near garden, *Wilson* in 1922 (A), *Hout* in 1859 (K); Donneybrook, *Wilson* in 1922 (A); The Boyle, *Bews* in 1922 (A), *Wilson* in 1922 (A—2 sheets); Van Reenery Prop., *Kuntze 1800* (K), *Gerard 127* (K), *Sanderson s.n.* (†K). Cape Province: East Griqualand: Umzimkulu, Mhlonga Forest, For. Dept. Herb. Pret. 2168, 2170, 2189 (♀ & ♂) *Kaufmann* (K); Maclear Dist., Pot River Berg, *Galpin 6831* (K); Emkazene Forest, Ingwangwane, For. Dept. Herb. Pret. 1957, *Houshold* (K); Instubani Forest, For. Dept. Herb. Pret. 2227, *Frazer* (K); Buswayo Forest, Manina, For. Dept. Herb. Pret. 2266, *Merwe* (K). Albany Division: near Grahamstown, *MacOwan 1408* (F, K, YU), *MacOwan 1958 in part* (†GH, †K), *Wilson* in 1922 (A—2 sheets); w. of Grahamstown, *Zeyher 3885* (K); Atherston, *Anon. 89* (†K). Uitenhage Division: *Zeyher 3880* (K). Knysna Dist.: Katzees Kraal, *Burchell 5223, 5254* (†GH, K); Deepwalls Crown Forest, *Wilson* in 1922 (†A—2 sheets); Harberville Forest, *Keet 524* (†K), *Bowie s.n.* (†K), *Burchell 5223* (†K), *Wilson* in 1922 (A—2 sheets), *Munde & Maire 1840* (K). George & Knysna: *Bowie s.n.* (K). George Dist.: *Drege 1639* (K), *Burchell 5843* (†GH, K), *Burchell 3505, 5843* (K). Cape Dist.: Table Mtn., near Brown's Krall, *Prior* in 1847 (K), *Wilson* in 1922 (†A—6 sheets), *Geehout 12* (A), *223* (A), *Zeyher 3533* (A); Stellenbosch, *Harvey s.n.* (†BM); Murchison, *Wood 3028* (K); Newland woods, *Wolley Dod 2729* (K); Groot Vader's Bosch, *Anon.* in 1906 (A), *Thunberg s.n.* (†UPS); Orange Kloof, *Gamble 22002* (K); Oliphant's River, *Pillans 5297* (†K); *Zeyher 3882* (†K), *3883* (†K), *Munde & Maire s.n.* (†K). Cape Colony but no locality: *Anon.* in 1879 (CAS), *Drege s.n.* (†Mo), *Ecklon & Zeyher s.n.* (†A), *Burtt-Davy 4549* (†K), Corney Westliche, *Prager 90* (†CAS), *Anon. s.n.* (K). No locality indicated: *H.R.P.* ex Herb. A.C.Limingani Comitis A (DS), *Anon, s.n.* (K).

CULTIVATED: South Africa: Tokai, near Capetown, *G.A.W.* in 1912 (K), *Eames* in 1939 (CU); Cleremont Garden, The Hill, *Wilson* in 1922 (A—5 sheets); Mission de Bunia, *Gilbert 505 bis* (†BR); Newlands, Kirstenbosch, *Compton* in 1941 (†Ill). England: Kew, *Cook* in 1937 (†Ill), *Buchholz* in 1950 (†Ill).

Podocarpus latifolius var. **latior** Pilger in Pflanzenreich IV. **5** (Heft 18): 90. 1903; Stapf in Fl. Cap. **5** (Sect. 2, suppl.): 7. 1933; Chalk et al., For. Trees & Timbers Brit. Emp. **3**: 82. 1935.

A variety with very wide leaves, which is easily recognizable.

DISTRIBUTION: Cape Province on mountain slopes, apparently quite rare.

SPECIMENS EXAMINED:

SOUTH AFRICA: Cape Province: Vogelgat, *Schlechter 9542* (K, †Ph); Table Mt., *Wilson* in 1922 (†A), Drege, in part, ex Bernhardi Herb. (†Mo).

Podocarpus Henkelii Stapf ex Dallimore & Jackson, Handb. Conif. 47. 1923, 1931, 71. 1948; Florin in Svenska Vet.-Akad. Handl. ser. 3, **10**: 279. 1931; Chalk et al., For. Trees & Timbers Brit. Emp. **1**: 23. 1932, **3**: 84. 1935; Stapf in Fl. Cap. **5** (Sect. 2, suppl.): 9. 1933.

This tree is closely associated with *P. latifolius*, but can readily be distinguished by the larger, drooping, attenuate and often falcate leaves. Its description, distribution and regeneration is treated at length by Chalk et al (3). In certain areas it is found abundantly (Natal, East Griqualand) where it forms 90% of the trees in pure open forests. In leaf anatomy it shows a range of variation similar to that of *P. latifolius*, and juvenile specimens of *P. latifolius* are often difficult to distinguish from it.

DISTRIBUTION: South Africa, in Natal, Swaziland, northern Transvaal and East Griqualand.

SPECIMENS EXAMINED:

SOUTH AFRICA: Transvaal: *Barbarton 2467* (†K). Natal: Swaziland, Forbes Reef, *Burtt-Davy 2748a* (†K), Pretoria For. Dept. 1880, *Houshold* (K); Swartzkop, *Sim* in 1921 (A—3 sheets); *Donnybrook*, Wilson on Feb. 16, 1922 (A—7 sheets); Kirstenbosch, *Sim 1252/14* (†Ill); Pietermaritzburg, *Lindeberg* in 1936 (†A), *Wilson* on Feb. 12, 1922 (A), *Wilson* on Feb. 14, 1922 (A—3 sheets ♂, 3 sheets ♀). Griqualand East: Mt. Ayliff, Ft. Donald, Balembu Forest, *Cochrane* in 1920 (†K—2 sheets); Nguhi Forest, *Cochrane* in 1920 (K); Gsewaleni Forest, Pret. For. Herb. *2172*, *Cochrane* (K); Insikini riverside, *Dawson 1441* (†K). Cape Province: Knysna, *W. A. & C. B. Setchell* in 1927 (†UC). Locality unknown: *Ad No. 1282*, Ser. I, ex Herb. L. van den Bossche (†BR).

CULTIVATED: Africa: Tokai near Capetown, *Wilmot* in 1912 (K). England: Kew, Buchholz in 1950 (†Ill). United States: New York Bot. Garden in 1926 (†NJU).

Podocarpus milanjianus Rendle in Trans. Linn. Soc. ser. 2, **4**: 61. 1844; Pilger in Pflanzenreich IV. **5** (Heft 18): 92. 1903, in Nat. Pflanzenfam. ed. 2, 13: 247. 1926; Dallimore & Jackson, Handb. Conif. 50. 1923, 1931, 75, 1948; Battiscombe, Desc. Cat. of Common Trees and Woody Plants of Kenya Colony 1. 1926; Florin in Svenska Vet.-Akad. Handl. ser. 3, **10**: 279. 1931; Chalk, Burtt-Davy & Desch, For. Trees & Timbers in Brit. Emp. 1: 24. 1932; Robyns in Inst. Roy. Col. Belge, Bull., **6**: 226. 1935, in Fl. du Congo Belge du Ruanda-Urundi 1: 6. 1948; Chevalier in Rev. Bot. Appl. **19**: 411. 1939.

Podocarpus milanjianus has a very wide tropical distribution from 15° s. lat to 10° n. lat. and across the entire width of the continent. It has wider leaves than *P. elongatus*, but no anatomical differences in the leaves from those of *P. latifolius* and *P. Henkelii*. However, the natural areas of these species are so far removed from each other that there is little chance of confusion. *Podocarpus milanjianus* shows considerable variation in the foliage due to its appearance in all horizons of mountain forest, even into subalpine regions where the reduction in size of both the foliage and the tree is considerable. In general appearance, the leaves seem to be more spreading than those of *P. latifolius*, but the form of the young specimens is very similar. The leaf anatomy shows no consistent difference of specific importance other than that the rows of stomata seem closer together.

In comparisons made by Laurent (4), *P. milanjianus* exceeds *P. latifolius* and *P. elongatus* in the greatest dimensions of leaves, male cones, peduncles, and length of seed. Chalk et al. (2) include it in their key to African *Podocarpus*, distinguishing it from *P. elongatus* by the larger leaves, but from *P. latifolius* only by the red receptacle which has been mentioned before as an error.

In a recent study of specimens accumulated at the Brussels Herbarium, Robyns (8) found such extreme variation that at first he thought he had more than one species, but his detailed discussion gives adequate evidence that this is within the range of normal variation of the species. Moreover, there is extreme difference between adult and juvenile foliage. Hence, Robyns abandons Pilger's *forma arborescens* and *forma typica*, and substitutes the more descriptive *forme adulte*, *forme éricoïde*, and *forme juvénile*. He illustrates these by photographs of both foliage and mature tree habit in the case of *forme éricoïde*.

DISTRIBUTION: Africa, from Cameroons and southern Sudan, south through Belgian Congo, Uganda, Kenya, Tanganyika, into Nyasaland and southern Rhodesia, on mountain slopes and alpine zones from 1900–3500 m. altitude.

SPECIMENS EXAMINED:

SUDAN: Immatong Mts., Ras Logoforsk, *Chipp 104* (†K); Mt. Kivetti, *Chipp 85* (K); Lomwaga Mt., E. Acholi, *Greenway & Hummel 7281* (K), *T. Smith s.n.* (K—2 sheets). UGANDA: Immatong Mts., *Eggeling 3600, 3564* (K); Kigezi, *Eggeling 3245, 3247, 3249, 3251* (K); Mt. Elgon, *Snowden 438* (A, K); Bulanbuli, *Snowden 912* (†A—3 sheets, BR, K—2 sheets); Butandiga, *Snowden 964* (A, K); Benet, *Eggeling 2465* (BR, K), *Eggeling 2470* (K); *Dummer 3623* (K), *Lugard 694* (K); Entebbe, *Dawe 273* (K); S. Budde, *Dawe 969* (K); Benet Sabei Bugishu, *Thomas 2633* (K). BELGIAN CONGO: Ruwenzori: Nyambitaba, *Humphreys 1402* (†BM); s. of Butahu River, Bambune, *Chapin 83* (†NY); westside, *Chapin 113* (BR, †NY), *Bequaert 3703* (BR), *Humbert 8903* (BR); Lukubuku valley, *Eggeling 1259* (K); *Fishlock & Hancock 160* (†K), *Dawe 547* (K), *Scott-Elliott s.n.* (K), *Doggett s.n.* (K), *Lebrun 4570* (BR, K), *Purseglove 347* (K), *Esmans 15* (BR); Tschiaberimu massif, between Kasindi & Lubango, *Lebrun 4762* (†BR, K); Mt. Tsiaberimu, *Prince Leopold 49, 50, 51* (†BR); Kahuzi Massif, *Humbert 7716, 7716bis, 7716ter* (†BR), *Scaetta 1408* (†BR, K); Mt. Kahuzi, *Scaetta* in 1928 (†BR), *Lebrun 5528* (K); Virunga Mts., Mushubangabo Volc. *Burtt 3158* (K); s. slope, Chambragongo Saddle, *Burtt 3169* (BR, K); Nyirangongo Volc., *Humbert 7951* (BR); Nyamlagira Volc., *Humbert 8148* (BR), *Heutmann* in 1938 (BR). Ruanda: Nyamusha-Kogunge, *Scaetta 1722* (†BR); Rutengeria, *Lestrade 1* (†BR). KENYA: Mt. Aberdare, *R. E. & C. E. Fries 798* (BR, K); Mt. Kenya, west slopes, *Mearns 1297* (†F, GH, NY—2 sheets, †US); Lari, *Wilson* in 1921 (A, †UC-seedling), (†A), (A—4 sheets); Nairobi, Kisuru, *Dummer 1565* (K); Kikuga Hills, *Comm. at Morubasa* (K); Muzherengira, *Elliott 251, 255* (K); *Whyte* in 1898 (K—2 sheets); *Hutchins* in 1907 (K—3 sheets); *Hutchins s.n.* (K); *Cooper 843* (BR); *Imp. For. Inst. 15a* (A). TANGANYIKA: Mt. Kilimanjaro, Bismarck Hill, *Greenway 3879* (BR, K); s. slope between Umbwe & Weruweru rivers, *Greenway 3180* (K); *Schlieben 4862* (BR); Pare Mts. Mushange, Kipare, *Greenway 6544* (K); East Usambara Mts., *Greenway 4673* (K), *4899* (K); Uluguru Mts., Lupanga Peak, Morogoro, *Burtt 4714* (A, K), *Schlieben 3153* (BR, K); Kirunga Volc., *Kassner 3202* (K); Kondoa, Iringa Dist., *Burtt 1068* (K); Kinguassi Mt., *Burtt 920* (K), *971* (K), *1174* (K), *1345* (K—2 sheets), Imp. For. Inst. 70, *Wigg* (A), Mbalamu, *Adamson 71, 72* (K). NYASALAND: north of Lake Nyasa, Kyimbila Dist., *Stolz 387* (K); Rungnee Sta., *Stolz 363* (GH, K); Mt. Malosa, *Whyte* in 1896 (†K); Mwanemba Point, *McClownie 171* (K), *Johnston* in 1896 (†K), *Topham 914* (K); below and w. of Lake Chiuta, *Cunningham 10* (K); Mt. M'lanji, *Burtt-Davy 22023* (†A, †F), *22007* (BR), *22145* (BR), *Stolz 373* (GH), *Whyte 34, 39* TYPE (†BM), *Whyte* in 1891 (†K), *Buchanan 949* (K—2 sheets), *969* (†K), *Clements* in 1924 (A), *Greenway 3001* (K), *Greenway 4673* (†K), *Greenway 6300* (K). S. RHODESIA: Gazaland, Chimanimani Mts., *Swynnerton 1962* (K); Umkali, Uumba, *Galpin 9242* (K), *Dept. Agr. 1167* (K); Mukungwa Valley, *Greenway & Trapnell 5550* (K). ANGOLA: Nkanda Hills (Congo), *Dawe 110* (†K); Dist. Bie, Cuito Rapids, N. Lisboa, *Gossweiler 10975* (K); Sierra da Chella, Humpata, *Humbert 16628* (†BM).

CULTIVATED: Tanganyika, *Comm. For. A65/33* (A, BM, BR, †F, Ill, K, NY,

†Y); Horti Thenensis, *Luja 77, Ser. III* (†BR); Nursery Kinohop, Aberdeen Mt., *Wilson* in 1921 (A-seedlings); N. Rhodesia, Bot. Garden, *Burtt-Davy 21883* (BR).

Podocarpus ulugurensis Pilger in Notizbl. Bot. Gart. Mus. Berlin **12**: 82. 1934.

This tree, recently described from a single collection, resembles *P. milanjianus* except for several rather striking differences. The leaves of *P. ulugurensis*, contrary to the foregoing species, have a distinctly grooved upper midrib. According to the description, the male cones have thickly coriaceous scales 4 mm. long and the cone on the type specimen measures 3 cm. long and 4 mm. wide. Study of the leaf anatomy shows extreme thickening of the cell walls in all regions. Most surprising of all, two additional resin canals are seen in the transfusion tissue, a feature found elsewhere only in certain specimens of *Eupodocarpus* from the South Pacific, *P. longifoliolatus* in New Caledonia and *P. decipiens* in the Fiji Islands.

DISTRIBUTION: In the Uluguru Mts. of Tanganyika, 2200 m. elevation, in fog forests.

SPECIMEN EXAMINED:

TANGANYIKA: Uluguru Mts., *Schlieben 4224* TYPE (†BR).

Podocarpus madagascariensis Baker in Jour. Linn. Soc. **21**: 447. 1885; Pilger in Pflanzenreich IV. **5** (Heft 18): 92. 1903, in Nat. Pflanzenfam. ed 2, **13**: 247. 1926; Laurent in Ann. Fac. Sci. Marseille **23**: 53. 1915; Dallimore & Jackson, Handb. Conif. 50, 1923, 1932; 74. 1948; Florin in Svenska Vet.-Akad. Handl. ser. 3, **10**: 279. 1931.

Podocarpus madagascariensis, as indicated by Baker, is closely related to the foregoing species. It is a small tree indigenous to the island of Madagascar. Numerous specimens were collected by Perrier de la Bathie in 1912. An excellent study of the species and comparison with *P. elongatus*, *P. latifolius*, and *P. milanjianus* were made by Laurent (4). The size of foliage leaves and peduncle exceeds that of all the other species, and the seed (20 mm. long) is twice as large as that found in the other three species. The length of the male cone, 13 mm., is the least of any species in this group. Pilger's (6) suggestion that this species belongs to section *Stachycarpus* is unfounded.

The leaf anatomy shows the greatest degree of thickening of cell walls, to the extent that most of the mesophyll, including much of the palisade parenchyma, is thickened, with pitted walls, and much of it is devoid of cell contents. The large seed is blackish and oval in shape, 20 mm. long and 8 mm. in diameter.

DISTRIBUTION: On mountain slopes on the island of Madagascar.

SPECIMENS EXAMINED:

MADAGASCAR: Massif de Beampingaratra (Sub-Est), Mt. Papanga, *Humbert 6398* (†A), *Baron 2794, 3129, 3441* (†K); *Chouvenot 107* (BM, †K); Kiknife Hills, *Warburg 549* (K).

Podocarpus madagascariensis var. **rotundus** Laurent in Ann. Fac. Sci. Marseille **23**: 59. 1915.

This variety grows at an altitude higher than that of the species. It possesses somewhat smaller leaves but larger seeds (28 mm. long).

DISTRIBUTION: Madagascar, on basalt at 1500–1800 m. altitude.

SPECIMEN EXAMINED:

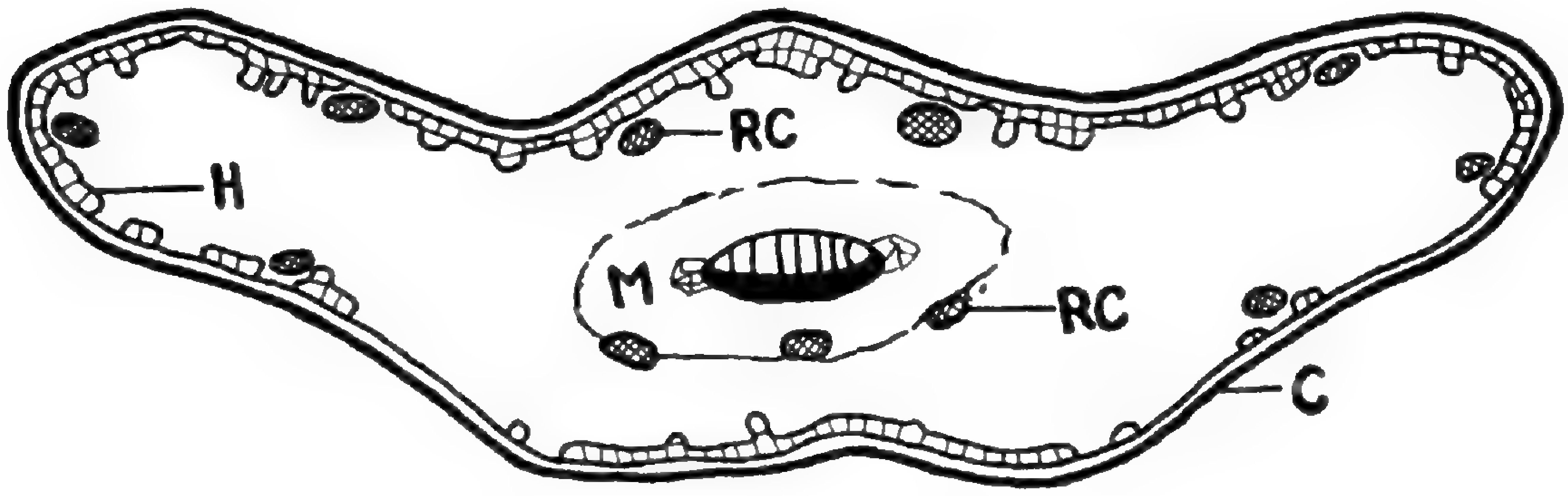
MADAGASCAR: *Parker s.n.* (†Kew).

Podocarpus rostratus Laurent in Ann. Fac. Sci. Marseille **23**: 60. 1915; Florin in Svenska Vet.-Akad. Handl. ser. 3, **10**: 262. 1931; Orr in Trans. Bot. Soc. Edinburgh **34**: 11. 1944.

This extremely rare, and perhaps now extinct, species from the island of Madagascar, is different from all other podocarp species. It is a small tree, 8–10 m. high, with somewhat shiny leaves, 2.3–3.6 cm. long and 1.25–2 mm. wide, sessile, straight, very narrowly lanceolate, gradually attentuate toward apex. Male cones solitary and sessile or in groups of 2 or 3 on a slender, 5–6.5 mm. peduncle, 10–20 mm. long and 3 mm. wide, with scales triangular and apiculate. Female cones and seeds are unknown.

The leaf anatomy shows a single midvein with two very small lateral groups of transfusion tissue, all of which is surrounded by a thick layer of parenchyma definitely distinguishable from the rest of the mesophyll of the leaf by the dense cell contents. Below the vascular bundle are 3 resin canals, one central and two lateral. Laurent (4) found a thin sheet of "irrigation tissue" on each side of the vein separating the palisade from the spongy parenchyma. We do not find this to be lignified and pitted as in true accessory transfusion tissue. There is a continuous hypoderm on the upper side of the leaf, often more than one layer thick, and it is present also between the rows of stomata below. Differing from all other podocarps, it has a number of resin canals, 6–10, around the edge of the leaf just inside the hypoderm (TEXT-FIG. 1). These were described rightly by Laurent (4) as varying in number from one leaf to another and even within the same leaf according to the position near the base, middle, or apex. Also the arrangement of the stomata into two bands on each side of the midrib, on the lower side of the leaf, is a distinctive character. The stomata show a definite Florin ring. The lack of the female structures prevents exact placing of this species taxonomically.

Laurent (4) tried to place this species among its relatives. He compared it with *P. gracillimus*, *Nelson 423* (which has been clearly shown to belong in section *Afrocarpus*), its foliage being the same shape, but *P. rostratus* differs from it, as expected. Because *P. gracillimus* was originally in the section *Stachycarpus*, as expressed by Pilger (6), Orr (5) attempted to place it as an aberrant member of that section. The differences listed by him, and which we have confirmed, indicate clearly the section *Eupodocarpus* where continuous upper hypoderm and the three vascular resin canals are compatible. In comparison with other species, we find *P. rostratus* most closely resembles *P. acutifolius* (New Zealand) in subsection D, which is found also in Chile and Australia. In all except two characters of the leaf anatomy *P. rostratus* matches *P. acutifolius*, even to the presence of the Florin ring in the stomatal subsidiary cells.



TEXT-FIGURE 1. *Podocarpus rostratus* Laurent. Cross-section of leaf showing relative thickness of (C) cuticle, extent of (H) hypodermal fibers, location of marginal and vascular (RC) resin canals, and the special layer of (M) mesophyll surrounding the vascular bundle and transfusion tissue. × 50

We are placing this species in a new subsection E of *Eupodocarpus* in recognition of the following anatomical features: (1) the presence of a variable number of marginal resin canals, different from the condition in all other podocarps; (2) the double stomatal bands on the lower side of the leaf, likewise not found in any other podocarps; (3) the three vascular resin canals found in African and Asiatic *Eupodocarpus* but not in sections *Afrocarpus* nor *Stachycarpus*.

DISTRIBUTION: Madagascar, on high summits of Mt. Tsaratana, in forests almost destroyed by fire.

SPECIMEN EXAMINED:

MADAGASCAR: Mt. Tsaratana, *H. Perrier de la Bathie 10443* (†ex Florin, Riksmuseet, Stockholm).

LITERATURE CITED

1. Buchholz, John T. & Netta E. Gray. A Taxonomic Revision of *Podocarpus*. I. The sections of the genus and their subdivisions with special reference to leaf anatomy. Jour. Arnold Arb. **29**: 49–63. 1948.
2. Chalk, L., J. Burtt-Davy & H. E. Desch. For. Trees & Timbers Brit. Emp. **1**: 20–26. 1932.
3. Chalk, L., M. M. Chattaway, J. Burtt-Davy, F. S. Laughton, & M. H. Scott. For. Trees & Timbers Brit. Emp. **3**: 69–90. 1935.
4. Laurent, M. L. Les *Podocarpus* de Madagascar. Ann. Fac. Sci. Marseille **23**: 52–64. 1915.
5. Orr, M. Y. The leaf anatomy of *Podocarpus*. Trans. Proc. Bot. Edinburgh **34**: 1–54. 1944.
6. Pilger, R. Taxaceae. Pflanzenreich IV. **5** (Heft 18): 1–124. 1903.
7. Pilger, R. Taxaceae. Notizbl. Bot. Gart. Mus. Berlin **12**: 82. 1934.
8. Robyns, W. Sur les especies de *Podocarpus* du Congo Belge et du Ruanda-Urundi. Inst. Roy. Col. Belge, Bull. **6**: 226–242. 1935.
9. Richard, L. C. and A. Comm. Bot. Conif. 1826.
10. Stapf, O. Podocarpaceae. Fl. Cap., ed. Hill, **5** (Sect. 2, suppl.): 3–14. 1933.

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THE IDENTITY OF VALENTINIA ILICIFOLIA SWARTZ

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THE ILICIOID CASEARIAS of Cuba have been studied recently by Fr. Marie-Victorin (Contrib. Inst. Bot. Univ. Montreal **49**: 19–56. 1944) who discussed the confusion existing between *Casearia ilicifolia* Vent. and *Valentinia ilicifolia* Sw. At that time Marie-Victorin did not have at his disposal information on the type specimens of these two species, nor the recent collections from Hispaniola which allow a more satisfactory description and disposition of these species.

The genus *Valentinia* was described by Swartz (Prod. 63. 1788 and Flor. Ind. Occ. **2**: 689–90, *t. 14.* 1800) based on descriptions and illustrations by Plumier (Cat. in add. 46. 1703, and ed. Burm. 160, *t. 167.* 1755) and Plukenet (Phytographie 196, *fig. 3.* 1691) as well as new material which Swartz illustrated. The genus contained one species, *Valentinia ilicifolia.* The genus and species were transferred to *Casearia* and placed in the section HEXANTHERAE by Bentham and Hooker (Gen. Pl. 1: 796. 1867). The section HEXANTHERAE of the genus *Casearia* had been established earlier by Endlicher (Gen. Pl. 917, 1840) for a single species, *Casearia ilicifolia* Ventenat. Endlicher had considered the Swartz genus *Valentinia* as of doubtful position. Bentham and Hooker, in referring *Valentinia* to *Casearia,* implied the identity of *Valentinia ilicifolia* Sw. and *Casearia ilicifolia* Vent. but did not specifically transfer the Swartz species. Eichler in 1871 [Flor. Bras. **13** (1): 462. 1871] cites *Valentinia ilicifolia* Sw. in synonymy with *Casearia ilicifolia* Vent. It appears, however, that Urban (Symbol. Ant. **8**: 446. 1920) was the first to publish the actual combination *Casearia ilicifolia* (Sw.) Vent. implied by the earlier workers and generally accepted in the literature today. Urban was in error in making or accepting such a combination, for *Casearia ilicifolia* Vent. and *Valentinia ilicifolia* Sw. are actually two distinct species although both belong to the genus *Casearia.* It should be noted here that Urban cited in synonymy with *Casearia ilicifolia* (Sw.) Vent., *Valentinia ilicifolia* Sw. as the basonym and also *Casearia comocladifolia* Vent.

Urban apparently recognized discordant elements in the original publication of *Valentinia ilicifolia* which Swartz had based on a Plumier reference and figure as well as material of his own. The Plumier figure was considered by Urban in several subsequent discussions. In 1919 (Fedde Rep. Spec. Nov. **15**: 403–4. 1919) he concluded Plumier's illustration could not be a *Malpighia* as Plumier had suggested and might possibly be an undescribed species of a different or possibly new genus but that it was not the same as *Valentinia ilicifolia* Sw. In his consideration of Plumier's life and writings in 1920 (Fedde Rep. Beih. **5**: 75. 1920) Urban continued to call the Plumier figure *Valentinia ilicifolia* Sw. but reported it as a tree of dubious affinities. Finally in 1922 (Fedde Rep. Spec. Nov. **18**: 365–6.

1922) Urban decided that the Plumier illustration was comparable to recently acquired herbarium specimens and these he described as *Sloanea ilicifolia* spec. nov. He cited in synonymy "V. ilicifolia Sw. quoad syn. Plum." Unfortunately Urban added to the confusion by using the same specific name and called this species *Sloanea ilicifolia.* We conclude that Urban did not intend to imply a new combination here as he referred the species *Valentinia ilicifolia* Sw., represented by the Swartz description and material, to *Casearia* in the same year.

Marie-Victorin, without access to the type specimens concluded it was difficult to determine what the Swartz species actually was and accepted Urban's disposal of the name *Valentinia ilicifolia* as a new combination in *Casearia.* We now have photographs of the type collections of *Valentinia ilicifolia* Sw. and *Casearia ilicifolia* Vent. In addition we have been aided by Dr. Ivan Johnston who examined the Swartz material of *Valentinia ilicifolia* in the British Museum.

The Swartz material is definitely a member of the genus *Casearia.* However, to transfer *Valentinia ilicifolia* Sw. to the genus *Casearia* as past workers have done would create a later homonym for *Casearia ilicifolia* Vent., a completely distinct species, hence a new name must be found. Gomez and Molinet recognized this transfer difficulty and created the name *Casearia Valentinia* for *Valentinia ilicifolia* Sw. (Gomez de la Maza, Flor de Cuba 33. 1887), however an earlier name is available. In 1803 Ventenat described a pubescent leafed Casearia which he called *C. ilicifolia* and a glabrous leafed species which he called *Casearia comocladifolia* (Choix de pl. 44. 1803). The latter was correctly recognized by Urban as identical with *Valentinia ilicifolia* Sw. and cited in synonymy when Urban referred the Swartz species to *Casearia* as *Casearia ilicifolia* (Sw.) Vent. (Symbol. Ant. **8**: 446. 1920). Marie-Victorin also accepts *C. comocladifolia* Vent. for the common glabrous, usually membranaceous ilicioid leafed Casearia of Hispaniola and Cuba; however, he did not recognize this was the same as *Valentinia ilicifolia* Sw. The correct nomenclature should be:

Casearia comocladifolia Vent. Choix de pl. 44. 1803.

Valentinia ilicifolia Sw. Prod. 63. 1788; Flor. Ind. Occ. **2**: 689–90, *t. 14.* 1800.

Casearia Valentinia Gomez and Molinet, Gomez de la Maza, Flor. de Cuba 33. 1887.

The pubescent leafed *Casearia ilicifolia* Vent. is well described and illustrated in the original publication (Choix de pl. 44. 1803), and is clearly distinct. This species was discovered by Turpin near Monte Cristi in Santo Domingo around 1800. Turpin himself did the illustration for Ventenat. It is clear from the original description that Ventenat was describing a new species and not transferring the earlier Swartz name to *Casearia* as Urban, Moscoso (Cat. Flor. Doming. 386. 1943), Gilg. (Nat. Pflanzenfam. ed. 2, **21**: 453. 1925) and others imply. The correct nomenclature for this species is:

Casearia ilicifolia Vent., Choix de pl. 44. 1803.

Samyda ilicifolia (Vent.) Poiret, Lam. Encycl. Suppl. 5: 31. 1817.

The lack of any collections of this species since 1800 have handicapped most recent considerations of this problem. In 1946, the senior author relocated the species near Monte Cristi in the Dominican Republic. Additional material was collected in 1950 and it was determined that the species is abundant in restricted locations and has only been overlooked by past collectors in the dry thorn shrub vegetation around Monte Cristi. The following description of *Casearia ilicifolia* Vent. has been compiled from a field knowledge of this species and the additional collections cited below.

Casearia ilicifolia Vent.

Spreading bushes 10 feet tall or trees 15–18 feet tall with trunk diameter averaging 4 inches at breast height. Branches occasionally geniculate and the youngest twigs densely pilose. Petioles 2–3.5 mm. long, densely pilose. Leaves oblong in outline, 5.5 × 3.0 to 7.0 × 3.0 cm. long and broad, coriaceous; apex truncate-emarginate tipped by two spines to slightly rounded; base truncate to truncate-cordate; margin strongly sinuate, spinose, the 10–13 lateral spines and ultimate leaf margins distinctly cartilaginous; primary veins 6–9 pairs, arcuate anastomosing near the margin with strong branch veins running into the spines; the blade lightly pubescent becoming glabrate and shining above, densely persistently pilose below. Flowering pedicels 3–4 mm. long; hypanthium 0.5 mm. long. Sepals 6, united at the base, pink, 6.5 × 2.3 to 7.5 × 3.5 mm. long and broad, densely short pilose outside, sparsely pubescent inside; corolla wanting; filaments and staminodes 8, thinly united at the base, the union 1.5 mm. long, the free portions of the filaments 2 mm. long, the free portions of the staminodes 1.5 mm. long, staminodes attenuate, filaments and staminodes sparsely short pilose, anthers affixed near the base, 1 mm. long; ovary globose, 3.0–3.5 mm. in diameter, short pilose above the middle, glabrous below, style 2.5–3.0 mm. long, sparsely short pilose, stigma capitate, 3-sided, apex depressed; fruiting pedicels 5–8 mm. long, the mature fruit a yellow-orange berry, depressed globose, 1 cm. in diameter, splitting along 3 lines, the pulp red, the seeds 4–8, yellow.

SPECIMENS SEEN:

DOMINICAN REPUBLIC: prov. Monte Cristi: Villa Isabella, *Howard 12520* (GH); Banks of the Rio Yaqui del Norte, south of Monte Cristi, *Howard 9570* (GH). Collected in flower and fruit in July and August.

Previous workers have been troubled by the earlier cited ranges of these species. Swartz, in the original publication of *Casearia comocladifolia* (*Valentinia ilicifolia* Sw.) gave the location as "habitat in sterilissimis petrosis Hispaniola, versus Oceanum. In Cuba circa Havanam." The species has never been relocated near Havana although collections are known from the Oriente Province of Cuba. In Hispaniola the current locations for this species are Gonaive Island and near Port au Prince in Haiti and near Barahona and Monte Cristi in the Dominican Republic. The Barahona location is a new record and is based on the collection *Howard 12599*. This was made from a 15 foot tree which had pink flowers which appeared while the plant was in full leaf. It was collected in flower in August and was growing in the thorn shrub area north of the town of Barahona.

Marie-Victorin refers both *Casearia ilicifolia* and *Casearia comocladifolia* to the section HEXANTHERAE DC which he emended. The primary character listed by Marie-Victorin is the production of flowers before the leaves appear. The two species considered here, which the senior author has seen in the field, may be leafless when flowering; may produce flowers on terminal leafless branches while the rest of the plant possesses leaves (*Howard 9570*), or may be in full leaf when flowering with the flowers hidden in the dense foliage (*Howard 12559*). The character of hysteranthous flowers as used by Marie-Victorin is not reliable.

The number of stamens in the species of the section HEXANTHERAE is also variable. Marie-Victorin distinguishes *Casearia comocladifolia* by having six stamens. However, Marie-Victorin's own dissections of a Gray Herbarium specimen of *Casearia comocladifolia* (*Wright 12*) with the open flowers spread on cards show flowers with six, seven and eight stamens and so indicated in Marie-Victorin's handwriting. The original plate given by Swartz in describing *Valentinia ilicifolia* shows eight stamens and the recent collections of this species from the Dominican Republic have most of the flowers with eight stamens, a few with seven and a very few with six stamens. Recent collections of *Casearia ilicifolia* also have flowers with eight stamens. The name of the section HEXANTHERAE is deceptive.

We can return now to a consideration of *Sloanea ilicifolia* Urban. In the original publication of this species Urban cited in synonymy "Valentinia ilicifolia Sw. quoad syn. Plum." In his citation of specimens Urban refers first to the Plumier figure and then to collections. No type was specifically selected. The original description is to a large extent based on a flowering specimen collected by Père Straessle at Morne Bellefontaine. All other specimens cited are indicated as sterile. The Straessle collection is presumably destroyed having been at Berlin. Only one of the other collections, *Leonard 3797a*, is available in this country.

In 1929 Urban and Ekman [Arkiv Bot. **22A** (17): 26. 1929] described a second species of *Sloanea* with ilicioid leaves which they called *Sloanea castor*. The distinctions between *Sloanea ilicifolia* and *Sloanea castor* do not seem reliable; the flowers and fruits are similar and the leaves of the two species show all intergradations in the material now available to us. Furthermore the ranges of the two entities coincide. It appears to us that *Sloanea castor* Urb. and Ekman must be reduced to synonymy with *Sloanea ilicifolia* Urb. An emended description of this species, based on the available collections, follows.

Sloanea ilicifolia Urban, Fedde Rep. Spec. Nov. **18**: 365. 1922.

Sloanea castor Urban and Ekman, Arkiv Bot. **22A** (17): 26. 1929.

Tree 15–20 m. tall. Branchlets with brown or grey-brown bark, scarcely striate to rough. Twigs more or less sulcate, scarcely to densely light brown puberulent. Leaves alternate to opposite, often clustered on many twigs towards the ends of the branchlets; stipules caducous, 3.5–4.5 mm. long, linear-lanceolate, light brown pubescent; petioles 3.0–12.0 mm. long, terete, scarcely incrassate at both ends, light brown puberulent; blade very variable in size and shape, 3.5 × 2.2 to 12.5 × 9.5 cm. long and wide, elliptic-lanceolate to broadly oval, stiff coriaceous, midrib and secondary veins impressed, scantily puberulent to glabrous above, prominent, puberulent to glabrous beneath, secondary veins 4 to 8, arcuate-ascending, generally terminating in a spine at the leaf margin, tertiary venation irregular, occasionally terminating in a marginal spine, base rounded to cordate, apex rounded to acute to short acuminate, the midrib prolonged into a spine, margin irregularly and deeply spinose dentate. Inflorescences axillary to leaf scars, one to several flowered; flowers 3.0–4.0 mm. long, about 4.0 mm. in diameter, sepals generally 6, to 3.0 mm. long, 0.5–1.25 mm. wide at the base, lanceolate-deltoid, obtuse, densely puberulent within and without; stamens 2.0–3.0 mm. long, filaments 1.5–2.0 mm. long, puberulent to pubescent, anthers 0.75–1.0 mm. long, deltoid, puberulent, dehiscing linearly most of their length, connective prolonged into a short knob above the anther sacs; pistil to 3.0 mm. long, ovary 1.0–2.0 mm. long, densely pubescent, indistinctly 4-angled, 4-loculed, gradually giving rise to the style, style often divided to the ovary to form two parts each of which may be divided again at the apex, pubescent at the base, glabrous above. Capsule brown, 1.5–1.75 cm. long, 1.25–1.5 cm. in diameter, subglobose to ellipsoidal, 1-loculed, 1–2-seeded, 3–4-valved; valves with velutinous outer surface densely covered with flexible spines; spines to 1.5 cm. long, densely antrorsely puberulent, straight, abruptly acute. Seeds enclosed almost completely in a deeply 3-lobed red aril which is firmly attached to the chalazal quarter of the seed.

SPECIMENS SEEN:

DOMINICAN REPUBLIC: Prov. of Barahona, Monteada Nueva, S.E. of Polo, alt. 3500 ft. *R. A. Howard 12355,* 50 ft. tree with small buttresses, d.b.h. 3 ft., fruit brown, Aug. 3, 1950 (GH); Prov. of Azua, Cordillera Central, Las Lagunas, 2250 ft., *E. L. Ekman H6366,* quite common tree, flowers past anthesis, July 13, 1926 (S).

HAITI: Vicinity of Mission, Fonds Varettes, alt. about 3000 ft., *E. C. Leonard 3797a* (CO-TYPE), occasional tree, steep wooded mountain slope, sterile, April 17–May 4, 1920 (NY, S); Massif de la Hotte, western group, Les Roseaux at Nan-Patates, 3000 ft. alt., *E. L. Ekman 10690* (TYPE of *S. castor*), common tree, in flower and fruit Sept. 17, 1928 (S, US); Massif de la Hotte, western group, Jeremie, Source-Cahouane, alt. 600 ft., *E. L.*

Ekman H10234, in fruit July 4, 1928 (S); Massif de la Hotte, western group, Torbee, La-Marie-Praux, alt. 2100 ft., *E. L. Ekman H5399*, sterile on Dec. 8, 1925 (S); Massif de la Selle, Morne Tranchaut, Fourcy, alt. 4620 ft., *E. L. Ekman H1285*, sterile on Aug. 4, 1924 (S); Massif du Nord, Port-de-Paix, high ridge of Haut Piton, alt. 3000 ft., *E. L. Ekman H3706*, sterile on April 6, 1925 (S); Petit Source, Morne de Commissaires, alt. 4560 ft., *L. R. Holdridge 1930*, tree 15 m. tall, d.b.h. 3 dm., in flower Sept. 1, 1944 (GH, US); Riviere Glace, alt. 2250 ft., *L. R. Holdridge 2219*, tree 20 m. tall, d.b.h. 3 dm., in flower and fruit Aug. 7, 1945 (US).

The figures given by Plumier and Plukenet agree with the specimens cited above.

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NEW SPECIES AND DISTRIBUTION RECORDS FOR LAS VILLAS PROVINCE, CUBA

RICHARD A. HOWARD AND WINSLOW R. BRIGGS

SEVERAL NEW SPECIES and significant extensions of known ranges of distribution were encountered in the course of general collecting and field work in southern Las Villas province of Cuba in the summer of 1951. These are reported in this paper.

The authors, instructor and member of the class in Tropical Botany of Harvard University, wish to express their appreciation to the other members of the class for their assistance during this work. Duplicate specimens are to be distributed and will cite as collectors, R. A. Howard, W. Briggs, I. Lane, P. Kamb, and R. Ritland. The many services supplied by Dr. I. D. Clement, economic botanist in charge of the Atkins Garden and Research Laboratory which was our headquarters for this work, are gratefully acknowledged by the authors speaking for the entire group.

Dorstenia Lanei sp. nov.

Herba acaulis; rhizomatibus erectis, cylindricis, crassis, 13–18 mm. longis, 3–4 mm. crassis; stipulis 0.4–0.6 mm. longis, ad 0.2 mm. latis, anguste acuminatis, minute puberulentis. Folia peltata, purpureo-grisea, orbiculari-ovata, 18 × 15, 15 × 12 vel 9 × 8 mm., apice rotundata, basi saepe truncata, ad medium inserta, margine undulata vel crenulata, supra glabra sicco paullo scabrida, subtus puberulenta, petiolis glabris 4–7 cm. longis basi etiolatis glabrisque, apice purpureis puberulentisque. Inflorescentia cyathiformia; pedunculis 8–20 mm. longis, ad apicem puberulentis; receptaculo 4–5 mm. diametro, peltato, puberulente, purpureo-rubiginoso, margine 6–10 dentibus triangularibus horizontalibus inaequalibus, 0.4–0.8 mm. longis; floribus ♂ et ♀ intermixtis, floribus ♂ verdis, floribus ♀ albis.

CUBA: Las Villas Province: 10 kms. south of Santa Clara on the road to Manicaragua, *Howard, Briggs, et al. 69* (TYPE, GH). Collected in flower July 5, 1951.

This is a unique species of *Dorstenia*, distinctive in its habit in the field and the first species known to us to occur on serpentine soil. The erect rhizome of *Dorstenia Lanei* is entirely buried so that the blade of the peltate leaf appears to be flat on the surface of the ground and the receptacle opens flush with the surface of the soil. The peduncle and petioles are all etiolated at the base and show pigmentation only at the immediate

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Soledad, Cienfuegos, Cuba

apices. The venation of the leaf blade is palmate from the point of attachment of the petiole. All the veins bifurcate once before reaching the margin. The midrib is not particularly distinct, appearing of the same size as the other veins and is not pinnately branched.

Dorstenia Lanei, named for Irwin Lane who discovered the first specimen in the field, is most nearly allied to *D. erythrandra* Wr. ex Griseb. but differs in habit, size and leaf venation.

Erythrina Elenae sp. nov.

Arbor ad 10 m. alta; truncus 30 cm. diametro, spinis suberis, magnis, persistentibus; ramulis aculeatis, spinis 5–6 mm. longis. Folia pinnata, pinnis 3; petiolis inermibus, 6.5–11.5 cm. longis, glabris; petiolulis 2–3 mm. longis, 0.4–0.7 mm. crassis, fuliginosis, puberulentis vel glabris, rugosis; stipellis 0.5 mm. longis, fuliginosis, glandulosis; foliolis 3, inermibus, glabris; foliolis terminalibus lanceolatis vel lanceolato-ovatis, 3–13 cm. longis, 0.4–2.8 cm. latis, late acuminatis, basi rotundatis, infra medium latissimis, nervis lateralibus 8–20, nervis secondariis prominente reticulatis, margine integro; foliolis lateralibus similibus aliquando brevioribus. Flores non visi. Inflorescentia subterminalis, racemosa, lignosa, ad basin tumida, ad apicem attenuata, ad 13 cm. longa; pedicellis lignosis, 4–7 mm. longis, 1.5–2.5 mm. crassis. Legumina usque 2.5 cm. stipitata, 5–8 cm. longa, 7–8 mm. lata, moniliformia, fuliginosa, sublignosa, glabra, apice 1.8–2 cm. arcuato-rostrata. Semina 2–5, ovalia, 6–8 mm. longa, scarlatina.

CUBA: Las Villas Province: limestone hillside ¼ mile west of the spot where the Camino de la Sur crosses the Rio San Juan along the south slope of the Trinidad Mountains. *Howard, Briggs, et al. 377* (TYPE, GH). Collected in fruit July 17, 1951.

The lanceolate to lanceolate-ovate glabrous leaflets of *Erythrina Elenae* set this species so distinctly apart from any other species reported from the Antilles that a satisfactory comparison is not possible with any of them. The specimens were collected in fruiting condition and until the flowers are known the species can not be assigned to any section in the genus.

Erythrina Elenae is respectfuly named for Mrs. William Claflin, nee Helen Atkins, in appreciation of her active interest in the flora and the study of botany in Cuba.

Tetrazygia aurea sp. nov.

Frutex vel arbor parva, ad 5 m. alta. Folia anguste oblonga, lamina 4–5 cm. longa, 1–1.5 cm. lata, apice attenuata demum incurvata, in mucrone 0.4–0.5 mm. longo terminata, basi rotundata, supra nitida, glabra, subtus ferrugineo-stellata margine incurvata, nervis primariis 3, subtus prominentibus, supra prominenter impressis, nervis secundariis rectis angulis divergentibus. Inflorescentia terminalis, paniculata, floribus 5, raro 7; calyx undulatus; petala 5–6, 8–10 mm. longa, 5–6 mm. lata, rosea, obovata vel orbicularia, unguiculata; stamina 10–12, antheris 5 mm. longis, filamentis 7 mm. longis; ovarium 5- vel 6-loculare, ovulis plurimis; stylis gracilibus, 11 mm. longis, ad apicem attenuatis, stigma punctiforme. Fructus depresso-globosus, 5- vel 6-locularis, 7–8 mm. diametro, pedicello 2 mm. longo (fructus pedicellusque persistente ferrugineo-stellatus); semina plurima, cuneiformia, 1 mm. longa, pars una adusta, pars altera castanea.

CUBA: Las Villas Province: Gaviñas, Trinidad Mountains, *Howard 6447* (TYPE, GH); Las Vegas de Mataguá, Trinidad Mountains, *Jack 5953*; Buenos Aires, Trinidad Mountains, *Leon, Jack & Rowe 13936, Smith, Hodgdon & Gonzales 3383*; El Purial on Rio Banao, Lomas de Banao, *Ekman 16236*.

The cited collections have all been named *Tetrazygia elaeagnoides*, a species which differs from *T. aurea* in having a cinereous pubescence, glabrate fruits, dull and acuminate leaves, 4-parted flowers and a strongly 4-lobed fruit. The specific epithet is derived from the golden color of the leaves.

Pectis Ritlandii sp. nov.

Herba prostrata. Folia oblongo-linearis, 5–8 mm. longa, 1–2 mm. lata, apice acuta et spinulosa, margine 3–4 paribus setarum, praecipue basin versum, non ad apicem, glandulosa, glandulis submarginalibus, uniseriatis, 4–9 per marginem. Capitula solitaria, terminalis; pedunculis 5–11 mm. longis, glabris; involucro campanulato, 4–5 mm. longo; phyllaribus 5, lineari-obovatis, acutis vel obtusis, basi gibbosis, carinatis, dorso glandulosis, glandulis oblongis irregulariter dispositis, margine scariosis hyalinis; floribus ligulatis 5, ligulis luteis, ad 5 mm. longis; floribus discoideis 4–8, corollis ad 3.5 mm. longis; pappi setis numerosis, inaequalibus, maturitate ad 2 mm. longis, scabris, pilulis minute excurrentibus.

CUBA: Las Villas Province: on coastal rocks between Punta Lobas and Pasa Caballos, *Howard, Briggs, et al. 357* (TYPE, GH); Castillo de Jagua, *Howard 4219*.

Pectis Ritlandii is named in honor of Richard Ritland who collected the first specimens. The species is most closely related to *Pectis Leonis* Rydb. which is known only from savannahs north of the Sancti Spiritus mountains. *Pectis Leonis* differs from the present species in having the stem and branches rough pubescent; the glands in the leaves about 16 in number, and the margins of the phyllaries purplish.

Xylosma Shaferi (Wils.) comb. nov.

Myroxylon Shaferi P. Wilson, Torreya **30:** 73. 1930.

Tillandsia argentea Griseb.

CUBA: Las Villas Province: forest on hillslope west of Rio San Juan crossing on the southern slopes of the Trinidad mountains, *Howard, Briggs, et al. 367*.

This small silvery *Tillandsia* was described by Grisebach on a Wright specimen collected at Monteverde in Oriente province. It has since been reported from Jamaica in the Greater Antilles. The current collection is the first record of its occurrence in Las Villas province.

Cattleyopsis Lindenii (Lindl.) Cogn.

CUBA: Las Villas Province: thorn shrub on the Camino de la Costa, west of Juraguá, *Howard, Briggs, et al. 245.*

This species has a wide distribution in Cuba, the adjacent Bahama Islands, and Jamaica but has not been reported previously from Las Villas.

Tetramicra erosa Carabia

CUBA: Las Villas Province: dry hillside 10 kms. south of Santa Clara on serpentine soil, *Howard, Briggs, et al. 293.*

Previously known from the Oriente province of Cuba this is the first record of the species from Las Villas.

Croton prostratus Urban

CUBA: Las Villas Province: dry hillside 10 kms. south of Santa Clara on serpentine soil, *Howard, Briggs et al. 78.*

The type collection and a single additional collection of this species were made by Ekman on Sierra de Nipe in Oriente province. The current collection was made from a few plants growing in association with *Croton nummularifolius* in an open savannah.

Leucocroton revolutus Wright

CUBA: Las Villas Province: dry hillside 10 kms. south of Santa Clara on serpentine soil, *Howard, Briggs et al. 107.*

The type collection of this species was made in Pinar del Rio province. It is also known from the Oriente province. This collection represents the first material from central Cuba.

Linociera bumelioides Griseb.

CUBA: Las Villas Province: thorn shrub along the Camino de la Costa south of Juraguá, *Howard, Briggs et al. 238.*

A widely distributed species not previously recorded from Las Villas province.

Heliotropium hypogaea Urb. and Ekman

CUBA: Las Villas Province: Camino de la Costa west of Juraguá, *Howard, Briggs et al. 226.*

Heliotropium hypogaea was described by Urban and Ekman based on material collected on Gonave Island off Hispaniola. The collection cited above is the first record of this interesting plant from Cuba. A small colony of this species was found growing on sandy soil in a thorn shrub thicket. The plants were in flower on July 11, 1951, and the corollas were white with yellow throats. Mature fruits had elongated peduncles and were pushed into the ground as described by Urban and Ekman. The species is distinctive in the genus *Heliotropium* in having these hypogeous fruits.

Tecoma microphylla (Lam.) Urban

CUBA: Las Villas Province: thorn shrub along the Camino de la Costa, south of Juraguá, *Howard, Briggs et al. 256.*

Like the preceding species *Tecoma microphylla* has been found only on Gonave Island off Hispaniola. This is the first record for this handsome shrub in Cuba.

Guettarda rigida A. Rich.

CUBA: Las Villas Province: dry hillside 10 kms. south of Santa Clara on serpentine soil, *Howard, Briggs et al. 73.*

This species has been collected previously in Matanzas province and the current collection represents the first record from Las Villas.

Machaonia microphylla Griseb.

CUBA: Las Villas Province: forested hillslope west of the Rio San Juan crossing on the southern slopes of the Trinidad mountains. *Howard, Briggs et al. 397*; San Blas — Buenos Aires area, *Howard 6537.*

This handsome 15 foot shrub has attractive white flowers with a strong and pleasant odor. The plants were extremely attractive to bees and might well be cultivated as ornamentals or honey plants. The collection made by the Tropical Botany class will be distributed as an Exsiccata of the Gray Herbarium. The two collections cited above are the first records of this species from Las Villas province.

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THE STRUCTURE AND DIAGNOSTIC SIGNIFICANCE OF CRATERIFORM BORDERED PITS IN THE VESSELS OF CERCIDIUM

DOMINGO COZZO

THE PECULIAR PITS in the vessels of *Cercidium australe* Johnston were first described and figured by Tortorelli & O'Donell (1937), who considered them to be "vestured pits" such as occur throughout most of the Leguminosae with the exception of the Bauhineae, Bailey (1933). In connection with my investigations (1950, 1951) of Argentine Leguminosae, I noted certain unusual characteristics of these pits which led me to believe that they merited detailed reinvestigation.

The vessels of *C. australe* are studded internally with projections which resemble miniature volcanic cones. Each of these projections contains a craterlike cavity that extends from its apex through the thick secondary wall of the vessel into the chamber of a bordered pit. According to the terminology adopted by the International Association of Wood Anatomists (1933), an extended opening through a thick secondary wall — which provides a means of communication between the lumen of a cell and the chamber of a bordered pit — is called a "pit canal." A pit canal has an "inner aperture" that opens into the lumen of the cell, and an "outer aperture" that leads into a "pit chamber." Thus, the projections in the vessels of *C. australe* are not a form of vesturing, but are excessive inward extensions of localized parts of the secondary wall which surround the pit canals. True vesturing [1] of the bordered pits in *C. australe* is confined largely to the rim of the outer aperture of the pit canal.

The detailed structure of this aberrant type of bordered pit in *C. australe*, *Fig. 1*, *A* and *B*, differs from the usual type in the following respects. In the case of tracheids and vessels with thin secondary walls, the area of the wall which jackets the pit chamber is embossed inwardly beyond the general contour of the wall which surrounds the lumen of the cell. With increasing thickness of the secondary wall and reduction in size of the pit chamber, this embossing effect is submerged and concealed. In very thick-walled vessels and fiber tracheids, having circular bordered pits, the outer aperture of the pit canal tends to be circular, but of conspicuously smaller diameter than the circular outer contour of the pit chamber. The pit canal flares toward the lumen of the cell by an enlargement of one of its diameters, and the inner aperture usually is more or less narrowly elliptical or slitlike. In the vessels of *C. australe*, on the contrary, the inner aperture of

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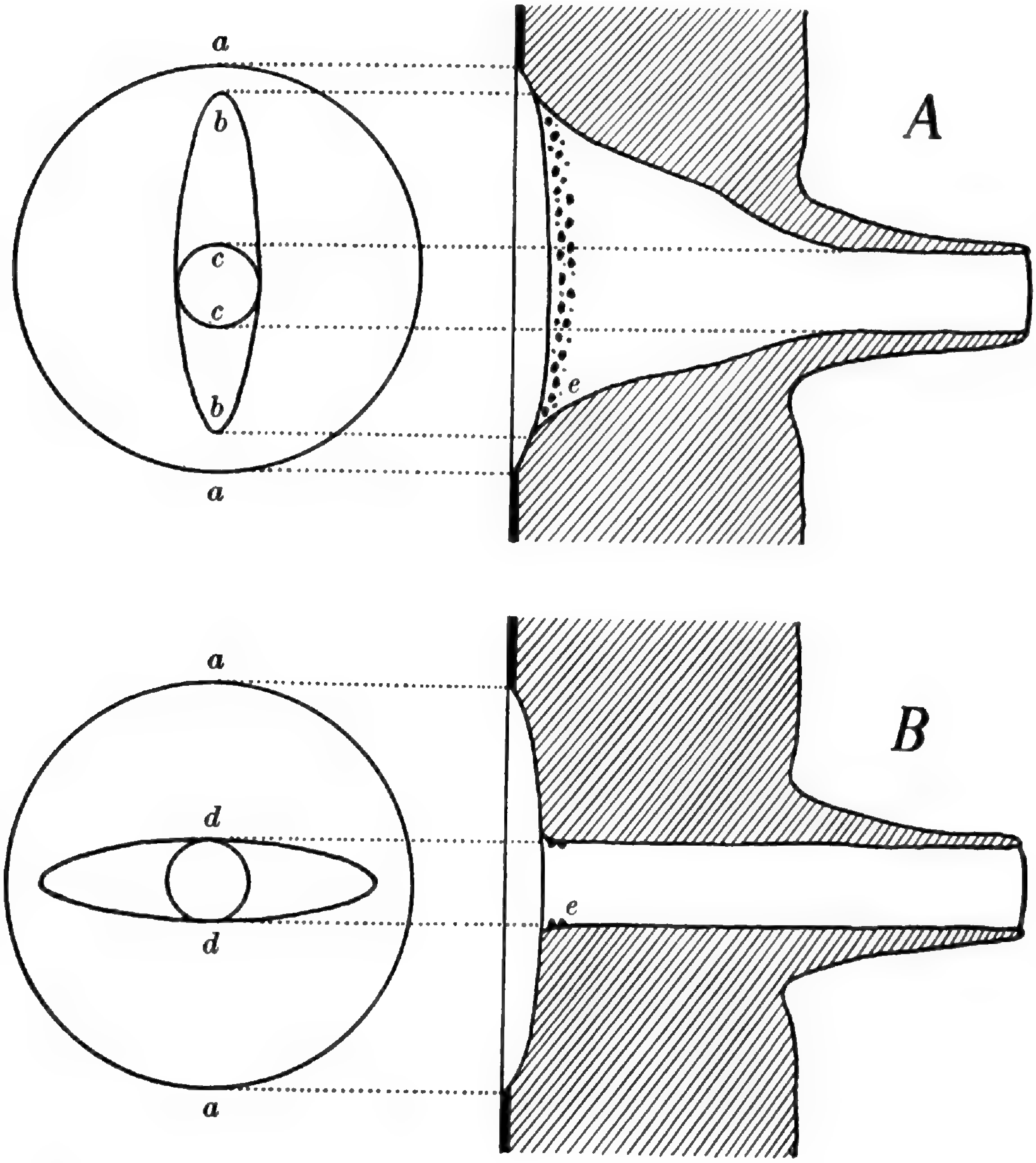
[1] In my opinion, the term "ornate" is preferable to "vestured." In any case, the Spanish term "orladas" as applied to this type of structure should be changed to "ornadas," the correct translation of both "vestured" and "ornate."



TEXT-FIGURE 1. Crateriform bordered pits in surface and sectional views. (A) Sectioned parallel to the long axis of the outer aperture of the pit canal. (B) Sectioned at right angle to (A). (a-a) Contour of pit chamber, (b-b) contour of outer aperture, (c-c) contour of inner aperture, (d-d) coincident diameters of inner and outer apertures, (e) vestured rim of outer aperture.

the extended pit canal is small and circular. Furthermore, the pit canal flares outwardly, being broadly elliptical at the level of its outer aperture.

TAXONOMIC CONSIDERATIONS

Crateriform bordered pits occur in the vessels of the first-formed, as well as the later-formed, secondary xylem of the stem. Therefore, it is possible to study their occurrence in small twigs from herbarium specimens. Their presence or absence in material obtained from the Arnold

Arboretum (AA), Gray Herbarium (GH), Museo Argentino de Ciencias Naturales (BA), Yale Forestry School (YF) and the Wood Collection of Harvard University (HU) is as follows:

CRATERIFORM PITS PRESENT

Cercidium australe Johnston: Argentina, Mendoza, *Mexia 4377* (GH); Argentina, La Rioja, *Cozzo (BA, 52235)*; Argentina, Salta, *Cozzo (BA, 52722)*, *Venturi 9507* (AA).

Cercidium praecox (R. & P.) Harms: Argentina, Jujuy, Ledesma, *Venturi 5343* (GH); Peru, Lambayeque, *J. West 3576* (GH); Equador, Loja, *Hitchcock 21331* (GH); Venezuela, *Pittier 12945* (AA), *Pittier* 1928 (*YF, 12458*); Venezuela, Llavo, *Curran* and *Haman 1251* (GH); Mexico, Sonora, La tinajo, *Hartman 241* (GH); Mexico, Sonora, *Abrams 13287* (GH).

CRATERIFORM PITS ABSENT

Cercidium andicola Gris.: Argentina, Jujuy, *DeCarles (BA, 27/1102)*; Argentina, Jujuy, Maimará, *Lorentz* & *Hieronymus 746* (GOET, TYPE); Argentina, Jujuy, Humahuaca, *Schreiter 11085* (GH); Bolivia, Toldos bei Bermejo, *Fiebrig 2493* (GH).

Cercidium floridum Benth.: Mexico, Nuevo Leon, *T. C.* and *E. M. Frye 2391* (GH); Mexico, Sonora, *Wiggins* and *Rollins 272* (HU, 25775); Mexico, Sinaloa, *Gentry 7016b* (GH); U.S., Arizona, *Pringle 1881* (AA).

Cercidium macrum Johnston: Mexico; Victoria, Tamaulipas, *Palmer 125* (GH); U.S., Texas, *Palmer 12303* (AA).

Cercidium microphyllum (Torr.) Rose & Johnston: U.S., Arizona; *Brass 14360* (GH); U.S., California, *Epling, Haines* and *Stewart 1933* (AA); *Pringle 1882* (AA); *HU 9678.*

Cercidium molle Johnston: U.S., Gulf of California, *Johnston 3877* (AA).

Cercidium peninsulare Rose: U.S., Gulf of California, Carmen Island, *Johnston 3802* (GH).

Cercidium sonora Rose & Johnston: Mexico, Sonora, *Abrams 13280* (GH).

Cercidium texanum Gray: U.S., Texas, *Buckley 1881* (AA).

The constant occurrence of crateriform bordered pits in two species of *Cercidium*, and their absence in eight other species, provides a diagnostic character of considerable significance; one which may be utilized by taxonomists in any future revision of the genus and its species. The character is so peculiar and unusual that it is indicative of close relationship between *C. australe* and *C. praecox*. It serves to differentiate these species sharply from *C. andicola*, as well as from North American representatives of the genus.

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LITERATURE CITED

BAILEY, I. W. (1933). The cambium and its derivative tissues VIII. Structure, distribution and diagnostic significance of vestured pits in dicotyledons. Jour. Arnold Arb. **14**: 259–273.

COZZO, D. (1950). Anatomia del leño secundario de las Leguminosas Papilionoideas Argentinas. Rev. Mus. Arg. Cien. Nat. **1**: 223–361.

———. (1951). Anatomia del leño secundario de las Leguminosas Mimosoideas y Cesalpinioideas Argentinas. Rev. Mus. Arg. Cien. Nat. **2**: 63–146.

International Association of Wood Anatomists (1933). Glossary of terms used in describing woods. Tropical Woods **36**: 1–12.

TORTORELLI, L. A. AND C. A. O'DONELL (1937). Las punctuaciones orladas de "Cercidium praecox." Rev. Arg. Agron. **4**: 197–201.

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PLANTAE PAPUANAE ARCHBOLDIANAE, XXI * THE PAPUASIAN SPECIES OF MACARANGA

LILY M. PERRY

IN 1876 THE GENUS *Macaranga* Thouars was first reported from New Guinea by F. Mueller. He published a single species, *M. aleuritoides,* in his Descriptive Notes on Papuan Plants. As exploration continued on the island other species were collected. Seven species and two varieties were recorded by Warburg as additions to the Papuan flora in Botanische Jahrbücher, **13**: 349–352. 1891. The first comprehensive flora of the northeast region of New Guinea was published by K. Schumann & Lauterbach, Fl. Deutsch. Schutzgeb. Südsee, 1900. This contained fourteen species of *Macaranga.* In 1910 and 1912 J. J. Smith, Nova Guinea (Botanique), added several species from Netherlands New Guinea. The first comprehensive work on the genus after that of Müller Argoviensis in DC. Prodromus **15**(2): 987–1016, is that of Pax & K. Hoffmann in Das Pflanzenreich, **63** (IV. 147. VII). Here, there are twenty-four species recorded from New Guinea. Five years later, 1919, in Pflanzenreich, **68** (IV. 147. XIV), Pax & K. Hoffmann added twenty more to the previously known species from that region. These were based chiefly on the large collections of Ledermann from the Sepik (Kaiserin Augustafluss-Expedition) River region. Since then only occasional new species have been reported. Meanwhile the collections of the Archbold Expeditions have been accumulating. These, with a considerable loan from the Bogor Herbarium, the Carr material from the British Museum, and the Papuan *Macaranga* from the Brisbane Herbarium, and that of Lae, form the basis of the work here presented. It brings together in one place the species of the Papuasian region. The study is admittedly incomplete. In determining specimens of a variable and dioecious genus, such as *Macaranga,* it is important to have material from both the staminate and the pistillate plants. Unfortunately, all too often this fact has not been recognized, and, as a result, species have been described from collections representing a single sex. It is difficult indeed to match a pistillate unknown with the description of a stami-

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* Botanical Results of the Richard Archbold Expeditions. See Jour. Arnold Arb. **32**: 369–389. 1951.

nate specimen, and even more so vice versa. This same difficulty presents itself when a key is to be drawn for the species. Another difficulty is the lack of sufficient material to estimate the variability within a species with any degree of accuracy. A question one often ponders is — what constitute good specific characters in this genus? Some of the findings which I consider pertinent are recorded below:

Stipules: The stipules seem to be fairly constant in size, outline and pubescence. Since usually they are shed rather quickly, good specimens should have at least two terminal buds. In several species the stipules are connate forming a single scale covering the terminal bud in the axil of the uppermost leaf. Such stipules leave a ring-like scar. In all species reported in this article as having connate stipules, a stipule has been removed from a bud for verification. There are other species which apparently bear large leaves clustered at or near the apex of the branchlets; here the stipules are large and it is not easy to determine whether they are connate or separate. However, if one is so fortunate as to have a part of the branchlet showing stipular scars, it may be noted that when the stipules are in pairs broad enough to surround the young branchlet, one is slightly higher than the other at the point of meeting, so the scar is slightly uneven at that point.

Leaves: In the group of species with palmately veined leaves, the character of lobed versus entire leaves is often unsatisfactory and one to be used much more cautiously than it has been in the past. Great variation is also encountered in the size and width of leaves even on the same branchlet.

Staminate inflorescence: Only a few staminate inflorescences are simple; most are panicles. The bracts subtending the branchlets should possibly be regarded as a negligible character, as these in most instances appear to have fallen from the herbarium specimens. However, the bracts subtending the glomerules are persistent and, although showing variation, are reasonably reliable. The presence or absence of patelliform glands appears to be quite constant, although the glands may vary in size, shape and position. Within limits the number of stamens tends to be a good character, but several dissections are necessary to establish the number accurately and it is preferable to have more than one gathering to work upon. Most anthers are four-locular, but in a few species both three-locular anthers and four-locular anthers occur in the same flower. Again in some species three-locular anthers are constant, while in one *Macaranga* two-locular anthers are found. In at least seven species the calyx is lobed only to the middle, although in most species the sepals are free or the calyx is tripartite.

Pistillate inflorescence: The bracts appear to fall very quickly from the pistillate inflorescence; however, if several of them can be seen, they offer a certain parallel with those found in the staminate inflorescence. The calyx is distinctive, at least for closely related groups, but this too is displaced by the growing flower and seldom observed. The unilocular character of the ovary appears to be dominant in certain species, but in *M. ovatifolia* Merr. from the Philippines, and here reported from the Solomon Islands, the bilocular ovary is almost as frequent as the unilocular ovary on the same specimen. Occasionally specimens have both smooth capsules and capsules irregularly marked with small tubercles. The majority of the species have capsules with processes. Any outgrowth which appears longer than broad is here regarded as a process. In *M. induta* the processes are broad in proportion to their length and obtuse. Some species have rather fine and relatively long, almost filiform, processes. On the other hand, *M. caudata* Pax & K. Hoffmann is marked by very short processes, almost short enough to be termed tubercles. However, they have minute hairs at the apex similar to those found along the long processes in other species. In *M. clemensiae* and *M. fragrans* the base of the process is broad. Another feature of the processes to be noted here is that in some species they tend to slough off as the capsule matures, so that the capsule, unless carefully observed, sometimes appears smooth.

Pubescence: The type of pubescence rather than the quantity is here regarded as a criterion. The terminal bud, the lower surface of the leaves, and the inflorescence usually have the same type. Often pubescence rubs off, but that found on the terminal bud and the inflorescence is fairly constant.

In the key given below I have not attempted to follow the phylogenetic order of Pax & K. Hoffmann, but rather to use those superficial characters which might aid in the identification of future collections.

I am deeply grateful to the directors and curators of the various herbaria who have given me the privilege of studying their material. I am indebted to Dr. E. D. Merrill for the photographs of two types and carbon rubbings of leaves of several other species not represented here. I also express my appreciation for the kindness of Dr. Taylor in having Mr. Stearn check a type-specimen in the British Museum for me. The institutions from which material for this study was used are indicated as follows: A — Arnold Arboretum; BM — British Museum; BO — Bogor Herbarium; BR — Brisbane Botanic Museum and Herbarium; F — Herbarium Universitatis Florentinae; G — Gray Herbarium; LAE — Department of Forests, Lae, New Guinea; MICH — University of Michigan; NY — New York Botanical Garden.

KEY TO THE SPECIES

A. Stipules connate (the terminal bud with a single scale).
    B. Bracts subtending the ♂ glomerules not patelliform-glandular on the upper surface. .... 1. *M. belensis.*
    BB. Bracts subtending the ♂ glomerules patelliform-glandular on the upper surface.
        C. Leaves conspicuously bullate. .... 2. *M. eymae.*
        CC. Leaves not bullate, or if bullate only observed with the aid of a lens.
            D. Capsule smooth; leaves lanceolate or ovate-lanceolate. .... 3. *M. reiteriana.*
            DD. Capsule processed (not known in *M. pleytei*); leaves ovate, elliptic or lobed.
                E. Anthers 2-locular. .... 4. *M. cucullata.*
                EE. Anthers mostly 3-locular, 4-locular ones occasionally occurring.

F. Leaves peltate; pubescence on the branchlets ca. 4 mm. long. .... 5. *M. pleytei*
FF. Leaves not peltate; pubescence on the branchlets not more than 2 mm. long.
G. Leaves biauriculate at the apex of the petiole.
H. Bracts subtending the ♂ glomerules linear, dilated at the apex and bearing a single orbicular patelliform gland; bracts subtending the ♀ flowers lanceolate or linear, narrowed at the base; calyx of the ♀ flower 6–8 mm. long; styles 0.8–2 cm. long. .... 6. *M. aleuritoides.*
HH. Bracts subtending the ♂ glomerules 3-lobed, the two basal lobes rounded, the middle lobe suborbicular and patelliform-glandular; bracts subtending the ♀ flowers ovate; calyx of the ♀ flower hardly 4 mm. long; styles ca. 0.5 cm. long. .... 7. *M. papuana.*
GG. Leaves not auriculate at the apex of the petiole.
H. Leaves elliptic-ovate, somewhat narrowed towards the apex and base, 3-nerved at the base; stipules 1.5–3 cm. long; sepals of the ♂ flower about 0.5 mm. long; stamens with 3-locular anthers; calyx of the ♀ flower about 3.5 mm. long. .... 8. *M. tessellata.*
HH. Leaves ovate or subrhombic-ovate or lobed, palmately 5-nerved; stipules 5–11 cm. long; sepals of the ♂ flower 1 mm. long; stamens with 3-locular (some with 4-locular) anthers; calyx of the ♀ flower 1 cm. or more long. .... 9. *M. platyclada.*

AA. Stipules separate (the terminal bud with two scales).
B. Bracts patelliform-glandular on the upper surface (♀ inflorescence unknown in *M. astrolabica*, *M. bullata*, and *M. stenophylla*, ♂ inflorescence unknown in *M. advena*).
C. Capsules with processes.
D. Leaves broadly (0.5–6.5 cm.) peltate.
E. Leaves bullate. .... 17. *M. bullata.*
EE. Leaves not bullate.
F. Stamens with 3-locular anthers; stipules 2–3 cm. long; leaves 1.5–6.5 cm. peltate. .... 10. *M. fallacina.*
FF. Stamens with 4-locular anthers; stipules less than 2 cm. long.
G. Stamens 15 or 16. .... 12. *M. stenophylla.*
GG. Stamens not more than 12.
H. Leaves 1.3–2.5 cm. peltate; capsule 2-locular with long (5–7 mm.) processes. .... 11. *M. salomonensis.*
HH. Leaves 0.4–0.8 cm. peltate; capsule 1-locular with shorter (up to 2.5 mm.) processes.
I. Stipules lanceolate or lance-ovate, 1–1.7 cm. long; inflorescence velutinous; bracts

subtending ♀ flowers subfoliaceous; style 6–9 mm. long. . . . . 27. *M. similis.*

II. Stipules linear-lanceolate or linear-oblong, 0.4–0.7 cm. long; inflorescence ferrugineous-tomentulose; bracts subtending ♀ flowers not foliaceous; style 4 mm. long. . . . . 29. *M. punctata.*

DD. Leaves apeltate or only slightly (0.2–0.4 cm.) peltate.
  E. Leaves 3–5-nerved or at least 3-nerved at the base.
    F. Ovary 2-locular (in *M. strigosa*, var. *carrii* sometimes 3-locular).
      G. Stipules 3–5.5 cm. long; capsules with very short (0.2–0.4 mm.) processes. . . . . . . 15. *M. caudata.*
      GG. Stipules not more than 2 cm. long; capsules with processes 1.5–4.5 mm. long (not known in *M. warburgiana*).
        H. Calyx of ♀ flowers urceolate or subtubular and denticulate, not splitting into almost even lobes; leaves not bullate except in *M. strigosa.*
          I. Stamens 11–18. . . . . 13. *M. rufibarbis.*
          II. Stamens 2–8.
            J. Stamens 2–4 with 3- or 4-locular anthers, mostly 3-locular.
              K. Leaves cordate at the base; petioles fulvous-setose with retrorse hairs; ♂ panicle villous. . . . . 16. *M. strigosa.*
              KK. Leaves truncate at the base; petioles glabrous; ♂ panicle glabrous. . . . . 18. *M. warburgiana.*
            JJ. Stamens 4–8 with 4-locular anthers.
              K. Leaves deeply bifoveate at the base; ♂ bracts thickish and cucullate or apiculate. . . . . 19. *M. bifoveata.*
              KK. Leaves with 4 flat glands at the base; ♂ bracts ovate, acutish or obtusish, not usually thickened. . . . . . . 20. *M. latifolia.*
        HH. Calyx of ♀ flowers conic, apparently splitting into 2 or 3 regular lobes; leaves more or less bullate. . . . . . . 21. *M. glandulifera.*
    FF. Ovary 1-locular (processes often caducous as fruit matures).
      G. Bracts of the ♀ inflorescence foliaceous; pubescence velutinous or spreading-pilose, not crisply tomentose nor setulose.
        H. Bracts subtending the ♂ glomerules dentate; stamens 3 or 4. . . . . 22. *M. densiflora.*
        23. *M. dalechampioides.*

HH. Bracts subtending the ♂ glomerules entire; stamens 4–12.
  I. Pistillate bracts lanceolate or linear-lanceolate, entire. . . . 24. *M. urophylla.*
  II. Pistillate bracts ovate or triangular-ovate denticulate or dentate.
    J. Stipules narrowly linear, 4–10 mm. long; leaves rounded, or truncate and retuse, or very slightly cordate at the base.
      K. Style 7–10 mm. long; capsule with processes 1.5–2.5 mm. long. . . . 25. *M. involucrata.*
      KK. Style 4–6 mm. long; capsule with processes hardly 1 mm. long. . . 26. *M. schleinitziana.*
    JJ. Stipules lanceolate or lance-ovate or slightly obovate-oblong; leaves cordate at the base. . . 27. *M. similis.*

GG. Bracts of the ♀ inflorescence not foliaceous; pubescence crisply tomentose or setulose.
  H. Capsule with very short (0.4–0.6 mm.) processes; pubescence setulose; stamens 2 or 3. . . . . 28. *M. chrysotricha.*
  HH. Capsule with processes about 2 mm. long; pubescence crisply tomentose; stamens 3–10 . . . . 29. *M. punctata.*

EE. Leaves pinnately nerved.
  F. Capsule 2-locular; stamens 2–4; ♀ bracts linear-lanceolate, narrowed towards the base. . . . . 14. *M. decipiens.*
  FF. Capsule 1-locular; stamens 11–15 (not known in *M. advena*).
    G. Leaves ovate-lanceolate with narrowly linear apex up to 4 cm. long; stipules ovate; ♀ bracts rhombic-ovate and narrowed at the base, patelliform-glandular within the margin. . . . . 30. *M. advena.*
    GG. Leaves lanceolate, acuminate; stipules linear-subulate; ♀ bracts, at least the lower ones (sometimes the upper small and lacking glands), ovate with entire or dentate apex, reflexed, and bearing near the base 2 large oval patelliform glands. . . . . 31. ***M. angustifolia.***

CC. Capsules smooth or marked irregularly with obtuse tubercles (not known in ***M. astrolabica***).
  D. New growth and inflorescence glabrous or inflorescence slightly puberulous; leaves lanceolate, subcoriaceous; capsule smooth, glabrous.
    E. Stamens 2. . . . . 32. *M. astrolabica.*
    EE. Stamens 10–16. . . . . 54. *M. gracilis.*

DD. New growth and inflorescence brownish sublanate-tomentose; leaves ovate, rather stiff; capsule tomentulose, smooth or sometimes with a few tubercles. ...... 33. *M. sterrophylla.*

BB. Bracts not patelliform-glandular on the upper surface (♀ unknown in *M. haplostachya*, *M. hoffmannii*, *M. kostermansii*, *M. longicaudata*, and *M. womersleyi*; ♂ unknown in *M. inermis*, *M. clemensiae*, and *M. magnifolia*); anthers usually 4-locular.

C. Leaves obviously bullate; capsules with processes.

D. Leaves coarsely bullate, the elevations on the upper surface about 5 mm. long, 2–3 mm. broad. ...... 34. *M. clemensiae.*

DD. Leaves more finely bullate, the elevations on the upper surface not more than 3 mm. long, 1–2 mm. broad.

E. Leaves caudate-acuminate, the acumen almost linear and 2–3 cm. long; venation close.

F. Staminate inflorescence (including the flowers) densely brown-tomentose; lower surface of the leaves densely tomentose, the veins villous. .... 35. *M. womersleyi.*

FF. Staminate inflorescence hirtellous; flowers glabrous; lower surface of the leaves not tomentose, all the veins hirtellous. .... 36. *M. longicaudata.*

EE. Leaves gradually or subabruptly acuminate, but not caudate; venation not so close.

F. Leaves 0.5–1 cm. peltate; ovary 1-locular .... 37. *M. leonardii.*

FF. Leaves rounded or slightly cordate at the base, scarcely peltate; ovary 2-locular. .... 38. *M. carrii.*

CC. Leaves not or only very slightly bullate; capsules smooth or with processes.

D. Leaves peltate.

E. Leaves broadly (1.5–20 cm.) peltate; stipules medium to large (1–13 cm. long).

F. Stamens with 3-locular anthers; capsules bilocular, with processes 1.5–3 mm. long. .... 10. *M. fallacina.*

FF. Stamens with 4-locular anthers; capsules 2–5-locular.

G. Stipules large, 4–13 cm. long; leaves large, 34–76 cm. long; capsules with short (0.5–2 mm.) tomentulose processes, or tuberculate, 2- or 3-locular; subtending bracts (where known) tomentulose on both sides.

H. Capsules densely covered with short (0.5–2 mm.), tomentulose processes. .... 39. *M. fragrans.*

HH. Capsules densely granulo-glandular and somewhat irregularly tuberculate; tubercles 0.5–0.7 mm. high, 1–1.5 mm. broad, pubescent. .... 40. *M. magnifolia.*

GG. Stipules smaller, 1–3 cm. long; leaves 7–33 cm. long; capsules with long (3–15 mm.) slender processes, 2–5-locular; subtending bracts glabrous or somewhat velutinous.

H. Bracts subtending the ♂ glomerules ovate, deeply concave and entire or sinuate; stamens

2 or 3; ovary (3–) 4–5-locular; leaves usually bearing 1–4 maculate glands on the basal nerves between the insertion of the petiole and the lower margin. . . . 41. *M. quadriglandulosa.*

HH. Bracts subtending the ♂ glomerules suborbicular-ovate, pectinate-lacinulate or dentate; stamens 4–14; ovary 2–3-locular; leaves usually without maculate glands. . . . . 42. *M. tanarius.*

EE. Leaves narrowly (not more than 1 cm.) peltate; stipules usually less than 1 cm. long.

F. Bracts subtending the ♂ glomerules deeply concave; stamens 2 or 3; capsules with slender processes. . . 41A. *M. quadriglandulosa*, var. *variabilis.*

FF. Bracts subtending the ♂ glomerules only slightly concave; stamens 3–15; capsules smooth or slightly and irregularly tuberculate, processed only in *M. induta.*

G. Branchlets with new growth glabrous; ♂ inflorescence glabrous (only pubescent part of plant mentioned is the sparsely pilose midrib on the lower surface of the leaves); primary veins 2–4 pairs above the basal ones. . . . . 43. *M. hoffmannii.*

GG. Branchlets with new growth and inflorescences tomentose; primary veins 5–9 pairs above the basal ones.

H. Ovary 2- or 3-locular, mostly 2-locular.

I. Leaves at maturity almost glabrous on the lower surface; capsules mostly 1-locular, rarely 2-locular. . 44. *M. versteeghii.*

II. Leaves at maturity tomentose on the lower surface.

J. Stamens 3–5, anthers with a few brownish wrinkled hairs attached to them; pubescence of the lower surface of the leaves uneven under a lens. . . . 45. *M. trichanthera.*

JJ. Stamens 10–15, anthers glabrous; pubescence of the lower surface of the leaves even (almost like a thin felt) under a lens; capsule processed or smooth. . . . . 46. *M. induta.*

HH. Ovary 1-locular, rarely 2-locular.

I. Leaves elliptic-ovate, almost glabrous at maturity; stipules oblong-lanceolate. . . . . 44. *M. versteeghii.*

II. Leaves subrhombic- or suborbicular-ovate, somewhat tomentose on the lower surface; stipules linear-lanceolate. . . . . 47. *M. albescens.*

DD. Leaves apeltate.

E. Stamens 20 or less.

F. Capsules with processes; stamens 2 or 3.

G. Bracts subtending the ♂ glomerules entire.

H. Bracts ovate, 3–5 mm. long, deeply concave, glabrous. . . . . 41A. *M. quadriglandulosa*, var. *variabilis*.

HH. Bracts densely hairy outside, about 1.3 mm. long, acuminate, somewhat clasping the rachis. . . . . 48. *M. nova-guineensis*.

GG. Bracts subtending the ♂ glomerules dentate, puberulous. . . . . 49. *M. subpeltata*.

FF. Capsules smooth; stamens 2–17.

G. Bracts subtending the ♂ glomerules dentate or lacinulate.

H. Bracts dentate with short (0.3–0.5 mm.) teeth; ovary 1- or 2-locular. . . . . 50. *M. ovatifolia*.

HH. Bracts lacinulate with laciniae 1–2.5 mm. long.

I. Ovary 1-locular. . . . 52. *M. polyadenia*.

II. Ovary 2-locular. . . . . 51. *M. fimbriata*.

GG. Bracts subtending the ♂ glomerules entire.

H. Lower surface of the leaves covered with rusty brown tomentum. . . . . 45. *M. trichanthera*.

HH. Lower surface of the leaves not tomentose.

I. Leaves sparsely pilose or setulose on the upper surface, short-villous beneath; stamens 3. . . . . 53. *M. villosula*.

II. Leaves glabrous on the upper surface and mostly glabrous beneath; stamens 5–17.

J. Stamens 10–17.

K. Leaves caudate-acuminate with the acumen 1.5–3 cm. long, 3-nerved at the base with 4–6 additional pairs of primary veins above the basal ones, not maculo-glandular on the upper surface. . . . . . 54. *M. gracilis*.

KK. Leaves obtusely cuspidate-acuminate, pinnately veined with 8–11 pairs of primary veins, maculo-biglandular on the upper surface at the base. . . . . 55. *M. haplostachya*.

JJ. Stamens 5–9.

K. Leaves at the base suddenly contracted to about 2–2.5 mm. broad and extended downward 2.5–3 mm. to join the petiole. . . 56. *M. lanceolata.*

KK. Leaves obtusely cuneate or obtuse at the base.

L. Leaves very small, 2.5–4.5 cm. long, 0.9–1.3 cm. broad; ♂ inflorescence simple or sparsely branched. . . . . 57. *M. kostermansii.*

LL. Leaves larger, 6–17 cm. long, 2–11 cm. broad; ♂ inflorescence branching from near the base (known only in the varieties). . . . . 58. *M. inermis.*

EE. Stamens 32–59. . . . . 59. *M. pleiostemona.*

1. **Macaranga belensis** sp. nov.

Arbor 10–12 m. alta; ramulis novellis, foliis novellis petiolis, stipulis, et inflorescentiis molliter pilosis vel subvillosulis, pilis 1.3–2 mm. longis; laminis firme chartaceis, 5–13 cm. longis, 2–5.5 cm. latis, ovatis, sensim longe acuminatis, acumine 1–2.5 cm. longo, versus basin angustatis, basi retusis vel emarginatis et supra maculari-2–6-glandulosis, maturis supra glabris olivaceis, subtus pallidioribus costa venisque paulum pilosis, utrinque flavo-granulari-glandulosis, inconspicue trinerviis vel penninerviis, venis primariis utrinsecus costa 6–9 oblique adscendentibus subtus prominulis et in axillis crispe pilosulis, venis secundariis et rete manifestis; petiolo 1–3.5 cm. longo; stipulis connatis cito caducis 1.1–2.3 cm. longis; inflorescentiis ♂ simplicibus 5–7.5 cm. longis (incl. basi 1–2.5 cm. nudis) dissite glomerulo-florigeris, bracteis extus dense pilosis, intus non patellari-glandulosis, ovatis inferioribus longe acuminatis ca. 7–10-floris; floribus ♂ pilosis et granulari-glandulosis; calyce tripartita, lobis circiter 2 mm. longis; staminibus 11–24, antheris 4-locularibus; floribus ♀ ignotis.

NETHERLANDS NEW GUINEA: common in secondary forest, Bele River, 18 km. NE. of Lake Habbema, alt. 2200 m., *Brass 11212* (TYPE, ♂, A), Nov. 1938 (tree 10–12 m. high).

The basal glands of the leaves are below the two basal lateral veins, which extend only about one-third of the length of the leaf. These are not more prominent than the other lateral veins, but in the larger leaves the basal laterals support secondary veins more remote than the upper laterals, hence suggesting three-nerved leaves.

2. **Macaranga eymae** sp. nov.

Habitus ignotus, probabiliter frutex vel arbor; ramulis teretibus apicem versus subadpresse villoso-hirsutis, pilis leoninis; laminis firme chartaceis, 13–30 cm. longis, 3.8–11.7 cm. latis, lanceolatis vel anguste ovatis sensim acuminatis, acumine 1.5–3 cm. longo, basi breviter cordatis, supra prope apicem petioli glandulis maculiformibus 4–6 ovalibus instructis, margine integris vel undulatis, novellis dense villoso-hirsutis, maturis glabrescentibus, supra in costa tantum, subtus costa et venis et venulis villoso-hirtellis, supra minute bullatis, pinnatinerviis vel basi breviter trinerviis, venis primariis utrinsecus costa 18–25 oblique adscendentibus prope marginem arcuatim conjunctis utrinque perspicuis; petiolo 1.5–5.5 cm. longo subadpresse hirtello; stipulis connatis, 3–6.5 cm. longis, cito caducis, adpresse villoso-hirsutis; inflorescentiis hirtellis; ♂ 7–9 cm. longis, 2.5–3 cm. pedunculatis, ramis inferioribus ad 5 cm. longis adscendenti-patentibus, bracteis sub ramos lineari-lanceolatis caducis, bracteis florigeris persistentibus e basi dilatata angustatis deinde in laminulam fere semiorbicularem intus patelliformi-pluriglandulosam protractis, supra basin ca. 2 mm. longis, 5–7-floris; calyce ♂ sub anthesin fere 1.5 mm. longo, sepalis 3 ovatis, staminibus 3–7 (saepe 4), antheris 4-locularibus; ♀ simplicibus, pedunculo 3–5 cm. longo, apice flores 1 vel 2 proferentibus, bracteis oblongis basin versus petioliformi-angustatis, circiter 1 cm. longis, parte superiore intus patelliformi-pluriglandulosis; floribus ♀ ca. 1 cm. pedicellatis, calyce tubuloso, 6.5 mm. longo, parte inferiore subglobosa ovarium arcte cingente, ca. 5 mm. diam., parte superiore brevi truncata, deinde rumpente et deciduo; ovario globoso dense adpresse molliter echinato, hirtello, 2-loculare, stigmatibus 2 linearibus plumosis circiter 6 mm. longis; capsula immatura sine echinis 9 mm. diam., 6 mm. alta, echinis numerosis subulatis leviter curvatis pilosis, fere 5 mm. longis.

NETHERLANDS NEW GUINEA: Wissel Lake region, SW. corner of Lake Paniai, Camp Moeie, alt. 1750 m., *Eyma 4966* (♂ & ♀, A, TYPE; BO), July 28, 1949.

3. **Macaranga reiteriana** Pax & K. Hoffmann in Pflanzenr. **85** (IV. 147. XVIII): 185. 1924.

Tree 6–20 m. tall; young parts (branchlets, petioles, young leaves, stipules, and in a lesser degree inflorescences) brownish golden-hirtellous with hairs 0.7–1 mm. long and antrorsely subappressed; the slender branchlets glabrate; stipules connate and caducous, 2.5–5 cm. long; petiole 1–2.5 cm. long; leaf-blades firmly chartaceous or thinly coriaceous, 4.5–10 cm. long, 1.5–4 cm. wide, lanceolate or ovate-lanceolate, entire and acuminate, obtuse at the base, above near the attachment of the petiole dotted with 2–6 small flat dark glands, glabrous above except for the sparsely hairy midrib, beneath more densely hairy on the midrib and veins and densely punctate with brownish depressed minute glands, 8–10 primary veins on either side of the midrib, with secondary veins and reticulations easily seen on the upper surface but inconspicuous below; the simple ♂ inflorescence 4–6 cm. long with scattered glomerules of flowers, the bracts subtending the glomerules about 2 mm. long with shallow concave base about 1 mm. deep, elongated on the dorsal side to form a shortly spatulate lobe with the apex patelliform-glandular (many minute glands) within and about equaling the narrowed portion in length; ♂ flower with 3 or 4 sepals 0.5–0.8 mm. long and granulo-glandular; stamens 3 or 4, the anthers 3- or 4-locular; ♀ flower (not seen) solitary and bibracteate at the apex of the peduncle; calyx fusiform enclosing the densely glandular ovary, the style plumose.

NETHERLANDS NEW GUINEA: occasional on slopes in primary forest, 15 km. SW. of Bernhard Camp, Idenburg River, alt. 1510 m., *Brass & Versteegh 11977* (♂, A), Jan. 1939 (tree 19 m. tall, diam. 35 cm., crown not wide-spreading; flowers grey; bark 5 mm. thick, black, fairly smooth; sapwood rose, heartwood red-brown).

This staminate collection agrees well with the original description; the only differences I find are that none of the leaves in the collection cited is broader than 2.7 cm., whereas the maximum width given in the original description is 4 cm., and that the anthers are as often 3-loculed as 4-loculed, not mostly 4-loculed. These features are only indicative of variation, and not in any way of specific value. The terminal bud of this species is long and very narrow (3 or 4 mm.), much like that of *M. longestipulata* (Kurz) Muell. Arg. from Ternate in the Moluccas. Unfortunately only the pistillate form of the latter has been collected, and apparently from the original description of *M. reiteriana* only the very young pistillate flowers of this are known. As between the two species there are no processes on the ovary, whereas they are characteristic of the fruit of *M. longestipulata.*

4. **Macaranga cucullata** J. J. Smith in Nova Guin. **8**: *237, t. 60.* 1910; l.c. 789. 1912. — Pax & K. Hoffmann in Pflanzenr. **63** (IV. 147. VII): 369. 1914.

Tree up to 8 m. high; young branchlets, petioles, peduncles, and branches of the inflorescence yellowish hirsute with (sometimes stiffish) hairs 1–6 mm. long, quickly glabrescent or glabrate; stipules connate, caducous, up to 13 cm. long, appressed hirsute (sometimes sparsely so) on the outer surface; petioles 8–43 cm. long; leaf-blades large and subcoriaceous, 18–63 cm. long, 14–44 cm. broad, 3–5-lobed or entire and elliptic-ovate with the apex of entire leaves or lobes abruptly and narrowly 1–4 cm. acuminate, distantly callose-dentate on the margin, broadly rounded on either side of the deeply cordate base and bearing at the sinus 2 narrow and rounded-undulate auricles with a few flat oval glands on the upper surface, strongly 3-nerved at base with 12–16 pairs of prominent primary veins above the basal ones, the secondary veins almost parallel; young leaves densely lanate-hirsute on the upper surface, later glabrate, densely and minutely dark-glandular beneath with the venation appressed hirtellous; ♂ inflorescence paniculate, 13–17 cm. long, the peduncle 3–5 cm. long; primary bracts stipule-like, caducous; bracts subtending the glomerules attached to the rachis forming a cup-like base 1–1.5 mm. wide and deep, the free part an oblong or spatulate-obovate lobe 1–1.5 mm. long, pilose outside, bearing a single orbicular patelliform gland within; ♂ flowers short-pedicellate; sepals 3 or 4, ovate, concave, 0.5–0.7 mm. long; stamens 3–7 with 2-locular anthers; ♀ inflorescence short, 3–3.5 cm. long, few-flowered, hirsute; capsule depressed quadrangular-globose, densely glandular, with pubescent subulate processes 2–2.5 mm. long.

NETHERLANDS NEW GUINEA: primary forest, North River, *Versteeg 1064* (♂, BO, TYPE), May 1907; primary forest, North River, *Von Roemer 431* (♀, BO), Oct. 1909; common in seral rain forest on edge of river floodplain, Bernhard Camp, Idenburg River, alt. 50 m., *Brass 13826* (♂, A), April 1938 (tree 6–8 m. high with very large cordate leaves about 55 × 44 cm.).

PAPUA: occasional in subseral rain forest on river bank, Palmer River, 2 miles below junction Black River, alt. 100 m., *Brass 7256* (♂, A), July 1936 (small tree 3 or 4 m. high with erect branches; leaves 63 × 39 cm., red beneath; panicles red, anthers white).

The only ♀ collection is *Von Roemer 431*. The ♂ inflorescences of the other specimens are so much alike that I feel sure that they belong to a single species. It should be noted, however, that the leaves of the Brass collections are entire and larger, whereas those of *Versteeg 1064* and *Von Roemer 431* are 3–5-lobed mostly. In view of the leaf variation shown in the excellent series of specimens belonging to *M. aleuritoides* F. Muell., cited above, the presence or absence of lobes cannot be regarded as a specific character. *Brass 7256* is more nearly glabrous than the other specimens; on the other hand *Brass 13826* is more hairy (with irritant hairs) than any of the others; here, even on the upper surface of the leaves, are scattered longish hairs, and the upper branchlet is almost hispid.

5. **Macaranga pleytei** sp. nov.

Arbor parva 8 m. alta; ramulis teretibus novellis setulosis, setulis patentissimis flavescentibus ca. 4 mm. longis; laminis novellis, petiolis, stipulis et pedunculis dense hirtello-setulosis, setulis saepissime patentissimis 2.5–4 mm. longis et pilis 0.2–0.5 mm. longis intermixtis; laminis chartaceis 6.5–14.5 cm. longis, 4.5–12 cm. latis, orbiculari-ovatis abrupte acuminatis, acumine 0.5–1 cm. longo, basi 0.6–1.9 cm. peltatis, supra in nervis inter insertionem petioli et marginem basalem glandulis maculiformibus 4–6 instructis, in sicco margine revolutis, glabrescentibus, maturis supra sparsim setulosis et interdum leviter rugulosis, subtus minute cerino-glandulosis etiam costa et venis et venulis hirtellis, palmatinerviis, venis primariis supra basalibus utrinsecus costa 7–9 oblique adscendentibus prominulis, secundariis et rete perspicuis; petiolo 4.5–11 cm. longo; stipulis connatis cito caducis, 3–5 cm. longis, setulis subadpresse adscendentibus; inflorescentiis ♂ paniculatis, 11–18 cm. longis, pedunculo 8.5–11 cm. longo, rhachi et ramis hirtellis, ramis inferioribus 2.5–4 cm. longis; bracteis sub ramos breviter triangularibus acuminatis, bracteis florigeris ca. 13-floris, glomerulos non superantibus rhachidem semiamplectentibus semiorbiculari-ovatis apiculatis, parte superiore intus patellari-pluriglandulosis; floribus ♂ saepissime alabastris, extus pauciglandulosis; calyce tripartita; staminibus 4, antheris 3-locularibus; floribus ♀ ignotis.

NETHERLANDS NEW GUINEA: Misool Island: in thinned forest near Fakal, alt. 40 m., *Pleyte 1117* (♂, A, TYPE; BO), Oct. 7, 1948 (tree 8 m. tall, 6 cm. diam., flowers yellow).

Although the pistillate plant of this species is not known, the connate stipules, the 3-locular anthers, the leaf-venation, and the somewhat coarse pubescence suggest a relationship with the section Dimorphanthera. It is readily distinguished from the other species of this section by the peltate leaves.

6. **Macaranga aleuritoides** F. Mueller, Descr. Notes Pap. Pl. 2: 21. 1876. — Pax & Hoffmann in Pflanzenr. 63 (IV. 147. VII): 366. 1914.

Macaranga riparia Engler in Bot. Jahrb. 7: 463. 1886; Forschungsr. Gaz. 35, *t. 11.* 1888. — K. Schumann & Lauterbach, Fl. Deutsch. Schutzgeb. Südsee 397. 1900. — J. J. Smith in Nova Guin. Bot. 8: 235. 1910; l.c. 789. 1912.

Tree up to 20 m. high; young branchlets, stipules, petioles, peduncles, and branches of the inflorescence puberulous and appressed-pilose with hairs 0.6–1.7 mm. long, quickly glabrate; stipules connate, caducous, 3.5–9 cm. long; petioles 1–38 (usually 5–15) cm. long; leaf-blades often large and subcoriaceous, 13–45 cm. long, 7–42 cm. wide, sometimes entire and ovate but usually with 3 erect-spreading and narrowly acuminate lobes, the middle one triangular-ovate and much larger than the oblique, mostly entire (occasionally bilobed) lateral ones, inconspicuously callose-dentate on the margin or entire, truncate to cordate or in a few instances rounded at the base and bearing at the apex of the petiole 2 rounded-undulate auricles with a series of 1–4 flat oval glands above often extending to the blade, strongly 3-nerved at the base with 10–18 less prominent pairs of primary veins obliquely spreading-ascending and shortly arcuate just within the margin and joined throughout by distinct and almost parallel secondaries, the latter connected in turn by finer reticulations; the upper surface of the young leaves cinnamon-colored tomentose becoming glabrate, the lower remaining permanently puberulous and rather closely dark glandular-punctate; ♂ inflorescence paniculate, 7.5–24 cm. long including the compressed 1–6 cm. peduncle, the primary bracts stipule-like and caducous, the bracts subtending the glomerules 2–5 mm. long, linear, dilated at the apex and here bearing a single orbicular gland within; ♂ flowers almost sessile, the sepals 3, ovate, the stamens 5–15, the filaments exserted, the anthers 3-locular; ♀ inflorescence mostly branching (sometimes simple), 5.5–29 cm. long with the compressed 3–8 cm. peduncle, the primary bracts stipule-like, the secondary ones variable, lanceolate or linear and narrowed at the base, within variously dotted along the margin or towards the apex with orbicular glands, outside pilose; calyx of ♀ flower pilose, 6–8 mm. long, subglobose at the base and cylindrical in the upper part with a truncate apex, quickly deciduous, the plumose-papillose 2 or 3 styles 0.8–2 cm. long and recurved at the apex, the subglobose capsule 2- or 3-locular, ca. 1.5 cm. diam., densely glandular and bearing minutely hairy subulate processes 3 or 4 mm. long.

MOLUCCAS: Key Islands, West Elal, *Jensen 342* (♂, A), May 1922.

NETHERLANDS NEW GUINEA: Pionier bivouac, alt. about 50 m., *Docters van Leeuwen 9373* (♂, A, BO), June 1926; same camp, *Van Eechoud 104* (sterile, BO), Nov. 1939; Albatros bivouac, alt. 50 m., *Docters van Leeuwen 9629* (♀, BO), July 1926; near Prauwen bivouac, alt. 90 m., *Lam 1037* (♂ & ♀, BO); Hollandia, alt. about 20 m., *Gjellerup 310* (♂, BO), Aug. 1910; swampy forest, Ransiki, Vogelkop, alt. 10 m., *Kostermans 2895* (♂, BO), Aug. 1948; on edge of rain forest Nabire, *Kanehira & Hatusima 11421* (♀, A, BO), Feb. 1940; common in rain-forest seral growths on ground seldom flooded, Bernhard Camp, Idenburg River, alt. 50 m., *Brass 13823* (♂ & ♀, A), April 1939 (tree 6–8 m. high; material from both ♂ and ♀ trees); Bernhard Camp, alt. 50 m., *Meyer-Drees 428* (♀, BO), July 1938. Misool: in thinned forest at Fakal, alt. 50 m., *Pleyte 960* (♂, A, BO), Sept. 20, 1948 (tree 8 m. high, 10 cm. diam.; flowers dirty yellow); west of Fakal, alt. 30 m., *Pleyte 1124* (♂, A, BO), Oct. 1948 (tree 10 m. high, 10 cm. diam.). Aroe Islands: primary forest and thickets, Poelau Wokam, Dosinamalaoe, *Buwalda 5044* (♂, A, BO), *5046* (♀, A, BO), May 1938; same locality, Neth. Ind. For. Serv. *bb.25314* (♀, A), May 1938.

PAPUA: Palmer River, 2 miles below junction Black River, alt. 100 m., *Brass 7284* (♀, A), July 1936 (dioecious tree 10 m. high; this and *Homalanthus* species the dominant species in rain-forest second growths); plentiful in seral shrubberies on muddy river banks, Oroville Camp, Fly River (30 miles above D'Albertis Junction), *Brass 7435* (♂, A), Aug. 1936; plentiful on river banks flooded by tides, Lower Fly River, east bank opposite Sturt Island, *Brass 8186* (♂, A), *8187* (♀, A), Oct. 1936; on old farm lands, Buna, *Lane-Poole 164* (♂, BR), July 1922; forest, Koitaki, alt. about 450 m., *Carr 12819* (♂, A, BM), July 1935; rain-forest second growth, Kubuna, alt. 100 m., *Brass 5636* (♀, A, NY), Dec. 1933; Ihu, Vailala River, *Brass 904* (♀, A), Feb. 1926; Bomgwina River, *Brass 1622* (♀, A), June 1926.

NORTHEAST NEW GUINEA: mountain bush, Boana, alt. about 1050 m., *Clemens 8306* (♂, A), June 1938; Boana, alt. 750 to 1350 m., *Clemens 41465* (♀, A), May–Nov. 1940; mountain bush above Markham River, vicinity of Kajabit Mission, alt. about 600 m., *Clemens 10893* (♂, A), Aug.–Dec. 1939; Bulu, *Schlechter 16078* (♂, A), May 1907; Kenejia, alt. 150 m., *Schlechter 18435* (♂, A), Oct. 1908; forest bank of Kerame River, 25 miles above Sepik River, *Herre 331* (♀, BO, NY); on rain-forest margin, Yalu, *White, Dadswell & Smith* NGF *1648* (♀, A, BR, LAE); in brown sandy loam on alluvial flat on bank of Munim Water, Yalu, alt. about 30 m., 2nd Austral. For. Surv. Co. NGF *275* (♀, A, BR, LAE), July 1944; between Lae and Yalu, *White, Dadswell & Smith* NGF *1519* (♀, BR), July 1944; near Aitape, *Smith* NGF *1216* (♀, A, BR, LAE), Jan. 1945.

BISMARCK ARCHIPELAGO: New Britain: in Nodup area, Gazelle Peninsula, *Waterhouse 237* (♀, NY), May, June 1934. Duke of York Is., without further locality, *Bradtke 339* (sterile, BR), 1918.

SOLOMON ISLANDS: Bougainville: Torokina, *Robinson & Volk* NGF *818* (♀, A, BR, LAE), Jan. 1945; Kieta, alt. 80 m., *Kajewski 1576* (♀, A), Mar. 1930; Kugu-maru, Buin, alt. 150 m., *Kajewski 1804* (♀, A, BO), June 1930; Karngu, Buin, *Kajewski 2227* (♂, A), Oct. 1930. San Cristobal: Waimamura, *Brass 2579* (♂ & ♀, A), Aug. 1932.

This common species of second-growth forest shows great variability in the size of the leaves and the length of the petioles; a few leaves are entire, and some of the very large ones have the lateral lobes somewhat bilobed, although they are only 3-nerved at the base (cf. *Gjellerup 310, Docters van Leeuwen 9373, White, Dadswell & Smith* NGF *1648, Clemens 10893, Schlechter 16078, Herre 331,* and *Brass 13823*).

The species is readily recognized by the three-lobed leaves with small rounded auricles close to the base of the petiole, the long apical bud covered by the connate stipules, the linear bracts (with an orbicular gland at the apex) subtending the glomerules of ♂ flowers, and the three-locular anthers. The single specimen cited from the Moluccas is the only one that I have seen from outside the Papuasian area.

7. **Macaranga papuana** (J. J. Smith) Pax & K. Hoffmann in Pflanzenr. 63 (IV. 147. VII): 368. 1914.

Macaranga hispida var. *papuana* J. J. Smith in Nova Guin. Bot. **8**: 234. 1910.
Macaranga ovalifolia Ridley in Trans. Linn. Soc. II. Bot. **9**: 148. 1916. — Pax & K. Hoffmann in Pflanzenr. **85** (IV. 147. XVII): 186. 1924.

Tree 7–17 m. high, 30–32 cm. diameter; branchlets tomentulose-puberulous, tardily glabrescent; stipules connate, caducous, 2–5.5 cm. long, sericeous outside; leaf-blades chartaceous, 7.5–18 cm. long, 5.5–15 cm. wide, ovate with entire margin, and acuminate at the apex, rounded or truncate or slightly cordate at the base and bearing at the apex of the petiole 2 rounded undulate auricles with 1–3 oval glands above, pinnately veined (3-nerved at the base) with 8–12 primary veins obliquely ascending from either side of the midrib, the secondary venation distinct on the lower surface, glabrous above except for the puberulous midrib, minutely dark-glandular and crisply puberulous beneath on all veins; young leaves densely short-pilose with hairs scarcely 1 mm. long; petiole 2–10 cm. long, tomentulose-puberulous like the branchlets; ♂ inflorescence 10–24 cm. long (including peduncle 1.5–3 cm.), tomentulose-puberulous or pilose, sparsely 2–6-branched with 2 or 3 long slender branches bearing dense many-flowered glomerules about 5 mm. apart; bracts subtending the glomerules 3-lobed, pilose on the outside, with the two lateral lobes rounded and the dorsal lobe suborbicular and patelliform-glandular within; ♂ flowers puberulous and sometimes granulo-glandular on the exposed part, the pedicels hairy, 1 mm. long; calyx 0.5–0.7 mm. long, 3-parted; stamens 4–8 with 3-locular anthers; ♀ inflorescence simple, immature, few-flowered; axis 2.5–5 cm. long, the bracts subtending the flowers ovate and patelliform-glandular within; calyx sparsely pilose, hardly 4 mm. long, truncate at the apex, deciduous, the ovary 2-locular, the 2 styles about 5 mm. long, pubescent on the dorsal surface and densely papillose above; capsule about 1 cm. diameter (probably immature), granulo-glandular and rather closely covered with pubescent processes 2–4 mm. long.

NETHERLANDS NEW GUINEA: Merauke River, *Jaheri s. n.* (♂ & ♀, BO, TYPE), Mar. 25, 1901; Camps I to III, Wollaston Exped., *Kloss s. n.*

(type of *M. ovalifolia* Ridl., ♂, BM; photo A); Babo, *Matatula 19* (Neth. Ind. For. Serv. *bb.21815*) (♀, BO); Hollandia, Bernhard Camp, about 50 m. alt., *Meyer-Drees 471* (Neth. Ind. For. Serv. *bb.25718*) (♂, A, BO).

PAPUA: Central Division, Mageri near Sogeri, *G. Angell* NGF *4197* (♂, A).

This species is undoubtedly closely related to *M. hispida* (Blume) Muell. Arg., but it is readily distinguished by the auricles and the lack of a deep sinus so characteristic of the Moluccan species. Also it is less hispid.

8. **Macaranga tessellata** Gage in Nova Guin. Bot. **12**: 481, *t. 186.* 1917. — Pax & K. Hoffmann in Pflanzenr. **85** (IV. 147. XVII): 184 (sphalm *tesselata*). 1924.

Tree about 16 m. high; apices of the branchlets, young leaves, stipules, and petioles densely hirtellous with hairs 0.4–1 mm. long, soon glabrate; stipules connate, caducous, 1.5–3 cm. long; petioles 1.7–3.5 cm. long; leaf-blades chartaceous, 13–18.5 cm. long, 6.5–10 cm. broad, elliptic-ovate with undulate or slightly dentate margin, somewhat narrowed at both ends, rather abruptly 1–1.5 cm. acuminate at the apex and shallowly cordate or rounded at the base, on the upper surface near the attachment of the petiole bearing 2 small oval glands or one or none, glabrous above except for the pubescent midrib and primary veins, hirtellous beneath on the midrib and veins and strewn with minute dark glandular dots, 8 or 9 primary veins (fairly prominent beneath) on either side of the midrib above the 3-nerved base, the secondaries prominulous and the reticulation visible to the naked eye; ♂ inflorescence in a few-branched panicle (only young ones in specimens studied) with pilose (hairs 0.5 mm. long) axis, the glabrous ♂ flowers glomerulate in the pubescent axis of the ultimate bracts, the latter about 2 mm. long with 2 basal lobes forming a shallow saucer-like cavity and the dorsal part elongating into a rounded or triangular-ovate lobe densely patelliform-glandular within; sepals about 0.5 mm. long, the stamens 3, with 3-locular anthers; ♀ inflorescence (not seen) short and bearing a few sessile crowded flowers; calyx about 3.5 mm. diameter and irregularly 3–5-lobed, tomentose on the outer surface, the styles 2; capsule compressed-globose, bearing yellowish tomentose subulate processes about 5 mm. long.

NETHERLANDS NEW GUINEA: North River near Bivak Island, *Pulle 132* (♂, BO, TYPE).

This species, associated by Pax & K. Hoffmann with *M. nova-guineensis* J. J. Sm. in the section Echinocarpae, has four characters in common with the section Dimorphanthera; they are: connate stipules, 3-locular anthers, the elongate dorsal part of the bracts subtending the staminate glomerule patelliform-glandular within, and fruits with processes. The stipules were originally described as lanceolate and caducous, inferring that they are free. In the two specimens at hand the stipules are found only on the terminal buds. I have detached one of the buds and soaked it to verify the fact that its cover is a single scale rather than two.

9. **Macaranga platyclada** Pax & K. Hoffmann in Pflanzenr. **68** (IV. 147. XIV): 30. 1919.

Macaranga roemeri Pax & K. Hoffmann in Pflanzenr. **85** (IV. 147. XVII): 185. 1924.

Tree to 26 m. high, 35 cm. diameter; young branchlets, young leaves, petioles, stipules, and inflorescences densely velvety-pilose or substrigose with hairs 0.8–1.2 (– 1.8 on stipules, and appressed) mm. long, glabrescent; stipules connate, caducous, 5–11 cm. long; petioles 8–16 cm. long; leaf-blades subcoriaceous, 11.5–33 cm. long, 7–22 cm. broad, entire or undulate and ovate or subrhombic-ovate or with 3 erect and narrowly acuminate lobes, with the middle lobe broadly triangular and up to 8 cm. acuminate and separated from the narrow laterals by wide sinuses, very shallowly cordate or truncate or rounded at the base, without basal glands on the upper surface, palmately 5-nerved with 7–9 ascending pairs of primary veins above the basal ones, becoming glabrescent above and dotted with scattered minute yellow glands, also sometimes minutely bullate, shortly pilose on all veins beneath and sprinkled with yellow glands, the secondary venation and reticulation distinct; bracts enclosing ♂ inflorescence stipule-like but not connate; panicle up to 22 cm. long, the compressed peduncle 4–7 cm. long, branches opposite, or 2 or 3 of different lengths clustered at a single node and usually subtended by lanceolate or linear acuminate bracts, the latter 0.5–2.5 cm. long and bearing several patelliform glands (in one instance the lowest branches subtended by a pair of lanceolate leaves 10 cm. long and 2.5 cm. wide with acumen 3 cm. long and petiole 5 mm.); the glomerules subtended by obtusish and oblong or slightly obovate bracts up to 5.5 mm. long, biauriculate at the base, patelliform-glandular and pubescent on the upper surface; ♂ flowers with 3 granulo-glandular and pubescent sepals 1 mm. long, the stamens 4–7 with 3- and 4-locular anthers; ♀ inflorescence simple, up to 15 cm. long, bearing apparently sessile flowers at 2 nodes but fruit on pedicels 5–9 mm. long, each node subtended by bracts with the petiolar bases 5 mm. long, the lower node with lanceolate acuminate bracts up to 2 cm. long, the upper node with bracts oblong or ovate and obtuse about 1 cm. long, all patelliform-glandular and pubescent on the upper surface; calyx of the ♀ flower densely pubescent and minutely glandular, 1.1–1.6 cm. long, globose at the base and about 4–5 mm. across, then somewhat narrowed into a tube bearing at the apex 5 narrow tapering lobes as long as the tube (sometimes lobes longer and tube very short), quickly deciduous; ovary 2- or 3-locular, the plumose papillose 2 or 3 styles with recurving apices up to 1.8 cm. long (including the 4–4.5 mm. connate base) and dorsally pubescent; fruit immature, densely granulo-glandular and covered with slender pubescent processes about 2 mm. long.

NETHERLANDS NEW GUINEA: frequent in rain forest, alt. 1630 m., *Brass & Versteegh 11936* (♂, A), Jan. 1939; in rain forest at 1700 m. alt., *Brass 12276* (♂, A), Jan. 1939; frequent in rather open rain forest on sides of ravines, alt. 1600 m., *Brass 12365* (♀, A), Jan. 1939; common seral tree on landslips in rain forest, alt. 1200 m., *Brass 12782* (♀, A), Feb. 1939.

With only the original description as a basis for comparison, I am unable to distinguish between *M. platyclada* and *M. roemeri*, although Pax & Hoffmann have assigned their two species to different sections. The collections above cited sometimes have lobed and entire leaves on the same specimen, illustrating the fact that, in palmately nerved leaves, entire leaves versus lobed leaves are not distinctive characters. In the specimens cited above, the upper surface of the leaves is softly pubescent and tends to be sparsely so. Although most of the anthers were 4-locular, some 3-locular anthers were also found.

10. **Macaranga fallacina** Pax & K. Hoffmann in Pflanzenr. 68 (IV. 147. XIV): 31. 1919.

Small tree 5–10 m. tall, apices of branchlets, stipules, and very young leaves ferrugineous tomentose-pilose; the stipules lanceolate, acuminate, 2–3 cm. long, free and caducous; petioles 6–28 cm. long, glabrescent; leaf-blades thinly coriaceous, 14–36 cm. long, 11–29 cm. wide, orbicular- or triangular-ovate with entire or sinuate margin, acuminate, the acumen 1–2.5 cm. long, rounded then truncate at the base and 1.5–6.5 cm. peltate, palmately 7-nerved with about 12 slightly curved primary veins above the basal ones obliquely ascending from either side of the midrib, bearing on the upper surface of the basal nerves (close to the insertion of the petiole) 3–5 flat oval glands, glabrous above, distantly and minutely dark-glandular beneath, glabrescent on the veins, the secondary venation distinct on both surfaces; the 2–3 cm. pedunculate ♂ panicles 8–12 cm. long and up to 8 cm. broad, puberulous; bracts at the base of the branches obovate, acute, carinate, 1–2 cm. long, ferrugineous-tomentose, not patelliform-glandular; bracts subtending the many-flowered glomerules about 2 mm. long, contracted from a broad base into an ovate blade patelliform-biglandular within; sepals 3, ovate, acute, and sparsely granulo-glandular; stamens 3–6 with 3-locular anthers; the 16–23 cm. pedunculate (peduncle scarred 2–10 cm. below the apex) ♀ inflorescence simple (?), bearing 3 or more fruits at the apex; ovary 2-locular; styles very broad (5 mm. long, 4 mm. broad), pubescent on the lower surface and very densely plumose on the upper, the papillae being about 2.5 mm. long and somewhat flattened; capsules immature, about 1 cm. diameter after being soaked, densely granulo-glandular, bearing deciduous pubescent processes 1.5–3 mm. long.

NETHERLANDS NEW GUINEA: van Gelder River, alt. about 100 m., *Docters van Leeuwen 9289* (♂, BO), May 1926; Albatros Bivouac, alt. about 60 m., *Docters van Leeuwen 9341* (♀, BO), June 1926; Motor Bivouac, alt. about 100 m., *Docters van Leeuwen 11057* (♂, A, BO), Nov. 1926; rain forest, Nabire, *Kanehira & Hatusima 11476* (♀, A, BO), Feb. 1940 (very rare).

The only authentic material which I have of this species is the carbon rubbing of the basal part of a leaf of an isotype which matches very well those of the collection cited above. It should be noted that in the staminate material which I have before me the apex of the bracts supporting the glomerules is very elongate and narrow rather than ovate, as in the original description. There are one or two small glands on the margin of these, whether they are patelliform I cannot say. The stamens are three and anthers three-locular; in the original description the stamens are three to six and the anthers three-locular. I regard these as variations within a species; without actual material for comparison I cannot place this material elsewhere than in this species.

11. **Macaranga salomonensis** sp. nov.

Arbor alta cortice cinereo; ramulis glabris; stipulis ovato-ellipticis 1.5 cm. longis, 0.9 cm. latis, concavis acutis, liberis fere glabris (apicem versus pilis paucis); petiolo 5.5–11 cm. longo glabro; laminis orbiculari-ovatis, 8.5–18 cm. longis, 5.5–11 cm. latis, breviter et late acuminatis vel acutis, basi 1.3–2.5 cm. peltatis, palmati-8-nerviis supra basales venis primariis 5–8 paribus prominulis, secundariis distinctis, novellis utrinque dense ferrugineo-lanato-tomentellis cito glabratis, maturis supra glabris subtus floccoso-tomentellis (fere glabris) et glanduloso-punctatis; ♂ inflorescentiis 6–17 cm. longis, pedunculo 2–7 cm. longo, glabro, ramulis 1.5–4 cm. longis floccoso-tomentellis deinde glabratis, bracteis florigeris basi 1.5 mm. concavis deinde ca. 2 mm. recurvis et crassiusculis semiorbicularibus intus glandulis patellaribus ± confluentibus ca. 25-floris, pedicellis vix 1 mm. longis pubescentibus; sepalis 3 ovatis 1–1.3 mm. longis; staminibus 5–8, antheris 4-locularibus; ♀ inflorescentiis ca. 8 cm. longis valde maturis, tantum una capsula terminale reliqua, 2-loculari, tomentoso-puberula, 1.7 cm. lata, 1.5 cm. alta, 1.4 cm. crassa; echinis mollibus 5–7 mm. longis, seminibus 0.9 × 0.8 × 0.7 cm., rugulosis.

SOLOMON ISLANDS: Ysabel: rain forests, Tiratona, alt. 600 m., *Brass 3327* (♂ & ♀, A, TYPE), Dec. 1932 (very tall gray-barked tree, dioecious). Bougainville: rain forest, Koniguru, Buin, alt. 800 m., *Kajewski 2038* (♂, A), Aug. 1930 (small tree up to 13 m. high; flowers on green stems supported by stiff bracts).

This species can be easily recognized by the practically glabrous branchlets, the densely tomentose new small leaves with glabrous petioles, the thickish recurved bracts (with at times confluent patelliform glands on the upper surface) subtending the glomerules of staminate flowers, and the deeply peltate leaves.

12. **Macaranga stenophylla** Pax & K. Hoffmann in Pflanzenr. 63 (IV. 147. VII): 371. 1914.

Branchlets slender with young parts at first ferrugineous-tomentose then quickly glabrate; stipules not seen; petioles 4.5–7 cm. long, tomentulose; leaf-blades elliptic-ovate or oblong or oblong-lanceolate, acuminate, 12–18 cm. long, 6–7 cm. broad, rounded at the base and 0.7–1 cm. peltate, 3-nerved and shortly palmate-nerved, glabrous above and bearing several gland-like spots between the attachment of the petiole and the basal margin, reticulate beneath, also sparsely puberulous and granulo-glandular on the veins; ♂ panicles ferrugineous-tomentose; glomerules many-flowered; bracts tomentulose, triangular at base, then contracted and produced into a lanceolate apex patelliform-glandular within; calyx granulo-glandular and tomentulose; stamens 15 or 16 with 4-locular anthers.

The type, *Schlechter 17724,* was collected at an altitude of 1000 m., on Kani Mountains, Northeast New Guinea. Pax & K. Hoffmann note that only the young ♂ plant is known, but believe that a significant character is found in the narrow and peltate leaves.

13. **Macaranga rufibarbis** Warburg in Bot. Jahrb. **16**: 21. 1893. — K. Schumann & Lauterbach in Fl. Deutsch. Schutzgeb. Südsee 397. 1900, in part. — Pax & K. Hoffmann in Pflanzenr. **63** (IV. 147. VII): 373. 1914.

Tree with varying amount of pubescence; young parts rusty tomentulose but very soon glabrate; stipules narrowly ovate, acuminate, 1.5 cm. long, glabrous or with a few hairs towards the apex or occasionally pubescent along the middle of the dorsal surface, caducous; petioles 2–5.5 cm. long, glabrate; leaf-blades 7–18 cm. long, 4–12 cm. broad, triangular-ovate and long-caudate with the narrow apex up to 4 cm. long, at the base rounded and narrowly (2–4 mm.) peltate or truncate and very narrowly and shallowly cordate, 2–6-maculo-glandular on the upper surface below or adjacent to the attachment of the petiole, dark granulo-glandular beneath, 3-nerved with 6–9 pairs of prominent veins above the basal ones, the secondary venation also prominent, the new leaves loosely rusty-tomentose but glabrous at maturity or with remnants of the pubescence along the midrib and around the attachment of the petiole beneath; ♂ panicle 5–12 cm. long, rusty-pilose with hairs seemingly clustered at times around the base of the branches and bracts; bracts subtending the glomerules 2 or 3 mm. long, usually triangular-ovate and obtusely acuminate, 1–2-patelliform-glandular on the upper surface, hairy beneath and granulo-glandular; sepals 3, ovate, 1.5 mm. long, pilose and sparsely granulo-glandular towards the apex; stamens 11–18 with 4-locular anthers; ♀ inflorescence 5–12.5 cm. long, simple, loosely rusty-tomentose, then glabrate; flowers clustered near the apex and also at a node about 2–5 cm. below the apex; bracts ovate, about 5 mm. long, 3–4 mm. broad, patelliform-glandular on the upper surface and pilose beneath, caducous; calyx appressed-pilose then glabrate, globose-pyriform, about 4 mm. high, truncate, splitting into 2 or 3 parts and falling; ovary 2-locular, granulo-glandular and covered with hairy processes which in fruit may be 2.5–3 mm. long, the styles about 3 mm. long, slenderly papillose or short-plumose; capsule about 1 cm. broad.

NORTHEAST NEW GUINEA: Wantoat, *Clemens 40925* (♂, A), Feb. 5, 1940; same locality, alt. 1050–1800 m., *Clemens 11198*bis (♀, A), Feb. 28, 1940;

mountain bush, Sarawaket, alt. 1200–1800 m., *Clemens 8308A* (♀, A), June 15–18, 1938 (tree 5 inches diameter; fruit garnet or wine-red); Samanzing, alt. 1650–1800 m., *Clemens 9205* (♀, A), Nov. 5, 1938; Sambanga, alt. 1500–1800 m., *Clemens 7740* (♀, A), Nov. 25, 1937 (tree or shrub 12–15 ft., with brown fruit).

Clemens 7740 is much more pubescent than the other specimens, but I believe this indicates a newer growth. Only the staminate collection has narrowly peltate leaves, but the prominent venation and the pubescence are similar in all the collections cited.

Macaranga rufibarbis var. tenella (Pax & K. Hoffmann), comb. nov.

Macaranga tenella Pax & K. Hoffmann in Pflanzenr. 63 (IV. 147. VII): 379. 1914.

This variety is characterized by the lanceolate or linear-lanceolate leaves 9–17 cm. long, 2–6 cm. broad, with rounded or broadly cuneate and minutely cordate base, 2- or 3-maculo-glandular on the upper surface near the attachment of the petiole; bracts beneath glomerules of flowers in the ♂ panicle dilated at the base, then narrowed a little and above broadened into a lanceolate apex 1–2-patelliform-glandular on the upper surface, beneath pubescent and granulo-glandular; sepals 2 or 3, stamens 8–10 with 4-locular anthers.

NORTHEAST NEW GUINEA: Finisterre Mt., alt. 1300 m., *Schlechter 19101* (♂, A), January 1909.

This collection differs from those cited for the species in being somewhat more glabrous. However, wherever pubescence remains on the specimens it is apparently the same type in all. The leaves are narrower and, although not so stated in the original description, they are maculo-glandular. The bracts in the species do not show the narrowed part above the dilated base, a character noted in the specimen cited above; there are also somewhat fewer stamens here, although one cannot say that more material wouldn't show overlapping numbers.

14. **Macaranga decipiens** sp. nov.

Frutex 2–3 m. altus; ramulis, stipulis, foliis novellis, et axibus inflorescentiarum breviter hirtellis, pilis albis ca. 0.5 mm. longis; stipulis linearibus vel lineari-lanceolatis, 3–5 mm. longis, caducis; petiolo 1.5–3.5 cm. longo; laminis oblongo-lanceolatis, variabilibus, 10.5 × 4 cm., 12 × 3 cm., 15 × 7 cm., 20 × 9 cm., 25 × 7 cm., utrinque angustatis, apice acutis vel acuminatis, basi rotundato-cuneatis, undulatis, supra glabris, costa et venis breviter pilosis, subtus granuloso-glandulosis, costa et venis dense rete sparsim pilosis, penninerviis, venis primariis 9–12 paribus oblique patentibus deinde prope marginem curvantibus et anastomosantibus, rete laxo; ♂ paniculis pauci-ramosis gracilibus, usque 5.5 cm. longis; ♂ floribus plerumque apice ramulorum dense confertis; bracteis sparsim pilosis, linearibus 2–2.5 mm. longis glomerulos excedentibus, basi dilatatis, apice leviter dilatatis et intus patellari-1-glandulosis; sepalis 3 vix 0.5 mm.

longis, pauce granuloso-glandulosis, staminibus 2–4, antheris 4-locularibus; ♀ inflorescentia 5–10 cm. longa, simplici; bracteis petiolulatis apicem versus lineari-lanceolatis, 6–10 mm. longis, intus patellari-glandulosis; calyce non viso; ovario 2-loculari echinis pubescentibus tecto, stylis ca. 3–5 mm. longis, plumosis; capsula immatura, echinis usque 1 mm. longis.

NETHERLANDS NEW GUINEA: rain forest, Waren, 60 miles south of Manokwari, alt. 20 m., *Kanehira & Hatusima 13256* (♂, A, TYPE; BO), Mar. 1940 (shrub 2 m. high, *13292* (♀, A, BO) (shrub 3 m. high); coastal plain forest, Momi, Vogelkop, alt. 30 m., *Kostermans 2829* (♂, BO), Aug. 1948 (tree 2 m. high); Klamono, Sorong, sea level, *Pleyte 664* (♀, A, BO), *666* (♂, A, BO), Aug. 1948 (shrub 2 m. high; many growing together).

15. **Macaranga caudata** Pax & K. Hoffmann in Pflanzenr. **68** (IV. 147. XIV): 30. 1919.

Shrub 2–3 m. (or tree 6–8 m.) high; young parts (branchlets, stipules, petioles, and peduncles) setulose with coarse hairs 1–2 mm. long mixed with fine hairs 0.1–0.2 mm. long; stipules 3–5.5 cm. long, ovate, long-acuminate; petioles 5–14 cm. long; leaf-blades slightly denticulate, 15–30 cm. long, 10–23 cm. broad, triangular- or orbicular-ovate, 3–5 cm. caudate-acuminate, truncate and minutely cordate at the base, inconspicuously maculo-glandular on the upper surface near the attachment of the petiole, pilose or villous-pubescent on both surfaces, particularly on the nerves and veins, and densely granulo-glandular beneath, 3–5 nerved at the base with 7 or 8 other pairs of ascending primary veins; the 4–10 cm. pedunculate and shortly branched ♂ panicle 10–20 cm. long, bracts subtending the many-flowered glomerules dilated at the base then contracted into an oblong free part puberulous outside and irregularly patelliform-glandular within; calyx 0.5 mm. long, the 3 sepals obovate, cucullate, apiculate and sparsely granulo-glandular; stamens 3 or 4 with 4-locular anthers; ♀ inflorescence 22–40 cm. long, the flowers crowded on short pedicels on the upper 3 or 4 cm. at two or three nodes and subtended by oblongish bracts, pedicels 1.5 mm. long in flower, becoming 4 mm. in fruit, the subtending bracts about 1 cm. long, coarsely pubescent on the lower midrib and bearing small patelliform glands above, calyx about 2 mm. high and dentate at the apex, splitting once or twice, circumscissile near the base; ovary 2-locular, styles 6–8 mm. long, pubescent on the lower surface and densely plumose above; capsule 1.2 cm. broad, 0.9 cm. high, and 0.8 cm. thick, covered with sparsely short-hairy soft processes 0.2–0.4 mm. long, the somewhat furrowed or rugulose seeds 5 mm. high, 6 mm. broad, and 3 mm. thick.

NETHERLANDS NEW GUINEA: occasional along small streams in flood plain primary rain forest, 4 km. SW. of Bernhard Camp, Idenburg River, alt. 850 m., *Brass 13361* (♀, A), March 1939 (open tree 6–8 m. high; leaves suborbicular with long slender apex; branches, etc. irritant hairy; petioles and peduncles red).

The smallest leaf of the above-cited collection is, in the long apex and ascending venation, a very good match for a carbon rubbing of a leaf of one of the isotypes of this species. It is to be noted, however, that the Brass material is not so pubescent (pilose rather than villous) as is described for the original; also, the stipules are obtuse and mucronate rather than long-acuminate. If I have interpreted this species correctly, it is much more closely related to *M. chrysotricha* Lauterb. & K. Schum. than to *M. urophylla* Pax & K. Hoffm., the former being characterized by stiff irritant hairs in the pubescence, few stamens, and the capsules with very short processes.

16. **Macaranga strigosa** Pax & K. Hoffmann in Pflanzenr. 68 (IV. 147. XIV): 30. 1919.

Shrub 1.5–2 m. tall with stout fulvous-setose branchlets, tardily glabrescent; stipules free, obliquely elliptic, 4–7 mm. long, appressed-villous on the outer surface; petioles 5–16 cm. long, fulvous-setose with retrorse hairs; leaf-blades bullate, orbicular-ovate, long-acuminate, 25–30 cm. long, 20–27 cm. broad, cordate at the base, remotely denticulate, glabrous above, densely granulo-glandular beneath and pilose along the nerves, densely reticulate-veined; ♂ panicle villous, 11–14 cm. long, the peduncle 7–9 cm. long; bracts subtending the branches about 3 scarlet, approximate, elliptic, 1–2.5 cm. long and about equaling the length of the branches of the inflorescence; bracts subtending the glomerules 3-lobed, the middle lobe extended and patelliform-glandular within, pilose outside; sepals 3 scarcely granulo-glandular, stamens 3 or 4 with 3- and 4-locular anthers; ♀ raceme to 15 cm. long, glabrescent, bearing small sterile bracts above the middle, 1–2-flowered at the apex; ovary 2-locular, densely covered with processes.

The type of this species, *Ledermann 10939*, was collected on Hunstein Mt., Northeast New Guinea, alt. about 1350 m. Although I have seen no material which matches this description well, I have described below some specimens from Papua as a variety. This variety differs in the somewhat larger stipules, the smaller bracts of the ♂ inflorescence, and the lack of sterile bracts along the peduncle of the ♀ inflorescence, also in foliar characters. The leaves of *M. strigosa* are very large, orbicular-ovate, bullate, and densely granulo-glandular on the lower surface, while the leaves of the variety are smaller, triangular-ovate, not bullate, and very sparsely granulo-glandular beneath.

Macaranga strigosa, var. **carrii** var. nov.

Arbor 4–6 m. alta; ramulis et petiolis setulosis et pubescentibus, setulis 1 mm. longis et pilis tenuissimis ca. 0.3 mm. longis intermixtis, setulis patentibus vel retrorsis demum caducis; stipulis 0.8–1.5 cm. longis, ovatis, acuminatis, concavis, subpersistentibus dorso adpresse setulosis; petiolo 4.5–11 cm. longo; laminis deltoideo-ovatis interdum lobulatis, 8–20 cm. longis, 6–14 cm. latis, apice longe acuminatis, acumine usque 2.5 cm. longo, basi subtruncatis vel repandis et emarginatis, dentatis vel denticulatis, novellis utrinque dense villosulis, maturis utrinque venis dense ceterum sparsim pilosis, pilis 0.3–0.5 mm. longis, basi supra eglandulosis vel maculari-biglandulosis, subtus sparsissime granuloso-glandulosis, trinerviis, venis primariis 7–9 paribus supra basales, utrinque prominulis, subtus secundariis et rete distinctis; ♂ paniculis immaturis usque 12 cm. longis, pubescentibus et granuloso-glandulosis; pedunculo 9 cm. longo; bracteis florigeris ca. 2.5 mm. longis, basi bilobatis deinde contractis, apice in laminulam late ovatam intus patellari-glandulosam abeuntibus, ♂ floribus apicem versus pauci-granuloso-glandulosis; sepalis 2, 0.5–0.7 mm. longis; staminibus 2 vel 3, antheris 4-locularibus; ♀ inflorescentia usque 28 cm. longa, fere villosula; ♀ floribus apice conferte dispositis; bracteis 4.5–8 mm. longis, triangulari-ovatis, basi angustatis, intus patellari-glandulosis; calyce urceolato, 1.5–2 mm. longo, glabrato; ovario 2-loculari, granuloso-glanduloso et molliter echinato, stylis 2 basi connatis, ca. 9 mm. longis, papillosis vel breviter plumosis; capsula 1 cm. lata, 0.8 cm. alta, fere matura, echinis ca. 1.5 mm. longis, ± caducis.

PAPUA: forest, Boridi, alt. about 1400 m., *Carr 13231* (♀, A, TYPE; BM), Sept. 1935 (tree about 20 ft. tall); same locality, alt. 1500 m., *Carr 13362* (♂, A, BM), Sept. 1935 (tree about 15 ft. tall); same locality, *Carr 14623* (♂, BM), Oct. 1935 (tree about 25 ft. tall); on debris of an old landslip, Mt. Tafa, alt. 2400 m., *Brass 4862* (♀, A), Aug. 1933 (small regrowth tree; branchlets, petioles and inflorescence reddish; nerves and veins reddish on the lower surface of the leaves; fruits on very long, slender, axillary peduncles; hairs irritant).

17. **Macaranga bullata** Pax & K. Hoffmann in Pflanzenr. **68** (IV. 147. XIV): 31. 1919.

This species differs from *M. strigosa* in having leaves narrowly ("fere 1 cm.") peltate, the ♂ inflorescence openly branched and more pyramidal, the calyx granulo-glandular, and the anthers 4-locular. The type is *Ledermann 11852* collected on Schrader Mt., Northeast New Guinea.

The above is the complete description of this species given in a footnote under *M. strigosa* which also has bullate leaves. This is a meagre list of characters to use for the determination of a species in a genus as large and varied as *Macaranga*. Unless an isotype is extant somewhere which can be studied further to elaborate additional characters, I believe the species must be rejected and its name regarded as a nomen subnudum.

18. **Macaranga warburgiana** Pax & K. Hoffmann in Pflanzenr. **63** (IV. 147. VII): 347. 1914.

Macaranga cuspidata Warburg in Bot. Jahrb. **13**: 351. 1891; non Boiv. ex Baill. (1860).

Shrub with glabrous branchlets; stipules free, lanceolate, acuminate, about 1 cm. long, caducous; petiole 5–17 cm. long; leaf-blades 14–25 cm. long, 10–16 cm. broad, deltoid-ovate, abruptly acuminate, truncate at the base, bearing 4 flat glands on the glabrous upper surface near the attachment of the petiole, yellowish granulo-glandular beneath, 3-nerved with 5 or 6 pairs of primary veins above the basal ones, the secondary venation distinct but not conspicuous; ♂ inflorescence granulo-glandular, shorter than the leaves (one in the isotype about 8.5 cm. long), bracts subtending the glomerules 1.5–2.5 mm. long, ovate or the free apex lanceolate, acuminate or acute, patelliform-glandular within; sepals 3, about 1 mm. long; stamens 2 or 3 with 3- rarely 4-locular anthers; ♀ inflorescence often longer than the leaves, on a pubescent peduncle; bracts lanceolate, granulo-glandular outside, patelliform-glandular within; calyx urceolate, truncate, glabrous, 2 mm. long; ovary pilose, 2-locular, styles papillose.

NORTHEAST NEW GUINEA: Sattelberg, *Warburg 20510* (♂, probable ISOTYPE, A), 1889.

This is a very fragmentary specimen with only a single terminal bud remaining; this bud is definitely wrapped in two stipules; further, it is to be noted that Warburg in his comment on the species stated that the stipules were not connate, hence his species could not belong to § Dimorphanthera. I wish to emphasize this character as Pax & K. Hoffmann established a new section, § Warburgianae, for this species and one of the characters mentioned for both section and species is the connate stipules; however, Pax & K. Hoffmann do not indicate that they have seen Warburg's specimen. For the most part the specimen is glabrous and granulo-glandular, but here and there, if one looks carefully with the aid of a lens, are a few short, fine, setulose hairs. The ♀ inflorescence is described as having a pubescent peduncle. In a pocket on our sheet is a small tip, 1 cm. long, from a ♀ inflorescence, which is finely pubescent along the axis; it also has a few of the same type of setulose hairs as were found on the specimen. The flowers are very young. One is 2.5 mm. long with an urceolate glabrous calyx 1 mm. long, and the two styles protrude beyond the calyx about 1.5 mm. Another flower is larger with the calyx 2.5 mm. long. When the calyx is removed the styles are 4 mm. long and the ovary 1.5 mm. high. The ovary is pubescent and granulo-glandular, with four or five small spots which look like incipient processes.

Either belonging to this species or very closely allied to it are two collections from Papua. They differ as follows: plants densely setulose on the new growth, later glabrate; leaves openly cordate and dentate; ♂ inflorescence longer or shorter than the leaves; anthers all three-locular, but the same number of stamens. There is a great variation in leaf-size here: 21 × 18.5 cm., 10.5 × 6 cm., 9.5 × 6 cm.

PAPUA: secondary forest, Yodda River, alt. about 1350 m., *Carr 13920* (♂, A, BM), Dec. 1935; Isuarava, alt. about 1200 m., *Carr 15481* (♂, A, BM), Feb. 1936 (shrub 8 ft. tall).

19. **Macaranga bifoveata** J. J. Smith in Nova Guin. Bot. **8**: 790, *t. 139*. 1912. — Pax & K. Hoffmann in Pflanzenr. 63 (IV. 147. VII): 377. 1914.

Shrub or tree with slender, slightly puberulous and granulo-glandular branchlets; the broadly triangular stipules 2–3 mm. long, caducous and somewhat pubescent; petioles 4–12 cm. long, at first granulo-glandular and puberulous, later glabrate; leaf-blades triangular-ovate, 12–22 cm. long, 7–16 cm. broad (the smaller ones elliptic, 6–15 cm. long, 3–8 cm. broad), somewhat abruptly short-acuminate, at base subtruncate or broadly cuneate or sometimes openly cordate, at apex of petiole very shortly cordulate and deeply glandular-bifoveate, denticulate, at first villous-tomentose above and tomentose beneath, gradually becoming glabrous above except for the puberulous nerves, puberulous also on the nerves and veins beneath and pale yellow granulo-glandular, 3-nerved, with 5–9 pairs of primary veins above the basal ones, secondary venation below easily seen with the naked eye; the loosely branched ♂ panicle 5–17 cm. long, pubescent and granulo-glandular becoming glabrate; peduncle 3–4.5 cm. long; bracts subtending glomerules about 1.5 mm. long, spreading or recurved, semiorbicular and obtusely apiculate, cucullate with the patelliform glands of the upper surface strongly impressed; pedicels about 0.7 mm. long; calyx 3- or 4-parted, 0.7–0.9 mm. long and puberulous; stamens 4–8 with 3- and 4-locular anthers; ♀ infructescence 5–10 cm. long with 2 or 3 very short branches, bracts 5–5.5 mm. long, ovate but narrowed at base as if 1 mm. petiolate, puberulous and granulo-glandular, concave, with the patelliform glands of the upper surface strongly impressed and somewhat confluent; ♀ calyx (fide P. & H.) fusiform, denticulate and tomentulose; ovary 2-locular; the plumose styles two, 2–3.5 mm. long; fruit 2-locular, granulo-glandular, and densely covered with short puberulous processes about 2.5–3 mm. long.

NETHERLANDS NEW GUINEA: in primary forest on the Begowri River, alt. about 170 m., *Gjellerup 209* (♂, TYPE, BO), June 1910 (tree 3 m. high).

NORTHEAST NEW GUINEA: on the way from Ramu to the coast, *Schlechter 14113* (♂, BO), Jan. 1902; in secondary forest at Kelel, alt. about 150 m., *Schlechter 16211* (♂, A), *16212* (one leaf, A), June 1907; margin of forest, Sattelberg, alt. about 900 m., *Clemens 438* (♀, A), Oct. 1935 (tree 30 ft. high); Wantoat (Wantot), alt. 1050–1800 m., *Clemens 11062* (♀, A), Jan. 1940.

The bifoveate glands at the base of the leaves and the deeply impressed somewhat confluent patelliform glands of the bracts of the inflorescences are characters which render this species easy to determine. In *Clemens 438* cited above an immature ♀ bud 3 mm. long is oblong, practically glabrous and granulo-glandular, the calyx looks as if it would be 3- or 4-lobed, the ovary is about 1 mm. long and definitely bears processes though very small ones at this stage of development.

20. **Macaranga latifolia** sp. nov.

Arbor 4–6 m. alta; ramulis puberulis vel glabris dense granuloso-glandulosis; stipulis glabris ciliolatis, triangulari-ovatis 3.5–5 mm. longis; petiolo 6–19 cm. longo, praecipue apicem versus minute puberulo; laminis latissime ovatis 13–22 cm. longis, 13.5–26 cm. latis, undulato-denticulatis, apice anguste acuminatis, acumine 1.5–3 cm. longo, basi truncatis vel subtruncatis, ad petioli apicem minute auriculatis et maculari-glandulosis, supra puberulis vel glabratis, subtus puberulis et atro-granuloso-glandulosis, trinerviis, venis primariis supra basales 5 vel 6 paribus prominulis, secundariis distinctis; paniculis ♂ usque 17 cm. longis, fere glabris et dense granuloso-glandulosis; bracteis florigeris basi concavis et fere lobatis, ovatis acutiusculis vel obtusiusculis, 1–2 mm. longis, intus patellari-glandulosis; alabastris parvis 0.7 mm. longis, sepalis 3 vel 4 apice granuloso-glandulosis, staminibus 4–7, antheris 4-locularibus; inflorescentiis ♀ usque 7 cm. longis, simplicibus flores apicem versus gerentibus; bracteis florigeris extus puberulis, ca. 4.5 mm. longis, subrhombico-spathulatis, intus patellari-pluriglandulosis, calyce subtubulato, 2–2.5 mm. longo, puberulo, ovario 2-loculari, stylis 2–3 mm. longis, plumosis; capsula sine echinis 1 cm. alta et lata, echinis 3–4.5 mm. longis, pubescentibus.

NETHERLANDS NEW GUINEA: thinned forest behind Kp. Baroe, along path, Sorong, *Pleyte 412* (♂ & ♀, A, TYPE; BO), July 1941 (small tree about 4 m. high, 4 cm. diam., common; flowers light green to white; fruit green); Horna, *Atasrip 41* (♀, BO), Feb. 1903; in rain forest, Nabire, *Kanehira & Hatusima 11673* (♀, A, BO), Feb. 1940; in fringing forest, between Ayerjat and Slieber, 40 km. inland from Nabire, *Kanehira & Hatusima 12655* (♂, A, BO), March 1940 (plant 6 m. high).

This species is unquestionably close to *M. bifoveata* J. J. Smith; in fact I have wondered whether the two are phases of a single species. They differ chiefly in the type of glands characteristic of the base of the leaves and of the floral bracts. In *M. bifoveata* the two basal glands are foveate, and those of the bracts are deeply impressed and fairly large, while in *M. latifolia* there are four small flat basal glands, and those of the bracts are also small; in the former, too, the bracts appear to be thicker or fleshier than in the latter. Smith's species is more pubescent than the one here described, and the stamens have a mixture of 4- and 3-locular anthers.

21. **Macaranga glandulifera** sp. nov.

Frutex arborescens 5–6 m. altus; ramulis novellis et petiolis dense hirtellis, pilis 1–1.5 mm. longis; stipulis triangulari-ovatis, 4–5 mm. longis, 2.5–3 mm. latis, acutiusculis, adpresse pubescentibus, rigidiusculis, subcarinatis, demum caducis; petiolo 3–12 cm. longo; laminis triangulari-ovatis, breviter acuminatis, 9–16 cm. longis, 6.5–16 cm. latis, basi truncatis et anguste cordatis, denticulatis, supra novellis pilosis, maturis costa et venis primariis tantum pilosis, saepe bullatis, basi supra maculari-pluri-glandulosis, subtus granuloso-glandulosis costa et venis dense venulis sparsim hirtellis, 5–7-nerviis 3 majoribus, venis primariis supra basales 4–8 paribus prominentibus, venulis prominulis; ♂ inflorescentia non visa; ♀ paniculis hirtellis, 6–17.5 cm. longis, ramis paucis et brevibus 3 cm. vel minus; bracteis oblongis basi angustatis, 7 mm. longis, extus granuloso-glandulosis et sparsim pilosulis, intus patellari-glandulosis, glandulis interdum confluentibus; calyce 3–3.8 mm. longo, subconico, 2 vel 3 lobos rumpente deinde caduco; ovario 2-loculari, granuloso-glanduloso et echinis mollibus tecto; stylis 2, plumosis, 6.5–7 mm. longis; capsula immatura, echinis 2–4 mm. longis, pubescentibus, ± caducis.

NETHERLANDS NEW GUINEA: common in secondary forest, Bele River, 18 km. NE of Lake Habbema, alt. 2200 m., *Brass 11393* (♀, TYPE, A), Nov. 1938 (one of the lesser species in regrowths; large arborescent shrub 5–6 m., with pubescent, rugose, subpeltate, broad leaves).

This species is undoubtedly closely related to *M. strigosa* Pax & K. Hoffm., however, the pubescence is much softer than that which I associate with the latter species, and the pistillate inflorescences are definitely branched. Those of *M. strigosa* are described as racemose. Unfortunately no description of the ♀ bracts or calyx of the ♀ flower is given in the original description of that species.

22. **Macaranga densiflora** Warburg in Bot. Jahrb. **13**: 350. 1891. — K. Schumann in Notizbl. Bot. Gard. Berlin **2**: 128. 1898. — K. Schumann & Lauterbach, Fl. Deutsch. Schutzgeb. Südsee 396. 1900. — J. J. Smith in Nova Guin. Bot. **8**: 238, 791. 1910, 1912; l.c. **12**: 546. 1917. — Rechinger, Denkschr. Akad. Wiss. Wien **89**: 568. 1913. — Pax & K. Hoffmann in Pflanzenr. **63** (IV. 147. VII): 372. 1914. — Kanehira & Hatusima in Bot. Mag. Tokyo **52**: 411. 1938.

Mallotus acuminata sensu K. Schumann Fl. Kaiser Wilhelms Land 77. 1889; non Muell. Arg.

Macaranga involucrata var. *acalyphoides* sensu Warburg in Bot. Jahrb. **13**: 352. 1891. — Sensu K. Schumann & Lauterbach, Fl. Deutsch. Schutzgeb. Südsee 397. 1900. — Sensu Valeton in Bull. Dept. Agric. Ind. Neerl. **10**: 26. 1907; non Muell. Arg.

Macaranga acuminata Ridley in Trans. Linn. Soc. II. Bot. **9**: 148. 1916.

Shrub or tree up to 8 m. high, the branchlets and petioles usually velvety-pubescent with whitish hairs 0.4–0.6 mm. long; stipules linear or linear-lanceolate, 3–6 mm. long, erect or sometimes reflexed, minutely pubescent on both sides or almost glabrous within, caducous; petioles 2–12 cm. long, the blades rhombic- or triangular- or lance-ovate, (5–) 7–18 cm. long, (2–) 4–11 cm. broad, widely cuneate, truncate or rounded then minutely cordate at the base and usually glandular-bifoveate, long-acuminate (1–3 cm.) at the apex, 3-nerved with 4–7 pairs of primary nerves obliquely ascending above the basal ones and anastomosing near the entire or denticulate margin, glabrous or sparsely pubescent above, particularly along the midrib and primaries, somewhat crisply pilose (especially on the nerves) beneath and copiously brown-glandular; ♂ panicle slender, 5–13 cm. long and pubescent, shortly branched and usually pedunculate; bracts subtending the glomerules crowded and pubescent on both sides, irregularly 1–5-dentate with teeth sometimes patelliform-glandular within; sepals 3, granulo-glandular at the apex; stamens 3 or 4 with 4-locular anthers; ♀ inflorescence up to 15 cm. long with flowers and subtending bracts usually crowded at the apex; bracts

0.5–2.5 cm. long, pubescent on both sides, ovate or rhombic-ovate, acuminate and dentate with teeth patelliform-glandular within; calyx short, urceolate and pubescent; ovary 1-locular, densely glandular and bearing short pubescent processes; style 3–5 mm. long and densely papillose; capsule 4.5–5 mm. diameter, subglobose with processes 1 mm. long, tending to be deciduous.

NETHERLANDS NEW GUINEA: Horna (in the N.W. peninsula), *Atasrip 42* (♂, BO); South McCluer, Moeteri near Babo, *Aet 20* (♂, A, BO); Aëndoea River near Oeta, *Aet 448* (♂, A, BO); Camp VI*a*, *Boden Kloss* (♂ & ♀, A, phot. of type of *M. acuminata* Ridl.); van Gelder River, *Docters van Leeuwen 9249* (♂, BO); seashore, Toronta, *Janowsky 577* (♂, BO); on the lower part of Arso River, *Gjellerup 55, 55a* (♂, BO); Andai, *Beccari 8883* (P. P. 703) (♂ + ♀, F); secondary forest, Nabire, *Kanehira & Hatusima 11431* (♂, A); common in seral growths on gravel banks in river, Hollandia, *Brass 8900* (♂, A); Japen Island, Mamoeri, *Neth. Ind. For. Serv. 30556* (*van Dijk 340*)(♂, A, BO); Soerei, *Aet & Idjan 785* (♀, A, BO).

NORTHEAST NEW GUINEA: woods near Kubai, *Schlechter 18943* (♂, A); Wau, *McAdam 98* (♀, LAE).

BISMARCK ARCHIPELAGO: New Britain: suburb of Rabaul, *Kanehira 3987* (♂, A), *3997* (♀, A); botanical garden, Rabaul, *Kanehira 3954* (♂, A); Nodup, *Waterhouse 224* (♂, A, NY); same locality, *d'Espeissis 98* (♀, BR). Duke of York Islands: *Bradtke 42* (♂, A, BR), *279* (♀, A; ♂ & ♀, BR).

SOLOMON ISLANDS: Bougainville: Kieta, *Kajewski 1579* (♀, A); Karngu, Buin, *Kajewski 2296* (♂, A).

In this species the striking characters are the crowded flower-clusters with sharply dentate bracts at the apices of the short branches of the ♂ inflorescence, the patelliform glands on the teeth of the bracts of the pistillate inflorescence rather than within the margin (as in *M. involucrata*), and the bifoveate glands at the base of the leaves. This last character is a variable one, for example: in *Docters van Leeuwen 9249* there are two glands on some leaves, one or sometimes none on others; in *Aet 448* the glands, if at all present, are very inconspicuous, but the ♂ inflorescence is typical of this species.

The pubescence is also variable, but there are here represented two ♀ collections which I believe deserve particular attention: *Carr 12206* (A, BM), from Koitaki, about 450 m. alt.; and *Brass 562* (A), Bisiatabu, about 450 m. alt. These specimens differ from the others cited above in having the leaves densely velvety-pubescent on the lower surface and sparsely pubescent above; bifoveate glands are lacking at the base of the leaves; the bracts of the inflorescence are densely pubescent on both surfaces and granular-glandular; whether they would be patelliform-glandular when more mature I cannot say; the flowers also are too immature to make any comparisons. Mansfeld in 1929 determined *Brass 562* as *M. densiflora*. Until a definite study of the type of *M. dalechampioides* S. Moore can be made I prefer to regard these as probably a densely pubescent form of *M. densiflora*. It is to be noted, however, that the type of Moore's species and these two collections are from the same region.

23. **Macaranga dalechampioides** S. Moore in Jour. Bot. 61: Suppl. 48. 1923.

I have been unable to examine the type specimen of this species. In his comment Moore compared it to *M. densiflora* Warb., from which it is said to differ in having more pubescent leaves and lacking glands at the base, larger and more deeply toothed inflorescence-bracts, and linear floral bracts. I have read the description carefully for distinctive characters, but the only ones mentioned which appear valuable are the linear floral bracts, the minutely pubescent ovary, and the very short style. The last two characters suggest that the flower may be very young, but of this I have no proof; as for the linear floral bracts, could it be possible that these are the stipules of the closely crowded bracts at the apex of the inflorescence? In other words, this type needs to be studied carefully with more and comparative material before its identity can be established.

24. **Macaranga urophylla** Pax & K. Hoffmann in Pflanzenr. 63 (IV. 147. VII): 377. 1914.

Tree to 15 m. high with ferrugineous subvillous branchlets; stipules lanceolate, 6–10 mm. long, acuminate, densely pubescent, and caducous; petioles 6–8 cm. long, pubescent; leaf-blades triangular-ovate and slightly denticulate, 12–18 cm. long, 7–13 cm. broad, caudate-acuminate at the apex, at the base 3-nerved and broadly truncate, also slightly cordate, with 2–4 flat glands on the upper surface near attachment of the petiole, reticulate-veined and densely granulo-glandular beneath, the veins villous; the pubescent and densely flowered ♂ panicle 12–17 cm. long with short remote branches, the peduncle 5–6 cm. long; all bracts small (2–3 mm. long), with the basal part suborbicular then contracted, the apex abruptly acuminate, pubescent on both sides, granulo-glandular beneath and patelliform-glandular above; ♂ flowers pubescent and granulo-glandular near the apex, 1.5 mm. long with 3 obovate acute sepals and 7–10 stamens with 4-locular (and sometimes 3-locular) anthers; ♀ inflorescence slender, simple (?), few-flowered, on pubescent peduncle 9–10 cm. long; bracts subfoliaceous and petiolate, lanceolate or linear-lanceolate, 1.5 cm. long, entire, within, along the margin, patelliform-glandular; pedicels 1–2 mm. long; ♀ flower with cupular dentate calyx pubescent and sparsely granulo-glandular, at length splitting spathe-like; the ovary 1-locular and densely covered with short unequal processes, the plumose style 2 mm. long; capsule unknown.

The type of this species was collected at Namatanai, New Ireland (*Peekel 669*). The description given above is a translation of the original and not drawn from the material here cited. None of these specimens agree wholly with the original description, nor do they agree too well with each other, but since there is not enough material at hand to estimate the amount of variation within the species, it seems best to place them here, indicating points of difference.

SOLOMON ISLANDS: Bougainville: rain forest, Kupei Gold Fields, alt. 950 m., *Kajewski 1648* (♀, A), April 1930 (small to medium-sized tree up to 15 m. high); Kieta, sea level, *Kajewski 1608* (♂, A), March 1930 (small tree up to 15 m. high); Kugu-maru, Buin, alt. 150 m., *Kajewski 1788* (♂, A), March 1930; east side of Kamo Mountain, alt. about 100 m., *Robinson & Volk* NGF *804* (♀, A, BR, LAE), Jan. 1945. Malaita: Quoi-mon-apu, sea level, *Kajewski 2314* (♂, A), Dec. 1930 (very small tree up to 10 m. high, the lower surface of the leaves is silky to touch and the natives use them to dry themselves after swimming). San Cristoval: rain-forest regrowths, lowlands, Waimamura, *Brass 2566* (♀, A), Aug. 1932 (common shapely small tree 5 m. tall, exuding a thick brown gum when cut; young parts velvety with shining gray pubescence; petioles and underside of main nerves purple).

Kajewski 1648 is perhaps most like the description of *M. urophylla*, with the apices of the leaves very slender and ca. 2 cm. long. The ♀ bracts are very slender, 1.5 cm. long and scarcely more than 2 mm. wide at the base. The styles are about 9 mm. long, yet the flowers have not yet lost the calyx; this style-length is much greater than that of the original. In *Kajewski 2314* the pubescence might be called subvillous, — the hairs are a little short of villous; the pubescence somewhat approaches that of the original. It is to be noted, however, that the leaves tend to be three-lobed, with the apex of the middle lobe about 4 cm. caudate; stamens five to seven. *Kajewski 1608* has a short compact pubescence (almost tomentose), but the leaves show the same tendency toward lobing as in the last specimen mentioned, only in a much less degree. *Kajewski 1788* and *Robinson & Volk 804* look like perfectly matched ♂ and ♀ plants. The glands at the base of the leaves are the same type and placed the same; the ♀ bracts are lanceolate, 1.5 cm. long and 3–5 mm. broad at the base, gradually tapering to the apex, the stipules are ovate-lanceolate or oblong. In *Brass 2566* the ♀ bracts are up to 3 cm. long and 8 mm. broad.

In addition to these already mentioned there are two more collections which I add here hesitantly. The stipules in *Brass 3243* (♀, A) are almost glabrous and membranaceous and the young leaves have a floccose tomentum; in *Kajewski 2557* (♂, A) the stipules are pubescent, but the upper surface of the young leaves is floccose. Both are regrowth trees. *Brass 3243* was collected at Kakatio, Ysabel, alt. 900 m., and *Kajewski 2557* came from Ulolo, Tutuve Mt., Guadalcanal, alt. 1200 m.

Although Pax & K. Hoffmann relate the species to *M. schleinitziana* K. Schum., I believe the material here cited is closer to *M. involucrata* (Roxb.) Baillon.

25. **Macaranga involucrata** (Roxb.) Baillon Etud. Gén. Euph. 432. 1852. — Warburg, Bot. Jahrb. 13: 352. 1891. — Pax & K. Hoffmann in Pflanzenr. 63 (IV. 147. VII): 374. 1914.

Urtica involucrata Roxburgh, Hort. Beng. 67. 1814; Fl. Ind. ed. 2, 3: 592. 1832.

Mecostylis acalyphoides Kurz ex Teysmann & Binnendijk in Tijdschr. Nederl. Ind. **27**: 44. 1864.

Macaranga amboinensis Mueller Arg. in DC. Prodr. **15** (2): 1002. 1866.

Tanarius involucratus O. Ktze. Rev. Gen. **2**: 620. 1891.

Shrub or tree with branchlets, petioles, stipules, and inflorescences spreading-pubescent or puberulous; stipules linear, 5–10 mm. long; petioles 3–7 cm. long; the ovate or triangular-ovate leaf-blades 8–17.5 cm. long, 5.5–15 cm. broad, 1–3 cm. acuminate, epeltate and very slightly cordate with the base rounded or truncate or sometimes very narrowly (2–4 mm.) peltate, densely pilose when young, later (except for the pilose veins) glabrous above and sparsely pilose beneath with veins more densely so, above maculo-glandular, beneath densely granulo-glandular, 3–5-nerved with 5 or 6 pairs above the basal ones; ♂ panicle 5–10 cm. long with spreading branches and usually granulo-glandular; the small (1–1.5 mm.) bracts subtending the glomerules triangular-ovate, patelliform-glandular within; flower buds just before anthesis 0.5–0.7 mm. long; sepals 3, stamens 6–10 with 4-locular anthers; ♀ inflorescence 5–15 cm. long, mostly with ♀ flowers clustered at the apices, the bracts foliaceous and bistipulate, up to 4 cm. long, ovate, dentate, and mostly long-acuminate, within the margin patelliform-glandular, usually pubescent or puberulous on both sides and outside granulo-glandular; pedicels 1.5–3 mm. long; calyx tubular-conic, quickly circumscissile or splitting and falling; ovary 1- (sometimes 2-) locular, the plumose style 7–10 mm. long and pubescent on the dorsal surface; capsule globose, 5–6 mm. diameter, granulo-glandular and bearing hairy processes 1.5–2.5 mm. long.

NETHERLANDS NEW GUINEA: on edge of rain forest, Nabire, alt. 20 m., *Kanehira & Hatusima 11669* (♀, A), Feb. 1940. Biak Island, on coral cliff top along coast near Soredo, alt. about 25 m., *Britton 85* (♂ & ♀, A), May 1945 (small tree 15–20 ft. high, common).

The second specimen is atypical in having appressed pubescence, but I can find no other difference in the material at hand. The species is a native of the Moluccas; there are at hand specimens from Amboina, Ternate, Ceram, and the Key Islands. I am doubtful whether Pax & K. Hoffmann were right in raising Warburg's var. *keyensis* to specific rank, as both taxa occur on the islands.

Macaranga involucrata var. mallotoides (F. Muell.) comb. nov.

Macaranga mallotoides F. Mueller, Fragm. **4**: 139. 1864. — Pax & K. Hoffmann in Pflanzenr. **63** (IV. 147. VII): 376. 1914.

Macaranga involucrata Baillon in Benth. & F. Muell., Fl. Austral. **6**: 146. 1873. — F. M. Bailey, Queensl. Fl. **5**: 1451. 1902.

This variety differs from the typical species in the densely flowered branches of the ♂ inflorescence; bracts subtending the crowded glomerules of ♂ flowers are recurved, ovate-suborbicular, and denticulate, granulo-glandular and somewhat puberulent on both sides, and on the upper surface at times patelliform-glandular; the bracts of the ♀ inflorescence are denticulate and usually acute rather than acuminate, and the style is 5–8 mm. long.

NETHERLANDS NEW GUINEA: forest near camp, Gelieb, *Branderhorst 210* (♂, BO), Nov. 1907.

PAPUA: gregarious in contact zone of rain and savannah forests, Gaima, Lower Fly River (east bank), *Brass 8342* (♂, A), *8342A* (♀, A), Nov. 1936 (tree 3 m. high); abundant in rain forest and invading disturbed savannah forests, Tarara, Wassi Kussa River, *Brass 8694* (♂, A), *8694A* (♀, A), Jan. 1937 (shrub or small tree 3 or 4 m. high).

This variety is very close to var. *keyensis*, the latter being more nearly glabrous with bracts undulate or only barely denticulate.

26. **Macaranga schleinitziana** K. Schumann in Bot. Jahrb. **9**: 207. 1887; in K. Schumann & Hollrung, Fl. Kaiser Wilhelms Land 79. 1889. — Warburg in Bot. Jahrb. **13**: 351. 1891. — K. Schumann & Lauterbach, Fl. Deutsch. Schutzgeb. Südsee 397. 1900; Nachtr. 297. 1905. — Pax & K. Hoffmann in Pflanzenr. **63** (IV. 147. VII): 373. 1914.

Macaranga Schleinitziana var. *β lobulata* Pax & K. Hoffmann, l.c.

Shrub or small tree with slender, densely velvety-pubescent branchlets, stipules, petioles, and inflorescence-axes; the narrowly linear stipules 4–6 mm. long, caducous; petioles 2.5–12 cm. long; leaf-blades (6.5–) 11–21 cm. long, (3–) 7–20 cm. broad, triangular-ovate or rhombic-ovate or somewhat 3-lobed, acuminate (apex 0.5–3 cm. long), broadly truncate or rounded and slightly cordate at the base, and above near the attachment of the petiole bearing 2–4 flat glands, 3-nerved with 5–8 pairs of primary veins above the basal ones, on the upper surface sparsely pubescent, beneath shortly villous and dark granulo-glandular, reticulations fairly distinct on the lower surface of the older leaves; ♂ panicle 4–15 cm. long with short but densely flowered branchlets; all bracts small, 1–3 mm. long, ovate or oblong, acute, often slightly lobed on either side at the base, within patelliform-glandular or sometimes eglandular, usually pubescent on both sides and recurved; pedicels about 1 mm. long; sepals 3, concave, about 0.7 mm. long, pubescent and granulo-glandular, stamens 7–12 with 4-locular anthers; ♀ inflorescence 6–25 cm. long (including the peduncle 5–15 cm. long), at times with very short branches (up to 2 cm. long); bracts foliaceous, 1–3 cm. long and ovate or rhombic-ovate, denticulate and acuminate, pubescent on both sides, within near the margin, especially toward the base, patelliform-glandular; pedicels short becoming up to 8 mm. long in fruit; calyx of the ♀ flowers cupular, truncate, 1–1.5 mm. long, densely pubescent and granulo-glandular; ovary 1-locular with pubescent processes overtopping the calyx, the plumose style 4–6 mm. long, pubescent on the back; capsule globose and granulo-glandular, 5 mm. diameter, the processes tending to be caducous, especially toward the base (those remaining on the fruit scarcely 1 mm. long).

NETHERLANDS NEW GUINEA: Sigar on McCluer Bay, *Warburg 20697* (♂ & ♀, A); Rori-esi near Babo, on McCluer Bay, *Aet 161* (♀, A, BO).

NORTHEAST NEW GUINEA: Kelel, alt. 150 m., *Schlechter 16146* (♀, A), June 1907; Saki, alt. 250 m., *Schlechter 18289* (♂, A), Sept. 1908; vicinity of Kajabit Mission, alt. 240–600 m., *Clemens 40681* (♂, MICH), Aug. 1939; Boana, alt. 750–1300 m., *Clemens 41482* (♂, A), May–Nov. 1940; Finschhafen, *Warburg 20507* (♀, A), March, April 1889; region of Bumi, *Weinland 125* (♀, BR), 1889–91; on rain-forest margin, Yalu, alt. about 15 m., *White, Dadswell, & Smith* NGF *1621* (♀, A, BR, LAE), July 1944; Lae, *White, Dadswell & Smith* NGF *1676* (♀, A, BR, LAE); Bulolo, *Fryar* NGF *3957* (♀, A), Feb. 1950; Bulolo, *McIntosh* NGF *3573A* (♀, A, LAE), Jan. 1950; on beach, Salamaua, *Kanehira 4018* (♀, A), Feb. 1937; Constantinhafen, *Schlechter 14225* (♂, BO).

27. **Macaranga similis** Pax & K. Hoffmann in Pflanzenr. **68** (IV. 147. XIV): 29. 1919.

Macaranga Brassii Mansfeld in Jour. Arnold Arb. **10**: 78, 232. 1929.

Small or middle-sized tree 4–7 m. high with young branchlets, stipules, petioles, leaf-blades, and inflorescences velutinous; stipules 1–1.7 cm. long, 0.4–0.6 cm. broad, lanceolate or lance-ovate or slightly obovate-oblong and carinate, not readily caducous; petioles 5–11.5 cm. long; leaf-blades triangular-ovate (sometimes somewhat 3-lobed or suborbicular-ovate), 8–21 cm. long, 6.5–19 cm. broad, subabruptly short-acuminate, cordate at the base or rarely narrowly (7 mm.) peltate, bearing 2–6 flat glands (occasionally none) on the upper surface near the attachment of the petiole, densely dark granulo-glandular beneath, 3-nerved or in peltate leaves shortly palmate-nerved, with 6–9 pairs of primary veins above the basal ones; ♂ panicle 4–18 cm. long, the peduncle 1.5–5 cm. long; bracts subtending glomerules small (1.5–4 mm. long), somewhat 2-lobed at the base then contracted and just above slightly broadened into a lanceolate or ovate apex, sparsely granulo-glandular and pubescent beneath, on the upper surface pubescent near the margin and above patelliform-glandular; sepals 3, concave and pubescent; stamens 6–12 with 4-locular anthers; ♀ inflorescence 10–22 (–35, fide Mansfeld) cm. long with flowers and fruits on the upper 2–9 cm., bracts and flowers crowded at 1–4 nodes; bracts triangular-ovate, 0.6–2.5 cm. long, 0.3–2 cm. broad, subfoliaceous, velutinous and granulo-glandular beneath, pilose on the upper surface along the veins and on the few or many patelliform glands well within the denticulate margin; pedicel 1.5 mm. long at time of flowering, becoming 6 mm. in fruit; calyx pubescent, cupular and truncate, about 1.2–1.5 cm. long, splitting and falling; ovary 1-locular, the plumose style 6–9 mm. long, pubescent on the lower surface; fruit subglobose, about 5 mm. diameter, granulo-glandular and bearing pubescent processes about 1–2.5 mm. long; seed dark-colored, rugulose, 3.5 mm. long, 3 mm. broad.

PAPUA: Laloki River, alt. about 260 m., *Brass 536* (♂ & ♀, A), Oct. 1935; on or about rocks on *Eucalyptus* savannahs, also rain-forest fringes; Rona, Laloki River, *Brass 3633* (♂, A, BO, NY), March 1933 (common small shapely tree 4–5 m. high); Mafulu, *White 566* (♂ & ♀, BR), July, Aug. 1918; open country, Veiya, *Carr 11707* (♂, A, BM), Mar. 1935 (tree 30 ft. tall); secondary forest, Kanosia, alt. about 60 m., *Carr 11060* (♀, A, BM, NY), *11063* (♂, A, BM, NY), Feb. 1935; secondary forest, Boridi, alt. about 1140 m., *Carr 14662* (♀, A, BM), *14687* (♂, BM), Oct. 1935; Buna area, *Lane-Poole 166A* (♂, BR), July 1922; Domara River, *Brass 1590* (♀, ISOTYPE of *M. Brassii*, A), May 1926 (common weed tree); Fife Bay, *Turner 81* (♀, A, BR), Oct. 1930.

In my work on this and related species I had no doubt as to the identity of *M. Brassii*, of which we have an isotype, but I was at a loss to interpret *M. similis* P. & H. because of the description of the pubescence of the leaves, given as a mixture of stellate and simple hairs. I have seen only one species of *Macaranga* with truly stellate hairs, *M. noblei* Elmer of the Philippines. In this species only the ♀ plant is known, although I must admit that, even though the fruit looks like a *Macaranga*, one should see the ♂ flowers to be sure of the genus. In *M. Brassii* the hairs at times appear to be clustered in little bunches or fascicles along the veins. Apart from the description of the pubescence, the rest of the characters fit *M. Brassii*, hence the reduction of the latter.

28. **Macaranga chrysotricha** Lauterbach & K. Schumann in K. Schum. & Lauterb. Fl. Deutsch. Schutzgeb. Südsee 399. 1900. — Pax & K. Hoffmann in Pflanzenr. 63 (IV. 147. VII): 378. 1914.

Small tree; branchlets, petioles, and peduncles closely covered with fine hairs 0.1–0.2 mm. long, also setulose with stiffish golden hairs 1–2 mm. long, tardily glabrescent; stipules 2–2.5 cm. long, ovate-lanceolate and acuminate, appressed setulose and free (in specimens seen); petioles 5–17 cm. long, the slightly denticulate leaf-blades 15–30 cm. long, 16–22 cm. broad, orbicular-ovate, entire or 3-lobed and acuminate, openly cordate at the base and inconspicuously 2–4-maculo-glandular above, pilose on both surfaces (young leaves densely hairy), finely bullate above and densely reticulate beneath, 3–7-nerved at the base with 4–6 additional pairs of openly ascending primary veins; the 7–13 cm. pedunculate ♂ inflorescence paniculate with pubescent and sparsely granulo-glandular branches; bracts subtending the glomerules dilated at the base then contracted into an ovate lobe patelliform-glandular within; sepals 2, triangular-ovate and granulo-glandular outside at the apex, stamens 2 or 3 with 4-locular anthers; the long-pedunculate ♀ inflorescence 21–30 cm. long and bearing flowers only at the apex; bracts subtending the flowers 2–3 mm. long, stipitate and obtusely ovate or subrhombic, pubescent below and patelliform-glandular above; calyx 1–2 mm. long splitting into 3 or 4 or sometimes 5 parts; ovary 1-locular, the style 2 or 3 mm. long, long-plumose; fruit small, 4 or 5 mm. diameter, granulo-glandular and covered with soft pubescent processes 0.4–0.6 mm. long.

NORTHEAST NEW GUINEA: Sattelberg, *Nyman 495* (♂, G), June 1899; Kani Mt., alt. about 1000 m., *Schlechter 17287* (♂, A), Feb. 1908 (small tree).

28A. **Macaranga chrysotricha** var. **glaucescens** Mansfeld in Jour. Arnold Arb. **10**: 78, 233. 1929.

Common small tree of forest regrowths, differing from *M. chrysotricha* in having leaves not or scarcely bullate, the branchlets, stipules, petioles, and often the peduncles glaucous (rather than finely pubescent as in the species) and setulose with coarse hairs about 1.5 mm. long.

PAPUA: rain forest, Bisiatabu, alt. about 450 m., *Brass 589* (♂, A, ISOTYPE), Aug. 1925 (slender tree about 6 m. tall; trunk smooth, green; branchlets glaucous, covered with small brownish prickles; stipules large, deciduous; leaf-scars prominent); Mafulu, *White 440* (♀, BR), July–Aug. 1918; in forest regrowths, Bella Vista, alt. 1450 m., *Brass 5464* (♂, A, BO, NY), *5473* (♀, A, BO), Nov. 1933 (small tree 3 or 4 m.; peduncles, petioles, stipules, and branchlets glaucous; inflorescence on long erect peduncle; capsules small).

29. **Macaranga punctata** K. Schumann in Fl. Kais. Wilhelms Land 80. 1889. — K. Schumann & Lauterbach, Fl. Deutsch. Schutzgeb. Südsee 397. 1900. — Pax & K. Hoffmann in Pflanzenr. **63** (IV. 147. VII): 362. 1914.

? *Macaranga isadenia* Pax & K. Hoffmann in Pflanzenr. **63** (IV, 147. VII): 377. 1914.

Macaranga ovalifolia Pax & K. Hoffmann in Pflanzenr. **68** (IV. 147. XIV): 29. 1919.

Macaranga pseudopeltata Pax & K. Hoffmann in Pflanzenr. **68** (IV. 147. XIV): 29. 1919.

Macaranga maluensis Pax & K. Hoffmann in Pflanzenr. **85** (IV. 147. XVII): 185. 1924.

Tree 4–12 m. tall with the tips of the branchlets somewhat crisply ferrugineous-tomentose, quickly glabrate; stipules linear-lanceolate or linear-oblong, 4–7 mm. long, stiffish, quickly caducous; petiole 2–8 cm. long; leaf-blades variable in form and size, oblong-ovate, elliptic-ovate or triangular-ovate, 11 × 4.5 cm., 13.5 × 4 cm., 19 × 9 cm., 22 × 10 cm., 22 × 14 cm., 26 × 15 cm., entire, acuminate, the acumen 0.5–2 (–4) cm. long, rounded at the base, very narrowly cordate or narrowly (4–8 mm.) peltate, glabrous above and marked at the base, close to the attachment of the petiole, with 4–8 small flat glands, puberulous beneath or sometimes pilose on the veins and rather densely dark granulo-glandular, 3-nerved with 8–11 pairs of primary veins above the basal ones, prominulous on the lower surface, the secondary venation easily seen; ♂ panicle 9–15 (–25) cm. long including the peduncle 3–12 cm. long, ferrugineous-tomentulose; bracts supporting the glomerules 1.5–2.5 mm. long, somewhat dilated at the base, obtusely ovate above, usually reflexed, beneath granulo-glandular, and on the upper surface patelliform-glandular; ♂ flowers small, usually with a few dark glands near the apex; sepals 3 or 4, about 0.7 mm. long; stamens (3–) 5–10 with 4-locular anthers; ♀ inflorescence 7–16 cm. long, ferrugineous-tomentulose, simple or with very short (0.5–1 cm.) branches at intervals along the axis; bracts subtending the branches lanceolate, about 1 cm. long, patelliform-glandular within;

bracts subtending the flowers 3 mm. long, 2.5 mm. broad, obtusely ovate or suborbicular, narrowed at the base into a very short stalk, patelliform-glandular on the upper surface; calyx pubescent, cupulate, 1.5 mm. high, splitting on one side and falling later; style 4 mm. long, plumose; ovary 1-locular, granulo-glandular, with slender puberulous processes, the latter in partly grown fruit about 2 mm. long.

NETHERLANDS NEW GUINEA: Humboldt Bay, *Beccari 8882* (♀, F), *8882A* (♂, F); west of Hollandia, north of Simboro Strait of Sentani Lake, alt. about 180 m., *Sigafoos 99* (♂, A), Mar. 1945; Mt. Cycloop, on the path from the foot to Netar close to the margin of the forest, alt. about 400 m., *Meyer-Drees 72* (*Neth. Ind. For. Serv. bb.25038*) (♀, A, BO), June 1938; hills north of Hollandia, alt. about 50 m., *Meyer-Drees 157* (*Neth. Ind. For. Serv. bb.25054*) (♂, A, BO). Misool: Blowpo Mt., alt. about 100 m., *Pleyte 937* (♂, A, BO), Sept. 1948 (shrub 5 m. high); near Fakal, *Pleyte 1101* (♂, A, BO), Oct. 1948 (shrub 5 m. high).

PAPUA: common in poor type rain forest on ridges, Lake Daviumbu, Middle Fly River, *Brass 7570* (♂, A), *7570A* (♀, A), Aug. 1936 (plentiful slender tree 6–8 m. high, apparently not subseral; leaves ovate-oblong, cordate or peltate on same tree); rain forest substage, Kubuna, alt. 100 m., *Brass 5603* (♂, A, BO), Nov. 1933 (small tree; leaves black punctate beneath).

NORTHEAST NEW GUINEA: Augusta River, *Hollrung 825* (♂, BO, ISOTYPE), 1887; in foothill forest, Yellow River hills, Sepik District, *Womersley* NGF *3932* (♀, A), Oct. 1949 (tree 60 ft. over all, diameter breast high 10″; leaves very light green, almost glaucous below; bark smooth, gray-brown on the back, inner bark straw-brown and rather fibrous; wood white).

It was my good fortune to find an isotype of this species in the loan from the Bogor Herbarium. In this specimen the bracts subtending the ♂ glomerules are densely patelliform-glandular on the upper surface. This feature is not mentioned in the original description, and it apparently was unobserved by Pax & K. Hoffmann, who placed the species in § Echinocarpae rather than in § Mecostylis to which it belongs. A carbon rubbing of a leaf of *Ledermann 12258*, the type of *M. pseudopeltata* Pax & K. Hoffm., is a perfect match for a leaf of the isotype of *M. punctata* K. Schum. It is a little more difficult to estimate *M. maluensis* Pax & K. Hoffm. (*M. ovalifolia* Pax. & K. Hoffm., not Ridley); in a carbon rubbing of a leaf of the latter species the primary veins are slightly further apart, but I believe *M. maluensis* to be merely the ♀ form of *M. punctata*. With a good deal of hesitancy I have added *M. isadenia* to the synonymy, indicating my indecision with a query. I have a carbon rubbing of a leaf of this species also; the rubbing is a good match for the form of the leaves of *Brass 7570A*, and *Womersley* NGF *3932*, but neither is so glandular as *M. isadenia* (according to the description). The leaves of these two collections are triangular-ovate and larger than those of the other specimens above cited. However, in the collections cited there are transitional forms so that I have been at a loss to draw a dividing line between the two extremes as to form and size of leaves. Further, *Womers-*

ley NGF *3932* is not the terminal part of a branchlet, hence might have larger leaves than the part with a growing tip. The ♂ collection, *Brass 7570,* has leaves somewhat larger than those of the isotype of *M. punctata* but the pubescence, the shape of the leaves, and the bracts subtending the glomerules are all very much like this species, and though the stamens tend to be fewer (3–5), I have no hesitancy in placing the collection in *M. punctata.* The material of *Brass 5603* shows another variation, the leaves are more pubescent than those of the other specimens cited above, further they are not maculo-glandular close to the attachment of the petiole, however, the characters of the inflorescence are those of this species.

29A. **Macaranga punctata** var. **whitei** var. nov.

A forma typica differt partibus juvenilibus granuloso-glandulosis et puberulis, foliis novellis tantum ± tomentosis; laminis plerumque angustioribus, 9.5–23 cm. longis, 3.5–8 cm. latis, subtus costa et venis minute puberulis vel interdum pilosis vel omnino glabris, venis primariis 5–7 paribus; ♂ paniculis puberulis, 10–18 cm. longis; bracteis basi dilatatis deinde subito contractis, demum in laminulam lanceolatam intus patellari-glandulosam productis, plerumque patentibus; staminibus 2–4, antheris 4-locularibus; ♀ inflorescentia 12–22 cm. longa, plerumque simplici, circa medium interdum bracteis sterilibus parvis instructa, apice ♀ floribus paucis conferta; stylo 5–7 mm. longo.

PAPUA: rain forest, Dieni, Ononge Road, alt. 500 m., *Brass 3976* (♀, A, BO), *3977* (♂, A, TYPE; BO), May 1933 (common small tree 5–6 m. high; leaf-nerves pale brown beneath); Bisiatabu, *White 289* (♀, BR), July/Aug. 1918; Mekeo area, Central District, *White 799* (♀, BR), July/Aug. 1918; Koitaki, alt. about 450 m., *Carr 11990* (♂, A, BM), *12070* (♀, A, BM), Apr. 1935 (tree about 15 ft. tall).

30. **Macaranga advena** Pax & K. Hoffmann in Pflanzenr. 68 (IV. 147. XIV): 31. 1919.

Small tree 5–6 m. high; new branchlets with young parts ferrugineous-tomentose, at length glabrate; stipules ovate, acuminate, almost 8 mm. long, glabrous and deciduous; petiole slender, 2–3 cm. long, pilose; leaf blades entire, 9–20 cm. long, 1.5–4 cm. broad, ovate-lanceolate with a very narrow linear apex up to 4 cm. long, at the base rounded and very narrowly cordate with the lobes overlapping, glabrous above and marked at the base with several flat glands, sparsely pilose below, reticulate and densely granulo-glandular, feather-veined with 6–8 pairs of primary veins; ♂ inflorescence unknown; ♀ raceme 5–10 cm. long, bearing sterile bracts below and about 4 flowers crowded at the apex of the slender tomentulose rachis; bracts rhombic-ovate and narrowed at the base, 6 mm. long, patelliform-glandular on the upper surface within the margin, pilose beneath and densely granulo-glandular; calyx cupular, denticulate and granulo-glandular; ovary 1-locular and bearing processes, the style lateral, densely plumose, 2 or 3 cm. long.

The type, *Ledermann 12490*, was collected in mountain forest at 1400–1500 m. in Northeast New Guinea. I have not seen it, and we do not have any material at hand which appears to fit the description. The style is two or three centimeters long, as given in the original description. Such a very long style is unusual in *Macaranga*, and it is likely that the authors intended the measurement to be in millimeters.

31. **Macaranga angustifolia** Lauterbach & K. Schumann in Fl. Deutsch. Schutzgeb. Südsee 398. 1900; Nachtr. 297. 1905. — Pax & K. Hoffmann in Pflanzenr. 63 (IV, 147. VII): 379. 1914. — C. T. White in Proc. Roy. Soc. Queensl. **34**: 39. 1922.

Glabrous tree to 20 m. high with pendulous branches; the linear-subulate stipules 4–6 mm. long falling very quickly; petioles 2–5 cm. long; the narrowly lanceolate leaf-blades 6.5–24 cm. long, 2.5–5.5 cm. broad, acuminate, more or less narrowed towards the base, then minutely cordate, above nearly oblong, maculo-biglandular, beneath densely appressed-granulo-glandular, pinnately veined with 8–10 pairs of distinct primary veins obliquely ascending and arcuate near the margin, the secondary venation easily seen on either side; panicles of both sexes puberulous or almost glabrous and granulo-glandular, 4–9 (–13 in ♀) cm. long; the ovate bracts at the base of branchlets in ♂ and at the base of fascicles of flowers in ♀ 5–7 mm. long with entire or dentate apex, reflexed and bearing on the upper surface near the base 2 (rarely 3) large (1.3–1.8 mm. long) patelliform glands; ♂ flowers in glomerules; ♀ flowers fascicled on pedicels 1.5 mm. in the young flowers to 5 mm. long in the fruit; ♂ flowers just before expanding 1 mm. long with 2 or 3 granulo-glandular sepals and 11–15 stamens with 4-locular anthers; ♀ flower according to the original description with very short truncate cupular calyx (in specimens cited below with a caducous 3-lobed calyx, the lobes about 1 mm. long and the lower part 0.5 mm.), ovary 1 (rarely 2) -locular, densely granulo-glandular and glabrous with 2 processes, the plumose style about 2 mm. long, lateral and deciduous; capsule subglobose 2.5–3 mm. diameter with processes about 1 mm. long; seed rugulose, brown.

NORTHEAST NEW GUINEA: on the way from Ramu to the coast, *Schlechter 14173* (♂, BO), February 1902; on Minjem below Albu, alt. about 100 m., *Schlechter 16224* (♂, A), July 1907; above the mission near Sattelburg, on a mountain trail at about 900 m. alt., *Clemens 8063* (♀, A), March 1938; forest hills, Quembung, alt. about 750 m., *Clemens 3193* (♀, A), June 1936; vicinity of Wantoat, alt. about 1200–1500 m., *Clemens 11329A* (♀, A), March 1940.

PAPUA: Central District, Deva Deva, *White 633* (♀, BR).

It should be pointed out here that the leaves of the pistillate material cited above are not as long as those of the staminate material, and that the base is not quite as narrow. I am satisfied, however, that the specimens all belong to this species.

32. **Macaranga astrolabica** Pax & K. Hoffmann in Pflanzenr. 63 (IV. 147. VII): 343. 1914.

Type-specimen glabrous except for the puberulous upper branchlets and bracts of the ♂ inflorescence; branchlets slender; stipules narrowly triangular, 2 mm. long, soon falling; petiole 2–4 cm. long; leaf-blades subcoriaceous and entire or repand, lanceolate 8–17 cm. long, 3.5–5.5 cm. broad, much smaller at the apices of the branchlets, acutely long-acuminate, rounded at the base, narrowly cordate at the attachment of the petiole and bearing 2–6 spot-like glands on the upper surface, shortly 3-nerved with 6 or 7 pairs of primary veins, granulo-glandular and net-veined beneath; ♂ panicle 4–8 cm. long, narrow and slender with few branches, fasciculate, borne on a peduncle, the rachis glabrous below, above with the branches puberulous; bracts subtending the branches ovate-triangular, acute, puberulous, glandular, the bracts subtending the glomerules 2–3 mm. long, spreading, lanceolate, narrowed at the base, acute, entire or repandly lobulate, glabrous or almost glabrous, patelliform-glandular within; ♂ flower 1 mm. broad, the sepals 2, ovate, concave, granulo-glandular outside at the apex; stamens 2 with 4-locular anthers; ♀ flowers and fruit unknown.

The type, *Brown 165*, was collected at Astrolabe Bay. I have seen nothing to match this description.

33. **Macaranga sterrophylla** sp. nov.

Arbor usque 12 m. alta; ramulis, petiolis, foliis novellis inflorescentiis, et dorso medio stipulorum brunnescenti-sublanato-tomentosis, tarde glabratis; stipulis anguste obovatis, acutiusculis, 0.8–1.3 cm. longis, subscariosis, marginem superiorem versus glabris; petiolo 1–3 cm. longo; laminis valde coriaceis, ovatis, acutis vel obtuse acuminatis, 3–5.5 (–9.5) cm. longis, 1.9–3.5 (–5) cm. latis, integris, maturis fere glabris, subtus dense granuloso-glandulosis, trinerviis, venis primariis 4 vel 5 paribus supra basales, subtus prominentibus, rete subtus prominulo; ♂ inflorescentia immatura vix 4 cm. longa, vix ramosa; bracteis ramigeris (?) approximatis, lanceolatis, ca. 8.5 mm. longis, basi petioliformibus; bracteis florigeris 1.5–3.5 mm. longis, ovatis vel ovalibus obtusis, intus patellari-glandulosis; ♂ alabastris tantum visis; staminibus 3, antheris 4-locularibus; ♀ inflorescentiis usque 6 cm. longis; floribus racemosis; bracteis obovatis, 4 mm. longis, basin versus angustatis, intus patellari-glandulosis; calyce 1–1.5 mm. alto, glabro et sparsim granuloso-glanduloso, demum rumpente; ovario 1-loculari, ca. 3.5 mm. longo, laxe tomentuloso et granuloso-glanduloso, interdum pauci-tuberculato; stylo obliquo, subterminali, sublaevi, vix 1 mm. longo; capsula ca. 8 mm. longa et 6 mm. lata; semine ca. 5 mm. diametro, subgloboso.

PAPUA: fairly common in forest, Murray Pass, Wharton Range, alt. 2840 m., *Brass 4560* (♀, A, TYPE; BO), July 1933 (erect branched tree up to 12 m. high, with dense crown of leaves; leaves very stiff, glossy above, paler below, nerves underneath prominent and whitish; indumentum pale brown; fruit immature);

on an old landslide, main range NW of The Gap, alt. about 2400 m., *Carr 15240* (♂, BM), Jan. 1936 (shrub about 7 ft. tall).

This species of *Macaranga* has stiffer leaves than any of the others which I have examined. The net-venation is prominent on the lower surface and very slightly raised above; none of the other species known from this area has such a short and almost smooth style, the tubercles are irregular and appear on only a few fruits.

34. **Macaranga clemensiae** sp. nov.

Arbor usque 10 m. alta; ramulis et partibus novellis dense et laxiuscule tomentosis, pilis tenuibus crispis; stipulis crassiusculis, lanceolatis, 4.5 mm. longis, cito caducis; petiolis 5–9 cm. longis, glabratis; laminis lanceolatis vel ovatis, 11.5–20 cm. longis, 3.7–7.5 cm. latis, acuminatis, acumine 1 vel 2 cm. longo, basi 0.3–0.7 cm. peltatis, margine valde recurvis, supra cito glabratis, sub magnificatione nitidis, crasse bullatis, olivaceis, subtus brunnescentibus, primum laxiuscule tomentosis deinde glabratis, dense granuloso-glandulosis, 3-nerviis, venis primariis supra basales 4–6 paribus oblique adscendentibus et curvantibus et anastomosantibus subtus prominentibus et elevatis, secundariis et rete conspicuis; ♂ inflorescentiis non visis; ♀ paniculis usque 14 cm. longis, laxiuscule tomentosis et tarde glabratis, bracteis 1–2.5 mm. longis, triangulari-ovatis, floribus puberulis et granuloso-glandulosis, sessilibus vel subsessilibus; calyce 3-lobato, 2 mm. longo; ovario 2 mm. alto; stylo 6 vel 7 mm. longo, margine recurvo, adpresse papilloso; capsula immatura subglobosa, 5 mm. diametro, molliter echinato; echinis conicis glabris, 0.5–1.1 mm. longis.

NORTHEAST NEW GUINEA: mountain forest, Sambanga, alt. 1500–1800 m., *Clemens 7902A* (♀, A, TYPE), Dec. 10, 1937; same locality, *Clemens 7011* (♀, A), Sept. 1937 (small tree, diameter breast high 4"); same locality, *Clemens 7629* (♀, A), Nov. 1937 (tree 25–35 ft.); Ogeramnang, alt. 1800 m., *Clemens 4937* (♀, A), Jan. 1937.

This species differs from all others in the coarsely bullate leaves. On the lower surface the pockets between the reticulated veins are deeply concave, but not all in the same degree; however, they form a fairly definite pattern. At maturity only a remnant of the tomentum remains along the veins or veinlets. The granular glands are impressed and the lower surface of the dried leaves is brownish. In an occasional flower two styles were observed, but not any fruit with two seeds was seen. Another distinctive character of this species is to be noted in the glabrous conical processes.

35. **Macaranga womersleyi** sp. nov.

Arbor usque 12 m. alta; ramulis et petiolis tomentosis tarde glabrescentibus, partibus novellis et inflorescentiis omnino laxe ferrugineo-tomentosis, pilis crispulis; stipulis lanceolato-oblongis, apice obtusiusculis, ca. 8 mm. longis; petiolo 4–5 cm. longo; laminis subcoriaceis, ovatis, 9.5–15 cm.

longis, 4–6 cm. latis, sensim longe acuminatis, acumine 2–3 cm. longo, basi rotundatis et angustissime (ca. 2 mm.) peltatis, trinerviis, 5 vel 6 paribus supra basales, subtus prominentibus, rete prominulo, supra bullatis et glabris, subtus subvilloso-tomentosis et granuloso-glandulosis, venis majoribus villosulis, pilis ca. 1.5 mm. longis; paniculis ♂ immaturis ca. 7 cm. longis; bracteis florigeris late triangularibus, ca. 1.5 mm. longis, 2 mm. latis; alabastris granuloso-grandulosis, 1 mm. diametro; calycis laciniis . . . , staminibus 8–11, antheris 4-locularibus; inflorescentia ♀ ignota.

NORTHEAST NEW GUINEA: mountains near Nondugl, Central Highlands, alt. about 1950 m., *Womersley* NGF *4475* (♂, A, TYPE), Sept. 1951 (tree 40 ft. overall in mountain forest; crown sparse; leaves densely tomentose below, pale green above; flowers in brownish spikes; bark gray, finely fissured, underbark red, inner bark pinkish, ¼" thick; wood white).

Although the general form of this collection suggests that of *M. longicaudata,* the pubescence everywhere on the two specimens is of an entirely different type. In *M. womersleyi* the hairs of the new bud (stipules and leaf) and all the inflorescence (axis, branches, bracts, and flowers) consist of crinkled fine hairs; this is true also of the underlayer of hairs on the lower surface of the leaves; the upper layer appears to be mostly on the veins and consists of separate fine, straight hairs. In *M. longicaudata*, on the other hand, the hairs are coarser, straight, and distinct except on the very young leaves; the stipules, the bracts of the inflorescence, and the flowers are glabrous, although the axis of the inflorescence and the branches are densely pubescent. In spite of the similarity in the shape of the leaves and the number of stamens, I cannot believe that the two collections represent the same species.

36. **Macaranga longicaudata** sp. nov.

Frutex ca. 2 m. altus; ramulis, petiolis, axibus inflorescentiarum dense hirtellis, pilis sub magnificatione nitidis; stipulis oblongis, apice fractis, 9 mm. longis, glabris et caducis; petiolo 1.5–3 cm. longo; laminis anguste ovatis, 7–13 cm. longis, 3–6 cm. latis, denticulatis, sensim caudato-acuminatis, acumine 2–3 cm. longo, basi rotundatis, supra conferte bullatis et glabris plerumque costa excepta, subtus dense reticulatis et atrofusco-granuloso-glandulosis, venis omnino hirtellis, trinerviis, venis primariis supra basales 9–13 paribus, novellis utrinque dense hirtellis; paniculis ♂ 3–9 cm. longis, ramis inferioribus usque 2 cm. longis; bracteis florigeris glabris ovatis vel lanceolatis, acuminatis, 1–2.5 mm. longis, concavis; alabastris subglobosis, 1 mm. diametro, glabris et leviter granuloso-glandulosis, calycis laciniis vel sepalis (incertis), staminibus 7–10, antheris 4-locularibus; inflorescentia ♀ ignota.

PAPUA: forest, main range NW of The Gap, alt. about 2400 m., *Carr 15303* (♂, A, TYPE; BM), Jan. 1936 (shrub about 7 ft. tall, with red flowers).

This is a striking collection with finely bullate and long-caudate leaves closely reticulate on the lower surface. Under the microscope the hairs of the branchlets, petioles, and inflorescence axes glisten. On the new leaves the pubescence is somewhat matted on both surfaces, but this disappears as the leaves mature, leaving a pubescent midrib above. On the lower surface all the veins support a sprinkling of these shining hairs. The venation is so deeply impressed that I cannot be sure whether the base is rounded and very narrowly peltate or has a very narrow and shallow sinus at the attachment of the petiole. The flower buds and the bracts of the inflorescence, in contrast to the axis and branches, are glabrous. For some reason — immaturity or mode of drying — I have been unable to separate the parts of the calyx, hence I am not able to say whether it is lobed or whether the sepals are separate.

37. **Macaranga leonardii** sp. nov.

Arbor 20 m. vel plus alta; ramulis, petiolis, costis stipularum et axibus inflorescentiarum villosis, pilis brunnescentibus tenuibus ca. 2 mm. longis tarde glabrescentibus; stipulis late ovatis, 1–2 cm. longis, ca. 0.7–1 cm. latis, praecipue apicem versus carinatis, marginem versus glabris et brunneis, subscariosis, caducis; petiolo 6–9 cm. longo; laminis coriaceis, in sicco rigidiusculis, ovatis, 13–26 cm. longis, (6.5—) 9–15 cm. latis, basi rotundatis et 0.4–1.5 (plerumque 0.7–1) cm. peltatis, acuminatis, acumine 0.5–2 cm. longo, novellis utrinque dense lanato-tomentosis, maturis supra glabris et bullatis, subtus lanato-tomentosis et granuloso-glandulosis, palmatinerviis 3 majoribus, supra basales venis primariis 7–11 paribus, secundariis supra impressis subtus manifestis; ♂ inflorescentiis usque 15 cm. longis, ramis usque 6 cm. longis; glomerulis saepe confertis, lanato-tomentosis; bracteis florigeris late ovatis, ca. 2.5 mm. longis; floribus post anthesin ca. 5 mm. longis; calyce 2–2.5 mm. longo, 3-lobato; staminibus 5–11, antheris 4-locularibus rariter 3-locularibus; ♀ inflorescentiis usque 17 cm. longis, pauci-ramosis, ramis usque 5 cm. longis, basi ramorum interdum foliis oblongis minimis, 1.5–2 cm. longis, 0.7 cm. latis, petiolo ca. 1 cm. longo; floribus sessilibus; bracteis anguste ovatis, ca. 5 mm. longis, 2.5 mm. latis, villosulis, intus non patellari-glandulosis glabris; calyce juvenili non viso, maturo 3-lobato extus villosulo, lobis 2–3 mm. longis, 1.7–2 mm. latis; ovario 1-loculari, molliter echinato, villosulo; stylo ca. 6 mm. longo, papilloso, dorso villosulo; capsula villosula, echinis 2–3 mm. longis, villosulis; semine ca. 4 mm. longo latoque, 3.5 mm. crasso, extus ruguloso, glabro, atro-brunnescente.

NETHERLANDS NEW GUINEA: forests of lower slopes and valley bottom, alt. 2750 m., *Brass 10969* (♂, TYPE, A), Oct. 1938 (common and conspicuous brown-foliaged tree attaining 20 m.); frequent in old secondary forest, same locality, alt. 2880 m., *Brass & Versteegh 10461* (♂, A), Oct. 1938 (tree 20 m. high, 31 cm. diameter, bark fairly smooth; wood rose; flowers brown); occasional in primary forest on slope of a ridge, 18 km. SW of Bernhard Camp, Idenburg River, alt. 2200 m., *Brass & Versteegh 12506* (♀, A), Feb. 1939 (tree 28 m. high, 42 cm. diameter; bark red-brown; wood light brown; fruit brownish green).

This is a very striking species, probably closest to *M. carrii.* It differs from the latter species in the peltate and somewhat stiffer leaves, and the 1-locular ovary. In the ♀ plant the leaves are less bullate and the stipules are slightly larger than those of the two ♂ plants.

This species is named for Mr. Leonard J. Brass whose work has contributed so greatly to the knowledge of New Guinean flora. An earlier described species, *M. Brassii,* named for him has been reduced to synonymy.

38. **Macaranga carrii** sp. nov.

Arbor ca. 6–24 m. alta; ramulis, petiolis, costis stipularum et axibus inflorescentiarum villosis, pilis brunnescentibus gracilibus 2–3 mm. longis tarde glabrescentibus; stipulis late ovatis 2–2.5 cm. longis, 1.3–1.8 cm. latis, acutis, marginem versus glabris margine pubescente; petiolo 2.5–9 cm. longo; laminis orbiculari-ovatis vel elliptico-ovatis, magnitudine variantibus 7.5 × 4.7 cm., 15 × 8.5 cm., 15.5 × 12.5 cm., 17 × 11 cm., acuminatis, acumine 0.5–1 cm. longis, basi rotundatis vel inconspicue et leviter cordatis, novellis dense lanato-tomentosis, maturis supra glabrescentibus conspicue bullatis, subtus lanato-tomentosis et granulo-glandulosis, basi trinerviis vel breviter palmati-7-nerviis, supra basales venis primariis 5 vel 6 paribus supra impressis subtus prominulis, secundariis supra impressis; ♂ inflorescentiis 8–17 cm. longis breviter ramosis; bracteis extus villosis, ramigeris ca. 1.5 cm. longis 3-lobis, lobis gracilibus, florigeris lanceolatis ca. 5 mm. longis basi 2–2.5 mm. latis acuminatis; calyce 2–2.5 mm. longo granulo-glanduloso et pauci-piloso 3-lobato, lobis 1–1.5 mm. longis, staminibus 7–10, antheris 4-locularibus; ♀ inflorescentiis 10–16 cm. longis, bracteis stipuliformibus, calyce ♀ floris 2-lobato villoso, ovario 2-loculari, stylis 1–1.3 cm. longis dense plumosis dorso villosis; capsula immatura molliter echinata et villosa.

PAPUA: above The Gap, alt. about 2400 m., *Carr 13746* (♀, A, BM), Dec. 1935 (tree about 20 ft. tall; leaves brown-woolly beneath; fruit olive-brown); forest, Mt. Ganeve, alt. about 2550 m., *Carr 15288* (♂, A, TYPE; BM), Jan. 1936 (tree about 80 ft. tall; leaves brown-woolly beneath; flowers red).

A very striking species readily distinguished by the finely bullate leaves, the villous and lanate pubescence, the large staminate flowers with lobed calyces; the granular glands on the calyx are about twice as large as those which are characteristic of smaller flowers.

39. **Macaranga fragrans** sp. nov.

Arbor usque 25 m. alta; ramulis apud stipulas glabris lenticellatis crassis 1.3–2 cm. diametro; stipulis liberis puberulis 4–13 cm. longis, 2–3 cm. latis, apice anguste obtusis et interdum mucronatis; petiolo 18–52 cm. longo, glabro; laminis magnis vix subcoriaceis, 34–76 cm. longis, 27–48 cm. latis, orbiculari-ovatis latissime (7–20 cm.) peltatis, breviter acutis vel acuminatis, basi rotundatis, 9-nerviis, supra basin utrinsecus costa 7–9 nervis primariis, juventate supra sparsim pilosis subtus fere glabris, maturitate utrinque glabris, subtus consperse et minute glandulosis, rete laxo; inflorescentiis ♂ paniculatis 24–49 cm. longis, fere a basi ramosis vel usque 12 cm. pedunculatis, axi inferiore glabro, versus apicem, etiam ramis et bracteis utrinque minute fulvo-tomentellis, ramis usque 18 cm. longis; bracteis ad basim glomerulorum usque 5 mm. longis, patentibus incurvis, semiorbicularibus acuminatis pectinato-laciniatis (laciniis 0.5–2 mm. longis), intus non patellari-glandulosis, multifloris; sepalis 3 vel 4 tomentellis, 0.5–0.7 mm. longis ovatis, staminibus 7–10, antheris 4-locularibus; pedicellis 0.3–1 mm. longis; infructescentiis paniculatis 34–43 cm. longis, pedunculo 5–12 cm. longo; ♀ floribus et bracteis non visis; capsulis 2 (interdum 3) -locularibus, tomentellis; coccis 0.9 cm. altis et crassis, 0.6 cm. latis, echinis 0.5–2 mm. longis cum minutis echinis intermixtis tectis; stigmatibus circiter 2 mm. longis, dense plumosis; seminibus fere levibus.

NETHERLANDS NEW GUINEA: occasional in secondary forest on edge of flood plain, Bernhard Camp, Idenburg River, alt. 70 m., *Brass & Versteegh 14025* (♂, A), April 1939 (tree 37 m. high, 50 cm. diam.; bark 8 mm. thick, gray-brown; wood red-brown).

PAPUA: common in seral forests on silt-loam soils of river flood plains, Palmer River, 2 miles below junction Black River, alt. 100 m., *Brass 7329* (♂, TYPE, A), *7329A* (♀, A), July 1938 (very conspicuous tree up to 25 m. or more high; leaves to about 90 × 60 cm., acute, peltate, crowded at the ends of the branches; panicles several, somewhat glaucous, at first axillary, later lateral close below the leaves; ♂ flowers minute, fragrant; seeds black, remaining attached to septum after fall of the valves of the fruit).

40. **Macaranga magnifolia** sp. nov.

Arbor ca. 9 m. alta; ramulis non visis; gemma terminali et stipulis lanceolatis persistentibus 6–7 cm. longis, flavo-setulosis, setulis 1.5–2 mm. longis; petiolo consperse setuloso fere glabro, paulo compresso; laminis coriaceis, orbiculari-ovatis, ca. 67 cm. longis, 60 cm. latis, basi late (17 cm.) peltatis, apice subabrupte et breviter acuminatis, supra costa et venis primariis consperse setulosis et puberulis ceterum glabris, subtus atro-granuloso-glandulosis et venis omnibus puberulis, palmatinerviis, venis primariis supra basales ca. 14 paribus prominentibus, secundariis prominulis, rete distincto; ♂ inflorescentia non visa; ♀ paniculis (in fructu tantum visis) ca. 9 cm. longis, axi et ramis dense tomentosis, bracteis rhombeis ca. 4 mm. longis, dentatis, utrinque tomentosis, caducis; calyce immaturo truncato-urceolato, tomentoso, vix 1.5 mm. alto; ovario dense granuloso-glanduloso, 2- vel 3-loculari, stylis (in fructu) brevissimis, 1 mm. longis, minute papillosis; capsula 1–1.3 cm. lata, ca. 0.8 cm. alta, 0.7 cm. crassa, dense granuloso-glandulosa et tuberculata, tuberculis obtusis tomentosis, 0.5–0.7 mm. longis, 1–1.5 mm. latis; seminibus subglobosis fere 5 mm. diametro, insculptis.

PAPUA: rain forest, Wamé River, Purari Delta, *Brass 1090* (♀, A, TYPE), March 1926 (erect tree 30 ft. high, with thin brown bark and pale wood; leaves very large and peltate, clustered at the ends of the branches; stipules persistent long after the fall of the leaves; inflorescence axillary; fruit green, covered with yellow granular substance).

This collection was previously reported as aff. *M. strigulosa* Muell. Arg. (error for *M. stipulosa*). The latter species from Polynesia has entire bracts patelliform-glandular within. I am inclined to believe, from the one remnant of a bract which I found between fruits on the infructescence of *Brass 1090*, that it is more nearly related to *M. gigantea* (Reichb. f. & Zoll.) Muell. Arg. from Malaysia. The Malaysian species, however, has smooth rather than tuberculate fruits.

41. **Macaranga quadriglandulosa** Warburg in Bot. Jahrb. **13**: 350. 1891. — Pax & K. Hoffmann in Pflanzenr. **63** (IV. 147. VII): 356 (incl. vars. *abbreviata* and *genuina*). 1914. — J. J. Smith in Nova Guin. Bot. **12**: 546. 1917. — Mansfeld in Jour. Arnold Arb. **10**: 232. 1929. — Kanehira & Hatusima in Bot. Mag. Tokyo **52**: 411. 1938.

Macaranga tanarius var. *abbreviata* J. J. Smith in Nova Guin. Bot. **8**: 238. 1910; l.c. 791. 1912.

Tree up to 20 m. high or sometimes a spreading shrub about 2 m.; young branchlets, stipules, and young leaves minutely puberulous or almost glabrous, rarely densely pubescent; stipules lanceolate, 1–2 cm. long, usually caducous; petioles 5–25 cm. long, glabrous or occasionally pilose, particularly around the apex; leaf-blades chartaceous or subcoriaceous, 7–33 cm. long, 4–25 cm. wide, orbicular-ovate with entire, infrequently sinuate or dentate margin, rounded or rarely truncate at the base and 1–5 cm. peltate, acuminate, palmately 7–9-nerved with 5–8 oblique primary veins from either side of the midrib, bearing on the basal nerves (between the insertion of the petiole and the margin) 1–4 (–8, or rarely none) oval glands, above glabrous, beneath densely and minutely glandular and occasionally puberulous, secondary venation visible but not prominent; ♂ panicle including peduncle (up to 11 cm.) up to 19 cm. long (in var. *abbreviata* up to 26 cm. long, including peduncle of 21 cm.); bracts subtending glomerules ovate, 3–5 mm. long, deeply concave and entire or sinuate, glabrous or minutely puberulous and minutely glandular, with a small hairy cushion at the base inside supporting the flowers of the glomerule on pedicels 0.5 mm. long; ♂ flower in bud about 0.5 mm. diameter, granulo-glandular; sepals 2 or 3, ovate, acute; stamens 2 or 3 with 4-locular anthers; ♀ inflorescence to 20 cm. long, simple or rarely branched, with flowers clustered at the apex (occasionally only a single flower), the outer bracts ovate, 5 or 6 mm. long, glabrous, the inner bracts obovate with the upper part sometimes lobed or very shortly pectinate-lobed and the lower portion narrowed and hairy inside toward the base, granulo-glandular; calyx globular narrowed into a short, scarcely dentate neck; styles 3–5 (–7) mm. long and densely papillose; ovary 3–5-locular; capsule usually densely granulo-glandular, depressed globose or ellipsoidal, near maturity including the processes about 2 cm. broad, processes 3–7 mm. long, glabrous and often granulo-glandular.

NETHERLANDS NEW GUINEA: in forest, Remore, Sorong, *Main 501* (♀, A, BO), Aug. 1948; coastal plain, Hollandia, *Neth. Ind. For. Serv. bb.25073* (♂, A), July 1938; Eti River, upper Tami, *Gjellerup 56* (♂, BO), April 1910; Giriwo River, *Janowsky 140* (♂ & ♀, BO); in edge of secondary forest, Nabire, *Kanehira & Hatusima 11427* (♀, A, BO), Feb. 1940; Canoe Camp, *C. Boden Kloss s. n.* (♀, BM); south of Geluks Hills, *Versteeg 1711* (TYPE of var. *abbreviata*, ♂, BO), Sept. 1907; Bivouac Island, North River, *Pulle 138* (♀, BO), Oct. 1912; near Kloof Bivouac, North River, *Pulle 160* (♀, BO), Oct. 1912; North River, *Von Römer 673* (♂, BO), Oct. 1909.

PAPUA: Veiya, *Carr 11713* p.p. (♂, A), Mar. 1935; Kanosia, *Carr 11094* (♂, A, BM, NY), *11531* (♂, A, BM, NY), Feb. 1935; Boridi, alt. about 1050–1200 m., *Carr 14734* (♀, BM), *14861* (♂, A, BM), Oct., Nov. 1935; Port Moresby, *White 20* (♂, BR), July 1918; Mafulu, alt. 1250 m., *Brass 5186* (♂, A, BO), Sept.–Nov. 1933; same locality, *White 511* (sterile, BR), July, Aug. 1918; Laloki River, alt. about 360 m., *Brass 537* (♂ & ♀, A), Oct. 1925; Rona, Laloki River, alt. 450 m., *Brass 3691* (♂, A, NY), April 1933; Hula, *Brass 526* (♀, A), Oct. 1926; Domara River, *Brass 1585* (♂, A), May 1926; Rigo area, Central District, *Turner s. n.* (♂, BR); Fife Bay, *Turner 80* (♂, BR), Sept. 1930.

NORTHEAST NEW GUINEA: Bulolo, *Fryar*, NGF *3975* (♀, A), Feb. 1950; Kelel, alt. 150 m., *Schlechter 16213* (♀, A, NY), June 1907; Keneyia, alt. 150 m., *Schlechter 18437* (♀, A), Oct. 1908; Matap, alt. about 1500–1800 m., *Clemens 11311* (♀, A), Feb.–April 1940; Boana, alt. 750–1050 m., *Clemens 41612* (♀, A), May–Nov. 1940; on beach, Salamaua, *Kanehira 4022* (♂ & ♀, A), *4023* (♀, A), Feb. 1937; in grey-brown sandy loam on alluvial flats beside Munim Waters, Second Austral For. Surv. Co., NGF *264* (♂, A, BR, LAE), July 1944; along creek bank, Yalu, *White, Dadswell, L. S. Smith*, NGF *1647* (♂, A, BR, LAE), July 1944.

BISMARCK ARCHIPELAGO: locality not on label but cited by Pax & Hoffmann as Kerawara, *Warburg 20534* (♀, type-coll., A), 1889; Duke of York Islands, *Bradtke 37* (♂ & ♀, BR), May 1917.

In addition to the above-cited specimens there are at hand three from Kajabit, Northeast New Guinea: *Clemens 10522* (♂, A), July 1939, *10657 bis* (♀, A), Aug.–Dec. 1939, and *40683* (♂, A), Aug. 1939; another from Kiapit (which I suspect is the same locality as Kajabit), NGF *2676* (♀, A); and a fifth collection from Hisiu, *Carr 11374* (♀, A, BM, NY), Feb. 1935.

The last five numbers, although lacking the typical oval glands on the basal nerves of the upper leaf-surface, are characterized by ♂ inflorescences with entire or sinuate and glabrous bracts, ♂ flowers with two or three stamens with four-locular anthers, four-locular ovary, and fairly short and densely papillose styles; i.e., they have all the characters of this species except the glands on the basal nerves. It might here be noted that the position of these glands varies from near the insertion of the petiole to below the upper half of the vein, and sometimes leaves of the same collection will illustrate different positions. In one collection there were four glands very close to the margin as well as four near the middle of the veins; other specimens have only two glands or sometimes only one, or as noted above none.

In the material before me I have found none with only a two-locular ovary as described for var. *digyna* Pax & K. Hoffmann. Some specimens have fruits with three and four locules, more show four and/or five locules, one specimen had fruits with five and six locules, and in one the fruit appeared to be two- and three-locular, though the material was too scanty to be sure. Most fruits have four or five locules, or both may be found on a single specimen. The obvious character of var. *abbreviata* (J. J. Sm.) Pax & K. Hoffmann is the long-peduncled and short-branched ♂ inflorescence (a feature not mentioned by Pax & K. Hoffmann), as illustrated in *Versteeg 1711*, *Von Römer 673*, *Gjellerup 56*, and *Neth. Ind. For. Serv. bb.25073*. In the abundance of the material at hand this seems to represent nothing more than an ecological form of the species.

41A. **Macaranga quadriglandulosa** var. **variabilis** var. nov.

Arbor glabra usque ca. 9 m. alta; ramulis in sicco atrofuscis; stipulis oblongis 9–10 mm. longis, basi 3.5 mm. latis, obtuse acuminatis, cito caducis; petiolo gracili, 3–10 cm. longo; laminis triangulari-ovatis acuminatis, acumine 1–2 cm. longo, basi truncatis vel 0.2–2 cm. peltatis, dentatis vel interdum subintegris, supra prope basin maculari-biglandulosis vel eglandulosis, subtus flavo-glanduloso-punctatis, trinerviis vel breviter palmatinerviis, venis primariis supra basales 6–8 paribus, rete inconspicuo; paniculis ♂ usque 14 cm. longis, ramis inferioribus ca. 5 cm. longis; bracteis et ♂ floribus ut in specie; inflorescentiis ♀ verisimiliter simplicibus apice flores paucos gerentibus, bracteis et calycibus non visis; capsula 3-loculari, ca. 1 cm. alta et 1.5 cm. lata, dense granuloso-glandulosa et echinibus mollibus tecta; stigmatibus ca. 3 mm. longis plumosis.

PAPUA: rain-forest regrowths, Kerema, *Brass 1204* (♂, A, TYPE), March 1926 (slender erect glabrous tree 20–25 ft.); Sogeri, alt. about 600 m., *Forbes 91* (♀, BM), Oct. 1885; Koitaki, alt. about 450 m., *Carr 12159* (♂, A, BM), May 1935 (tree 20 ft. tall; leaves with ± crimson glands at base of blades); stream bank in very steep hill forest, Rouna, alt. about 420 m., *Carr 12388* (♂, A, BM, NY), May 1935; Veiya, *Carr 11714* (♀, A, BM, NY), March 1935; Isuarava, alt. about 1050 m., *Carr 15601* (♂, A, BM), Feb. 1936.

The staminate inflorescence and the capsule with the granular glands covering not only the main part but also the lower part of the processes as well, are the characters which ally this variety with *M. quadriglandulosa*. The processes are about 6 mm. long. Here the capsule seems to be constantly 3-locular. In the species the capsule is 2–5-locular, but mostly 4- or 5-locular. In most of the collections cited for this variety the leaves are only very narrowly peltate or epeltate with two oblong (sometimes nearly orbicular) flat glands on the upper surface between the attachment of the petiole and the adjacent margin; sometimes only one gland is present, sometime none. *Carr 15601* has leaves which are one or two centimeters peltate, and hence it appears to form a transition to the species.

42. **Macaranga tanarius** (L.) Mueller Arg. in DC. Prodr. 15 (2): 997. 1866. — F. Mueller, Descr. Notes Pap. Pl. 2: 27. 1886. — K. Schu-

mann in Bot. Jahrb. **9**: 206. 1887; in Notizbl. Bot. Gart. Berlin **2**: 128. 1898. — Warburg in Bot. Jahrb. **13**: 352. 1891. — K. Schumann & Lauterbach, Fl. Deutsch. Schutzgeb. Südsee 398. 1900. — J. J. Smith in Nova Guin. Bot. **8**: 238. 1910; l. c. **8**: 791. 1912. — Pax & K. Hoffmann in Pflanzenr. **63** (IV. 147. XIV): 352, *t. 59.* 1914. — Kanehira & Hatusima in Bot. Mag. Tokyo **52**: 411. 1938.

Ricinus tanarius L. Spec. Pl. ed. 2, 1430. 1763.

Mappa tanaria Spreng. Syst. **3**: 878. 1826. — F. Mueller, Descr. Notes Pap. Pl. **1**: 7. 1875.

Macaranga clavata Warburg in Engl. Bot. Jahrb. **13**: 349. 1891. — K. Schumann & Lauterbach, Fl. Deutsch. Schutzgeb. Südsee 396. 1900.

Macaranga tanarius var. *α tomentosa* (Bl.) Mueller Arg. in DC. Prodr. **15** (2): 997. 1866. — K. Schumann & Hollrung, Fl. Kais. Wilhelms Land 79. 1889. — K. Schumann & Lauterbach, Fl. Deutsch. Schutzgeb. Südsee 398. 1900.

Mappa tomentosa Blume Bijdr. 624. 1825.

Tree 10–20 m. high; branchlets, stipules, petioles, and new leaves puberulous or shortly villous and later glabrate or sometimes glabrous; stipules somewhat scarious, oblong or ovate, acuminate, 1–3 cm. long, 0.5–1.3 cm. broad, caducous; petioles 6–28 cm. long; leaf-blades suborbicular-ovate, 8–30 cm. long, 5–28 cm. broad, acuminate, broadly (2–7 cm.) peltate at base, repand-denticulate or entire, usually glabrous and eglandular on the upper surface but sometimes with 2–4 glands as in *M. quadriglandulosa*, rather densely granulo-glandular beneath and varying in pubescence from velutinous and shortly villous on the veins to glabrous, net-venation distinct, palmately veined with 6–9 pairs of primary veins above the basal ones; ♂ panicle 7–25 cm. long, pedunculate; bracts subtending the glomerules deeply concave, suborbicular-ovate, 4–7 mm. long, acuminate, pectinate-lacinulate or dentate, very often velutinous; ♂ flowers small, about 1 mm. long; sepals usually 3, stamens 4–14 with 4-locular anthers; ♀ panicle 5–30 cm. long with few branches or simple; floral bracts ovate, 0.9–2 cm. long, acuminate, pectinate-lacinulate; ♀ calyx closely covering the ovary, subtruncate, velutinous; ovary 2- or 3-locular, styles 4–8 mm. long, irregularly and slightly papillose; capsule glabrous, densely granulo-glandular and bearing practically glabrous processes, the processes somewhat remote, 5–15 mm. long.

NETHERLANDS NEW GUINEA: without further locality, *Warburg 20692* (♂, A); in alangalang field, Kp. Opeko (Topeko), *Anta 173* (♂, A, BO), July 1941; Soron, *Beccari 8889* (P. P. 459) (♀, F); "Mt. Arfak a Putat," *Beccari 8886* (P. P. 935) (♀, F); Nabire, *Kanehira & Hatusima 11435* (♂, A); Oria (Oeta), Exp. *Lundquist 163* (sterile, BO); hills north of Hollandia, *Neth. Ind. For. Serv. bb.25090* (♂, A). Misool Is., *Pleyte 847* (♂, BO). Japen-Biak, Kp. Baroe near Seroei, *Aet & Idjan 239* (♂, BO).

NORTHEAST NEW GUINEA: Finschhafen, *Warburg 20511* (♀, A, probable ISOTYPE of *M. clavata*); Busu River bush, Lae, *Clemens 10468* (♂, A), July 1939; Bulolo, *Fryar* NGF *3974* (♂, A); Wau Garden area, *McAdam 226* (♂, BR), Aug. 1938 (medium-sized tree; leaves up to 20" diam. on young trees with petioles up to 25″ long, sometimes with drip tips up to 2″ long and very narrow; hairy thin stipules persist for some time giving the branch tips a shaggy appearance); Morobe, *Womersley* NGF *2918* (♂, A, LAE); Boana, above 1000 m., alt., *Clemens 8468* (♀, A), *41727* (♂, A); vicinity of Kajabit Mission, alt. 240–600 m., *Clemens 10628* (♂, A), *10648* (♂, A); in gray-brown sandy loam on alluvial flats beside Munim Waters, Yalu, 2nd Aust. For. Surv. Co. NGF *260* (♀, A, BR, LAE).

PAPUA: second-growth rain forest, Lake Daviumbu, Middle Fly River, *Brass 7501* (♂, A), Aug. 1936 (tree 5 or 6 m. high; branchlets myrmecophilous); same locality, *Brass 7721* (♀, A), Sept. 1936 (tree 10 m. high); Daru Island, *Brass 6394* (♀, A), Mar. 1936 (the principal component of rain-forest second growths on the islands); on open grass ridges, Dagwa, Oriomo River, *Brass 6008* (♀, A, BO, NY), *6009* (♂, A, BO, NY); Veiya, *Carr 11713* p.p. (♂, A, BM, NY); Isuarava, alt. about 1500 m., *Carr 15574* (♂, A, BM); on rich gray sandy loam in Dobodura Plain — Giuri River — Soputa area, Buna hinterland, alt. about 100 m., *Cavanaugh & Fryar* NGF *2045* (♂, A, BR, LAE); Fife Bay, by a sago swamp, *Turner 26* (♀, BR).

BISMARCK ARCHIPELAGO: New Britain: suburb of Rabaul, *Kanehira 3996* (♂, A).

SOLOMON ISLANDS: Bougainville: Karngu, Buin, *Kajewski 2254* (♂, A); Korniguru, Buin, alt. 900 m., *Kajewski 2104* (♂, A). Guadalcanal: without further locality, alt. about 200 m., *Pendleton 463* (♂, A), July 1944 (large shrub or small tree 4 m. tall, forming dense groves in areas where rain forest has been destroyed, also in edges of rain forest). San Cristoval: Manihuki, *Brass 2616* (♂, A).

This is indeed a variable species as to pubescence, size of the bracts subtending the glomerules, and the number of stamens. However, I have been unable to find any combination in the characters which might serve as distinctive for the varieties which have been established and discarded at various times. Most of the material would fall under the so-called var. *tomentosa*. *Kajewski 2254*, *Pendleton 463*, and *Brass 2616* are almost glabrous collections. In *Brass 2616* there are only a few scattering hairs on the very young leaves and stipules; in *Kajewski 2254* the young leaves and stipules are densely hairy, but the mature leaves are glabrous, and the axis of the inflorescence is puberulous; in *Pendleton 463* only the branchlets of the inflorescence are puberulous, but in the Brass specimen the inflorescence axis and its branchlets are glabrous. The following specimens have glands on the leaves, as in *M. quadriglandulosa*, but the bracts of the inflorescence are like those of this species: *Carr 11713*, *Warburg 20692*, *Clemens 41727*, *Brass 6009*, and *7501*, *Pleyte 847*, *Neth. Ind. For. Serv. 25090*, *Kanehira & Hatusima 11435*; the number of glands varies from one to four. Two collections from Biak Island, *Britton 39* and *86* (♂ & ♀, A) probably belong here. The bracts of the ♂ collection are very small and apparently entire, but the specimen agrees in other details with this species; possibly this represents the form *brevibracteata* Mueller Arg.

43. **Macaranga hoffmannii** nom. nov.

Macaranga acuminata Pax & K. Hoffmann in Pflanzenr. **68** (IV. 147. XIV): 28. 1919; non Ridley (1916).

Tree 10–20 m. high with slender glabrous and sparsely granulo-glandular young growth; stipules not seen; petiole 2–3.5 cm. long, glabrous and slender; leaf-blades coriaceous, entire, ovate or ovate-lanceolate, 7–12 cm. long, 2.5–4 cm. broad, caudate-acuminate, narrowed towards the base and narrowly peltate, glabrous above, very sparsely pilose on the midrib beneath and very densely impressed-granulo-glandular, 3-nerved and shortly palmate-nerved, the primary veins 2–4 pairs above the basal ones; ♂ panicle branched almost from the base, 4–6 cm. long, glabrous and granulo-glandular; bracts denticulate, not patelliform-glandular within, the lower oblong, 2 mm. long, the upper triangular, glomerules 10–20 flowered; ♂ flower 2 mm. broad; sepals 3, elliptic, acute, densely granulo-glandular; stamens 10–12 with 4-locular anthers; ♀ flowers unknown.

Two collections cited in the original, *Ledermann 12685* and *12957*, were found on Felsspitze, Northeast New Guinea. The only pubescence mentioned in the description is that along the midrib on the lower surface of the leaves.

44. **Macaranga versteeghii** sp. nov.

Arbor 5–13 m. alta; partibus juvenilibus ferrugineo-tomentosis deinde glabratis; stipulis oblongo-lanceolatis, ca. 5 mm. longis, acutis vel subacuminatis, rigidiusculis, cito caducis; petiolo 2–5.5 cm. longo, glabrato; laminis maturis coriaceis, 7.5–16 cm. longis, 3.7–9.5 cm. latis, elliptico-ovatis, abrupte acuminatis, acumine 1–1.7 cm. longo, basi rotundatis et 0.5–0.7 cm. peltatis, supra glabris, subtus impresse sanguineo-granuloso-glandulosis et glabris vel costa venisque flocculoso-tomentosis, trinerviis et breviter palmatinerviis, venis primariis 5–7 paribus supra basales, supra impressis, subtus prominentibus, venis secundariis prominulis, rete utrinque manifesto; ♂ paniculis 5–7 cm. longis, ferrugineo-tomentosis, valde juvenilibus tantum visis; bracteis majoribus lanceolatis, 3.5 mm. longis, minoribus late ovatis, 1.5 mm. longis, abrupte et minute acuminatis, non patellari-glandulosis; alabastris ♂ tomentulosis et granuloso-glandulosis; staminibus 9–12, antheris 4-locularibus; ♀ inflorescentiis 5–8 cm. longis, sparsim et brevissime ramosis; calyce 3-lobato; ovario tomentuloso et granuloso-glanduloso; stylo 1 (vel 2) ca. 5 mm. longo, minute papilloso; capsula subglobosa, vix 5 mm. diametro, glabrata et granuloso-glandulosa, inermi vel interdum minute tuberculata.

NETHERLANDS NEW GUINEA: primary forest, Bele River, 18 km. NE of Lake Habbema, alt. about 2220 m., *Brass & Versteegh 11116* (♂, A, TYPE), Nov. 1938 (rare substage tree 13 m. high, 30 cm. diameter, with narrow crown; bark fairly smooth, brown; wood rose); abundant in seral forest of lower slopes, Bele River, 18 km. NE of Lake Habbema, alt. 2200 m., *Brass 11398* (♀, A), Nov. 1938 (second growth tree 5–7 m. high, with stiff peltate leaves).

It is to be noted that there are several fruits with two styles attached, but when the fruit is opened only one locule appears to have developed. I have seen only one fruit with two locules and two seeds.

45. **Macaranga trichanthera** sp. nov.

Arbor alta gracilis; partibus juvenilibus brunnescenti-tomentosis, tarde glabrescentibus; stipulis ca. 3 mm. longis, rotundato-ovatis, cito caducis; petiolo 2.5–6 cm. longo; laminis integris, elliptico-ovatis vel rhombeo-ovatis, 3.5–13 cm. longis, 2.5–9 cm. latis, acuminatis vel interdum acutis, acumine usque 1.5 cm. longo, basi rotundato-cuneatis et 0.1–0.7 cm. peltatis, novellis supra floccoso-tomentosis, maturis supra glabris et sub magnificatione reticulatis, subtus brunnescenti-tomentosis et granuloso-glandulosis, trinerviis vel in foliis manifeste peltatis breviter palmatinerviis, venis primariis 5–7 paribus supra basales, obliquis, prope marginem arcuatis et anastomosantibus, prominentibus, secundariis prominulis; ♂ paniculis 4–9.5 cm. longis, brunnescenti-tomentosis, vix floccosis, glomerulis plerumque confertis; bracteis florigeris parvis, ca. 1 mm. longis latisque, obtusis, intus non patellari-glandulosis; calyce 3-lobato, staminibus 3–5, antheris pilosis, pilis paucis brunnescentibus, 4-locularibus; ♀ inflorescentia usque 8 cm. longa, simplici (?), floribus sessilibus, bracteis incertis; calyce 2-lobato, 1.5–2 mm. alto; ovario 2-loculari, pubescente et granuloso-glanduloso; stylis 2, ca. 6 mm. longis, papillosis, basi 1.5 mm. connatis; capsula inermi, 1 cm. lata et alta, ca. 0.7 cm. crassa, seminibus rugulosis.

NETHERLANDS NEW GUINEA: occasional on slopes in primary forest, 15 km. SW of Bernhard Camp, Idenburg River, alt. about 1900 m., *Brass & Versteegh 11953* (♀, A), Jan. 1939 (tree 28 m. high, 66 cm. diameter; fruits brown, ♀ flowers yellow-green; bark dark brown and fairly rough; wood light brown).

PAPUA: common in valley forest, Mt. Tafa, Central Division, alt. about 2400 m., *Brass 5077* (♂, A, TYPE), Sept. 1933 (tall and rather slender tree with small open crown; leaves pale green above, brown-pubescent beneath, giving the tree a brownish appearance); forest, Alola, alt. about 1600 m., *Carr 13671* (♀, A), Dec. 1935 (tree about 15 ft.); forest, The Gap, alt. about 2000 m., *Carr 13713* (♂, A), Dec. 1935 (tree about 70 ft. high).

NORTHEAST NEW GUINEA: Sutherland's Camp, Kaindi, alt. about 2100 m., *McAdam 245* (♂, BR), Aug. 1938 (small tree 6″ diameter broken by falling tree; leaves broadly ovate to deltoid, green above, densely covered with rusty brown hairs underneath, thus giving the head of the tree a brown appearance, young leaves densely rusty on both surfaces); Ogeramnang, alt. about 1770 m., *Clemens 4829* (very young ♀, practically sterile, A), *5055* (♂, A), *5533* (♂, A), Jan., Feb. 1937.

In the material cited, the leaves of half of the collections are barely peltate or epeltate. Those of *Brass & Versteegh 11953* and *Carr 13671* and *13713* are obviously peltate, while those of *McAdam 245* are both peltate and epeltate. The pubescence of this species is not so compact as that of *M. induta* and the leaves are different in outline; nevertheless, probably on account of the persistent brown pubescence on the lower surface of the leaves, there is a resemblance between the two. *Macaranga trichanthera* differs from all the other species examined in having a few brownish and wrinkled hairs attached to the back of the anthers. The fruits do not have any processes or tubercles, if I have matched correctly ♂ and ♀ specimens, but are consistently two-locular, and the styles appear to persist longer than in the other species.

46. **Macaranga induta** sp. nov.

Arbor usque ca. 15 m. alta; partibus juvenilibus tomentosis, pilis tenuissimis crispis; stipulis 3.5–6 mm. longis, oblongo-linearibus, acutis, cito caducis; petiolo 2.5–6.5 cm. longo, glabrato; laminis ovatis vel ovato-lanceolatis, acuminatis, 8–15.5 cm. longis, 3–10.5 cm. latis, basi cuneato-rotundatis et 0.3–0.8 cm. peltatis, maturis supra glabris, subtus tomentosis et granuloso-glandulosis, trinerviis et breviter palmatinerviis, venis primariis 7–9 paribus supra basales, subtus prominentibus, secundariis prominulis; ♂ paniculis 6–9 cm. longis, tomentulosis et dense granuloso-glandulosis; bracteis florigeris late ovatis, ca. 2 mm. longis, basi concavis, acutis vel obtusiusculis, intus non patellari-glandulosis; calyce 3- vel 4-lobato, staminibus 10–15, antheris 4-locularibus; ♀ inflorescentiis saepissime racemosis vel 1–2-ramosis; ♀ floribus primum simulate sessilibus demum in pedicellis usque 1 cm. longis; bracteis florigeris ovato-lanceolatis, acuminatis, ca. 3.5 mm. longis, cito caducis; calyce 4 mm. longo, tubuloso apice 2-lobato deinde rumpente et caduco; ovario pubescente, 2- vel 3-loculari, stylis 2 vel 3, ca. 8 mm. longis, dorso pubescentibus, dense papillosis, rectis apice recurvis; capsula immatura dense granuloso-glandulosa et irregulariter vel non molliter echinatis, echinis 1.5 mm. longis, basi pubescentibus et 0.5 mm. latis.

PAPUA: forest, Alola, alt. about 1700 m., *Carr 13888* (♀, A, BM), Dec. 1935 (tree about 20 ft. tall); Uniri River, alt. about 1950 m., *Carr 15185* (♂, A, BM), Jan. 1936 (tree 30 ft. high).

NORTHEAST NEW GUINEA: open forest, Yunzaing, alt. about 1350 m., *Clemens 3394 bis* (♂, A), Aug. 1936 (tree 50 ft. high); same locality, *Clemens 3714* (♂, A), July 1936 (tree 50–60 ft. high); same locality, *Clemens 6568* (♀, A, TYPE), July 1937.

All the collections cited above are poor specimens. Those from Yunzaing show a greater variation than those from Papua in the size and shape of the leaves. It should be pointed out that the fruit of *Carr 13888* does not appear to be developing any processes, but the young flower with calyx looks very much like that of the Clemens collection designated as the type.

47. **Macaranga albescens** sp. nov.

Arbor alta; ramulis, stipulis, petiolis, foliis novellis et inflorescentiis dense tomentosis, pilis crassiusculis (demum caducis) et tenuissimis aliquatenus intermixtis; stipulis ca. 4 mm. longis, lanceolato-linearibus, caducis; petiolo

2–10 cm. longo; laminis 5–14 cm. longis, 3.5–9 cm. latis, suborbiculari-ovatis, undulatis, subcoriaceis, subabrupte et breviter acuminatis, basi subtruncatis vel cuneatis deinde rotundatis et 0.3–0.7 cm. peltatis, maturis supra glabris et conferte reticulatis, subtus minute et dense tomentosis et granuloso-glandulosis, trinerviis et breviter palmatinerviis, venis primariis 5–7 paribus supra basales prominentibus, secundariis prominulis; ♂ paniculis granuloso-glandulosis, ca. 5 cm. longis nondum maturis, glomerulis fere confertis; bracteis florigeris parvis, ca. 0.5 mm. longis, non patellari-glandulosis; calyce ca. 1.5 mm. longo 2-vel 3-lobato, prope apicem granuloso-glanduloso et tomentoso; staminibus 5–11, antheris 4-locularibus; ♀ inflorescentiis 6–9 cm. longis vel plus; pedicellis usque 5 mm. longis; calyce irregulariter 3–4-lobato; capsula 1-loculari inermi subglobosa, ca. 6 mm. diametro, tomentosa et granuloso-glandulosa; stylo (in fructu tantum viso) papilloso; semine brunnescenti ruguloso, ca. 4 mm. longo latoque.

NORTHEAST NEW GUINEA: Sarawaket, *Clemens 5632* (♀, A), Mar. 1937; mountain forest, same locality, alt. 1800–2400 m., *Clemens 7550B* (♂, A, TYPE), Nov. 1937 (tall tree); marsh meadow camp, vicinity of Samanzing, alt. 2100–2400 m., *Clemens 9484A* (♀, A), Jan. 1939 (treelet 3" diameter); high forest on mountain, Sambanga, alt. 1500–1800 m., *Clemens 6955* (♂, very young, A), Sept. 1937 (tall tree 2 ft. diameter); Sutherland's Camp, Kaindi, alt. about 2100 m., *McAdam 239* (♂, A, BR), Aug. 1938 (tall, dark, somewhat fluted, lumpy-boled tree 45/60/100; crown open with leaves pale green above and pure white underneath due to a very dense white bloom; twigs, petioles, and lower leaf-surface all heavily covered with it; bark dark brown; blaze red-brown with light brown line at sapwood).

PAPUA: common in valley forests, alt. 2500 m., *Brass 5081* (♀, A), May–Sept. 1933 (tree 25–30 m. with thinly foliaged rounded crown; fruit oblique).

The pubescence of this species on the new growth, as observed under a lens, has distinct and longish wrinkled hairs covering or mixed with a rather compact layer of fine tomentum of shorter hairs. Later the longer hairs fall off leaving a minute tomentum on the branchlets, petioles, lower surface of the leaves, and inflorescences; the tomentum on the upper surface of the leaves, although not loose, disappears in spots, as if floccose, until finally none is left except at the attachment of the petiole. In most of the collections the lower surface of the dried leaves is brownish gray with flecks of white, but in *McAdam 239* and an older leaf of *Clemens 6955* the lower surface has a whitish tinge. Apart from the pubescence the species is characterized by narrowly peltate, orbicular-ovate leaves; ♂ flowers with calyx-lobes about half the length of the calyx; five to eleven stamens with four-locular anthers; and small, smooth, one-locular capsules.

In addition to the above cited specimens I have two from Netherlands New Guinea: *Brass & Versteegh 10482* (♂, A), rare in old secondary forest at 2680 m. altitude, collected 9 km. NE of Lake Habbema; and *Kanehira & Hatusima 13908* (♀, A), collected at 1900 m. altitude, in the fringing forests by Iray, Lake Giji. These differ from the others, as far as I can see, only in having the two basal lateral nerves ascending much nearer the margin than those in the other collections cited.

48. **Macaranga nova-guineensis** J. J. Smith in Nova Guin. Bot. **8**: 789, *t. 138*. 1912. — Pax & K. Hoffmann in Pflanzenr. **63** (IV. 147. VII): 363. 1914.

Shrub; branchlets, stipules, petioles, young leaves, and the peduncles of the inflorescences densely velvety-pubescent with yellowish hairs 0.5–0.7 mm. long; stipules erect, subulate, caducous; petioles 1.3–5 cm. long; leaf-blades elliptic or oblong, 9–22 cm. long, 4.5–10 cm. broad, subabruptly acuminate with the narrow acumen 1–2.5 cm. long, rounded or obtuse and very shallowly cordate at the base, denticulate, on both sides slightly rough with very short hairs, only on the veins densely velutinous, feather-veined with 9–12 pairs of conspicuous primary veins curving upward and anastomosing near the margin, the reticulations distinct on the lower surface; inflorescence unisexual or androgynous; ♂ panicle with very few (3) branches, about 5.5 cm. long; bracts somewhat clasping the rachis, semiorbicular-triangular, about 1.3 mm. long, 2 mm. broad, acuminate, densely hairy beneath; ♂ flower short-pedicellate and towards the apex sparsely pilose; calyx tripartite, the 3 stamens with 4-locular anthers; ♀ inflorescence simple (?), peduncle about 15.5 cm. long, capsule covered with hairy processes up to 6 mm. long, 2-locular.

NETHERLANDS NEW GUINEA: in primary forest of the plain, North River, *Von Roemer 514* (♂ & ♀, TYPE, BO), Oct. 1909.

PAPUA: sporadic in undergrowth of ridge forests, alt. 80 m., *Brass 6643* (♀, A), May 1936 (shrub of erect or ascending habit 1–1.2 m. high; leaf-nerves purple beneath; fruit red); in rain forests, Aroara, Vailala River, alt. about 60 m., *Brass 1061* (♀, A), Feb. 1926 (loosely branched bush about 1.5 m. high, with red fruit).

The specimen from the Bogor Herbarium has a small ♂ inflorescence, as shown in plate 138 cited above, also a very short inflorescence on the same branch below it, possibly the androgynous inflorescence to which the author refers; separate from the branch is the rachis of the long ♀ inflorescence, and immature fruits in a pocket. The collections from Papua have dark granular glands on the under surface of the leaves. These glands are not mentioned in the original description, and I do not find them on the single leaf of the Bogor specimen showing the lower surface; nevertheless I believe the Papuan specimens belong to this species. Perhaps it should be noted that *Brass 1061* has been previously determined as *M. subpeltata*; unfortunately, none of the bracts of the inflorescence remains in a condition good enough to give a clue to its relationship. Further, the only bract seen with the type specimen of *M. nova-guineensis* was loose, and the ♀ bracts are not mentioned in the original description. This only underlines the necessity for more material before the species can be known in all its aspects. The type of *M. nova-guineensis* is the only material of *Macaranga* which I have seen with both ♂ and ♀ flowers on the same plant and on the same inflorescence.

49. **Macaranga subpeltata** Lauterbach & K. Schumann in K. Schumann & Lauterbach, Fl. Deutsch. Schutzgeb. Südsee 400. 1900. — Pax & K. Hoffmann in Pflanzenr. 63 (IV. 147. VII): 359. 1914.

Tree 10 m. high with the new growth fulvous-tomentulose, tardily glabrescent; stipules lanceolate or ovate, acute, 3–6 mm. long, caducous; petioles 3.5–10 cm. long, tomentulose; leaf-blades chartaceous, entire, ovate or ovate-oblong, 15–28 cm. long, 8–16 cm. broad, subabruptly acuminate, rounded and slightly cordate at the base, on the upper surface pubescent only on the midrib and primary veins, inconspicuously maculo-glandular near the base, scabrous-pubescent with very short hairs on veins and veinlets beneath and minutely dark-glandular punctate, 3-nerved with 7–10 pairs of primary veins above the basal ones; ♂ panicle 12–20 cm. long, pedunculate; ♂ flowers crowded at the apices of the branches; bracts subtending the many-flowered glomerules rhombic, incised-dentate, 2–3 mm. long; ♂ flower scarcely 1.5 mm. broad; sepals 3, sparsely pilose; stamens 3 with 4-locular anthers; ♀ inflorescence 2.5–11.5 cm. long, tomentulose, with ♀ flowers only at the apex, but with sterile bracts scattered along the peduncle; the terminal bracts rhombic or oblong-ovate, acuminate, dentate, 7–12 mm. long, sparsely patelliform-glandular; calyx cupular with short lobes, hardly 1 mm. long; ovary 2-locular, covered with processes; styles 4–5 mm. long, plumose; capsule 14 mm. broad without the processes, the processes pilose, 7–10 mm. long.

NORTHEAST NEW GUINEA: Keneyia, alt. 150 m., *Schlechter 18330* (♂, A, BR), Oct. 1908.

50. **Macaranga ovatifolia** Merrill in Philip. Jour. Sci. 16: 562. 1920.

A small tree with the new growth at the tips of the branchlets, the young leaves and the inflorescences all ferrugineous-tomentulose, otherwise glabrous; stipules lanceolate, about 1 cm. long, caducous; petioles up to 17 cm. long; leaf-blades ovate, acuminate, 9–25 cm. long, 5–18 cm. broad, truncate at the base and very inconspicuously cordulate (in material here cited very shortly truncate-cuneate), 3-nerved with 8–11 pairs of primary veins above the basal ones, very densely granulo-glandular beneath; ♂ panicles up to 12 cm. long, the bracts subtending the glomerules somewhat obovate, 3–5 mm. long, 1.7–2.7 mm. broad, dentate with short (0.3–0.5 mm.) teeth and tomentulose on both surfaces; calyx 2- or 3-lobed; stamens 3 or 4 with 4-locular anthers; ♀ panicle 6–9 cm. long, the bracts similar to those of the ♂ panicle; capsules sometimes globose, 4 mm. diameter or broader, 1- and 2-locular, granulo-glandular and smooth; style 1 mm. long, minutely papillose.

SOLOMON ISLANDS: Bougainville: rain forest, Kieta, sea level, *Kajewski 1534* (♂, A), March 1930 (tall shrub up to 7 m. high; bracts of buds pink); Kieta, alt. 100 m., *Kajewski 1603* (♀, A), March 1930; rain forest close to sea beach, Karngu, Buin, *Kajewski 2287* (♀, A), Oct. 1930 (medium-sized tree up to 25 m. high); Siwai, *Waterhouse 169* (♂, A, NY), Dec. 1932. Shortland Islands: secondary growth in old gardens, lowland rain forest, near Aliang, *Walker* BSIP *296* (♀, A, BR).

There is at hand an isotype of *M. ovatifolia* Merr. as well as two other ♀ collections. The description of the ♂ inflorescence is drawn from *Kajewski 1534*. There is a tendency towards small macular glands on the upper surface of the leaves near the attachment of the petiole in the material here cited, but not in the Philippine material. Staminate material from the Philippines is necessary to complete the species, and to verify whether this material is correctly assigned to *M. ovatifolia*; there is great similarity in the terminal buds, bracts, and capsules, as well as in the general outline and lower surface of the leaves. I have seen also two sterile collections from the Admiralty Islands, *Hepplethwaite 544* and *563*, which appear to belong here.

51. **Macaranga fimbriata** S. Moore in Jour. Bot. **61**: Suppl. 48. 1923.

Large tree with young growth (branchlets, stipules, petioles, and leaf-blades) ferrugineous-tomentulose but usually very soon glabrate; the oblong stipules 3.5–5 mm. (sometimes almost 1 cm.) long and caducous; petioles 3.5–8 cm. long; leaf-blades variable in form and size, ovate-oblong or lanceolate or elliptic, acute or shortly acuminate, 8 × 3.5 cm., 9.5 × 3 cm., 15.5 × 7 cm., 17 × 5.5 cm., 21 × 9 cm., at base rather obtusely cuneate and 2–4 maculo-glandular on the upper surface, beneath densely and minutely granulo-glandular and mostly glabrous, although with fragments of the pubescence here and there along the midrib and main veins, feather-veined or shortly 3-nerved at base, with 6–8 pairs of primary veins above the basal ones and almost equally distinct on both surfaces, the secondary venation inconspicuous; ♂ panicle loosely branched, 6–14 cm. long, fulvous-tomentulose; bracts 4.5–5 mm. long, often 5 subtending the glomerules at the tip of a branchlet, ovate or suborbicular and fimbriate with about 12 (in cited specimens 5–7) slender processes 1–2.5 mm. long; sepals 3 or 4 minutely fulvous-tomentulose at the apex; stamens (3–) 5–8 with 4-locular anthers; ♀ panicle up to 7 cm. long with several widely spreading branches 1–3 cm. long, the bracts similar to but smaller (3 or 4 mm. long) than those of the ♂ panicle; young flower 1.5 mm. high, cup-like pubescent calyx about 1 mm. high; ovary 2-locular and densely granulo-glandular, styles 1–1.5 mm. long, shortly papillose; capsule 3.5 mm. high, 5 mm. wide; seed 2.5 mm. diameter, finely sulcate.

PAPUA: common in drier parts of rain forest, Lake Daviumbu, Middle Fly River, *Brass 7494* (♀, A), Aug. 1936 (substage tree 12–15 m. high; leaves pale underneath; young fruit viscid); on rain-forest margin, Milne Bay area, about 6 miles up the Dawa Dawa River, alt. about 45 m., *L. S. Smith* NGF *1319* (♂, A, BR, LAE), Mar. 1945 (tree 60 feet over all, with pale brown sparsely lenticellate bark; inflorescences creamy green).

NORTHEAST NEW GUINEA: on crest of ridge in foothill forest, August River, Sepik District, *Womersley* NGF *3842* (♂, A), Sept. 1949 (small tree up to 20 feet high; flowers creamish, on long peduncles; bark gray-brown outside, rather flaky; inner bark red with wedges of whitish tissue); Quembung, alt. about 600 m., *Clemens 2155* (♂, A), March 1936.

51A. **Macaranga fimbriata** var. **doctersii** var. nov.

A forma typica differt foliis majoribus 13–31 cm. longis, 5–16 cm. latis, glabris, ovatis acuminatis; staminibus 2–5.

NETHERLANDS NEW GUINEA: Rouffaer River, alt. about 250 m., *Docters van Leeuwen 10257* (♂, A, TYPE; BO), Sept. 1926; rain forest of the lower mountain slopes, Bernhard Camp, Idenburg River, alt. 170 m., *Brass 13866* (♂, A), Apr. 1939 (tree 22 m. high, 30 cm. diameter); Andai, *Beccari 8887* (♂, F).

52. **Macaranga polyadenia** Pax & K. Hoffmann in Pflanzenr. **68** (IV. 147. XIV): 25. 1919.

Slender glabrous tree 10–25 m. tall; linear stipules 4–5 mm. long; petiole 3–5 cm. long; leaf-blades entire, ovate-lanceolate, acuminate, 7–12 cm. long, 3–5.5 cm. broad, narrowed towards the very shallowly cordulate base, with 4–8 glandular spots on the upper surface near the attachment of the petiole, very densely granulo-glandular beneath, feather-veined with 6–9 pairs of primary veins; ♂ panicle puberulous, 6–8 cm. long, branched almost from the base; bracts crowded at the apex and along the branchlets, up to 5 mm. long, spatulate with the apex palmately parted into long teeth; flowers in bud only, puberulous; stamens 7 or 8 with 4-locular anthers; ♀ panicle 4–8 cm. long, branching less than the ♂, the bracts small; calyx ♀ cupular and 2- or 3-lobed; ovary smooth and densely granulo-glandular, 1-locular; style 1.5 mm. long, papillose.

The basis of this species is *Ledermann 8664* and *8677* from the April River at 100 m. alt. It differs from *M. fimbriata* in being glabrous and having 1-locular capsules, otherwise the two are very close, according to the original descriptions.

53. **Macaranga villosula** Pax & K. Hoffmann in Pflanzenr. **68** (IV. 147. XIV): 27. 1919.

Tree 4–8 m. high with young growth grayish short-villous, tardily glabrescent; stipules small and falling very soon; petiole 4.5–9 cm. long, slender, villous; leaf-blades chartaceous, 13–18 cm. long, 5–7.5 cm. broad, ovate or oblong, acuminate, rounded at the base, entire or repand-denticulate, longish setulose on the upper surface, the veins more densely covered with a mixture of long and short hairs, at the base maculo-biglandular, more densely hairy and granulo-glandular beneath, pinnately veined, the primary veins 12 or 13 pairs; ♂ panicle 5–7 cm. long, branched almost from the base, the 5 or 6 bracts and the several-flowered glomerules subtended by them densely congested simulating a sessile or pedicellate head of flowers, the bracts about 2 mm. long, broadly ovate, 2-lobed at the base, granulo-glandular on both sides, ♂ flower short-pedicellate; calyx hardly 1 mm. long, clavate, pubescent; stamens 3 with 4-locular anthers; ♀ panicle on a short peduncle; bracts 1 mm. long, triangular, acute; pedicels 2–5 mm. long; ♀ flower with 3 triangular acute sepals;

ovary 1-locular, smooth, densely granulo-glandular, the style 4 mm. long, filiform, remotely papillose; capsule about 3 mm. diameter.

I have not seen either collection cited in the original (*Ledermann 9787* and *10593*), and I do not seem to have any specimens to match the description.

54. **Macaranga gracilis** Pax & K. Hoffmann in Pflanzenr. 68 (IV. 147. XIV): 31. 1919.

Glabrous tree up to 10 m. high with slender branchlets (2–2.5 mm. diameter at 15 cm. below the apex); the linear stipules 3–6 mm. long and caducous; petioles 1–3 cm. long; the lanceolate 1.5–3 cm. caudate-acuminate leaf-blades 6–13 cm. long, 1.5–3.7 cm. broad, with obtuse or subcuneate base, not maculo-glandular above but sparsely granulo-glandular on both surfaces and distinctly reticulate, 3-nerved at the base (the two laterals extending about half the length of the blade) with 4–6 additional pairs of curved ascending primary veins; the slender and scattered granulo-glandular ♂ panicle 3–6 cm. long, sometimes sparsely branched or almost simple, with 1–6-flowered glomerules subtended by a very small eglandular (or 1-glandular in original description) triangular bract; sepals 2 or 3, ovate and acutish; stamens 10–16 with 4-locular anthers; the ♀ inflorescence 5–8 cm. long with 2 or 3 branches bearing a single flower at the apex of each, the bracts stipule-like, 1.7 mm. long; calyx almost tubular, 2-lobed at the apex, 2–2.5 mm. long, quickly splitting; style to 1.5 cm. long bearing on one side a smooth stigma 1.3 cm. long; capsule about 5 mm. diameter, subglobose; seed smooth.

NETHERLANDS NEW GUINEA: frequent in mossy forest seral growths, 15 km. SW of Bernhard Camp, Idenburg River, alt. 1800 m., *Brass 12052* (♂, A), *12059* (♀, A), Jan. 1939 (slender tree attaining 10 m.); summit of Mt. Digitara, Wissel Lake region, *Eyma 5365* (♂, A, BO), Oct. 1939.

55. **Macaranga haplostachya** Pax & K. Hoffmann in Pflanzenr. 68 (IV. 147. XIV): 25. 1919.

Shrub or tree 4–12 m. tall, with slender, glabrous, granulo-glandular branchlets; stipules small, subulate, 3–4 mm. long, caducous; petiole 1–3 cm. long, glabrous; leaf-blades chartaceous, lanceolate, obtusely cuspidate-acuminate, 7–13 cm. long, 2–4.5 cm. broad, attenuate towards the base, the base very narrowly and shallowly cordate, very shortly repand-crenulate, pinnately veined, glabrous, biglandular on the upper surface at base, impressed granulo-glandular beneath, the primary veins 8–11 pairs; ♂ inflorescence simple, solitary, 2–5 cm. long, short-puberulous, glomerules many-flowered; bracts subtending the glomerules ovate-triangular, acuminate, entire, 2 mm. long, not patelliform-glandular within; flowers pale yellow or almost white, 3.5 mm. broad, on pedicels 2 mm. long; sepals 3, obovate, acute, outside puberulous and granulo-glandular, firm; stamens 15–17 with 4-locular anthers; ♀ flowers and fruit unknown.

Two collections are cited in the original description, *Ledermann 8912* and *9020,* alt. 850 m., Etappen Mountain, Northeast New Guinea. I have seen nothing which appears to match this description.

56. **Macaranga lanceolata** Pax & K. Hoffmann in Pflanzenr. 68 (IV. 147. XIV): 25. 1919.

Tree 15–20 m. high; young parts sparsely pilose but very quickly glabrate; stipules linear-lanceolate, stiffish, 2–3 mm. long, caducous; petioles 1–4 cm. long, slender; leaf-blades entire, chartaceous, 7–12 cm. long, 2–4 cm. broad, lanceolate, cuspidate-acuminate, at base suddenly contracted to about 2–2.5 mm. broad and extended downward to join the petiole, on the upper surface of this narrowed part bearing 2–4 shallow glands, pinnately veined with 6–9 pairs of inconspicuous primary veins, glabrous above, ± granulo-glandular beneath; ♂ panicle sparsely pilose, 3–5 cm. long, fascicled, branched from the base, rachis slender, glomerules many-flowered; bracts subtending the glomerules triangular, acute, 1 mm. long, not patelliform-glandular within; sepals 3, about 1 mm. long, pilose outside and granulo-glandular; stamens 5–8 with 4-locular anthers; ♀ panicle with branching and bracts similar to ♂; ♀ calyx 3-lobed; ovary 1-locular, densely granulo-glandular, the style 1–3 mm. long, lateral and papillose; capsule globose, smooth, about 3 mm. diameter, borne on a pedicel up to 5 mm. long.

Eight collections are cited by Pax & K. Hoffmann, all brought out from Northeast New Guinea by Ledermann from an altitude of 850–1000 m. I have seen a few leaves; they are very scantily granulo-glandular beneath, and the unusual character noted is the very narrow short base to which the petiole is joined. I have seen no material like these leaves in the collections at hand.

57. **Macaranga kostermansii** sp. nov.

Arbor 6 m. alta; ramulis gracilibus, breviter pilosis et granuloso-glandulosis; stipulis oblongis, 2–3 mm. longis, obtusiusculis, glabris vel costa pilosa; petiolo 2–10 mm. longo; laminis (1.5–) 2.5–4.5 cm. longis, (0.5–) 0.9–1.3 cm. latis, obovato-oblongis apice obtusis, basi obtuse cuneatis, supra glabris et prope basin maculari-2–4-glandulosis, subtus dense granuloso-glandulosis et glabris, novellis costa breviter pilosis, penninerviis, venis primariis 5–7 paribus patentibus deinde prope marginem adscendentibus et anastomosantibus, rete irregulari et inconspicuo; inflorescentiis ♂ tantum visis, 1–3 cm. longis, dense granuloso-glandulosis, simplicibus vel sparsim ramosis, axi puberulo; bracteis florigeris non patelliformi-glandulosis, parvis, ovatis, acutis, 1 mm. longis; calyce 3-lobato, 1–1.3 mm. longo; staminibus 5–9, antheris 4-locularibus.

NETHERLANDS NEW GUINEA: Angi Gita lake, Vogelkop, alt. 1800 m., *Kostermans 2099* (♂, A, TYPE), Oct. 1948 (tree 6 m. high; flowers greenish).

No other species of *Macaranga* from Malaysia in our herbarium has leaves as small as those found in this species. The characters may be summarized as follows: very small leaves; short and simple or one- or two-branched ♂ inflorescences with densely granulo-glandular flowers closely crowded in glomerules along the axis; calyx three-lobed to the middle; five to nine stamens with four-locular anthers.

58. **Macaranga inermis** Pax & K. Hoffmann in Pflanzenr. **63** (IV. 147. VII): 333. 1914.

Tree with young growth densely fulvous-tomentose but very soon glabrate; branchlets angled; stipules falling very quickly, 5 mm. long, ovate, acute, tomentulose on the outer surface; petioles 4–8 cm. long, glabrous; leaf-blades coriaceous, entire, ovate or elliptic, acute or short-acuminate, 12–16 cm. long, 7–8 cm. broad, obtuse at the base and bearing 2–4 spot-like glands on the upper surface adjacent to the attachment of the petiole, glabrous above, beneath densely granulo-glandular and glabrous or with a slight pubescence remaining along the midrib, pinnately veined with 9–12 pairs of prominent primary veins, the secondary veins distinct; ♂ inflorescence unknown; ♀ panicle tomentulose, 4–7 cm. long, with spreading branches; bracts 3–5 mm. long, triangular, acute, not patelliform-glandular within, each bract often subtending 2 flowers; pedicels up to 3.5 mm. long in fruit; ovary 1-locular, tomentulose and granulo-glandular, smooth, the style lateral, plumose; capsule subglobose, tomentulose.

NORTHEAST NEW GUINEA: forest of Kani Mountain, alt. 1000 m., *Schlechter 17740* (♀, A), May 1908.

Schlechter's specimen represents one of two numbers cited in the original description. Unfortunately the growing tips of both branchlets have been broken off so that I have not seen the stipules. Although I can match the leaves and the tomentulose axis and pedicels of the inflorescence with those of other collections, in the latter none of the capsules is so tomentulose as those on this specimen, in fact most of them are glabrous. It has not been an easy task to try to determine the abundant related collections at hand. Four closely related species have been described from New Guinea: *M. inermis, M. effusa, M. penninervia,* and *M. mallotiformis.* I have only a couple of carbon rubbings from leaves of *M. mallotiformis,* and one rubbing from a leaf of *M. effusa,* to represent these species. At present I am unable to accept them as distinct species, and the key to the § Inermes, Pflanzenr. **68** (IV. 147. XIV): 25, is inadequate for separating the species therein indicated.

58A. **Macaranga inermis var. mallotiformis** (Pax & K. Hoffmann) comb. nov.

Macaranga mallotiformis Pax & K. Hoffmann in Pflanzenr. **68** (IV. 147. XIV): 27. 1919.

Shrub or tree with pubescent new growth; stipules lanceolate or ovate-lanceolate, 3–8 mm. long, caducous or subpersistent; leaf-blades 6–15 cm. long, 2.5–8 cm. broad, pilose on the veins beneath or glabrous, densely granulo-glandular; ♂ panicle puberulous or sometimes almost glabrous, branching from near the base; bracts subtending the glomerules triangular, acute, hardly 1 mm. long, not patelliform-glandular within; calyx about 1 mm. long, 3-lobed; stamens 5–8 with 4-locular anthers; ♀ panicle puberulous; calyx 3-lobed and persistent; capsule 1-locular, smooth, somewhat oblique, densely granulo-glandular, glabrous, about 2 mm. diameter, the style plumose, quickly falling.

NETHERLANDS NEW GUINEA: occasional in rain forest, 15 km. SW of Bernhard Camp, Idenburg River, alt. 1750 m., *Brass & Versteegh 11933* (♀, A), Jan. 1939 (tree 21 m. high with white flowers; fruit yellow-brown); common in mossy forest seral growths, same locality, alt. 1800 m., *Brass 12062* (♀, A), Jan. 1939 (tree attaining 12 m.; bark a conspicuous pale gray; leaf-margins recurved at base); open place in mossy forest, same locality, *Brass 12145* (♂, A), Jan. 1939 (tree 2.5 m. high); frequent in primary forest, Bele River, 18 km. NE of Lake Habbema, alt. about 2270 m., *Brass & Versteegh 11122* (♀, A), Nov. 1938 (tree 25 m. high, 43 cm. diameter; bark gray, smooth; wood rose).

PAPUA: forest, Boridi, alt. 1500 m., *Carr 13153* (♂, A, BM), Sept. 1935 (tree 100 ft. tall); same locality, *Carr 13187* (♀, BM), Sept. 1935 (tree 80 ft.); same locality, *Carr 13328* (♂, A, BM), *13387* (♂, A, BM); same locality, alt. about 1400 m., *Carr 14446* (♀, BM), Oct. 1935 (tree 50 ft.); same locality, *Carr 14468* (♂, A, BM); same locality, alt. about 1500 m., *Carr 14562* (♂, BM), Oct. 1935 (tree about 50 ft. tall; flowers cream suffused red); same locality, alt. about 1650 m., *Carr 14603* (♀, A, BM); same locality, alt. about 1350 m., *Carr 14773* (♀, A, BM), Nov. 1935 (tree about 25 ft. tall; flowers and fruit green); Alola, alt. about 1950 m., *Carr 13735* (♂, A, BM), Dec. 1935 (tree about 100 ft. tall).

NORTHEAST NEW GUINEA: Black Cat — Bitoi, alt. about 1340 m., *McAdam 401* (♀, BR, LAE), Apr. 1939 (small tree 29/54/81 with small spurs, fluted to 10 ft., and trunk in wavy bends above 20 ft.; crown small and compact; bark reddish brown; blaze a green line lightening inward to cream, then red for major portion); Ogeramnang, alt. 1770–1800 m., *Clemens 4466* (♀, A), Dec. 1936; Sambanga, alt. 1500–1800 m., *Clemens 6955A* (♀, A), Sept. 1937; same locality, *Clemens 7604* (♀, A), Nov. 1937.

Most of the specimens cited above have glabrous mature leaves, but in *Brass 12062* and *12145* a few hairs may be found on the lower surface along the veins. Apart from the glabrous character most of these specimens fall within the range of the description of *M. mallotiformis* Pax & K. Hoffm. A few in the large series from Boridi show a transition in the size of the leaves to those of the isotype of *M. inermis,* and these, with the instability of the pubescence character, have brought me to believe that the differences are only of a varietal nature. An opportunity to examine the cited collections of *M. mallotiformis* and more material of *M. inermis* might reveal other differences which are specific.

58B. **Macaranga inermis** var. **penninervia** (Pax & K. Hoffmann) comb. nov.

Macaranga penninervia Pax & K. Hoffmann in Pflanzenr. **68** (IV. 147. XIV): 26. 1919.

? *Macaranga effusa* Pax & K. Hoffmann in Pflanzenr. **68** (IV. 147. XIV): 26. 1919.

Glabrous tree; stipules subpersistent, about 8 mm. long, concave, acute; petioles 5–8 cm. long; leaf-blades coriaceous and entire, elliptic, 12–17 cm. long, 6.5–11 cm. broad, short-acuminate, acute at the base and bearing 2 flat glands on the upper surface near the attachment of the petiole, densely granulo-glandular beneath, pinnately veined and net-veined, the primary veins 10–12 pairs; ♂ panicle 5–7 cm. long, divaricately branched, granulo-glandular; bracts subtending the glomerules triangular-ovate, concave, 2 mm. long, not patelliform-glandular within; calyx 3-lobed; stamens 5–8 with 4-locular (very rarely 3-locular) anthers; ♀ panicle similar to ♂; calyx 3-dentate; capsule 2–3 mm. diameter, densely granulo-glandular, smooth.

NETHERLANDS NEW GUINEA: Barara, Wissel Lake region, *Eyma 5168* (♂, A, BO), *5169* (♀, A, BO), Sept. 1939.

The specimens cited here are very densely granulo-glandular on the lower surface of the leaves and on the inflorescence; the upper surface of the leaves is also granulo-glandular or minutely punctate, a feature characteristic of young leaves, but usually not persisting.

Macaranga effusa Pax & K. Hoffm. has been placed in the synonymy with a query. Without authentic material to examine, it seems to me to be only a vigorous growth of this variety with which it is placed. Possibly I have overlooked some significant character in the description. It is true that the ♂ flowers are described as having nine to twelve stamens, and I have seen none in the varieties with more than eight; however, in a genus where the number of stamens is variable, the variation between eight and nine cannot be considered distinguishing.

58C. **Macaranga inermis** var. **plurifoveata** var. nov.

A forma typica differt laminis 9–18 cm. longis, 5.5–11.5 cm. latis, basi supra 3–8-foveatis, venis primariis 10–14 paribus; ♂ paniculis 5–8 cm. longis, bracteis triangularibus 1 mm. longis, non patellari-glandulosis; calyce 3-lobato, puberulo, granuloso-glanduloso, staminibus 5–7, antheris 4-locularibus; capsula 1-loculari, granuloso-glandulosa, parce puberulo-tomentulosa.

NETHERLANDS NEW GUINEA: occasional in primary forest, 6 km. SW of Bernhard Camp, Idenburg River, alt. 1230 m., *Brass & Versteegh 12591* (♂, A, TYPE), Feb. 1939 (tree 24 m. high, 56 cm. diameter; bark black; wood red; flowers gray); occasional in primary forest, 15 km. SW of Bernhard Camp, Idenburg River, alt. 1480 m., *Brass & Versteegh 11979* (♀, A), Jan. 1939 (tree 29 m. high, 40 cm. diameter; bark black; wood red-brown; fruit brown); Angi. Arfak Mts., in the forest by Iray, Lake Giji, alt. 1900 m., *Kanehira & Hatusima 13750* (♂, A, BO), April 1940 (tree 10 m.); Angi Gita

Lake, Arfak, alt. 1800 m., *Kostermans 2328* (♀, A, BO), Oct. 1948 (tree 5 m. high).

This variety differs from the other material of this alliance chiefly in the pit-like glands on the upper surface around the attachment of the petiole.

59. **Macaranga pleiostemona** Pax & K. Hoffmann in Pflanzenr. 68 (IV. 147. XIV) : 24. 1919.

Glabrous tree to 15 m. tall with branchlets often drying striate; the linear-subulate stipules 4 or 5 mm. long and caducous; petioles 1–2.5 cm. long; leaf-blades linear-lanceolate, acuminate or acute, 11–20 cm. long, 2–4 cm. broad, narrowed towards the minutely cordate or truncate base, on the upper surface adjacent to the petiole attachment bearing 2 oblong flat glands and here the margin recurved, beneath very densely granulo-glandular, strongly feather-veined with 12–20 pairs of primary veins spreading-ascending and arcuate near the denticulate margin; ♂ panicle granulo-glandular, 3–6 cm. long with a few short branches; the triangular bracts subtending the glomerules about 1.3 mm. long, 1.5 mm. broad, not patelliform-glandular within; the acutish ♂ bud 2 mm. high and almost as broad; stamens 38–53 with 4-locular anthers; ♀ panicle 4 cm. long and few-branched; pedicels 1–2 mm. long in the flower to 4 mm. long in the fruit, subtended by a small triangular bract; the 1.5 mm. long calyx deeply 3-lobed (lobes about 1 mm.); ovary 1-locular and densely granulo-glandular with 1–5 short processes (0.5 mm. long) near the apex, the style lateral, about 3 mm. long and densely papillose; capsule very small, 2.5 mm. diameter with usually 1 or 2 processes or none, the seed 2 mm. diameter, minutely rugulose.

NETHERLANDS NEW GUINEA: Prauw bivouac, Tigmeerlake — Enarotali, Lake Tigi, alt. 1650–1750 m., *Eyma 4884* (♂, A, BO); brushy seral growths on old stone wash, Balim River, alt. 1600 m., *Brass 11663* (♀, A), *11664* (♂, A), Dec. 1938 (tree 2 m. high).

NORTHEAST NEW GUINEA: open woods, Wantoat (Wantot), alt. about 1200 m., *Clemens 40911A* (♀, A), Feb. 1940; forest margin, Yunzaing, alt. about 1350 m., *Clemens 3279* (♂, A), June 1936 (tree 5 inches diameter breast high; flowers white).

Superficially this species suggests a narrow-leaved form of *M. angustifolio* having the two oblong flat glands near the petiole attachment, a profusion of minute glands on the lower surface of the leaf, small fruits with one or two processes (or none); *M. pleiostemona* differs, however, in having rather numerous stamens and very inconspicuous bracts without patelliform glands on the upper surface, also the fruits are hardly fascicled, often two from a node but not usually three or four or more, as in *M. angustifolia.* In the Clemens collections the leaves are more nearly acute than acuminate.

59A. **Macaranga pleiostemona f. pubescens** forma nov.

A forma typica differt partibus juvenilibus etiam axibus et bracteis inflorescentiae, pedicellis et calycibus minute pubescentibus.

PAPUA: forest, Boridi, alt. about 1500 m., *Carr 14588* (♂, A, BM), Oct. 1935 (tree about 17 ft. tall); open country, Boridi, alt. about 1200 m., *Carr 14837* (♂, A, BM), Nov. 1935 (tree about 15 ft. tall); secondary forest, Isuarava, alt. about 1350 m., *Carr 15347* (♂, A, TYPE; BM), *15348* (♀, A, BM), Feb. 1936 (tree about 10 ft. tall).

These collections differ from those cited for the species in having pubescent new growth and pubescent inflorescences. While this is not a heavy pubescence (it might be called a puberulence), it is particularly noticeable around the axils of the bracts. Sometimes a few hairs occur on the ovary, but these quickly disappear. I searched the fruits of this form carefully for processes before finding three with one process each; in the typical species a fruit usually has one process. It should be pointed out that there is considerable variation in the number of stamens also, in five flowers counted I found 32, 38, 45, 46, and 59 stamens respectively.

DOUBTFUL SPECIES

Macaranga brunneo-floccosa Pax & K. Hoffmann in Pflanzenr. 68 (IV. 147. XIV): 28. 1919.

Macaranga brunneo-floccosa var. *β calvescens* Pax & K. Hoffmann l. c.

Tree 10–12 m. tall with densely ferrugineous floccose tomentum on the branchlets, petioles, stipules, and young leaves, tardily glabrate; stipules lance-oblong, 2 mm. long, caducous; leaf-blades entire, coriaceous, rhombic-ovate or broadly elliptic, 7–15 cm. long, 3.5–10 cm. broad, shortly and abruptly acuminate, obtuse or rounded at the base, not glandular on either surface, on maturing glabrous above except for the pubescent veins, the tomentum appearing here and there in small patches on the under surface, probably finally glabrous, 3-nerved at the base with 3–5 pairs of primary veins above the basal ones, the secondary venation distinct on the lower surface; ♂ panicles about 4 cm. long, irregularly branched, densely hairy with very fine crisped hairs and sparsely granulo-glandular; bracts subtending the glomerules ovate, 1.5 mm. long, not patelliform-glandular; sepals 3, concave, crisply hairy; stamens ± 10 with 4-locular anthers; ♀ inflorescence unknown.

There are in our herbarium the following collections from Netherlands New Guinea, characterized by floccose tomentum, and the lack of granular glands on the leaves: *Brass & Versteegh 13163* (♀); *Brass 12711* (♂); *Kostermans 2232* (♂) and *2292* (♂); and *Kanehira & Hatusima 13470* (♂). The leaves of *Brass & Versteegh* correspond in size and glabrescence to those in the description of *M. brunneo-floccosa*, var. *β calvescens*. The capsule appears to be four-lobed but when dissected there are only two locules with one ovule in each, but the locules are densely hairy inside, a character not observed in the other species of *Macaranga*. So far as the ♂ material is concerned, I see no reason for excluding it from *Macaranga*; but my lack of knowledge of the other genera of this large and diverse family has led me to place this as a doubtful species.

Another collection, *Brass 5052*, with large peltate leaves and villous-tomentose pubescence has all the characters of *Macaranga*, as far as I can judge from the specimen at hand, excepting the dense coat of longish hairs inside the locules of the capsules.

In addition to the above I have at hand several collections of unnamed *Macaranga*, some of which may possibly be new but are not sufficiently distinctive to describe or comment on without supplementary material.

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STUDIES IN THE BORAGINACEAE, XXV
A REVALUATION OF SOME GENERA OF THE LITHOSPERMEAE

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AS A BACKGROUND for a study of *Lithospermum* and its immediate relatives it has been necessary to investigate and determine the characters of some of the other genera included in the Lithospermeae. It has been surprising to discover that most of these latter genera have a variety of interesting features that have gone unmentioned in published accounts of them. So much of interest was found that it has seemed desirable to prepare new and more complete descriptions of these genera and also to discuss their characters and relations. Six genera, all confined to the Old World, are so treated in the present paper.

The general affinities of the genera treated are well indicated by their pollen morphology. *Lithodora* appears to be a highly specialized derivative of the *Lithospermum*-complex, notable chiefly for its frutescent habit and aberrant nutlets. Its pollen has eight pores and a form duplicated also in *Lithospermum* and its close allies. The remaining five genera discussed appear to be more closely related to one another than to *Lithospermum* or its close allies. Except in one section of *Moltkia* their pollen is 3-pored and hence of a type different from that in *Lithospermum* and its immediate allies. As a group the five genera are also notable for the frequent development of bent nutlets and for the recurring manifestations of bilateral symmetry in their corolla and androecium.

The six genera discussed may be distinguished by the following key:

Nutlets circumscissile above the base, their major seminiferous portion falling away, leaving the true base persisting as a usually cupulate appendage permanently affixed to the gynobase; corolla without annulus or appendages; pollen ellipsoidal or somewhat ovoid, pores usually 8, borne at or slightly below the middle of the grain; body of nutlet straight. .... 1. *Lithodora*.
Nutlets detaching completely from the gynobase.
  Corolla without annulus; stamens all affixed at the same height on the corolla; pollen globose or globose-ellipsoid, pores 3–8, equatorial; body of nutlet somewhat bent.
    Corolla without appendages; lobes short, broadly imbricate in the bud, becoming erect; style exserted only after the corolla is fully developed; anthers not ciliate; pollen with 3–8 pores. .... 2. *Moltkia*.
    Corolla with squamate appendages between the base of the filaments; corolla-lobes elongate, very narrowly imbricate in the bud; style precociously exserted, protruding from the incompletely developed corolla; anthers having the margins of the theca ciliate with crowded stout hairs; pollen with 3 pores. .... 3. *Halacsya*.

Corolla with annulus developed; stamens usually affixed at unequal heights on the corolla; pollen usually conic-ovoid with the sides straight and convergent above the broad rounded base, pores 3, borne above base of the grain.

Nutlets very strongly and conspicuously bent, attachment small and substipitate; stamens deeply included, never exserted from the corolla, sometimes all affixed at the same height on the corolla but usually with the 2 adaxial ones affixed lower than the other 3; filaments very short; anthers with a narrow connective to which the filament is directly affixed, lacking a pit in the connective; corolla usually with appendages at the base of the deep throat or near the middle of the tube, these appendages alternating with the stamens and borne near or somewhat above the level of the filament-attachments; corolla usually glanduliferous inside; style deeply included, usually less than half the length of the corolla. .... 4. *Alkanna.*

Nutlets straight or rarely weakly bent, attachment sessile and usually broad; stamens some or all usually exserted from the corolla-throat, sometimes affixed at the same altitude on the corolla but usually with the 2 adaxial members highest or the abaxial one lowest on the corolla; filaments usually very elongate; filaments affixed to the anthers in the depths of a pit located near the middle of the relatively broad connective; corolla without any appendages alternating with the stamens and never glanduliferous inside; style usually elongated and usually exserted at least beyond the throat of the corolla.

Annulus composed of a minute collar or of a ring of 5–10 minute sparingly hairy lobes, borne very close to (less than 1 mm. above) the corolla-base; style almost always 2-lobed; corolla facing backwards over the curved top of the cyme and more or less distinctly resupinate. .. .. 5. *Echium.*

Annulus developed well above (1.5–6 mm. above) the corolla base and represented by 5 evident, densely villous swellings or 5 squamose appendages borne one below the attachment of each stamen; style always simple; corolla usually erect, rarely resupinate; South Africa. .... 6. *Lobostemon.*

1. **Lithodora** Griseb. Spicileg. Fl. Rumel. **2**: 85 (1844); Reichenb. Icon. Fl. Germ. **18**: 66, t. 1315 (1858); Johnston, Contr. Gray Herb. **73**: 55 (1924); G. Stroh, Beih. Bot. Centralbl. **58**^{B}: 211 (1938). Type species *L. fruticosum* L.

Lithospermum § *Lithodora* Boiss. Fl. Orient. **4**: 219 (1879).

Plant perennial, fruticose. Leaves veinless or nearly so. Cymes small, lax, 1–10-flowered, not scorpioid. Calyx 5-parted, lobes narrow, subequal, slightly accrescent at maturity. Flowers heterostylic or monomorphic. Corolla blue or purple, funnelform, with a cylindric tube and a short obconic throat, outside glabrous or hairy; lobes ascending or spreading, rounded ovate or suborbicular, imbricate in the bud; throat without appendages, glabrous or bearing stipitate glands or sometimes villose; tube glabrous inside, lacking a basal annulus [1] or vestiges of it. Stamens affixed low in the throat and all borne at the same level, or the stamens affixed at unequal heights in the throat of the individual corolla. Filaments filiform, much shorter than the anthers or nearly as long or even longer, in heterostylic species short filaments associated with long-styled flowers and long filaments with short-styled ones, in species having stamens borne at unequal heights on the throat the lower stamen usually with the shortest filament. Anther oblong, usually several times longer than broad, affixed medially or slightly submedially, included or slightly exserted only in some short-styled flowers, base emarginate, apex obtuse or retuse, thecae usually united almost to the base but in one species these more or less separate below their middle. Style filiform and frequently somewhat laterally compressed, usually either shorter than the calyx or about twice as long, simple or somewhat forked at the summit, included or shortly exserted from the throat; stigmas 2, terminal and juxtaposed on the tip of the simple style or one terminating each of the short stout lobes of the apically forked style. Pollen small, 18–25 × 15–23 μ, ellipsoidal or somewhat ovoid; pores usually 8, borne in a single row around the grain at or slightly below the equator. Nutlets straight, ovoid or ovoid-cylindric, commonly only one maturing, smooth or very abundantly and minutely muriculate, turberculate or rugulose, with a prominent ventral keel (ventral suture fused, obscure), at maturity developing a circumscissile abscission above the base, the major seminiferous portion of the nutlet detaching and falling away, leaving the short sterile basal section to form a usually cupulate appendage permanently affixed to the low pyramidal gynobase; attachment scar of detached nutlets basal, horizontal, or slightly oblique, nearly as broad as long, bearing a projecting indurate appendage; appendage usually peg-like and nearly central but in one species angulate, somewhat pyramidal, and occupying most of the dorsal half of the scar.

The genus *Lithodora* has been recognized by few authors. Its species have been almost universally assigned to *Lithospermum,* and because of general similarities in fruticose habit even associated with species referable

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[1] The term **annulus** is applied to the usually minute appendages borne inside the corolla-tube usually just above its very base. Though in some species and genera it is never developed, in most Boraginoideae it is usually represented either by a tumid ring, a narrow annular ridge, or a collar-like structure, or, perhaps more commonly, by a ring of 5–10 small equidistant lobes borne just above the corolla-base. When present the annulus is usually appressed against the base of the ovary and apparently functions in limiting access to the nectary beneath the ovary. Only in a few genera, such as *Onosma,* are the lobes of the annulus themselves apparently nectariferous. Because of this it seems desirable to substitute the appellation *annulus* for "tube-nectary," which I have used in several previous papers of this series. The annulus is a structure that has been generally ignored by students of the Boraginaceae, although its usefulness in classification was long ago indicated by Bunge, Heliocarya 10–11 (1871). For some recent notes on its function see H. Schaefer, Bot. Jahrb. 72: 319 (1942).

to *Moltkia* and *Buglossoides*. As a matter of fact the genus is probably not very closely related to the genera mentioned. Actually it is one of the very distinct members of the *Lithospermeae*. It has nutlets of a type that is unique in the whole Boraginaceae. Only in a group of plants that has had no over-all critical re-examination for over a hundred years, such as the *Lithospermeae*, could the unusual features of this genus have gone so long unrecognized.

The species of *Lithodora* are low shrubs which frequent cliffs and other exposed rocky places. One species ranges in western France (north to Brittany) and in western portions of the Iberian peninsula and Morocco. The six other congeners occur in restricted areas scattered in the Mediterranean region as far east as coastal Anatolia.

The distinctive features of the fruits of *Lithodora* are all associated with the fact that the nutlets are freed from the gynobase not by a basal, but a suprabasal abscission. In all *Boraginoideae* other than *Lithodora* the abscission is developed at the very base of the nutlet at the level where the latter becomes differentiated from the gynobase. In such genera as *Lithospermum*, which may agree with *Lithodora* in having erect basally affixed nutlets, the abscission, usually plane, is exactly basal, and as a result the complete nutlet is freed from the gynobase. In *Lithodora*, however, a basal section of the nutlet never becomes detached from the gynobase. The abscission freeing the major seminiferous portion of the nutlet develops not at the morphological base of the nutlet but distinctly (0.5–1 mm.) above it. As a result, when the fertile upper section of the nutlet detaches, a short basal section of it remains as a persisting saucer-shaped or cup-shaped appendage on the gynobase. The condition is unique. It distinguishes *Lithodora* from all other genera of the Boraginaceae.

Since the attachment end of the freed nutlets is not the morphological base of the nutlet, it is not surprising that its attachment scar should have peculiarities. The scar may be horizontal or slightly oblique but is never plane, as is prevalent with the nutlets of genera related to *Lithospermum*. In six of the seven species of *Lithodora*, the attachment surface bears near its center a vertical peg-like appendage 1–2 mm. long. This appendage is composed of indurate tissue that surrounds the tubular canal through which the ovule was formerly supplied by a vascular strand arising from the gynobase. On the detached nutlets of *L. rosmarinifolia*, *L. moroccana*, *L. oleaefolia* and *L. diffusa*, the canal within the appendage is usually empty. The section of the funicular strand which formerly occupied it remains attached to the basal section of the nutlet, and like a bristle arises from the center of that cup-like structure. In *L. fruticosa* the base of the detached nutlet has different features. The dorsal half of the base is occupied by a solid, irregular, somewhat pyramidal mass of salient indurate tissue. An angular excavation may occupy most of the ventral half of the base. The projecting rough pyramidal mass contains two embedded vascular strands but no tubular canal. This appendage on the detached nutlets of *L. fruticosa* not only has a more dorsal position on the base, it has a structure that is different from the peg-like appendage on the nutlets of the other species of the genus. In the latter the appendage is made up of hardly more than the bony walls of the funicular canal. In *L. fruticosa* the funicular canal is not included in the appendage. The canal for the funicle has a course paralleling and just inside the ventral keel of the nutlet and continues so downward to just below the abscission. In the portion of the nutlet remaining affixed to the gynobase, its lower course is apparently marked by a ridge sloping downward and inward towards the middle of the cup-like structure. The canal remains close to the ventral wall of the nutlet and joined to it.

The prominences on the base of the detached nutlets of *Lithodora* have a superficial similarity to the strophiolate outgrowths on the attachment surface of the nutlets of the *Anchuseae.* They are, however, morphologically very different structures. The nutlets of the *Anchuseae* detach completely from the gynobase. Their prominent, rounded, plug-like attachment surface is oily and parenchymatous (an elaiosome) and is seated in a socket in the gynobase, cf. Bacin, Bul. Fac. de Ştilnţe, Cernauţi 9: 123–169 (1935). The prominences on the attachment scar of nutlets in *Lithodora* are bony tissue formerly filling a basal section of the nutlet that never becomes freed from the gynobase.

The androecium of *Lithodora* shows considerable diversity and presents some unusual developments. Heterostyly is well developed in five of the seven species. In flowers with long styles the stamens are borne low in the corolla-throat on filaments much shorter than the anthers (usually about a quarter as long) while in short-styled flowers the stamens are borne slightly higher in the throat on filaments equaling or even slightly longer than the anthers. The dimorphism here involves not merely differences in style length and the height at which stamens are affixed in the throat, but also length of filaments. Among the Boraginaceae I know of only one other example with this particular type of dimorphism, viz., *Lithospermum hispidissimum,* cf. Jour. Arnold Arb. **33**: 325 (1952). Unlike that species, however, the five members of *Lithodora* show no dimorphism in pollen. In *Lithodora* the pollen of long- and short-styled flowers is indistingishable. Illustrations of the dissected corollas of *L. hispidula, L. oleaefolia, L. Zahnii,* and *L. rosmarinifolia* are given by Spengler, Oesterr. Bot. Zeitschr. **68**: 115, t. 1, f. 18, 20, 21 and 22 (1919), but by coincidence only the short-styled corollas of all these species were selected for illustration.

Lithodora fruticosa presents a very simple form of heterostyly. As in the species previously described, the flowers have either a short style, reaching about half way up the corolla-tube, or a long one which may equal the corolla-tube or become shortly exserted from it. In *L. fruticosa,* however, there is no concomitant dimorphy in the androecium. The stamens always have short filaments and are always borne in the same relative position low in the corolla-throat, cf. Spengler l.c., t. 1, f. 17. Heterostyly in this species appears to be reduced to its simplest expression, dimorphy of style only.

In *L. diffusa* the androecium deviates in organization from that in all other species of the genus. The flowers are not at all heterostylic. The stamens are not equal nor verticillate. The five stamens within a flower differ in length of filament and in the altitude at which each is attached above the corolla-base. There are three uppermost stamens borne at nearly the same level. Below these there is a fourth stamen attached at middle height and below that a fifth, obviously affixed lowest down in the corolla-throat. The distance between the attachment points of the highest and lowest stamens may be 1.5–3 mm. Associated with the varying heights above the corolla-base at which the stamens are attached is also a variation in the length of the filaments. The higher the position of the stamen the longer its filament. The lowest stamen, accordingly, is distinguishable not merely by its low attachment but by the shortness of its filament as well. Its position on the corolla relative to the axis of the cyme (whether axial or abaxial) I have been unable to determine with certainty. The anthers in most species of *Lithodora* are elongate, usually several times as long as broad. In *L. diffusa* they are proportionately shorter, usually less than twice as long as broad, and instead of having merely emarginate bases usually tend to be distinctly lobed below their middle. Plants of *L. diffusa* have either a long style in the flower or a short one. From the collections examined I can find no evidence that individual plants differing only in style length grow together in one locality. Interestingly, all the plants seen from northern portions of the geographic range of the species have long styles only, whereas those from the south have only short styles. The indications are that in *L. diffusa* style length varies only as a character of geographic races.

The pollen of *Lithodora* is small, 18–25 × 15–23 μ, and usually ellipsoidal or ovoid. It is circular in polar profile. The eight pores are inconspicuous and are arranged around the grain in a single row on the equator or slightly below it. None of the species of the genus have distinctive pollen, and there is no difference in the grains of long- and short-styled flowers of heterostylic species. In some species individual plants producing somewhat ovoid grains with submedial pores appear to be more common than those producing ellipsoidal grains with equatorial pores. In other species the reverse condition prevails. In varying degrees, however, the variation from ellipsoidal to ovoid is observable among individuals in all the species.

The bracted inflorescence is short, loose, and few-flowered, and not at all markedly differentiated from the leafy mass of the plant. It commonly bears three to seven flowers (rarely as many as ten), and even at maturity is not at all scorpioid.

When he established *Lithodora,* Grisebach gave a generic description and listed six species of *Lithospermum* referable to the proposed genus, viz., *Lithospermum fruticosum* L. ("cum forma brevistyla: *L. rosmarinifolio* Ten."), *L. hispidulum* Sm., *L. calabrum* Ten. (known only from description), *L. oleaefolium* Lois. (no flowers seen) and as "parum a ceteris aberrant," also *L. prostratum* Lois., and *L. graminifolium* Viv. Of the six species mentioned *L. calabrum* belongs to *Buglossoides* and *L. graminifolium* to *Moltkia.* Two species, *L. prostratum* and *L. graminifolium,* Grisebach considered aberrrant, for as he states, they have characters not in accord with his diagnosis of *Lithodora*. Grisebach knew *L. calabrum* only from the literature and had only incomplete specimens of *L. oleaefolium*. His concept of *Lithodora*, accordingly, must have been founded primarily upon *L. fruticosum* and *L. hispidulum*. Of these two the former is selected as type of the genus. It is to be noted that at the time he founded the genus *Lithodora*, Grisebach made no new binomials under that genus. He merely listed species of *Lithospermum* referable to it. Five new combinations (for all the species mentioned except *L. rosmarinifolium*) are, however, legitimately published in the index concluding the volume. The two volumes of Grisebach's "Spicilegium Florae rumelicae et bithynicae" were published in six fascicles issued over a period of three years. The description of *Lithodora*, vol. 2, p. 85, was included in Heft 5 (pp. 1–160) issued in mid-1844, cf. Flora **1844**^{2}: 526, Aug. 14, 1844. The index concluding volume 2 was included in the Double Heft, 5–6 (pp. 161–548) issued early in 1846, cf. Flora **1846**: 96, Feb. 14, 1846, and Bot. Zeit. **4**: 226, March 27, 1846. Although published in the same volume, Grisebach's genus bears the date 1844, whereas his binomials under that genus date from 1846.

Gymnoleima Decne. (1844) has been treated as a synonym of *Lithodora*, but I have typified it by *Lithospermum graminifolium* Viv. and placed it as a synonym of *Moltkia*.

Section **Allostema**, sect. nov.

Flores evidenter dimorphi. Stamina sub altitudinibus aequalibus inserta; eis in flores stylum longiorem gerente basim versus faucium orientibus, filamentis quam antheris brevioribus donatis; eis in flore stylum breviorem gerente supra medium faucium orientibus, filamentis antheris aequilongis vel longioribus donatis. Antherae elongatae basi emarginatae. Nuculae laeves vel (ea L. hispidulae) muriculatae cicatrice appendiculam erectam gracilem elongatam canale funiculari inclusam proferente donatae.

Lithodora rosmarinifolia (Ten.) Johnston, Contr. Gray Herb. **73**: 56 (1924).

Lithospermum rosmarinifolium Ten. Fl. Neap. Prodr., Suppl. **2**: 66 (1811–13) and Fl. Neap. **3**: t. 114 (1811–15).

Known only from southern Italy, Sicily, and northeastern Algeria. Shrub to 6 dm. tall; stem and narrow elongate leaves strigose (hairs usually less than 1 mm. long, closely appressed, all antrorse); corolla evidently hairy outside, throat sparsely glanduliferous inside; calyx short, base becoming distinctly thickened and ribbed at maturity; nutlets smooth.

Lithodora moroccana, sp. nov.

Lithospermum diffusum var. *micranthum* Faure & Maire in Maire, Bull. Soc. d'Hist. Nat. Afr. du Nord **22**: 56 (1931).

Known only from Morocco. Shrubby with prostrate stems, plant less than 1.5 dm. tall; stems and narrow elongate leaves clothed with slender loosely appressed hairs (0.8–2 mm. long) which are partly antrorse and partly retrorse; corolla evidently hairy outside, inside with sparsely glanduliferous throat; calyx short, the base becoming thickened and ribbed at maturity; nutlets smooth.

Frutex depressa 5–15 cm. alta cinerea; caulibus prostratis lignosis ramosis vetustiore decorticatis, ramulis foliatis 1–10 cm. longis erectis vel adscendentibus dense hispido-villosis pilos gracillimos rigidulos 1.5–2.5 mm. longos juventate adscendentes mox erectos deinde retrorsos gerentibus; foliis oblanceolatis 1–2.5 cm. longis 2–6 mm. latis margine saepe revolutis, facie superiore pilos gracillimos 0.8–2 (saepe ca. 1) mm. longos laxe antrorseque adpressos e basi bulbosa vel rariter discoidea orientes gerentibus, facie inferiore pilis albis abundantibus gracillimis laxe appressis alii antrorsis alii retrorsis gestis indumento denso albo laxe appresso praeditis; calyce 5–6 mm. longo tubo corollae conspicue breviore sessili maturitate basi evidenter incrassato, lobis cuneatis; corolla 15–18 mm. longa, extus pilis numerosis gracilibus antrorsis gesta, limba ca. 1 cm. diametro, lobis rotundis 3–3.5 mm. longis 2.5–3 mm. latis ascendentibus, faucibus inconspicue glanduliferis, tubo 12–16 mm. longo intus glabro; antheris elongatis 1.5–2 mm. longis; filamentis aequalibus, in floribus stylum longum gerentibus supra medium tubi corollae (6–9 mm. supra basim tubi) affixis brevis ca. 0.5 mm. longis, in floribus stylum longum gerentibus longioribus 1.5–2 mm. longis apice tubo corollae affixis; stylo 6–7 mm. longo et paulo supra medium tubi corollae attingente vel 12–17 mm. longo et tubo aequilongo vel longiore; nuculis erectis albis laevibus 2.7–3.7 mm. longis.

MOROCCO: env. de Debdou, rocailles et rochers dominant le Camp Roumons, 100–1200 m., Apr. 4, 1928, *Briquet 227* (G); Debdou, ad rupes supra Castra Roumens, ca. 1300 m., Apr. 10, 1928, *Wilczek & Dutoit 294* (Kew); Monte Bu-Ibdiren (Beni-bu-Yahi), coteaux calcaires, Jan. 23, 1931, *Mauricio 7946* (G); Monte Bu-Ibdiren, Apr. 22, 1934, *Mauricio & Sennen 7946* (TYPE, Brit. Museum); Beni Snassen, Taforalt, broussailles du Djebel Metchick, 1050 m., 1930, *A. Faure* (G); above Xauen in El Rif, 4500–5500 ft., limestone, April 14, 1939, *Peter Davis 462* and *468* (Kew).

Although confused with *L. diffusa,* this plant is actually very much more closely related to *L. rosmarinifolia.* From the latter it differs in its depressed habit and its indument of much longer, more loosely appressed hairs. In *L. rosmarinifolia* the indument is distinctly strigose, the hairs being much shorter than those of *L. moroccana* and very much more closely appressed. Furthermore they are always antrorse. In the short-styled flowers of *L. moroccana* the filament and anthers are about equal in length. In comparable flowers of *L. rosmarinifolia* the filaments are longer than the anthers.

Lithodora oleaefolia (Lapeyr.) Griseb. Spicileg. Fl. Rumel. 2: 531 (1846).

Lithospermum oleaefolium Lapeyr. Hist. Abr. Pl. Pyr., Suppl. 28 (1813); Stapf, Bot. Mag. **149:** t. 8994 (1924).

Local in the eastern Pyrenees. Plant shrubby, with slender, loosely decumbent stems; larger leaves 7–13 mm. broad, margins obscurely if at all revolute, lower surface with a dense white indument of abundant slender appressed hairs; corolla evidently hairy outside, inside with the throat sparingly glanduliferous; calyx at maturity divided into slender elongate lobes, base not thickened; nutlets smooth and shiny.

Lithodora Zahnii (Heldr.) Johnston, Contr. Gray Herb. 73: 56 (1924).

Lithospermum Zahnii Heldr. in Halacsy, Verh. Zool.-Bot. Ges. Wien **49:** 190 (1899).

Lithospermum fruticosum sensu Sibth. & Sm. Fl. Graecae **11:** 52, t. 161 (1813).

Mountains of Greece. Low shrub becoming 4 dm. tall, branches ascending and more or less regularly dichotomous. Leaves *Lavendula*-like, narrow, elongate and strongly revolute, 2–4 cm. long; corolla glabrous inside and out, throat not glanduliferous; calyx divided at maturity, the lobes not rigid, 8–11 mm. long, base not thickened; nutlets smooth, lustrous.

In this species the cupulate base of the nutlet, remaining joined to the gynobase, is well developed, commonly 1 mm. high. In *L. rosmarinifolia, L. moroccana*, *L. oleaefolia*, and *L. diffusa* a section of the funicular strand normally remains affixed in the depth of the persisting cup and arises bristle-like from within it. This section of strand is that formerly occupying the tubular canal in the appendage on the lower end of the detached nutlet. In *L. Zahnii* the strand remains within the canal of the detached nutlet, and there is, accordingly, no bristle-like section of it arising inside of the cupule.

Lithodora hispidula (Sibth. & Sm.) Griseb. Spicileg. Fl. Rumel. 2: 531 (1846).

Lithospermum hispidulum Sibth. & Sm. Prodr. Fl. Graecae **1:** 114 (1806) and Fl. Graec. **2:** 53, t. 162 (1813).

A low, twiggy, stiffly much branched shrub 1–3 dm. tall, restricted to islands and coastal regions of the eastern Mediterranean (Crete to southwest Turkey). Corolla glabrous inside and out, throat not glanduliferous; leaves small, spathulate to oblanceolate, less than 15 mm. long, usually ciliate with stout pungent hairs; calyx at maturity with a thick base and a short but distinct tube 1.5–2 mm. long; lobes rigid, 5–6 mm. long; nutlets dull, abundantly and minutely muriculate.

The most mature fruiting structures seen of this species are some with practically mature nutlets still firmly affixed. In these the basal section of the nutlet (that affixed to the gynobase), unlike that in other species of the genus, is longer than thick, and short-cylindric rather than cupulate in form. In collections of other species with a little search one can usually find some old calyces still persisting on the plant after the nutlets have been matured and freed. In such old calyces the persisting base of the nutlet is studied to best advantage. Although eight collections of *L. hispidula* have been examined, in none of them have old calyces been found persisting.

Section **Eulithodora.**

Flowers not truly heterostylic; style long or short, but the stamens (all borne at the same level) constant as to position on the corolla and as to length of filaments. Corolla glabrous or with some hairs on the outer surface of the lobes; throat glabrous, not glanduliferous. Nutlets minutely and longitudinally striate, strongly constricted just above the base, attachment scar bearing a somewhat pyramidal angulate projection.

Lithodora fruticosa (L.) Griseb. Spicileg. Fl. Rumel. 2: 531 (1846).

Lithospermum fruticosum L. Sp. Pl. 133 (1753).
Lithospermum consobrinum Pomel, Nouv. Mat. Fl. Atlant. 296 (1874).
Lithodora consobrina (Pomel) Johnston, Contr. Gray Herb. **73**: 56 (1924).

A species native to southeastern (Mediterranean) France, middle and eastern Spain, and the coast of Algeria. In vegetative condition sometimes confused with the very different *L. diffusa*, but readily distinguished by having short, more closely appressed hairs on the herbage, usually more revolute leaf-margins, and lower leaf surface distinctly pallid from minute (0.2–0.3 mm. long), very closely appressed white hairs.

Section **Lasioglottis,** sect. nov.

Flores monomorphi. Stamina sub altitudinibus inaequalibus inserta; filamentis inaequalibus. Corollae extus saepe strigosae; faucibus intus antrorse villoso-strigosis et non rariter glanduliferis. Nuculae minute abundanterque tuberculatae opacae cicatrice appendiculam erectam gracilem elongatam canale funiculari inclusam proferente donatae.

Lithodora diffusa (Lag.) Johnston, Contr. Gray Herb. 73: 56 (1924).

Lithospermum diffusum Lag. Varied. Cienc. **4**^{4}: 39 (1805).
Lithospermum prostratum Lois. Fl. Gall. 105 (1806).
Lithodora prostrata (Lois.) Griseb. Spicileg. Fl. Rumel. **2**: 531 (1846).

As here accepted, the species is given the very broad definition almost universally accepted by past authors. It includes a very variable group of plants ranging in western France (north to Finistère), in western and southern Spain, and in Portugal and Morocco. The species needs a detailed study. A number of varieties have been published, but these are based on rather intangible differences in gross habit. No attention has been given to characters revealed only by the dissection of the corolla. Some of these appear to be geographically correlated, and when properly studied will probably be useful in defining really significant varieties (and possibly segregates) of the species. Between northern and southern forms of *L. diffusa* I have noted differences in length of style, size of anthers, lobing of anthers, and abundance of hairs and glands in the corolla-throat.

In having the filaments unequal and affixed at unequal heights on the corolla-throat, and in having the corolla-throat usually conspicuously hairy, *L. diffusa* is not merely distinguished from its congenera — it has features unusual in the Boraginaceae. The irregular distribution of stamens in the throat seems most like that characteristic of two species of *Lithospermum*, cf. Jour. Arnold Arb. 33: 303 (1952). In those species, however, the filaments are equal and do not vary in length according to their high or low position in the throat, as in *L. diffusa*. The irregular androecia of all these species no doubt have a fixed orientation within the corolla, but this can be determined with certainty only by someone with a supply of fresh flowers for dissection. From my observations, the odd stamen, that affixed lowest down in the throat, seems to be located on the abaxial side of the flower. Possibly it alternates with the two anterior lobes of the corolla, which, in all the species mentioned, frequently seem to be more spreading than the three posterior lobes. The hairy corolla-throat of *L. diffusa* is also noteworthy. In some southern forms of the species the throat may be sparingly hairy or rarely nearly glabrous, but in the common forms of the plant the throat is densely clothed with evident slender, antrorsely appressed hairs. The stamens emerge from among the abundant hairs. This condition is found elsewhere in the *Boraginoideae* only in *Ancistrocarya, Sericostoma,* and *Echiochilon.*

2. **Moltkia** Lehm. N. Schrift. Naturfor. Ges. Halle 3^2: (1817); Lehm. Asperif. 2: 339 (1818); Lehm. Icones 26, t. 43–44 (1821). — based on *M. punctata* Lehm. and *M. caerulea* Lehm.

Gymnoleima Decne. in Jacquemont, Voy. Ind. 4^2: 122 (1844). Type species *Lithospermum graminifolium* Viv.

Lithospermum § *Gymnoleima* [Decne.] Endl. Gen. Pl. Suppl. 3: 77 (1843).

Plants perennial. Stems herbaceous or more or less fruticose, strigose. Leaves alternate, veinless. Cymes evidently bracted, solitary or clustered at the ends of the stems or branches, becoming elongate and evidently unilateral at maturity. Calyx 5-parted, the lobes firm, linear, equal or nearly so. Corolla blue, purple or yellow, elongate and gradually ampliate or with a differentiated tube and swollen throat, glabrous inside and out or with some coarse hairs on the inner face of the lobes and on the adjacent throat; lobes imbricate, becoming erect, rounded, longer than broad to broader than long, equal or practically so; throat without glands or appendages; tube not developing an annulus, smooth and glabrous. Stamens affixed at equal heights above the middle of the corolla; filaments linear, with an evident midvein, equal or unequal, usually longer than the anther, short to very elongate; anthers included or more or less exserted, oblong to lanceolate, straight to strongly recurved, affixed at or near the middle or distinctly below the middle, apex obtuse or emarginate or somewhat apiculate, theca more or less distinct at the base. Pollen sphaeric or slightly longer than broad, small (16–31 μ), pores 3–8, equatorial. Style very slender, filiform, eventually exserted beyond the corolla-lobes, terminated by a very small entire or weakly lobed stigma. Nutlets smooth and lustrous or minutely tuberculate or papillate and opaque, bent ventrally above the base; ventral keel usually prominent, bearing a closed more or less fused suture; attachment scar large, morphologically basal but because of the bend in the nutlet body appearing to be obliquely basal or suprabasal, ovate or ovate-triangular, flat or concave. Embryo more or less curved or bent, tip of cotyledons directly above the nutlet attachment. Gynobase pyramidal when bearing four nutlets, flat when only a single nutlet is matured.

The six species of *Moltkia* are equally divided between two well-marked sections, one confined to southern Europe from northern Italy to northern Greece, the other to western Asia from Anatolia to Transcaucasia and northwestern Iran. The genus has been confused with *Lithospermum* and some of its species have been persistently referred to it, particularly by gardeners. *Moltkia,* however, differs from *Lithospermum* in having a corolla with erect lobes, glabrous outer surface, and an unappendaged non-glanduliferous throat, as well as a very slender, eventually long-exserted style, a very small entire or only weakly lobed stigma, and not straight, but distinctly bent nutlets. In its fruit *Moltkia* is most like *Halacsya* and *Alkanna,* and its relations are probably closer with these genera than with *Lithospermum.*

The most recent treatment of the genus is by Wettstein, Oesterr. Bot. Zeitschr. **67**: 361–69, f. 1–6, t. 3 (1918), who discussed its characters and illustrated the flowers and fruit of most of the species. Among the eight species he admitted to the genus, however, two must be excluded. The plant he accepted as *Moltkia callosa* (Vahl) Wettst. represents the recently proposed monotypic genus *Moltkiopsis,* cf. Jour. Arnold Arb. **34**: 3 (1953). His *Moltkia parviflora* (Decne.) Wettst. belongs with the Himalayan representatives of *Mertensia,* with which it agrees in having sparingly bracted inflorescence and very distinctive nutlets. Neither of these two excluded species has any close affinity with *Moltkia.*

Although the nutlets of *Moltkia* appear to have an attachment that is obliquely basal or even suprabasally lateral, the attachment is, in a morphological sense, truly basal. A medio-longitudinal section of the nutlet reveals that the embryo is curved but has the distal portion of its cotyledons located inside the pericarp directly above the attachment scar and in a plane vertical to it, the relation in all basifixed nutlets. The longitudinal section shows further that the nutlet body is bent, at or distinctly below the middle, 45°–90° inward towards the center of the flower. It is because of this distortion of the nutlet body that the attachment has the appearance of being oblique or suprabasal when actually it is basal on the only portion (the lower third to a half) of the body which is morphologically erect. When only one of these nutlets is matured in a flower, and, as a result, the gynobase is not elevated, the nutlet body is more or less horizontal or obliquely ascending. In flowers which mature four nutlets, the gynobase does elevate and is pyramidal and about as broad as high. Straight basifixed nutlets, such as those of *Lithospermum,* if borne on this pyramidal gynobase, would be very strongly divergent. Since the basifixed nutlets of *Moltkia* are bent, when they are affixed on the pyramidal gynobase their bent form corrects any tendency to divergence, and their tips become connivent and their long axes seem parallel.

The behavior of the androecium in the maturing corolla of *Moltkia* has interesting diversity and some puzzling aspects. Two of the species (*M. Dörfleri* and *M. suffruticosa*) have included stamens with short filaments that have reached their maximum length as the corolla opens. In the four other species of the genus, however, the filaments elongate conspicuously after the corolla opens and eventually become evidently exserted beyond the corolla-lobes. The filaments of the five stamens within a flower do not elongate simultaneously. In *M. caerulea* and *M. longiflora* the individual stamens elongate according to an obvious pattern. The filament of the median forward stamen elongates first, then the filaments of the posterior lateral pair of stamens, and finally those of the anterior lateral pair. Those elongating last never become as long as the other three. As a result, the androecium has evident bilateral symmetry. In *M. aurea* and particularly in *M. petraea* the androecium has no such pattern. Although the filaments eventually become about equally elongate, the rate of elongation and the time of its initiation may differ for each of the five stamens. Indeed, for an interval between the time that the corolla opens and the time the stamens are fully exserted, the filaments of a given flower may all have different lengths. On some plants of *M. petraea* the sequence of elongation seems possibly even in accord with a 2/5 phyllotaxy. The matter deserves attention from someone who has fresh flowers available for observation.

As in other genera of this relationship, the anthers of *Moltkia* dehisce and spill out much of their pollen just before the corolla opens. At this time the style usually surpasses the anthers, and the stigma has a position at the top of the bud above the anthers. Only in some (not all) flowers of *M. caerulea* have I found the style shorter at this stage, i.e., with the stigma borne between and not above the anthers. In *M. Dörfleri* and *M. petraea,* indeed, the style is so elongate that it is accommodated within the closed corolla only by becoming contorted or by having its apex appressed against and even decurved against the still tightly folded corolla-lobes. After the corolla opens the style elongates. In the species having exserted stamens, although the style reaches maximum extension promptly, the elongating filaments eventually raise the anthers to the same height as the stigma or nearly so. What purpose and interrelation the described sequences of changes may have in effecting pollinization is obscure. Since the anthers dehisce and lose much if not all of their pollen while still included in the corolla, their subsequent extrusion would seem to have little purpose.

The generic name *Gymnoleima* was published rather casually by Decaisne in a brief very general discussion of the affinities of the Himalayan species now referred to *Mertensia*. As a proposed segregate of *Lithospermum* it was launched as follows: "Je désignerais par le nom de *Gymnoleima* les *Lith. graminifolium, oleifolium, rosmarinifolium* et *fruticulosum,* dont la gorge de la corolla n'offre aucun appendice, dont le stigmate est plus ou moins échancré, . . ." Of the species mentioned, the first belongs to *Moltkia* and the remaining three to *Lithodora.* The genus has never been accepted. The only binomials under the genus are the four attributed to Decaisne, which appear in print for the first and only time in the Index Kewensis. Since Decaisne's brief characterization of *Gymnoleima* applies equally well to all the species he lists, I have accepted the first mentioned, *Lithospermum graminifolium,* as the type of the genus. *Gymnoleima* accordingly becomes a synonym of *Moltkia.* This is desirable, for any other typification would bring *Gymnoleima* (1844) into competition with the later *Lithodora* (1845).

Section **Eumoltkia.**

Nutlets with roughened opaque surface, very abundantly and minutely tuberculate or papillate and also coarsely warted, rugose, or pitted, apex of nutlet rounded. Attachment surface of the nutlets and faces of the gynobase green. Corolla with a well-differentiated, more or less swollen throat. Filaments arising from 5 weak invaginations at the base of the corolla throat, elongate, equal or nearly so or 2 distinctly shorter than the other 3. Anthers affixed between the base and middle, becoming conspicuously recurved. Pollen sphaeric or nearly so, polar profile circular or somewhat 3-sided, lateral profile circular or nearly so, pores remaining obscure, apparently 3 and equatorial.

Moltkia caerulea (Willd.) Lehm. N. Schrift. Naturf. Ges. Halle 3^2: 6 (1817).

Onosma caerulea Willd. Sp. Pl. 1^2: 775 (1798).
Moltkia punctata Lehm. N. Schrift. Naturf. Ges. Halle 3^2: 5 (1817).
Cynoglossum rugosum Willd. ex R. & S. **4**: 764 (1819); Cham. **Linnaea 4:** 447 (1829).
Lithospermum rugosum (Willd.) DC. Prodr. **10**: 83 (1846).
Moltkia anatolica Boiss. Diag. ser. 1, **11**: 114 (1849).

Ranging from western Anatolia into Transcaucasia and northwestern Iran. Corolla elongate, 11–19 mm. long, with blue lobes and throat, bearing scattered straight, stiff, antrorsely and loosely appressed hairs on the inner surface of the lobes and adjacent throat but otherwise completely glabrous, lobes 1.5–1.7 mm. long, usually with a thickened papillate midrib, throat 3–4 mm. long. Stamens eventually exserted, usually surpassing the corolla-lobes; filaments 4–7 mm. long, those of the adaxial lateral pair of stamens and the single anterior median stamens 1 mm. longer than those of the two anterior lateral stamens; anthers purpurescent, 2–2.5 long, attached 1 mm. above the base. Pollen 25–28 μ, surface perhaps minutely rugulose. Style evidently surpassing the filaments. Nutlets irregularly ovoid, 3–4 mm. long, bent at a 90° angle below the middle, pericarp thick and bony, surface densely and minutely low-papillate and also coarsely roughened by low broad ridges and warts and by coarse pitting, attachment scar large and usually bright green. Gynobase bearing chlorophyll, when maturing 4 nutlets becoming pyramidal and ca. 1.5 mm. high.

This species shares several noteworthy features with the closely related *M. longiflora*. Especially interesting is the presence of rather numerous stiff, loosely appressed, upwardly directed hairs in the throat of the corolla and on the inner face of the corolla-lobes. These relatively coarse hairs would seem to be a hindrance to any insect seeking to enter the corolla, but if they function as a barrier they would seem to have little purpose, since there is no annulus in the corolla-tube and since the anthers and style eventually become exserted from the corolla. Also unique in the genus is the development of distinctly unequal filaments. The androecium has a very clear bilateral symmetry, but the corolla seems to be otherwise regular, or at most has its two abaxial lobes only very slightly more spreading than the other three.

Moltkia Kemal-Paschii Bornm. Magyar Bot. Lapok **30**: 66 (1931), is a putative natural hybrid between *M. caerulea* and *M. aurea* from the mountains of central Anatolia. Authentic specimens of the hybrid are before me. Its anthers contain extremely few grains of pollen that are perfect. From *M. aurea* it has acquired a pale corolla, but in other respects characters of *M. caerulea* predominate in the hybrid.

Moltkia longiflora (Bertol.) Wettst. Oesterr. Bot. Zeitschr. **67**: 368 (1918).

Echium longiflora Bertol. [Miscl. Bot. **1**:] Nov. Comment. Acad. Sci. Inst. Bonn **5**: 425 (1842).
Moltkia angustiflora DC. Prodr. **10**: 72 (1846).

Known only from eastern Syria and northern Iraq. A very close relative of *M. caerulea* which differs in geographic range, in habit of growth, and in fruit. It is readily distinguished from its relative by its longer, much more slender, strict fruticulose stems, and usually longer and always more slender corollas. The fruiting calyx is subsessile, not borne on a stout pedicel 1–2 mm. long, as in *M. caerulea*. The nutlets are half the size of those of *M. caerulea* and have a very much thinner pericarp bearing not low rounded but very prominent warts.

In *M. longiflora* the stems apparently arise directly from the center of a functioning winter rosette of leaves. The lower leaves on the flowering stems, though rarely persisting, are larger than the middle and upper ones. Flowering plants develop no sterile radical leaf-clusters such as those usually present in *M. caerulea*. In *M. caerulea* the stems arise from among the remnants of a basal leaf-cluster developed the previous season. Its lowest cauline leaves, usually persisting at flowering time, are commonly distinctly smaller than those higher up the stem.

Moltkia aurea Boiss. Diag. ser. 1, **4**: 49 (1844) and Fl. Orient **4**: 222 (1875).

Known only from western and central Anatolia. Corolla bright golden yellow, completely glabrous, 7–9 mm. long, with a short tube 3.5–4 mm.

long and an abruptly swollen campanulate throat 4–5 mm. long, lobes broader than long, 1–2 mm. long or nearly so. Filaments 3.5–6 mm. long, eventually much surpassing the corolla-lobes; anthers yellow, 1.5–2.5 mm. long, strongly recurved, attached ca. 0.5 mm. above the base, apex rounded, base of each anther-sac apiculate. Pollen 22–25 μ diameter. Nutlets with a thick pericarp, bent about 90° at the middle, 2.5–3 mm. high, maximum length 4–5 mm., clothed with an abundance of very minute elongate papillae, coarsely roughened by low broad ridges and tuberculations and frequently coarsely pitted. Gynobase pyramidal, ca. 1 mm. tall. Style exserted before the stamens but usually eventually surpassed by them.

Notable for its yellow corolla with campanulate throat. In vegetative characters and general habit it is very similar to *M. caerulea.*

Section **Echianthus** (Vis.), comb. nov.

Lithospermum § *Echianthus* Visiani, Fl. Dalmat. 2: 247 (1847). Type species *L. petraeum.*

Moltkia § *Lithospermoideae* Boiss. Fl. Orient. 4: 221 (1875). Type species *Lithospermum petraeum.*

Nutlets smooth, lustrous, more or less pointed. Attachment scar of nutlet and faces of the gynobase not green. Corolla gradually ampliate from the base, lacking a sharply differentiated throat. Filaments not arising from invaginations of the corolla, short to elongate, included or exserted, equal or nearly so. Anthers affixed at or very slightly below the middle, straight or only very weakly falcate. Pollen perceptibly longer than broad, globose-ellipsoidal, polar profile circular or sometimes polygonal, lateral profile frequently with obtusely angulate sides, pores equatorial, usually 6–8, frequently protrudent.

Moltkia petraea (Tratt.) Griseb. Spicileg. Fl. Rumel. et Bithyn. 2: 515 and 532 (1846).

Echium petraeum Trattinnick, Thes. Bot. 8, t. 34 (1819).

Lithospermum petraeum (Tratt.) DC. Prodr. **10**: 82 (1846); Visiani, Fl. Dalmat. 2: 247 (1847).

Dalmatia, from the vicinity of Split south into Albania. Plant frutescent, forming a small bush 2–4 dm. tall, much branched. Leaves oblanceolate, 1–5 cm. long. Corolla blue, 7–8 mm. long, gradually ampliate or with an ill-defined tube (2.5–3 mm. long) and throat (ca. 3.5 mm.); lobes elongate, ca. 1.5 mm. long and 1 mm. broad. Filaments affixed 2.5–3 mm. above base of corolla and eventually surpassing the corolla-lobes 3–3.5 mm. Anthers blue, 1–2 mm. long, straight or very weakly curved, affixed at or very slightly below the middle, apex rounded, base emarginate. Pollen smallest in the genus, 16–20 μ long, pores 8. Style surpassing the corolla 2–4 mm. Nutlets 2.5–3 mm. long.

In Europe widely cultivated in rock-gardens. Under garden conditions it crosses with *M. suffruticosa* and produces fertile hybrids. Two of these crosses bear binomials *Lithospermum intermedium* Froebel and *L. Froebelii* Sündermann, Allgem. Bot. Zeit. 12: 92 (1906).

Moltkia suffruticosa (L.) Brand in Koch, Synop. Deutsch. u. Schweiz. Fl. ed. 3, **3**: 1999 (1903).

Pulmonaria suffruticosa L. Sp. Pl. ed. 2, **2**: 1667 (1763).
Lithospermum suffruticosum (L.) Kerner, Sched. Fl. Aust.-Hung. **1**: 52 (1881).
Lithospermum graminifolium Viviani, Ann. de Bot. **1**^{2}: 163, t. 14 (1804).
Lithodora graminifolia (Viv.) Griseb. Spicileg. Fl. Rumel. et Bithyn. **2**: 530 (1846); Reichenb. Icon. **18**: t. 114 (1858).
Moltkia graminifolia (Viv.) Nyman, Consp. Fl. Europ. 519 (1881).

A plant of northern Italy. From a trailing caudex of slender, loosely branched stems producing sterile clusters of very slender and elongate (5–15 cm. long) leaves and slender erect leafy flowering stems 1–2 dm. tall. Flowering stems arising from among the remnants of a sterile leaf-cluster of the previous season, its leaves 2–6 cm. long. Corolla blue, elongate, gradually ampliate, 15–17 mm. long; lobes elliptic, 3–3.5 mm. long, rounded. Filaments 2.5–3 mm. long, affixed 1.5–2 mm. below the sinus of the corolla-lobes (i.e., ca. 12 mm. above the base of the corolla). Anthers yellow, straight, ca. 3 mm. long, exserted from the corolla-tube but scarcely if at all surpassing the erect corolla-lobes, affixed ca. 1 mm. above the base, tip stoutly apiculate, base of theca acute, usually unequal. Pollen 20–22 μ long, pores (7 or) 8. Style very slender, eventually surpassing the corolla 3–4 mm.; nutlets 3 mm. long.

Moltkia Dörfleri Wettst. Anz. Akad. Wiss. Wien **55**: 284 (1918) and Oesterr. Bot. Zeitschr. **67**: 361 and 404, t. 3 (1918).

Known only from the mountains of northeastern Albania. Plant an herbaceous perennial, producing scattered simple erect leafy stems 3–5 dm. tall from a thick sympodial rhizome. Leaves lanceolate, all cauline, the lowest imperfectly developed. Corolla purple, elongate, gradually ampliate, 19–22 mm. long; lobes broad, rounded, 2–2.5 mm. long, 3.5–4 mm. broad. Filaments compressed, 1.5–2 mm. long, shorter than the anthers, affixed 13–14 mm. above the base of the corolla. Anthers yellow, elongate, straight, 2.5–3.5 mm. long, included (apex 0.5–1.5 mm. below the sinus of the corolla), affixed 1 mm. above the retuse base, apex bearing a pair of acuminate tips. Pollen largest in the genus, 28–31 μ long, pores 5–7 but usually 6, equatorial. Style filiform, eventually exserted 2–5 mm. beyond the corolla-lobes. Nutlets 4 mm. long, plump, minutely mottled with purple.

Although readily accommodated in *Moltkia*, this species has a number of unusual features. Its habit of growth is more suggestive of some of the perennial species of *Lithospermum* than of any of its congeners. Its annual flowering stems arise from a bud on the rhizome, and its lowermost leaves (small and imperfect) are conspicuously smaller than its middle and uppermost ones. The rhizome is unique in this group of genera. It is obviously sympodial, being made up of annual increments 3–4 mm. long which are thickest (7–10 mm.) near their attachment and then gradually contracted towards the stem-bearing end. The corolla is purple rather than blue or yellow. Unlike those in other species, the anthers are longer, not shorter than the filaments, and are decidedly included rather than exserted from the corolla-tube. All species of ***Moltkia*** have a more or less papillate epidermis on the corolla-lobes. In ***M. Dörfleri*** the epidermal papillae have the maximum development and furthermore are usually tipped by an abortive trichome. Because of the large apiculate papillae, the corolla-lobes of the species appear to be puberulent when viewed under moderately high magnification. In this genus the calyx persists for some time after the nutlets have fallen away, and in all species save the present one eventually turns brown and falls off entire. In *M. Dörfleri,* however, the calyx-lobes disarticulate at the base and fall away individually before the base of the calyx detaches from the stem. I have studied five collections of this species (*Dörfler 446, 450, 472, 502* and *848*), duplicates of the five upon which the species was originally based. The last two of these, nos. *502* and *848*, i.e., the last two cited by Wettstein, have glabrous anthers. The other three collections, however, and particularly no. *472*, are notable for bearing scattered coarse appressed hairs on the sides of the anthers.

3. **Halacsya** Dörfler, Allgem. Bot. Zeitschr. **9**: 46 (1903). — a renaming of *Zwackhia* Sendt. (1858), not Körber (1855).

Zwackhia Sendt. ex Reichenb. Icon. Fl. Germ. **18**: 65, t. 1316 (1858). Type species *Z. aurea* Sendt.

Plant herbaceous, perennial. Leaves strigose, veinless, alternate. Cymes scorpioid, evidently bracted, solitary and terminal on leafy stems, becoming elongate and racemose at maturity. Calyx 5-parted, evidently pedicellate; lobes firm, lanceolate, equal or nearly so. Corolla yellow, completely glabrous, lobed to the middle; limb slightly oblique, most deeply lobed on the abaxial side; lobes narrowly imbricate in the bud, eventually ascending, elongate, broadly lanceolate or lance-elliptic, acutish, the two abaxial lobes smallest and least spreading; tube about as long as the lobes, lacking an annulus, upper third strongly ampliate and forming a short, ill-defined throat; throat bearing 5 rounded or triangular squamate appendages which alternate with the stamens and are borne at or slightly below the level of the filament attachments. Stamens borne at equal height low in the throat; filaments short, compressed, equal or nearly so; anthers oblong-lanceolate, only the apical portion exserted from the throat, affixed directly above the basal sinus, base cordate, apex acute and tipped by a short thickish prolongation of the narrow connective, margin of theca densely and coarsely short-ciliolate. Pollen sphaeric or slightly prolate, 30–37 μ long; pores equatorial, 3, usually swollen; polar profile circular or somewhat three-sided (with the pores medial on each of the three faces); lateral profile circular or slightly longer than broad. Style precociously long-exserted, terminated by a very small obscurely lobed or parted stigma. Nutlets compressed ovoid, bent, incurved above the middle, densely tuberculate or tuberculate-rugose, gray, opaque, back broadly convex, venter prominently keeled, suture closed and fused; attachment scar transversely elliptic, basal on the erect lower half of the nutlet body; embryo weakly curved, tip of the cotyledons above the attachment scar and vertical to it. Gynobase depressed pyramidal when fully developed, attachment faces distinct, with narrow elevated cartilaginous margins.

An extremely well marked monotype which is known only from serpentine areas in southern Yugoslavia and adjacent Albania. For a general account of the plant and an excellent colored plate see K. Maly, Wiss. Mitt. Bosn. u. Herzegowina 20: 674–5, t. 11 (1907).

Halacsya Sendtneri (Boiss.) Dörfler, Allgem. Bot. Zeitschr. 9: 47 (1903).

Moltkia Sendtneri Boiss. Diag. ser. 2, 3: 138 (1857). — Bosnia, *Sendtner 479.*

Mertensia Sendtneri (Boiss.) Janka, Oesterr. Bot. Zeitschr. 9: 314 (1859).

"*Moltkia aurea* Boiss." sensu Sendt. Das Ausland 21: 424 (1848).

Zwackhia aurea Sendt. ex Reichenb. Icon. Fl. Germ. 18: 65, t. 1316 (1858). — Bosnia, *Sendtner 479.*

Mertensia serbica Janka, Oesterr. Bot. Zeitschr. 9: 314 (1859). — Serbia, *Pancic.*

Although the flowers of *Halacsya* eventually develop conspicuous yellow corollas 11–13 mm. long, they become sexually mature when very small and long before the corolla becomes conspicuous. Above the conspicuous flowers in the cyme is a series of gradually smaller ones which may have open corollas, long-exserted styles, and fully developed, even dehiscent anthers when the corolla is only 3–5 mm. long and accordingly only a fraction of its eventual size. In some of these juvenile flowers the corolla may even open when only 2.5 mm. long and when it is actually shorter than the calyx (ca. 3 mm. long). Usually the anthers have attained maximum dimensions (1.9 mm. long) and the style is well exserted when the corolla and calyx become as much as 5 mm. long. The corolla of such flowers is lobed to the middle and evidently zygomorphic, having the two abaxial lobes very distinctly (0.5–1 mm.) shorter than the posterior three. Their mature anthers, borne on filaments only half their eventual length, are disproportionately large in the incompletely developed corolla. They are almost completely exserted from the very short corolla-tube. In fact, in these juvenile flowers, the tip of the anther may almost reach the tip of the shorter corolla-lobes. The style emerges from the corolla very soon after it opens, and when the latter is only 4–6 mm. long may have attained as much as 10–15 mm. in length. It is only after the style is greatly extended and the anthers have dehisced that the corolla rapidly enlarges and achieves its mature form. A somewhat similar condition occurs among some of the American relatives of *Lithospermum,* as for example in *Onosmodium*, but I know of no parallel among any of the *Lithospermum* relatives in the Old World. In this group of genera such precocious sexuality appears to have some correlation with the type of corolla aestivation, since it is associated either with species that have their corolla-lobes valvate in the bud or with those, such as *Halacsya*, which have distinctly elongate corolla-lobes only very narrowly imbricate in the bud.

Fully developed flowers have a calyx 5–6 mm. long, a pedicel 1.5–3 mm. long, and a conspicuous deeply lobed yellow corolla 11–13 mm. long. The completely glabrous corolla has a funnelform outline but is lobed to the middle. The lobes of the slightly oblique limb are oblong-lanceolate and unequal. The two anterior lobes are 4–5.5 mm. long and 1.5–1.8 mm. wide, and the three larger posterior ones 5.5–6.6 mm. long and 2.5–3 mm. wide. The sinus on the anterior side of the corolla is 0.5–1 mm. deeper than that on the posterior. The tubular lower half of the corolla, ca. 1.5 mm. thick at the base, is most strongly ampliate in the upper third and so forms an ill-defined throat 4–5 mm. thick at the base of the lobes. There is no nectary developed near the base of the tube. The most unusual feature of these corollas is the five scale-like appendages borne in the throat, 4–5 mm. above the base of the tube. These are minute, rounded, or deltoid squamae which alternate with the stamens and are borne very slightly below the level of the filament attachments. At maturity they are usually a quarter to a third as long as the filaments. The primary vein supplying the corolla-lobes passes beneath the scales and is not detoured over them. They are, therefore, lamelliform and epidermal in origin and accordingly very different from the invaginate type of appendage present in such genera as *Lithospermum*.

The stamens of this genus are very distinctive. The short filaments (0.5–0.9 mm. long) are affixed at equal heights in the corolla 4.5–5 mm. above the corolla-base and usually very slightly above the squamate appendages. They are equal or nearly so, or possibly the posterior filaments may be almost inperceptibly longer than those of the anterior three. The anthers are oblong-lanceolate, 1.5–1.9 mm. long, acute and stoutly appendiculate at the apex and distinctly cordate at the base. Their attachment is just above the basal sinus, about 0.3–0.4 mm. above the base of the theca. The most unusual feature of the anther is the ciliate fringe of short stout hairs decorating the margins of the theca. In fully developed flowers the anthers on the more deeply lobed anterior side of the corolla have their upper half or third projecting above the base of the adjacent corolla sinus. On the posterior side of the corolla usually only the tip of the anther is to be seen projecting above the base of the sinus.

The stoutly beaked nutlets are about 3 mm. long and are gray and densely tuberculate. The body is somewhat dorsi-ventrally compressed and above the middle is bent about 45° inward towards the center of the flower. The ventral keel is prominent and the suture completely closed and fused. The attachment scar is basal on the erect lower half of the nutlet and is broader than long. When maturing four nutlets the gynobase is broadly pyramidal. Its attachment surfaces are distinct and each has a narrow pale cartilaginous margin.

The plant is perennial and apparently forms a loose multicipital caudex. The radical leaves, 5–15 cm. long, occur in sterile clusters. The simple erect or ascending stems, 2–4 dm. tall, have middle and lower leaves of about equal size and spring from a site occupied by a cluster of radical leaves of the previous season.

The genus is a very distinct one but probably has its closest relationship in *Moltkia* § *Eumoltkia*, as indicated by similarities in nutlets, style, stigma, pollen, and habit of growth. The very distinctive anthers of *Halacsya*, as well as its deeply lobed zygomorphic corolla with squamate appendages, readily distinguish it not only from *Moltkia* but from all other genera of this affinity. Although sometimes classed with *Echium* because of its zygomorphic corolla, its relationship with that genus is only of the most general sort.

4. **Alkanna** Tausch, Flora 7: 234 (1824), nom conserv. prop. Type species *A. tinctoria* (L.) Tausch [non *Alkanna* Adans. Fam. 2: 444 (1763) = *Lawsonia* L. (1753)].

Baphorhiza Link, Handb. 1: 578 (1829). Type species *A. tinctoria* (L.) Tausch.

Campylocaryum DC. ex Meisner, Pl. Vasc. Gen. 1: 280, and 2: 189 (1840). Type species *A. lutea* (DC.) Moris.

Camptocarpus C. Koch, Linnaea 17: 304 (1843). Type species *A. orientalis* (L.) Boiss.

Onochiles [Tournef.] Bubani, Fl. Pyrenaea 1: 491 (1897) — a renaming of *Alkanna* Tausch (1824), not Adans. (1763).

Plant herbaceous, mostly perennial, frequently glanduliferous. Leaves numerous, alternate, veinless. Cymes scorpioid, leafy-bracted, usually solitary or geminate at the ends of leafy stems, elongate and racemose in age. Calyx 5-lobed, short-pedicellate, in fruit moderately accrescent, broadened at the base and usually deflexed; lobes equal, narrow to broadly lanceolate, usually attenuate, in age connivent. Corolla yellow, whitish or blue, salverform or infundibuliform, regular or zygomorphic, outside glabrous or in a few species inconspicuously hairy; tube usually cylindric and with its upper portion not differentiated into a well-defined throat, glabrous or exceptionally with minute hairs below the tumid annular or 10-lobulate suprabasal annulus; limb with loosely ascending broad rounded lobes; throat on inner surface usually bearing abundant stipitate glands. Appendages of the corolla borne near the middle of the tube or at the base of the throat, included, alternating with the stamens, usually transversely oblong or trapeziform, glabrous, sometimes minutely papillate at the summit, borne at the same height in the corolla and all equal, or 3 adaxial ones borne slightly higher than the other 2 and sometimes differing in degree of development. Stamens 5, equal, included, in a few species borne at equal heights in the corolla-tube and all attached below the appendages, but in most species borne in two groups, one at a higher level than the other, the 3 abaxial stamens being affixed at or slightly above the level of the appendages and the 2 adaxial ones affixed distinctly below the appendages. Filaments a half to two thirds as long as the anthers; anthers affixed at or near the middle. Pollen conic with rounded base or rarely ovate-oblong, 16–21 μ long, broadest and bearing the 3 pores above the rounded base, summit acute with only the tip rounded or rarely broad and rounded, polar profile circular, pores very obscure. Style entire or obscurely bilobed at the very apex, included in the corolla-tube, rarely surpassing the anthers; stigmas very small, 2, usually broader than long, apical and juxtaposed or subterminal on opposite sides of the style tip, simple or somewhat bilobed. Nutlets 4 or more commonly 1–3 aborting, verrucose or scrobiculate-rugose, short-stipitate, strongly bent, usually with the long axis more or less horizontal and the attachment apparently suprabasally lateral (attachment actually on morphological base of nutlet body), back rounded, ventral keel prominent, formed of a fused suture. Gynobase swollen, lobed to form distinct pulvini supporting the concave ovate attachment surfaces.

A very well marked and interesting genus greatly in need of monographic study. The twenty-five to thirty species occur in the Mediterranean area and eastward to Transcaucasia and northern Iran, in greatest concentration and diversity in Anatolia and Greece.

The corolla of *Alkanna* usually bears invaginate appendages, not exposed in the mouth of the corolla as in most Boraginaceae but deeply included in the corolla-tube or -throat where they are revealed only when the corolla is dissected. The included appendages of *Alkanna* possibly may have a parallel in the interstaminal appendages of *Halacsya,* but otherwise the condition is unknown in related genera. The appendages have a characteristic development in each of the three sections of the genus. Another common feature of the corolla is the abundant development of stipitate glands on the corolla walls above the stamens. These glands are present and evident in all species except *A. lutea.* In no other genus of this relationship are they so abundant and conspicuous.

The nutlets of *Alkanna* are excessively bent and evidently short-stipitate. Except for the stipitate attachment they are fundamentally similar to those of *Halacsya* and *Moltkia.* In all three genera the nutlet body is distorted as a result of a sharp medial bend, 45–90° in *Halacsya* and *Moltkia* but about 130° in *Alkanna.* The embryo inside the nutlet is bent also, that of *Alkanna* usually having a very distinct transverse flexure near the middle of the cotyledons. It is to be especially noted that these nutlets are distorted only above the middle and that below they are similar to other nutlets of the Lithospermeae. Inside their basal section, the lower half of the cotyledons is vertical to the attachment scar, and the tips of the cotyledons are directly above it, as in all truly basifixed nutlets. Although the nutlet has a bend near the middle, its basal section remains straight or practically so and bears its attachment at the lower end. In *Alkanna* the nutlet can become arched or even more sharply bent, so that its morphological tip is brought down to nearly the same level as the attachment end, and, in some species, even proximate to it. Because the nutlet is bent double, its long axis is not vertical but transverse. Because the nutlets are transverse elongate, the attachment has the appearance of being suprabasally lateral, and numerous authors have so described it. Although this may be empirically correct, it is not so morphologically, for despite appearances, the nutlets, though distorted, still retain an erect base and a truly basal attachment.

In this genus the gynobase also is distinctive. When maturing a full complement of nutlets it is not angulate and more or less pyramidal as in related genera. It is pale in color, cartilaginous in texture, and swollen, and bears each of the four broad attachment surfaces elevated on distinct cushion-like lobes. The attachment surfaces are oblique, ovate, and distinctly concave. The nutlets, when attached, have the broadened tip of their basal stipe seated in these concave surfaces.

Two types of pollen occur in *Alkanna*. In one species, *A. lutea*, the grains have a form similar to that found in *Lithospermum*, but in all other species of the genus they are somewhat conic and show great similarity with the pollen of *Echium*. The conic grains are nearly as broad as long. They have a convex base and well-developed straight sides converging on a blunted rounded apex. The three pores, perhaps in ill-defined furrows, are arranged equidistant about the grain above its base, where it is broadest. The pollen of *A. lutea*, however, is somewhat ovate-oblong. It also is broadest above the convex base, and also has its pores located where its diameter is greatest. Above the level of the pores it is at first abruptly constricted, to form short but well-defined upwardly sloping shoulders, and then, above the middle of the grain, becomes very gradually narrowed. Towards its rounded summit the grain is narrowed to about half of its maximum basal diameter. I have found the pores on this ovate-oblong pollen of *A. lutea* difficult to discern. There seem to be three pores usually developed, but sometimes as many as four.

The two kinds of pollen in *Alkanna* are readily homologized as additional manifestations of a type of pollen asymmetry previously observed and discussed in *Lithospermum*, Jour. Arnold Arb. 33: 310–11, f. 1 (1952). The pollen of *A. lutea* obviously has the distinctive features previously noted in the asymmetric grains of *Lithospermum*. The pores have the same position on the grain, being borne where the grain is broadest, just above its curved convex base and directly below the first sharp constriction that forms the distinctive shoulders in all such asymmetric grains. In the conic grains found in all other species of *Alkanna*, the pores have a similar position. They are borne above the convex base where the grain is broadest and directly below the sharp constriction. These conic grains differ from the ovate-oblong ones of *A. lutea* only in the form of their upper half. In *A. lutea* the constriction is at first abrupt (forming the shoulders) and then becomes very gradual in the upper half of the grain. In the other species of the genus the first abrupt constriction continues uninterrupted into the upper half of the grain and on to its apex. The conic form of these grains is the result of an exaggerated continued upward prolongation of the usually limited constriction that forms the shoulder in other asymmetric grains.

Although showing some resemblance to that of *Lithospermum* in asymmetric form, the pollen of *Alkanna* differs in having fewer pores, usually only three. Interestingly, the triporate condition is that found in the globose or subglobose symmetric pollen of *Halacsya* and *Moltkia* §

Eumoltkia, the two groups which appear to be most closely related to *Alkanna.*

The generic name *Alkanna* Tausch (1824) has an early homonym in *Alkanna* Adans. Fam. 2: 444 (1763), a synonym of *Lawsonia* L. (1753), cf. Schwarz in Fedde, Repert. **47**: 288 (1939) and Font-Quer & Rothmaler in Fedde, Repert. **50**: 286 (1941). However, as a name proposed for conservation, *Alkanna* Tausch is listed among the Nomina Generica Conservanda in the recently published Code of Botanical Nomenclature, Utrecht, pg. 130 (1952). If the name *Alkanna* is rejected, the next available for the genus is *Baphorhiza* Link (1829). Only three binomials have been proposed under the latter genus, *B. tinctoria* Link (1829), *B. lutea* Font-Quer & Rothmaler (1940), and *B. orientalis* (L.) Font-Quer & Rothmaler (1940). *Alkanna,* as a well-established name associated with over sixty binomials, deserves conservation, and pending final judgment, should be retained.

Section **Eualkanna.**

Alkanna § *Baphorhiza* DC. Prodr. **9**: 97 (1846).

Stamens borne at unequal heights in the corolla, two affixed below the appendages and surpassed by them and three affixed at or slightly above the level of the appendages and surpassing them; appendages transversely oblong or trapeziform, invaginate; pollen conic, with a broad convex base and a rounded tip, 16–17.5 μ long, 14–16 μ broad, broadest and bearing the 3 equally spaced pores 5–7 μ above the base, polar profile circular, lateral profile with a broad rounded base and straight, strongly convergent sides; corolla zygomorphic, densely glanduliferous inside above the appendages; plant perennial.

This section embraces all but two of the twenty-five or thirty species of the genus. Its best known and most widely distributed species are *Alkanna orientalis* (L.) Boiss. and *A. tinctoria* (L.) Tausch.

In this section the corollas are distinctly zygomorphic. The two abaxial lobes of the corolla (outermost in the bud) are more spreading than the other three, the three abaxial stamens are borne higher on the tube than the other two, and the corolla tube below the stamens has constrictions that are usually conspicuously stronger on the abaxial side. The corolla, blue, whitish, or yellow, has a well-developed tube and an abruptly expanding limb but no well-differentiated throat. It is usually completely glabrous. Only in a few species is it sparingly hairy outside, particularly on the lobes, or inside about the nectary low in the tube. In all species the corolla bears an abundance of stipitate glands on the inner surface of the tube above the stamens. In most species the tube of the corolla is longer than the breadth of the limb. At or above the middle it bears small invaginate appendages alternating with the stamens. Interestingly, those on the abaxial side of the tube tend to have a very slight but still perceptibly higher position (and rarely also a greater or a less development) than those on the opposing side of the tube. Associated with the appendages are two groups of stamens, an abaxial set of three affixed at or slightly above the level of the appendages, and an adaxial set of two affixed distinctly below them. The anthers of the upper group much surpass the appendages, while those of the lower group at most reach up only to the base of the appendages. The filaments are short, shorter than the anthers, and those of the upper stamens possibly very slightly longer than those of the lower stamens.[2]

Section **Allolepis**, sect. nov.

Stamina infra appendiculas corollae aequaliter affixa; antheris appendiculas superantibus; appendiculis quadratis grandis solum infra medium invaginatis; granulis pollinis conicis eis sectionis Eualkannae similibus; faucibus corollae evidenter differentiatis tubo longioribus intus glandulis stipitatis obsitis; planta perennis.

A monotypic section containing only *A. scardica* Griseb., a plant of the mountains of northern Albania and adjacent Montenegro. Of this very distinct species two generous collections have been available for dissection (*Dörfler 123* and *713*). The blue corollas are regular and are sparsely villulose outside above the middle and very minutely hairy inside below the tube-nectary, but are otherwise glabrous. They have a short tube and a large well-differentiated campanulate throat about twice as long. The inner surface of the throat is abundantly stipitate glandular. The corolla appendages, borne at the base of the large throat, are the largest in the genus. They are quadrate in form and have only their lower third or half formed by invagination. The veins supplying the corolla-lobes enter the appendage and make a detour, not over the summit of the appendage, but only over its lower half. The upper half or two thirds of the appendage is a lamelliform prolongation of its invaginate basal portion. It is epidermal in origin. The stamens of *A. scardica* are the largest in the genus. The filaments (about half the length of the anthers) are affixed distinctly below the appendages, all at the same height above the base of the corolla. The anthers (ca. 1.5 mm. long) are borne with their middle at about the same level as the base of the corolla appendages and, unlike those of all congeners, project not only below the appendages but above them also.

Section **Campylocaryum** A.DC. Prodr. 9: 102 (1846).

Stamens affixed at equal heights in the corolla and borne entirely below the obscure, weakly developed, low-convex appendages; pollen ovate-oblong, 20–21 μ long, 14–16 μ broad, broadest and bearing its 3 pores ca. 8 μ above the hemispheric base, thereafter at first abruptly and then (above

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[2] The organization of the androecium in *Alkanna* was given incorrectly in my recent discussion of *Moltkiopsis*, cf. Jour. Arnold Arb. **34**: 3 (1953). As in *Alkanna* two of the five stamens of *Moltkiopsis* have filaments shorter and attached slightly lower on the corolla than the other three. Unlike *Alkanna*, however, the two shorter and lower stamens in *Moltkiopsis* are not juxtaposed nor are they adaxial. They are separated by a long stamen (the abaxial medial one) and appear to represent the two abaxial lateral members of the androecium.

the middle of the grain) more gradually narrowed to the rounded summit, polar profile circular, lateral profile with short, steeply sloping shoulders above the broad rounded base and above the middle with nearly straight sides weakly converging towards the rounded summit. Corolla regular, tube becoming ampliate above the middle and forming a moderately well differentiated throat, bearing no stipitate glands on its inner surface; plant annual.

A monotypic section containing only the single species *A. lutea* (DC.) Moris of southern France, eastern Spain and Sardinia. It is the only annual species in the genus. Its small yellow corollas are regular. Except for minute hairs associated with the annulus, they are completely glabrous. Unlike those of other species in the genus, the corollas of *A. lutea* bear no stipitate glands in the throat. The very small stamens are borne below the middle of the corolla. The appendages at the base of the ill-defined throat are very weakly developed and obscure. At most, they are usually only vague convexities and are revealed only when the corolla is viewed under high magnification. The nutlets are very small.

5. **Echium** [Tournef.] L. Sp. Pl. 139 (1753) and Gen. Pl. 68 (1754). Type species *E. vulgare* L.

Isoplesion Raf. Fl. Tellur. 4: 86 (1836–38). — based on *E. italicum* L., *E. giganteum* L., *E. pyrenaicum* L., and *E. rubrum* Jacq.

Larephes Raf. Fl. Tellur. 4: 86 (1836–38). Type species *E. parviflorum* Moench.

Argyrexias Raf. Fl. Tellur. 4: 86 (1836–38). Type species *E. candicans* L.

Megacaryon Boiss. Pl. Orient. Nov. Dec. 1: 7 (1875) and Fl. Orient. 4: 203 (1875); Lacaita, Jour. Linn. Soc. Bot. 44: 393 (1919). Type species *E. orientale* L.

Echium § *Eleutherolepis* Coincy, Cong. Intern. Bot. Paris, Actes 349, fig. (1900). Type species *E. albicans* Boiss.

Echium § *Gamolepis* Coincy, Cong. Intern. Bot. Paris, Actes 349, fig. (1900). Type species *E. angustifolium* Lam.

Echium § *Pachylepis* Coincy, Bull. Herb. Boiss. ser. 2, 3: 261 (1903). Type species *E. candicans* L.

Plants annual, biennial or perennial, small to very large, herbs, shrubs or small trees, hispid or strigose; leaves usually without evident veins. Inflorescence consisting of elongating scorpioid cymes borne terminally on the stems and leafy branches, or of abundant usually small scorpioid cymes aggregated into a usually dense very elongate thyrse; cymes simple or sometimes forked, densely flowered, abundantly and evidently bracted. Calyx 5-fid or rarely with a short tube, usually pedicellate; lobes usually slender and attenuate, rarely becoming broadly lanceolate or somewhat elliptic, accrescent and connivent in fruit, the two adaxial lobes usually smallest. Flowers monomorphic or gynodioecious, perfect or with the stamens and pollen imperfectly developed. Corolla blue, purple or pink, rarely white or red, resupinate, more or less distinctly zygomorphic, sometimes tubular but usually narrowly to broadly infundibuliform, usually most prolonged on the two-lobed abaxial side; limb usually oblique; lobes ascending, sometimes equal or rarely the three adaxial ones largest, but prevailingly with the two abaxial ones most developed; tube usually short, commonly bent or abaxially swollen just above the base; outside of corolla usually hairy, usually marked with short vertical inflexures under the stamen-attachments; inside of corolla without faucal appendages or stipitate glands, glabrous except for hairs associated with the annulus; annulus borne extremely close to the base of the corolla-tube, very small, sparingly strigose or more or less villose or glabrous, commonly represented by 5–10 lobes but rarely reduced to merely a lineate ring or to 5–10 swellings. Stamens 5, the adaxial pair borne highest on the corolla, the medial abaxial one lowest and the two abaxial lateral ones at an intermediate level, or the two abaxial laterals and the medial one all affixed at or about the same level and below the adaxial pair, or rarely all the stamens borne at or about the same level; the single medial abaxial stamen practically always distinguishable to some degree by the distinctive form of its filament and manner of attachment; filaments slender and elongate, sometimes all included but usually with two or more exserted, commonly declinate, glabrous or very rarely pilose, all equal or of two or three different lengths, usually with a thickened, somewhat decurrent base, the odd medial stamen frequently joined to the corolla by a membrane for a distance above its proper base. Anthers small, short-oblong to oblong, displayed in an inverted position with the emarginate base uppermost, attached to the filament in a pit near the middle of the broad, somewhat cartilaginous connective. Pollen ovoid or conic-ovoid ($16–26 \times 13–25\ \mu$), broadest above the broadly rounded base and then gradually narrowed to the rounded apex; polar profile circular, usually with the pores slightly protrudent or their position marked by three nicks in the circumference; pores 3 (perhaps associated with short furrows), arranged equidistant about the broadest part of the grain. Style exserted, always bearing some slender appressed hairs, usually flattened and under transmitted light usually showing 2 distinct vascular strands at least above the middle, forked below the summit or exceptionally unbranched; lobes attenuate, frequently unequal; stigmas 2, distinct, terminal, capitate, very small. Nutlets ovoid or lance-ovoid, usually brownish and tuberculate, rarely lobulate-tuberculate or smooth or nearly so, dull or exceptionally lustrous, erect or somewhat divergent, straight or slightly incurved or sometimes strongly bent ventrally at the middle; venter with a well-developed elongate keel bearing a nearly obliterated suture, base rounded or more commonly narrowed and even constricted just above the attachment; attachment scar flat or slightly concave, usually small, medial or more commonly tending to be restricted to the ventral half of the nutlet base, usually more or less flabelliform, marked ventrally by a conspicuous pit (i.e., the open end of the funicular canal) and dorsally by an arc of two or more broken vascular strands. Gynobase flat or sometimes broadly pyramidal, usually maturing four nutlets.

A genus in great need of a monographer. It has never had a complete methodical study, and no comprehensive system exists for the classification of its species. Past work on the genus has been almost exclusively floristic. Some of this has been very discriminating, but in general it has been provincial in scope and much of it over-solicitous concerning minor variations. Named species have been needlessly multiplied and broader identities and relationships misunderstood or ignored. The nomenclature of the species is chaotic. Many of the familiar binomials no longer have precise application and have come to need special definition each time they are used. The genus in its present state is one of the most confused and confusing of the Boraginoideae and will probably continue so until it has been surveyed and organized by a monographer.

Echium has a very close relation in the South African genus *Lobostemon*. So close is the relationship, in fact, that with reason the two could be merged. Other affinities of *Echium* are much less evident. The genus, however, in a number of significant details shows similarity with *Moltkia, Halacsya,* and *Alkanna,* and in some degree probably has particular relations with that group of three genera. Though this affinity seems a very generalized one, it is at least closer than any existing between *Echium* and the other groups of the Lithospermeae.

Some fifty or more species of *Echium* are restricted to the Atlantic islands and especially to the Canary Archipelago, and to the Mediterranean area and adjacent regions. The ancestors of the modern genus probably became isolated in these two regions at an early date, since evolution in *Echium,* proceeding independently in the two centers, has had time to produce specialized modifications in habit of growth and distinctive elaborations of floral structure in each. It seems also probable that *Lobostemon* has arisen from other ancestors of modern *Echium* which became isolated in South Africa. That southern genus is obviously very closely related to modern *Echium* and is distinguished only by a high degree of specialization and modification of the annulus in the corolla-tube. Its particular specializations are essentially no more remarkable than the extreme and highly evolved growth-form evolved by the *Echia* of the Atlantic islands and may very well have been elaborated in about the same length of time. The indications are that *Echium* has been a plastic group which formerly had a very wide distribution and that subsequently, with its geographic range reduced to three isolated regions, has become specialized in a distinctive manner in each of them.

The species of the Mediterranean area are annual, biennial, or perennial herbs with a general facies of a sort conventional among the herbaceous borages. They may be loosely branched, with relatively few elongating scorpioid cymes terminating stems and leafy branches, or have an erect main axis bearing very numerous small cymes aggregated into a dense very elongate thyrse. A few become somewhat suffruticose at the base, but most are distinctly herbaceous, and the majority are annuals or biennials. With the exception of a few very coarse biennials, such as *E. orientale* and

E. pomponium, the species are all less than a meter tall and most of them only about half that height.

On the Atlantic islands, however, the endemic species have become large plants, and some of them have developed the woody habit to a degree unparalleled elsewhere among the Boraginoideae. Some are coarse, long-lived, monocarpic plants, at first forming huge basal rosettes and later massive columnar inflorescences a meter or more tall. Others bear their leaves on the younger parts of a continuously elongating axis which after a period of years is terminated in a large, even gigantic thyrse. Some such plants attain as much as five meters in height. Still others are shrubs or small trees, decidedly ligneous and prevailingly with a loose branching of the candelabra type, normally becoming one to two meters in height. Most of the species of this latter type bear their leaves clustered at the ends of the loose branches and hence have the distinctive traits of the so-called "rosette-trees."

In evaluating the remarkable development of *Echium* on the Madeira, Canary, and Cape Verde islands, it is to be recalled that their distinctive habit is also paralleled on these islands by representatives of genera in other families which also have only lowly herbaceous, or at most only small fruticulose congeners elsewhere, e.g., *Sempervivum, Limonium, Sonchus,* etc. Although the particular factors which govern it may be in dispute, the fact remains that similar behavior is known to be associated with plants isolated on particular oceanic islands in various parts of the world. Good examples of this behavior are to be seen in the Revillagigedo and Juan Fernandez Islands, both off the west coast of America. Indeed, on the Juan Fernandez Islands there is another member of the Boraginoideae that parallels the behavior of the Atlantic islands *Echia.* This endemic genus, *Selkirkia,* is a small rosette-tree. It is one of the very few arborescent Boraginoideae and the only rosette-tree outside of *Echium.* Interestingly, it gives every evidence of being only an extreme insular modification of the herbaceous continental genus *Hackelia.*

Among the Lithospermeae the frutescent habit seems to be developed more frequently than in other tribes of the Boraginoideae. Certainly at least a tendency in this regard may have been well developed among the ancestors of modern *Echium.* Although evolution among the Mediterranean species seems to have been directed towards the development of the short-lived herbaceous habit, the shrubby habit persists in *Lobostemon* and may also have been present to some degree among the species of *Echium* originally isolated on the Atlantic islands. There is, however, no good reason for believing that the original *Echia* of the islands were more than suffruticose, or, at most, any more fruticose than modern *Lobostemon.* I cannot believe that the giant *Echia* of the islands have retained a primitive arborescent habit now lost by the more lowly congeners on the mainland, as has been suggested in some similar cases by those who insist that in the modification of stem-structure evolution can only proceed from the woody to the herbaceous (i.e., from trees and shrubs to herbs) and never *vice versa.* To accept this dictum would force us to consider those particular islands in which plants display behavior comparable to that of *Echium* as merely refugia in which conservative old plants have been preserved and little changed. Very pertinent here is the high degree of incidence of the candelabra-type branching and the rosette-tree habit among woody insular representatives of groups which are elsewhere herbaceous. Though the habit of these plants is arborescent and distinctly woody, the type is an uncommon one. It is difficult to believe that this relatively uncommon growth form could be primitive in all the many genera of many different families which have only insular representatives displaying it. The frequency of its development on certain oceanic islands, particularly in members of groups elsewhere herbaceous, gives good reason for believing that it is somehow associated with the particular insular environment. It appears to be merely an epharmonic response shared by a wide variety of originally herbaceous or at most fruticose plants that have been allowed to develop in isolation under an equitable oceanic climate with all the benefits of a prolonged growing season. Although it must be accepted as an almost universal rule that evolution has proceeded from the arborescent towards the herbaceous, and stem structure from the ligneous to the herbaceous, there are reasons for believing these prevailing directions can in some instances be reversed under special insular conditions, and that under these conditions it is possible for a group of lowly plants to elaborate *de novo* woody stems and the arborescent habit. I am of the opinion that the insular *Echia* are a group of this sort, and that their arborescent habit and woody stems are elaborations rather than primitive. The gigantism and woody habit of these insular species are to be recognized as representing a high degree of specialization and as epharmonic in character.

The corollas of *Echium* are zygomorphic, and evidently so in all species except for a few in the Canary Islands. They are almost always distinctly bilabiate and most prolonged on the side which is bilobed and bears the individualized medial stamen. The side with the bilobed lip and the medial stamen is without doubt the side of the corolla facing away from the axis of the cyme. It is abaxial! Unhappily numerous authors have incorrectly identified it as to position. This confusion appears to have resulted from a misunderstanding of the peculiar behavior of the flower at anthesis. Unlike the flowers of most borages, those of *Echium* mature and display their corollas only on the dense curved uppermost section of the scorpioid cyme. At anthesis the pedicels bearing them are strict. Borne on the rounded uppermost part of the cyme and always directed towards the youngest part of the inflorescence, the pedicels tend to become more or less horizontal. The flowers they bear, accordingly, do not face away from the straightened, usually vertical older parts of the cyme as in most borages, but rather backwards over its coiled summit. They have become more or less horizontal in an unorthodox manner and in doing so have become resupinate. This condition — backwardly facing resupinate flowers — appears to be present in all species of the genus. To a casual observer and to the insect visitor the corolla of *Echium* has a three-lobed lower lip and a usually prolonged two-lobed upper one. In a functional and empiric sense these can be referred to respectively as the anterior and posterior lips. If, however, they are to be identified morphologically, then the forward three-lobed lip is unquestionably the adaxial and the usually prolonged two-lobed rear lip is with equal certainty the abaxial one. Confusion of terminology in the past appears to have resulted from a lack of general awareness that the corollas of *Echium* are backwardly directed and accordingly resupinate.

In *Echium*, because the corollas are zygomorphic and have developed distinguishable upper and lower lips, the manner in which they are displayed on the cyme and the fact that they become resupinate are readily established. This mode of display, however, is not unique. In Southern California, recently, it was observed in *Cryptantha* and *Amsinckia* and, most interestingly, also in *Phacelia*, a member of the Hydrophyllaceae which also develops scorpioid cymes. In *Amsinckia intermedia* F. & M. the habit is well developed, and the resupinate nature of the corolla is also readily determined, since the corolla-limb is oblique (with the abaxial pair of lobes less spreading than the other three), and since the stamens are borne at three superimposed levels in the corolla-tube and the abaxial medial stamen is always identifiable by the high point of attachment and the usually large size. As in *Echium* the corollas of *Amsinckia* face backwards at anthesis and bear their identifiable odd stamen and the two-lobed abaxial lip uppermost. Additional examples of this habit of bearing backwardly directed resupinate flowers at the summit of the scorpioid cyme will doubtless be found in other species and genera of the Boraginaceae. Although it is difficult to believe that the habit has escaped previous attention, I am forced to report that I can find no mention of it in the literature.

Among the continental species of *Echium* the corolla is always prolonged on the abaxial side and usually very distinctly so. It is most commonly obliquely funnelform but in some species can approach a distinctly tubular form. It may attain as much as 30 mm. in length, as in the attractive large funnelform corollas of *E. plantagineum,* or be very small (only 8–12 mm. long), as in the subtubular flowers of *E. arenarium* and *E. parviflorum*. The zygomorphy of these corollas is always evident, not only in their outward form, but also in the arrangement and differentiation among their stamens. In their departure from radial symmetry the corollas of the Mediterranean *Echia* are the most extreme in the Boraginaceae. Except in *E. italicum* and its allies, the stamens are always borne at three evidently different levels on the corolla walls. In all species the medial (abaxial) member is clearly individualized by its form, manner of attachment, and lowest position.

The insular species are not only distinct as to growth-form, but also in the character and degree of specialization of their corollas. A few of the island plants have tubular corollas, e.g., *E. stenosiphon* and *E. onosmaefolium,* but in most of the insular species the corolla is relatively short and broad and somewhat obconic in form. The corolla usually has a limb that is nearly regular or only slightly (though still perceptibly) longest on the abaxial side. Suprisingly, however, in five species related to *E. giganteum* (cf. Sprague & Hutch. Kew Bull. 1914: 116–122, f. 1–5, 1914), and at least also in *E. Decaisnei,* the corolla is most prolonged not on the abaxial but very definitely on the three-lobed axial side. Among the insular species, hence, the corolla may be prolonged abaxially or adaxially or be regular or nearly so. In all these corollas, however, there is some evidence of bilateral symmetry in the arrangement and differentiation among the stamens. In about half of the insular species the axial pair of stamens is affixed obviously higher on the corolla than the remaining three. In addition, the odd medial stamen is usually recognizable because of its distinctive form and manner of attachment. In the other half of the insular species the stamens may be all affixed at or about the same level on the corolla, but in most of these at least the medial abaxial stamen has distinctive characteristics and is so identifiable. Only in a few of the species, such as *E. nervosum* and *E. simplex,* are the stamens all so similar in general appearance and height of attachment that the medial one is distinguishable only with difficulty. In these species, however, the corolla is very slightly but still perceptibly prolonged on the abaxial side. Though zygomorphy is here reduced to a minimum in the androecium, there is at least a modest expression of it in the corolla form.

In general level of evolution and organization, the flowers of the insular species are in many ways more similar to those of *Lobostemon* than to those of the Mediterranean species of *Echium.* As has been indicated, its seems probable that *Lobostemon* is directly derived from *Echium* or its immediate ancestors, and like both the Mediterranean and the Atlantic island *Echia* has achieved distinctive features through a long period of isolation. Since we appear to be dealing with different products from the dissolution of a former widely ranging group, the general similarities in the flowers of *Lobostemon* and the insular *Echia* can have significance. A few species of *Lobostemon* are herbaceous perennials, and some are merely frutescent, but most of them are shrubs, usually a meter or less high. Accordingly, in both *Lobostemon* and the insular species of *Echium* relatively simple features of floral structure are combined with a prevailingly woody habit. In this combination of features we probably have the cause and the effect. Evolution of habit in the Mediterranean has been directed quite differently from that on the islands and in South Africa. The assumption of the herbaceous habit by the species of the Mediterranean area entailed not merely a shortening of the life-span of the individuals; what is more important, it also brought more frequent generations within the various races of these plants. With the generations occurring more frequently in the herbs than in the shrubs, in the same period of time tendencies for evolutionary change would proceed more rapidly and reach more extreme expression in the herbs than in the shrubs. The woody insular *Echia* and *Lobostemon,* having a slower rate of evolution than the Mediterranean herbs, should retain more of the characters of their common ancestors and so present the most over-all similarities.

The annulus in *Echium* is usually represented by ten minute glabrous or hairy lobes. It encircles the corolla tube usually 0.15–0.2 mm. above the base and is usually less than 0.25 mm. wide. The annulus is accordingly very small and is located unusually low in the corolla-tube. It is always lobed, commonly with the lobes thickish, rounded, nearly as broad as long, and closely juxtaposed, but in some species it is reduced to hardly more than five to ten hairy swellings or to scarcely more than a lineate ring with obscure lobes. It may be glabrous, sparingly strigose, or villulose in various degrees.

The annulus in its various modifications is evidently a useful feature in characterizing species. Its value in defining larger groups within the genus, however, seems doubtful. Coincy, Act. Cong. Intern. Bot. Paris 346–52 (1900) and Bull. Herb. Boiss. ser. 2, 3: 261 (1903), proposed three sections of the genus which he distinguished solely by differences in the annulus. Between the extreme types which he emphasized, however, there are all intermediate stages. Furthermore, the groups defined by stressing the nature of the annulus are not at all convincingly natural. Indeed, they are much less so than groups which can be defined by use of growth-habit or corolla-form or stamen-arrangement.

The members of the androecium in *Echium* vary considerably from species to species in size and form and in position and manner of attachment. The abaxial medial filament is always individualized. It may differ in length from the other four filaments or be borne lower on the corolla, or the character of its base and the manner of its attachment to the corolla may be distinctive. In most continental species it differs in all these respects. Among the insular species, however, the odd filament tends to be very slightly if at all lower than those immediately adjacent and differs very little if at all in length. It is usually most easily recognized by the distinctive form and attachment of its base.

The filaments of the Mediterranean species are arranged in three groups. The adaxial pair is affixed highest on the corolla, the abaxial two laterals at an intermediate level, and the odd medial (abaxial) one lowest. In *E. italicum* and its allies these differences may be slight, but in the other continental species they are very marked. Besides differing in height of attachment, the three groups may also differ in length and degree of exsertion from the corolla. The adaxial pair tends to be most protrudent and in a few species may be alone exserted. In *E. parviflorum* and *E. arenarium* no stamens are exserted. Although prevailingly the stamens of *Echium* are glabrous, occasional forms of *E. plantagineum* and related species may have the upper pair of filaments glabrous and the other three sparingly hairy. Among the insular species the androecium is more simply organized than in the species of the Mediterranean. At most, the stamens are affixed at only two evidently differing levels on the corolla and among some species may be affixed all at practically the same level. The filaments tend to be of about the same length and are practically always equally well exserted.

In most species of this genus the filaments (and the style) have become so elongate before the corolla opens that in order to accommodate their length to their cramped quarters they necessarily become excessively decurved, frequently to such an extent that their tip comes to lie close to their base. After the corolla opens some of this curving tends to persist even after the stamens are fully exserted and so produces the declinate filaments, a characteristic feature of the flowers of *Echium*.

It is to be noted that *Echium,* like most other genera of the Lithospermeae, has anthers that dehisce while the flower is in bud and always before the corolla opens. In the present genus, because of the decurved filaments, the anthers, when they dehisce, may have a position deep in the throat of the still unopened corolla and adjacent to the tip of the decurved style. This frequently occurs in flower buds in which the immature corolla has not yet surpassed the calyx or as yet attained half of its eventual length. If self-pollinization is possible, there is an excellent opportunity for it before the flower opens.

Neither heterostylous nor specialized cleistogamic flowers are known in *Echium*. Within the genus, however, there are species which have forms that differ in size, organization, and function of their flowers. The condition is best known in *E. vulgare*. In addition to the usual form of that species, which produces functionally bisexual flowers, there is another less common form that has distinctly smaller, functionally female flowers. In the latter the style is exserted but the short stamens are included and never mature pollen. Similar functionally female forms have been encountered among the Mediterranean species which I have dissected. The indications are that gynodioecism, of the sort long recognized in *E. vulgare*, occurs in many of the herbaceous species.

A more complicated floral heteromorphism has been recently reported by Camus, Bull. Soc. Bot. Fr. **84**: 451–57, figs. (1937), among plants of *E. candicans* L. cultivated in gardens of southern France. Some of these plants had relatively large corollas with salient stamens and style, others had smaller corollas with the stamens included but the elongate style exserted, while still others with equally small corollas had the stamens and the excessively short style both included. Each of the three types of flowers was associated with an inflorescence distinctive in form. Viable pollen was produced abundantly in the first type of flower, not at all in the second, and only scantily in the third. It would appear that we are concerned here with gynodioecism in which not one but two types of female flowers are involved. Among the herbarium material of the insular species which has been dissected I have found evidences of gynodioecism only in *E. strictum*. One of my specimens (Laguna, Teneriffe, March 1855, *Perraudière, s.n.*) has short included stamens producing no pollen and appears to be the small-flowered functionally female form of that species.

The anthers of *Echium* are usually small, relatively broad, and commonly ca. 0.6 mm. long. Only in a few of the continental species are they oblong and as much as 1.2 mm. in length. The connective is very distinctive. It is somewhat cartilaginous in texture and relatively broad and at the middle bears a well-developed pit in the depths of which the filament is attached. This pit in which the filament is joined to the anther is a unique feature shared with *Echium* only by *Lobostemon*. The apex of the anthers is rounded or obtuse, but their base is distinctly emarginate. In the female flowers of gynodioecious species, in which the stamens are only imperfectly developed, the sterile anthers are always erect. In the perfect flowers, however, the anthers are displayed in an inverted position, with their basal end (that with the sinus) held uppermost. The line of dehiscence on the anther-theca is usually lateral to its medial line, and the expanded thecae are accordingly usually asymmetric. On certain herbarium specimens representing various different species of *Echium* (and also *Lobostemon*), the opened anthers may have the margin of the theca more or less ciliate with very slender elongate incurving hairs. Similar slender hairs may also arise from along the midline of the open empty theca. The condition is not uncommon, though it is usually best developed in specimens of *E. plantagineum* and its allies. The precise nature of these hair-like structures is uncertain. Under high magnification they are revealed to be unicellular, unbranched, and frequently collapsed. Interestingly, at irregular intervals along their length they become locally swollen. If these "hairs" be pollen-tubes they are unusually rigid for that organ, and if projecting ends of mycelium their rigid character is likewise unusual. In either case their restriction to the margin and middle of the theca is difficult to understand.

Pollen of *Echium* shows little variation from species to species, differing only slightly in size and only moderately in the relation of length to breadth. The grains are ovoid or conic-ovoid and bear their three pores equidistant about their broadest part just above the broadly rounded base. In general they much resemble the grains of *Alkanna*, but above the pores are more gradually constricted and their apex accordingly broader and less pointed. The extremes, in the more than forty samples examined, are 16–26 × 13–25 μ. The grains of the Mediterranean herbs (commonly 22–25 × 13–25 μ) are larger than those of the island species, commonly 18–22 × 20 μ.

The nutlets of *Echium* are basifixed and have a prominent, very elongate ventral keel formed of a fused suture. In *E. orientale* and in *E. Rauwolfii* they are nearly smooth and in the latter even lustrous, but in almost all other species they are dull and more or less tuberculate. In some of the Canary Islands species, such as *E. simplex*, the pericarpial protuberances become so large and so very coarse that the nutlet has the appearance of being lobed. The nutlet body, though straight or at most only obscurely incurved in most species, becomes very distinctly bent in some of the island species, e.g., *E. exasperatum, E. Webbii, E. giganteum* and allies. In these latter the nutlet is sharply bent at the middle at an angle of ninety degrees in a manner suggestive of the nutlet of *Moltkia* and *Halacsya*, which it tends to resemble. The attachment scar on the nutlets of *Echium* is basal, usually horizontal or nearly so, and commonly flabelliform. Among the insular species it is frequently green in color, as is frequently the case in *Moltkia*. The nutlet body tends to be narrowed at the base and is frequently somewhat constricted just above the attachment. The scar, accordingly, is usually much smaller than the maximum diameter of the body. The disrupted funicular canal usually forms a conspicuous pit in the ventral angle of the scar. The ends of several vascular strands form an arc towards its dorsal edge.

The gynobase is usually flat. Occasionally, however, it may become distinctly pyramidal, and the nutlets borne upon it are parallel only when incurved. Straight nutlets on such an elevated gynobase are somewhat diverging. The style is always sparingly but distinctly hairy and usually contains two distinct vascular traces, at least above the middle. It is simple and terminated by two small, distinct, closely juxtaposed stigmas in *E. rubrum,* but in all other species is distinctly forked below the tip. The two lobes tend to be subulate and commonly are unequal in length. They are each terminated by a very small stigma.

As here defined, *Echium* includes *E. orientale* L., a species which recent botanists have separated from *Echium* and treated as forming the monotypic genus *Megacaryon* Boiss. The distinctive characters of the plant are supposed to be its rank habit of growth and its very large, nearly smooth nutlets. In biennial habit and the organization of its corolla and androecium, the species agrees with other continental species. In coarseness of habit it is no more remarkable than *E. pomponium,* another continental species. In any case, in a genus such as *Echium*, which contains such great diversity in types of habit — from lowly annuals to woody plants up to five meters tall — it is utterly inconsistent to emphasize habit in any attempt to justify the generic segregation of *E. orientale.* Smooth nutlets, though uncommon in *Echium*, do occur in *E. Rauwolfii.* With this fact recognized it becomes evident that *E. orientale* is particularly notable only from the relatively large size of its nutlets, certainly no basis for the recognition of a segregate genus.

6. **Lobostemon** Lehm. Linnaea **5**: 378, t. 5 (1830); Levyns, Jour. Linn. Soc. Bot. **49**: 393–445 (1930). Type species *L. echioides* Lehm.

Lobostema Spreng. Gen. **1**: 126 (1830), a variant spelling of *Lobostemon* Lehm.

Echiopsis Reichenb. Handb. 192 (1837). Type species *Echium fruticosum* Pers.

Isorium Raf. Fl. Tellur. 2: 61 (1836). Type species *Echium formosum* Pers. (= *L. grandiflorus* Levyns).

Traxara Raf. Fl. Tellur. **4**: 85 (1836–38). Type species *Echium capitatum* L.

Oplexion Raf. Fl. Tellur. **4**: 86 (1836–38). Type species *Echium ferox* Pers. (= *L. argenteus* Buek).

Penthysa Raf. Fl. Tellur. **4**: 86 (1836–38). Based upon *Echium fruticosum* L., *E. glaucophyllum* Jacq., and *E. laevigatum* L.

Echiostachys Levyns, Jour. Linn. Soc. Bot. **49**: 445 (1934). Based on *Echium incanum* Thunb., *E. spicatum* Burm. f., and *L. Ecklonianus* Buek.

Echium § *Trichobasis* DC. Prodr. **10**: 13 (1846). Type species *Echium caudatum* Thunb. (= *E. spicatum* Burm. f., Prodr. Cap. 4, 1768 = **Lobostemon spicatus** comb. nov.).

Lobostemon § *Trichobasis* (DC.) Gürke in E. & P. Nat. Pflanzenfam. IV, Abt. **3A**: 128 (1893).

Echium § *Synlobus* DC. Prodr. **10**: 15 (1846). Type species *Echium formosum* Pers.

Lobostemon § *Synlobus* (DC.) Gürke in E. & P. Pflanzenfam. IV, Abt. **3A**: 128 (1893).

Plant perennial, sometimes suffrutescent or herbaceous but usually distinctly fruticose, mostly small shrubs; hispid or strigose or nearly glabrous; leaves thickish, numerous, veinless or nearly so, all cauline. Cymes densely to loosely scorpioid, forked or simple, conspicuously bracted, frequently becoming very loose at maturity, few- to many-flowered, usually borne terminally or subterminally on leafy branches but sometimes reduced to few-flowered axillary glomerules and aggregated to form a loosely spicate or a very dense cylindric thyrse. Calyx usually 5-parted, only rarely tubular below the middle, sessile or distinctly pedicellate, small or nearly half as long as the corolla; lobes equal or very unequal (or sometimes all dissimilar), frequently with the anterior lateral ones best developed, sometimes with the anterior three more or less united, moderately or very weakly accrescent at maturity. Flowers monomorphic. Corolla blue, pink, white or red, small to large, nearly regular or more commonly somewhat zygomorphic, tending to be prolonged on the abaxial side, outside somewhat strigose or glabrous, inside without stipitate glands or true faucal appendages, glabrous except for hairs on and about the infra-staminal appendages or on the tube below them; corolla-lobes ascending or spreading, rounded, subequal or with the abaxial two perceptibly the largest; limb frequently oblique; tube cylindric or slightly bent and swollen abaxially; throat usually gradually expanding, commonly funnelform and as long or longer than the tube but in some species becoming very abruptly ampliate and shallow and not much if at all longer than the tube; annulus highly specialized and represented by the infra-staminal appendages. Stamens 5, all arising at or near the same altitude on the corolla, or the axial pair highest on the corolla, the medial abaxial one lowest and the two abaxial lateral ones at an intermediate level; filaments slender, usually with a prolonged decurrent base, arising at or below the middle of the corolla, equal or unequal, the abaxial one usually shorter than the two adaxial, all exserted or some or all included, weakly or not at all declinate; the abaxial medial stamen frequently distinguishable by its low attachment or its short length. Infra-staminal appendages (apparently modifications of the annulus) borne at or below the attachment of the stamens and at equal altitudes on the corolla walls and usually conspicuously above the corolla-base, usually tumid and frequently with squamose margins, conspicuously villose at least on the edge, sometimes spreading and shelf-like but usually with the rim ascending and forming a villose cup or a pocket-like recess, sometimes merely a tumid area bearing a cluster of hairs or a transverse densely villose arcuate ridge, at other times represented merely by a short thickened section of the decurrent base of the filament which is densely villose about its thicker upper end. Anthers small, short-oblong, attached to the filament in a pit near the middle of the thickened connective, usually displayed inverted with the base uppermost. Pollen ovoid or conic-ovoid (16–28 × 13–22 μ), broadest above the broadly rounded base and then gradually narrowed to the narrow rounded apex, polar profile circular, usually with the pores slightly protrudent or their position marked by three nicks in the circumference; pores 3, arranged equidistant about the broadest part of the grain. Style slender, with or without appressed slender hairs, not lobed, terminated by 2 very small juxtaposed stigmas, included or exserted, straight or somewhat declinate. Nutlets erect, one to four maturing, sparingly to abundantly tuberculate or even muricate or nearly smooth, venter angulate, prominently keeled, the suture obliterated; dorsum usually with a medial keel at least above the middle but sometimes keeled to the base and with lateral keels also; attachment scar usually large, basal, horizontal or somewhat oblique. Gynobase depressed pyramidal, the attachment faces usually large and well defined.

A group of South African plants containing 25–30 species. It has obvious affinities with *Echium* and was probably derived from the same immediate ancestors. The nature of its relations with *Echium* has been discussed under that genus. *Lobostemon* is distinguished from *Echium* only by having the annulus in the corolla modified into conspicuous, specialized infra-staminal appendages which, unlike the lobes of the annulus in *Echium* and other Boraginoideae, are borne not merely near the base of the corolla but also conspicuously above it. In *L. echioides* the extreme modification and elevation of the annulus has produced flowers with features conspicuously different from those in *Echium,* but in *L. montanus* the flowers are very similar in appearance and general organization to those found in *Echium,* and indeed differ from them only in the large rather than small size of the annulus-lobes. The differences between *Lobostemon* and *Echium* are those between a very small, inconspicuously hairy, simple annulus always borne very close to the base of the corolla and a large villose annulus, frequently with conspicuous squamate outgrowths, which may be near the corolla-base but is usually evidently above it. The only absolute difference, it is to be noted, is that of size. According to D. M. Britton, Brittonia 7: 248 (1951), ". . . all the Lobostemons examined have a basic chromosome number of seven. All the Echiums except *Echium hispidissimum* R. Lit. ($2n = 14$ and 28), have a basic chromosome number of eight." Although it has become traditional to give generic recognition to the South African plants, it is to be recognized that with much justification they could be treated as constituting merely one of the well-marked sections of *Echium.*

The most recent study of *Lobostemon* is by Levyns, Jour. Linn. Soc. Bot. 49: 393–452, f. 1–16, t. 29 (1934). Unhappily the author compartmentized her study, and despite the obvious relations of the genus with *Echium,* appears to have made no attempt to familiarize herself with the variety of structures in that genus. Her discussion of the infra-staminal appendages as organs *sui generis* and her selection of *L. echioides* as the most primitive species in her discussion of phylogeny are equally unacceptable for anyone having familiarity with the range and types of floral structure in *Echium*. Also unacceptable is her segregation of the allies of *L. spicatus* and her erection of the genus *Echiostachys* for them. This proposed segregate genus differs from the species remaining in *Lobostemon* only in the herbaceous habit and very dense cylindrical thyrse. The differences in habit and inflorescence dignified are no more striking nor important than those existing between groups of species in *Echium,* and are no more worthy of generic recognition.

In general organization the corollas of *Lobostemon* are very similar to those of *Echium* and in some species are almost identical. The only important differences are those concerned with the elaboration of the annulus and the accompanying elongation of the basal section of the corolla-tube. As in *Echium* the corollas of *Lobostemon* are more or less evidently zygomorphic and tend to be most elongate on the two-lobed abaxial side. Accompanying this is another strong tendency, that for the abaxial medial stamen to be differentiated, commonly by being shortest, and frequently also by being affixed lowest on the corolla walls. In *L. echioides* and its relatives, though the corolla may be practically regular, a close examination usually reveals the abaxial pair of lobes slightly but still perceptibly larger than the other three, and furthermore, the abaxial medial stamen appreciably shorter than its companions. Although in the *L. echioides*-group the filaments usually arise directly above the appendages and accordingly from the same height above the corolla-base, sometimes (especially the axial pair) they tend to become decurrent for a short distance above the appendages before becoming free. However, when this tendency is present, it is always most weakly expressed in the medial stamen. In other groups of the genus the filaments are usually all evidently decurrent for some distance above the appendages. The differentiation among the stamens is similar to that in the Mediterranean species of *Echium*. In *L. montanus* the filaments are all decurrent 5–6 mm. and become free at nearly the same level above the corolla-base, and all are about the same length. Although the corolla is most prolonged on the abaxial side, the abaxial filament is only very obscurely shorter and lower than its companions. In other relatives, e.g., *L. fruticosus, L. argenteus,* and *L. glaucophyllus,* the adaxial pair of filaments are evidently longest and the abaxial stamen is shortest. The other stamens may be intermediate in size and position. It is a general rule in *Lobostemon* for the abaxial stamen to be shortest and for the remaining four stamens to be either nearly equal in length or the higher pair to be longest. In *L. montanus* all stamens may be exserted, but in its relatives frequently only the highest (the adaxial) pair of filaments equal or surpass the tips of the corolla-lobes. The short stamens are practically always included. This unequal exsertion of the stamens has numerous parallels among the Mediterranean *Echia*. Interestingly, the flowers of *Lobostemon,* unlike those of *Echium,* frequently have the paired stamens with members although practically equal, still not precisely equal in length. Indeed, in some flowers, although there are three well-marked groups of stamens, because of the slight but still evident differences in length within the pairs there are no two stamens within the corolla which are precisely the same length.

The infra-staminal appendages of *Lobostemon* are the most distinctive feature of the genus. These structures, as apparently first suggested by Bunge, Heliocarya pg. 11 (1871), appear to be specialized elaborations of the annulus, a structure which in *Echium* consists of an annular arrangement of five to ten very small lobes borne scarcely above the base of the corolla. The appendages in *Lobostemon* are usually borne on the ridges representing the downwardly decurrent base of the filaments. In *L. montanus* they are located 0.5–1 mm. above the base of the corolla and are in the position at which the annulus is developed in most Boraginoideae. They consist merely of a short specialized section of the ridge below the filament-attachment which is swollen, darkened, and apparently secretory in nature, and conspicuously villose about the thicker and usually somewhat excavated upper end. These infra-staminal appendages of *L. montanus* give every evidence of being no more than a specialized development of a five-lobed annulus. In other species of *Lobostemon,* however, the relation of the infra-staminal appendage to the annulus in other genera is much less obvious. Their position is no longer near the base of the corolla, the conventional position of the annulus, but rather well above it and at times even as much as half-way up the corolla. That section of the corolla which is below the annulus, which in other genera is weakly developed (usually less than 1 mm. long) is in *Lobostemon* elongated and in some species of the genus actually forms the tube of the corolla. It is as a result of intercalary growth in this basal section of the corolla that the annulus has achieved its relatively high position on the corolla. Besides being borne well above the corolla-base, the annulus of *Lobostemon* has become relatively large and has also developed distinctive forms. In some species it consists merely of five villose areas (*L. spicatus*) or five swellings, each decorated by an arcuate lineate ridge bearing abundant hairs (*L. argenteus*). Usually it develops squamate marginal outgrowths and is evidently villous at least on the edge. The squamate margins may be entire or (in *L. hispidus*) more or less distinctly three-lobed. The appendage may be spreading to form a bracket-like shelf (*L. fruticosus*) or be upturned to form a cup or a pocket-like cavity (*L. glaucophyllus*). The most remarkable development of these appendages is in *L. echioides* and allies. In these the appendages are borne at the summit of a well-developed cylindric tube which may be nearly half the total length of the corolla. Since above the tube the corolla expands abruptly and widely into a broad open shallow throat, the appendages filling the opening to the tube are fully exposed to view. They have the general appearance and function of faucal appendages. Unlike true faucal appendages, however, they do not alternate with the stamens. They subtend the protruding stamens which arise directly above them. This condition is unique, for in all other Boraginaceae in which it is developed, the annulus is at most only an obscure structure hidden deep in the corolla, where it functions either as a nectary or as a collar about the nectary at the base of the ovary.

The anthers and the pollen have all the distinctive features of those of *Echium* and are indistinguishable from them. As in *Echium,* the anthers dehisce before the flower bud reaches full size or the corolla is ready to open. At this early stage the filaments are decurved within the bud and the dehiscing anthers clustered at the middle of the bud cavity. The style may be erect and the stigma pressed against the folded corolla-lobes or be recurved with its stigmas among the dehiscent anthers. In most species of *Lobostemon* it would appear that the plants can escape self-pollinization only if they are self-sterile. Although the longer filaments of *Lobostemon,* as in *Echium,* are strongly decurved within the flower bud, they show less inclination to remain declinate after they become exserted from the open corolla. In most species the filaments at maturity are straight or only slightly curving. As in *Echium,* however, they are bent abruptly subapically and thereby effect the inversion of the anther.

The cymes of *Lobostemon* tend to be less dense or less abundantly flowered than in *Echium.* Most of these South African plants have a cyme which is looser than the densely flowered, distinctly biseriate, very elongating scorpioid cymes characteristic of *Echium.* The closest approach to the latter type is in *L. montanus* and its relatives, the group most like *Echium* in its floral structures. In the species-group of which *L. glaucophyllus* is typical, the flower buds are not very crowded on the younger parts of the cyme and furthermore are almost uniseriate. At maturity these cymes become very loosely flowered and racemose. In *L. echioides* and allies the inflorescence is more suggestive of *Anchusa* than of *Echium.* Two groups of species have the cymes reduced to very numerous few-flowered glomerules and the latter aggregated into an elongate thyrse. The dense cylindrical thyrse of *L. spicatus* and its allies is very similar in organization to that of *Echium rubrum.* The most distinctive thyrse is that of *L. argenteus,* in which usually two-flowered glomerules, subtended by large bracts, are scattered along the upper parts of the branch to form an elongate, interrupted pseudo-spike.

In *Lobostemon* the pedicels, as in *Echium,* are strict, but unlike in *Echium* the open flowers are usually borne not on the curved summit of the scorpioid cyme but below the summit near the point where the axis of the cyme first becomes straight or nearly so. The open flowers, borne on strict pedicels at the tip of the straightened portion of the cyme axis, are accordingly nearly vertical. This behavior of the flower is especially clear in those species such as *L. glaucophyllus* and allies, in which the cymes are especially loose. It is a transitional state between the customary manner of floral display in the Boraginaceae, in which the flowers, borne on spreading pedicels on the straightened part of the cyme, have the corollas facing directly away from the axis, and the manner in *Echium,* in which the flowers, borne on strict pedicels on the curved summit of the cyme, have the corollas facing in the opposite direction and accordingly inverted. *Echium* has backwardly directed resupinate corollas. *Lobostemon* has the corolla usually erect and facing upwards. Only in one *Lobostemon, L. argenteus,* a species with an interrupted pseudo-spike of one- to three-flowered axillary glomerules, are the flowers distinctly resupinate.

The style in the allies of *L. echioides* may be completely glabrous, but in most species of *Lobostemon,* as in *Echium,* it bears some appressed slender hairs, at least below the middle. As in *Echium rubrum* and allies, but unlike most species of *Echium,* the style of *Lobostemon* is unlobed and terminated by a pair of very minute stigmas. It may be included or only slightly longer than the corolla.

Arnold Arboretum,
Harvard University.

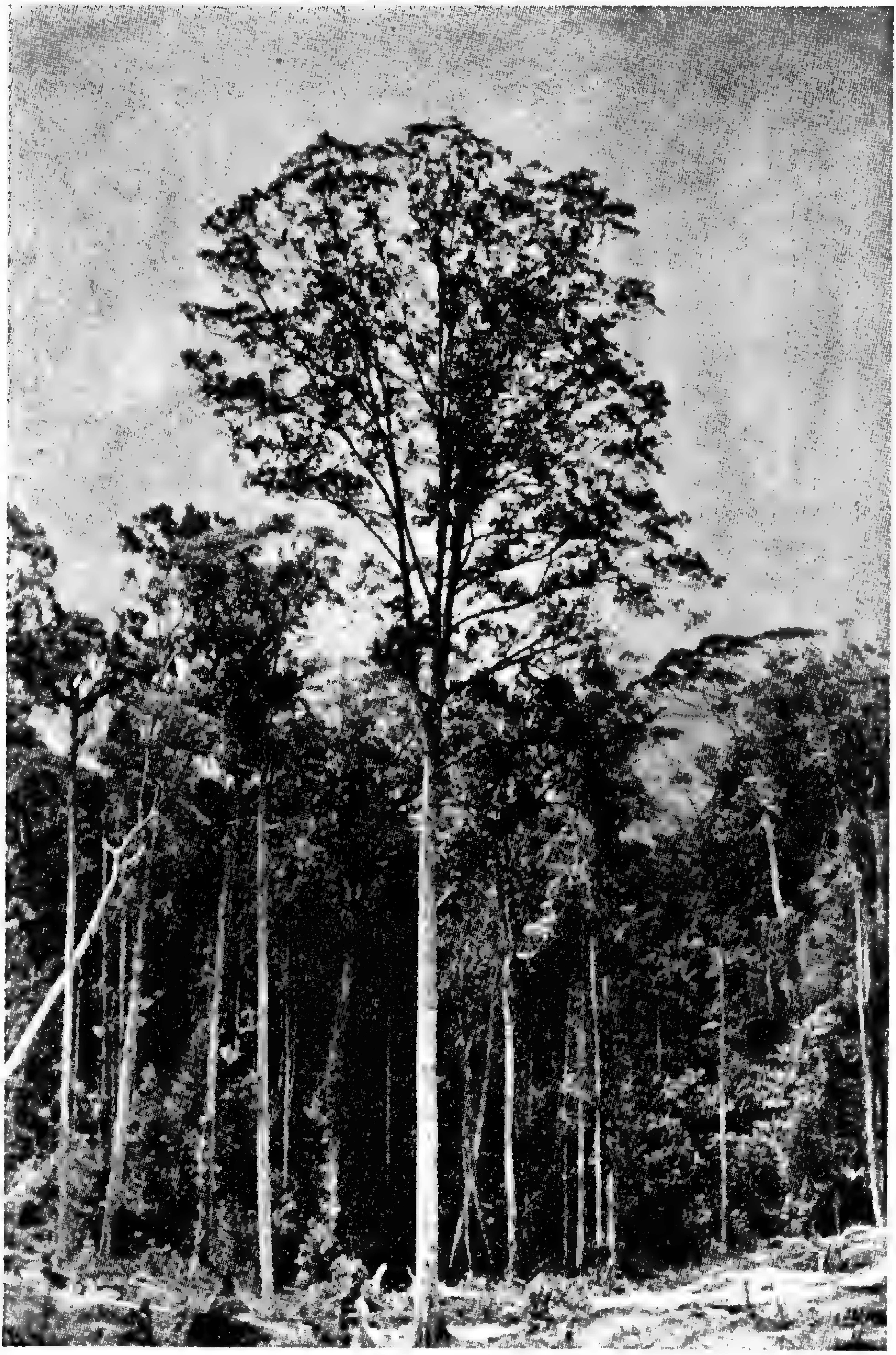

PLATE I. *Nothofagus* cf. *grandis* Steen. At Aiyura, Territory of New Guinea, clearing in rain-forest for coffee-plantation, should be related to No. *NGF 3389* which was collected near by. Photograph by J. S. Womersley, Sept. 1951.

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RESULTS OF THE ARCHBOLD EXPEDITIONS
PAPUAN NOTHOFAGUS

C. G. G. J. van Steenis

With twenty-two figures and frontispiece

CONTENTS

One of the most remarkable finds of the Third Archbold New Guinean Expedition has been the discovery of extensive forests in New Guinea in which the fagaceous element dominates the framework of the canopy. Representatives of *Nothofagus* are very common among these fagaceous dominants.

The big size of the trees is probably one of the reasons why this genus has been overlooked in the often hurried field work during the expeditions to the interior of the island. However, field workers with more leisure, as, for example, Lauterbach, Ledermann, Miss Gibbs, and even Lane-Poole, apparently failed to collect *Nothofagus*, unless their material was not recognized and remains concealed among *incertae sedis* of some other family.[1]

There is another reason for this neglect in collecting *Nothofagus*, and that is that the ♀ flowering is very inconspicuous, and that the more showy and abundant ♂ flowers are only present during a remarkably short "flush" period, as in *Fagus*. Besides the arboreal habit the flowering itself makes *Nothofagus* unattractive to the field botanist.

From these considerations it is quite understandable that the first collection, as far as known, was by Dr. A. A. Pulle (nestor of Dutch systematists and my revered teacher) under favourable circumstances, from a stunted shrub in anthesis on the crest of Mt. Hellwig, in 1913. Over twenty years elapsed before the genus was collected again, this time by C. E. Carr in 1935–1936. After that collections came in independently very rapidly, by Clemens in 1937, Brass and Brass & Versteegh in 1938–1939, Kanehira & Hatusima in 1940, and Eyma in the same year. After the war several more new collections were made by A. J. G. H. Kostermans on Mt. Arfak and by the collectors of the N. G. F. series, L. S. Smith, J. S. Womersley, J. Cavanaugh, and A. J. Schindler.

The assemblage of these collections, totaling forty-seven, which has been generously put at my disposal during several years, forms the basis of this paper. It shows that the genus is distributed through the mountains of the island, between 1000 and 3000 m. altitude.

I have to express my gratitude for loan of collections to the Keeper of the Herbarium Bogoriense, the Director of the Arnold Arboretum, the Forest Botanist at Lae, the Director of the Fielding Herbarium of Oxford University, and the Director of the Herbarium of Utrecht University. In addition I have the privilege of rendering special thanks to the following individual botanists who assisted me in various ways: Dr. R. C. Bakhuizen van den Brink, Jr., Leyden, Dr. M. G. Baumann-Bodenheim, Zürich, Dr. B. K. Boom, Wageningen, Mr. L. J. Brass, Florida, Mr. A. A. Bullock, Kew, Miss Isabel Cookson, Melbourne, Dr. H. E. Dadswell, Melbourne, Dr. W. M. Docters van Leeuwen, Leersum, Netherlands, Mr. L. L. Forman, Kew, Dr. E. Kausel, Santiago de Chile, Mr. P. W. Leenhouts, Leyden, Dr. E. D. Merrill, Jamaica Plain, Mass., Miss L. M. Perry, Jamaica Plain, Mass., Dr. C. Skottsberg, Stockholm, Dr. H. Sleumer, Leiden, Dr. W. T. Stearn, London, the late Mr. C. T. White, Brisbane, and Mr. J. S. Womersley, Lae.

PLANT GEOGRAPHICAL SIGNIFICANCE

As to the geographical range, there is nothing unique about the occurrence of *Nothofagus* in New Guinea. Its generic area fits in satisfactorily with that outstanding set of microtherm, now subantarctically distributed

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[1] Sterile sheets can immediately be recognized by the remarkable (sometimes early caducous) peltate stipules, the distichous leaves with a sulcate midrib and a glandular undersurface, and the resinous colleters on the adaxial base of stipules and perular bracts.

genera ranging from Chile to Fuegia, the Subantarctic Islands and New Zealand to the Tasmanian and Victorian Alps, often extending their area to New Caledonia [1] — sometimes also including Queensland — and protruding into Malaysia,[2] primarily into the Alps of New Guinea, often prolongating their track to the high peaks of Ceram, Central Celebes, the Philippine Islands, Mt. Kinabalu, and in single cases even to the Malay Peninsula and N. Sumatra (*Oreobolus*), as revealed by my exploration of the Gajo Lands in North Sumatra (3).

Prof. Diels, in his contribution to an analysis of the Papuan mountain flora (1), had already grasped this generality, and as early as 1930 had included *Nothofagus* in his list of subantarctic elements as a genus which would likely turn up at least in the Island of New Guinea. Since he made this list, this and other remarkable additions have indeed been recorded, mostly from the Archbold-Brass collections, supplementary to those which I had listed in 1934 (2). There is little doubt that several others will be collected later or have already been collected and are waiting identification.

This group includes *Plantago* § *Plantaginella*, *Araucaria*, *Scleranthus* § *Mniarum*, *Libertia*, *Carpha*, *Pratia*, *Oreomyrrhis*, *Coriaria* § *C*, *Eulibocedrus*, *Drapetes* (incl. *Kelleria*), *Erechtites*, *Abrotanella*, *Oxalis magellanica*.

Some of these, like *Pratia*, have reached the southeastern part of the Asiatic continent, and a typical one, *Euphrasia,* of which the greatest morphological polymorphy is found in Subantarctica, is spread over the Northern hemisphere. In contradiction to Du Rietz and others, *Euphrasia* seems to me to represent a subantarctic element on the Northern hemisphere, and not the reverse.

The set of areas just mentioned, manifestly bound to a wet and cool to cold climate, is one of a group of four types of southern distribution which appear to make part of the development or represent relics of the former spread of ancient distribution on the Southern hemispere. The set just mentioned, which I call *type I*, is restricted to *circum-South Pacific distribution.*

A second set of areas of smaller size (*type II*) could be called *Australasian areas*, comprising Australia, Tasmania, New Zealand, and extending towards Eastern Malaysia. To this set belong *Myriophyllum* § *Pelonastes*, *Bubbia*, *Diuris*, *Pterostylis*, *Thelymitra*, *Olearia*, *Quintinia*, *Phyllocladus*, *Trachymene*, *Corybas*, *Patersonia* (absent from New Zealand), *Dichelachne*, *Cotula* § *Leptinella*, and *Centrolepis.*

There is a great affinity between these two types, which form only variations on one basic pattern. For instance, *Centrolepis* belongs to type II, but the Centrolepidaceae as a whole to type I, *Kelleria* to type II, but *Drapetes* s.l. to type I.

A third set of areas of larger size which belongs to the same pattern occupies the area of type I, but in addition also extends to the East to

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[1] And sometimes to other adjacent islands within the andesite line: Fiji, New Hebrides, and Solomons.

[2] Sometimes without occurring in Australasia, like the *Corsiaceae*.

the Central Pacific Islands (e.g., Hawaii, Juan Fernandez). This type has been termed *old-Oceanic* (*type III*). To this type can be assigned the genera *Oreobolus, Uncinia, Coprosma, Hebe, Muehlenbeckia,* and *Lagenophora.*

Type III comprises apparently also several genera endemic in New Guinea, the alliance of which definitely points to the Pacific and which represent ancient relics now confined to small refuges, for instance, *Papuzilla*, *Brachionostylum.*

Also there are intermediates between type III and type II, as *Ascarina, Hecatactis,* and *Tetramolopium.*

A fourth type is that which conforms either to type I or type III, but in addition its representatives occur also outside the Pacific circle; they may be found in remote islands in the S. Indian and Atlantic Oceans, in S. Africa, in Madagascar, or in the Mascarenes. I should like to call this *type IV*: *General Subantarctic.* Examples of this type IV are: *Acaena, Astelia, Gunnera, Nertera, Brachycome.*

This type also shows intermediates with others, e.g., with type II, the Australasian one, in *Hibbertia.*

The sequence of gradual extension in size from type II, via I, and III, to IV, the fact that these genera occur in the same or similar associations and under similar climatological conditions, all more or less microtherm in character, and further, the occurrence of typical intermediates between the types, show that they belonged to similar conditions in the past and have made a part of one regime. The big disjunctions, further, indicate that they represent relics of former distributions in the Southern hemisphere. In considering these disjunctions I agree with Diels, Skottsberg, Du Rietz, and many others, that there is no escape from accepting ancient continental land in the Southern hemisphere, bringing together here what is now remote.

To date this southern land, to fit it into geological history, and to delimit precisely its various subsequent borders, are exceptionally difficult, since no definite palaeogeographic sources can guide us. But, judging from what is known of plant distribution just brought to the fore, and what is known with certainty from other sources, these distributions date at least back to Old Tertiary or even Cretaceous time. What we observe of these distributions at present is a mere chance fraction of what has been.

Among the larger continental islands, New Guinea occupies a predominant place as a refuge of these relics.

One wonders why these distributions, accepted as very ancient, are still limited to the Southern hemisphere theatre. Why have they not dispersed themselves more widely and frequently during this enormous lapse of time into the Northern hemisphere, like *Euphrasia*? Why do so few of the wide areas flare out only to the southeastern corner of continental Asia with stray representatives like *Centrolepis*, *Pratia*, *Nertera*, *Corybas*, and others?

There are not, and in all probability there never were climatic obstacles to a further dispersal of *Nothofagus* into Malaysia.

Nothofagus requires a cool, constantly humid climate. These conditions, however, are not peculiar to the island of New Guinea but are common to the vast majority of Malaysian mountains, as well as to large tracts of the Sino-Himalayan ranges.

Species of both deciduous and evergreen sections show a similar response to constantly humid conditions, though the first has a hygromorphic and the latter a distinctly xeromorphic leaf anatomy, both inside and outside the tropics.

Generalizing, several major groups (affinities) of the plant world possess a northern hemisphere complement to one in the southern hemisphere, and, though their areas may overlap, they more or less exclude each other, e.g., Ericaceae and Epacridaceae, *Dillenia* and *Hibbertia*, etc. With the Fagaceae the genera *Fagus*, *Quercus* s.l., and *Castanopsis* together practically exclude the area of *Nothofagus*.

Southern hemisphere *Nothofagus* and Northern hemisphere *Fagus*, mutually more closely allied than to any other genus, represent, as *Fagoideae*, a marked example of bi-polar distribution, a plant-geographical topic of considerable importance, of which Du Rietz (51) has recently given an exhaustive classical survey.

For an explanation of this bi-polar distribution there are two possibilities.

First, the northern and southern hemisphere complements can be assumed to be descendants of an earlier common worldwide (or at least tropical and subtropical) distributed matrix and to have evolved and spread more or less independently, the one towards northern and the other towards southern regions.

Or, secondly, one of the complements may be more ancient than the other and has produced the other complement, but through later isolation the other has diverged *in situ*, while the ancestral matrix of the one became extinct in that hemisphere.

Both possibilities may have come true in different groups, as there are examples for both.

A marked example for the first possibility is the area of *Euphrasia*, which shows a remarkably uninterrupted distribution from the southern to the northern hemisphere. If the area had been very disjunct in the subtropics and tropics and the two populations had differed a little more, systematists could easily have distinguished two different genera.[1]

Examples for the second possibility (extinction) are based on palaeontological evidence of *Araucaria* in the northern hemisphere, living *Araucaria* being restricted to the southern hemisphere. A similar example is that of *Libocedrus*, of which the disjunct northern hemisphere areas have been recently found to support a genus distinct from that of the southern hemisphere.

Engler (40) was inclined to accept for *Fagus-Nothofagus* the first explanation, assuming an ancient, extinct, common ancestry in Malaysia.

It is certainly most remarkable that the areas of *Euphrasia*, *Fagus* and

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[1] As a matter of fact two separate genera, *Siphonidium* and *Anagosperma*, have been proposed to accommodate the long-tubed New Zealand species.

Nothofagus, *Araucaria* (living and fossil), and *Libocedrus* are obviously essentially conformal and represent "equiformal relic areas." If they were only seemingly so, it would be an extraordinary coincidence that *Nothofagus* forms, in South America, a substage in the *Araucaria* or *Libocedrus* forest, and that the genera just mentioned all grow together in Patagonia and in the Papuan mountains!

Is it not true that some of these southern hemisphere floral elements were in very ancient time very widely distributed in northern regions, as fossil *Araucaria* seems to indicate? Has not this flora been retreating since, giving us the impression that they are truly southern hemisphere genera now engaged in invading the northern hemisphere via the tropical "bridges"?

Could it not be that *Euphrasia* is one of the very few survivors showing this ancient distributional type, as well as the Fagoideae?

Why *Euphrasia* has maintained itself as one genus on both hemispheres, whereas *Fagus* and *Nothofagus* have been segregated from a common ancestor and represent distinct genera, is a question difficult to answer, as it concerns questions of genetic potentialities which are untraceable and will, in all probability, differ from taxon to taxon.

There is, of course, reason to accept neither an exclusive "monoboreal relic hypothesis" as advanced by Thiselton-Dyer (52) nor an equally exclusive "mono-antarctic relic hypothesis" as advocated by Copeland for the Pteridophytes — and in extreme form by Croizat for the Phanerogams in his recent Manual. Both hemispheres had, it stands to reason, their own autonomous Phanerogamic flora from a common more ancient matrix. There has been no monopoly of either of the hemispheres: plants have extended their areas both from the South towards the North and in the reverse direction. How the epiontological taxonomy and geography have evolved for each individual group can only be ascertained by considering the geographic position of its present living relics in the regime of its taxonomic affinities. This is for isolated, ancient groups like *Nothofagus* a most delicate task to perform.

For several of these groups I am inclined to accept the idea of an early general retreat (extinction), cq. isolated instances of evolution in the northern hemisphere of so-called southern hemisphere plants which formerly enjoyed world-wide distribution. Fossil finds in the northern hemisphere whose identification is beyond question might prove this. If it should turn out to be true, many southern hemisphere groups represent living fossils, as has been suggested before (52). A northern hemisphere fossil record from the Eocene of England, *Dicotylophyllum stopesae*, was described in detail by Miss Bandulska (57) and considered to represent a *Nothofagus* on the strength of the structure of leaf cuticles with particular reference to the stomata.

Returning to factual data, Papuan *Nothofagus* gives definite additional support to the relatively great age of these distributions. Darrah (58), reviewing the evidence, states that the family Fagaceae "was spread to all continents including the Antarctic in the upper Cretaceous." This is supported by Te Punga (59) who recorded a *Nothofagus* pollen form also from New Zealand Cretaceous beds.

Papuan *Nothofagus* is, most probably, a living fossil similar to, though less spectacular than *Metasequoia*. This has been found by Miss Isabel Cookson, who has described its pollen type from fossil Oligocene or Miocene Australian soils. The pollen type she described could not be assigned to any *living Nothofagus* until she got material from some living species of Papua and New Caledonia (5). Miss Cookson is strongly convinced that the fossil record shows that the type of *Nothofagus* now still thriving in and confined to New Guinea and New Caledonia had been growing in Australia in former geological epochs. She has found this fossil pollen type widely distributed in Australia, from southern Queensland to Tasmania and westward into South Australia. According to R. A. Couper (46) similar, if not identical, "intermediate" pollen species have been distinguished in Cretaceous and Tertiary beds in New Zealand. Apparently the Australian climate in the Cretaceous was colder than it is now. The early Tertiary in Australia was characterized by abundant rainfall and moderate temperatures, according to Wood (53), as shown by the fossil distribution of mesic elements of the rain-forest — to which recent *Nothofagus* in Australia is also confined — which was then much more extensive than it is at present. According to Miss Cookson (4, 5) *Nothofagus* is a most conspicuous pollen in the Oligocene and Miocene deposits from South Queensland to southeastern Victoria, eastern South Australia and Tasmania, as well as in New Zealand, being found in lignites, clays, and mudstones in sheets which are sometimes over 300 m. thick. Pollens belong to at least nine species and occur in vast numbers. Besides the two types of living Australasian species, there are seven more fossil pollen types, one of which is represented by the living Papuan species.

Additional support for the high antiquity of Papuan Fagaceae is rendered by the judgment of F. Markgraf, who in 1925 remarked (7) that, though the number of living Fagaceae at that moment known from New Guinea was small, they were remarkable and of importance for phylogeny: of both *Lithocarpus* and *Pasania* markedly primitive forms were found among the assemblage.

As Torres Straits represents an abrupt demarcation of Fagaceous occurrence (*Quercus* s.l. and *Castanopsis*) towards the Pacific and Australasia, it is highly noteworthy to find just near that border such ancient forms. This again points to a prolonged ancient functioning refuge of the New Guinean continental mass and to long periods of relative isolation both from Australia and Melanesia and from the western parts of Malaysia.

Thus New Guinea is in the unique position of sheltering most primitive northern hemisphere Fagaceae together with living fossils of southern hemisphere representatives.

The intimate botanical affinity between the New Guinean and New Caledonian floras, especially with regard to ancient southern hemisphere genera, is strongly supported by the finding in New Caledonia of several species of *Nothofagus* of the Papuan type. Other taxa supporting the rather close affinity of New Guinea and New Caledonia are *Agathea, Antholoma, Bubbia, Dubouzetia, Durandea, Joinvillea, Meryta, Tapeinosperma,* and *Nepenthes vieillardii* Hook. f.

This discovery we owe to Dr. M. G. Baumann-Bodenheim [1] of Zürich, who, enthused by a hint from Prof. Dr. H. J. Lam, has been on the lookout especially for *Nothofagus* during his recent long-range exploration of New Caledonia. During a visit to Zürich in 1952 I presented my data to Prof. Däniker and Dr. Baumann, and the latter courteously showed me his specimens, which belong to five undescribed distinct species. All of them are coarse in foliage and possess cupules like those of *N. grandis, N. brassi,* and *N. dura.* No small-leaved representative seems to occur in New Caledonia. Moreover, all New Caledonian species show three nuts per cupule; one-flowered species seems to be absent.

Therefore, although the New Guinean and New Caledonian floras again exhibit their close affinity and show that they have equal standing as the result of a parallel, comparable geological history, New Guinea seems to be the richer as far as *Nothofagus* is concerned. Its morphological diversity is notably greater in New Guinea than in New Caledonia. Reduction phenomena occurring in the cupule of New Guinean species are remarkable, as will be explained below.

Moreover, New Guinea seems to exceed New Caledonia in number of species, and, though the state of the material is not what it should be and the systematic treatment is, in all probability, unfortunately not to be regarded as final, I am convinced that this number will not be reduced below ten distinct species, even when more ample material has come to hand.

This shows that the Papuan-New Caledonian section is by no means a small part of the genus. It is merely by priority of collections and descriptions that *Nothofagus* has been listed, plant geographically, as a "subantarctic" genus, which it still is, but in a much broader sense. It cannot be denied that by the new finds the main point has been appreciably shifted towards the West Pacific.[2] With sixteen species in New Guinea and five in New Caledonia the Papuan-Melanesian centre stands at least on an equal footing with the South Pacific area of distribution as far as number of species is concerned.

For the appreciation of the New Guinean-New Caledonian *Nothofagus,* which together form a special taxon, sect. *Planae* subsect. *Bipartitae,* it is important to have an idea whether it is an ancient type or, morphologically, a more modern derivative. This hinges on the interpretation of the morphology of the inflorescences, especially that of the female sex.

Eichler accepted (41) the cupule of *Fagus* as having originated from four bracteoles; the cupular bracts he regards as emergences. Schacht,

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[1] The manuscript of his paper on the New Caledonian species was finished in March 1953 and was submitted for the approval of his director, Prof. Däniker, Zürich.

[2] A similar shifting of the centre of genera caused merely by priority of description through the haphazard historical sequence of collecting has occurred in other South Pacific and Australasian genera, as in *Ascarina, Drimys, Vavaea, Faradaya,* and *Corybas,* and to a smaller extent in genera like *Trachymene, Oreomyrrhis,* and *Olearia.*

Celakovski (42, 43) and Prantl (23) accept the cupule as an intercalary hollow axial structure covered with reduced leaves ("Hochblätter") comparable with the inflorescence of a fig, though Prantl claims to have seen two bracteoles at the base of each cupule. Also Berridge (44) accepts the cupule as an axial structure with reduced leaves. Helmqvist equally (21, p. 86) recognizes its axial structure.

Miss Langdon, in her valuable study on the morphology of *Nothofagus*, comes to the (similar) conclusion (17, p. 365), that on the basis of vascular organization the cupular valves of *Nothofagus* may be interpreted as corresponding to the bracts and modified floral parts, including the axial portions, of the "tertiary units" of an originally more complex cymose inflorescence.

In the following I wish to disregard the question whether the cupule of all Fagaceous genera is homologous, and will limit myself to that of *Nothofagus*.

Broadly speaking, the character of the flowering parts is, in both sexes, that of a contracted, cymose inflorescence. This point of view is accepted by nearly all authors concerned save a single one who believes that the cupule is entirely an axial structure.

The appendages on the cupular valves of *Nothofagus* are by most authors accepted as representing "bracts" inserted on a lining of axial origin, but what kind of "bracts" are meant is not always clearly expressed.

In both sexes the flowers do not possess bracteoles. A bracteolate origin of the appendages is, therefore, not very probable.

Other "bracts" available are either the caducous perular "bracts" at the base of the flush or the stipules.

As in *Fagus*, the perular "bracts" are homologous with stipules. Like the latter they are inserted decussately, hence form four orthostichies and are provided with colleters at the adaxial base, but they are invariably basally attached. In various *Nothofagus* species with small basally attached stipules, the perular bracts do not differ much in shape or size from the stipules, though by contrast they never sustain flowers. In species with distinctly peltate stipules, however, perular bracts and stipules proper differ distinctly in size and shape.

The stipules are also inserted in four rows, orthostichies, as they accompany the alternate leaves on either side. They are firmly inserted and are more apt to have functioned in the formation of the cupule, as they are found apically of the perules. They also possess colleters. In the living species, ♂ flowers are never found in the axils of the perular bracts, but are often found on the leafless twig-base above the perular bracts sustained by the stipules.

It seems to me, therefore, that not the perular bracts, but the stipules proper, have taken part in the contraction of the ♀ inflorescence leading to the cupule.

A hypothetical Fagoidaceous ancestor of *Nothofagus* thus would have the following characters:

Male flowers in lateral cymose catkins at the base of the flush (in the living species reduced to a triad or even a solitary flower, e.g., in 5. *N. pullei* and 7. *N. resinosa*, which both also show a remarkable parallel reduction in the ♀ sex!).

Female flowers in axillary prolonged catkins on lateral twigs provided with stipules but probably without leaves (as is sometimes the state of the basal part of the flush in living species).

Imagining a suppression of the length-growth of the female catkin-bearing twig and a simultaneous reduction of the basal catkins, the resulting ♀ inflorescence would be a crowded mass of stipules arranged in four orthostichies surrounding the terminal ♀ flowers of the upper catkins.

In this condensed inflorescence the stipules would still remain inserted on a base of axial origin, and these bases together would clothe the inner side of the then hollow (suppressed) twig with a coating of woody tissue of axial origin.

In this way four valves would result, capsule-like covering the ♀ flowers, each valve consisting of the inner lining of axial origin covered outside by the concrescent stipules, represented as "lamellae" in the living species.

It seems that only suppressed length-growth is needed for explaining the origin of the *Nothofagus* cupule.

Additional argument is derived from the presence of the colleters on the adaxial base of the lamellae in the living species. Also, the scarious apical part of the stipules is well reflected in the scarious nature of the lamellae in various living species. Another argument is the fact that the outer lamellae (representing the lowest stipules in the hypothetical ancestor) develop earliest in Papuan *Nothofagus*; the telescoping development of the lamellae could be well observed in 11. *N. bernhardi* (*fig. 16c*) where the very young cupule shows only one lamella, outside, concealing the inner ones, which are shorter but which gradually slide away from under the outer lamella.

The fact that the sexes in *Nothofagus* are separated agrees with the situation in other Fagaceae, Betulaceae, and allied families.

If this mode of origin of the cupule is accepted, there is little difficulty in correlating the morphology of the living species. I have presented this in a schematic construction in *fig. 1*.

A four-valved cupule with undivided scarious lamellae and containing at least three ♀ flowers is accepted as morphologically primitive both in sect. *Calucechinus* and sect. *Calusparassus*. The central (terminal) flower may be 2- or 3-merous.

In sect. *Calucechinus* the most primitive stage is found in *N. alessandri*, which normally possesses seven ♀ flowers in each cupule: one 2-merous flower is basal (central), the two lateral flowers are 3-merous and are inserted near the junction of the valves; besides, the base of each of the valves bears an additional 2-merous flower, so that apparently three cymes are represented. If we assume that the central (terminal) flower of each cyme is normally 2-merous in *Nothofagus*, this species even shows a tendency to a more complicated inflorescential design, viz., of five cymes, of which only in the basal one the lateral flowers are developed. Reduction

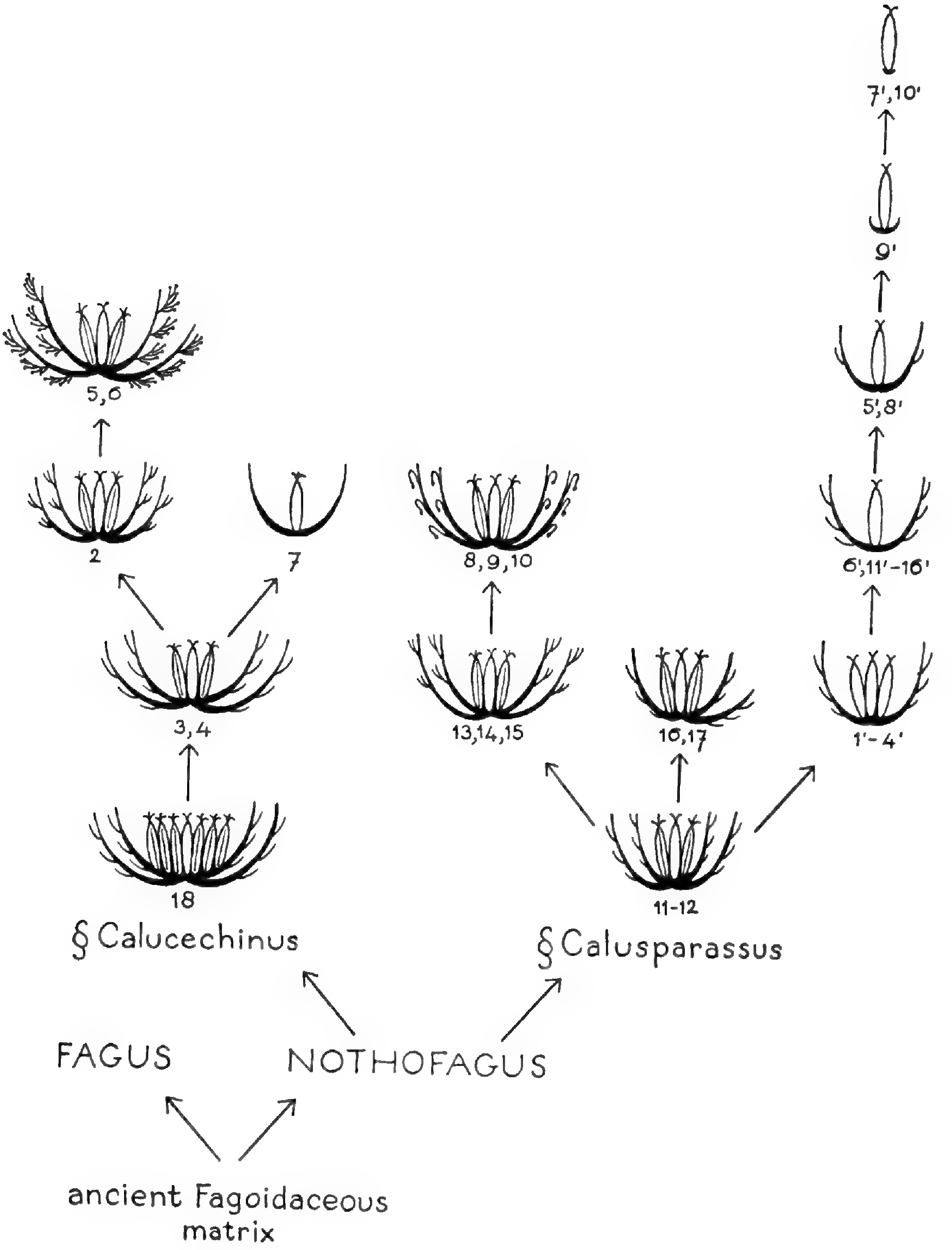

FIGURE 1. Scheme of morphological interrelations in the cupular structure of *Nothofagus*. Below each type the species referable to that type are cited by numbers corresponding with those of the key to extra-Papuan species. The numbers of the Papuan species (right column) correspond with those in their key and have been marked with an acute accent.

in number of female flowers leads to a 3-flowered cupule with entire lamellae. On the left side of the *fig. 1* there is a line leading to a further division of the cupular lamellae via species numbers 1 and 2 towards the intricate-fringed lamellae in species 5 and 6. On the other side there is a reduction of the lamellae leading towards further simplification of the valves by concrescence in pairs leading to the elamellar 2-valved cupule in species 7.

An argument for the possibility of concrescence of four valves into two has been found in some New Guinean 2-valved species with occasionally notched valves in the 2-valved species, e.g., in 2. *N. perryi* (*fig. 6e*).

An additional argument may be derived from the peculiar candelabra-shaped cupule of *N. glauca,* of which the flat basal part is broadened by the pairwise connate bases of the cupular valves through which these look forked. The lateral nuts are inserted at the junction of each fork, remote from the central flowers. Outside, the connate bases show a distinct furrow indicating the connation.

In sect. *Calusparassus* similar processes can be observed: reduction of valves and flowers on one side and ornamentation of the cupular lamellae on the other side.

Also here the most primitive morphology of the ♀ inflorescence is the one resembling that of sect. *Calucechinus,* viz., a 4-valved cupule with undivided lamellae and three ♀ flowers (in 14. *N. nitida* occasionally five ♀ flowers have been recorded!).

On the left side of the *Calusparassus* ancestry is a line leading towards cupules with intricate patterns of ornamentation brought about by a steady progression in the splitting of the cupular lamellae, which are split in spp. 13–15 followed by still more appendages, which are recurved and gland-tipped in spp. 8–10.

The other way round, viz., towards reduction, is found in the branch towards spp. 16 and 17, in which 3-valved cupules have been produced. As a matter of fact one of the three valves in these species is often broader than the two others and points to concrescence of one pair of valves into a single valve.

Another line of still greater reduction is the one on the right side of the scheme represented by the Papuan-New Caledonian species of series *Triflorae,* which are probably close to the ancient state in sect. *Calusparassus* save for their possession of exclusively 2-merous flowers (each probably representing the terminal flower of a cyme) and concrescence of four valves by pairs into two cupular valves. This leads easily to the species of series *Uniflorae,* where the number of flowers is reduced to a solitary one. And within this series *Uniflorae* a rather full series of four steps is observed leading to a still greater reduction of the cupule, which gradually loses its lamellae, resulting in the entire loss of the cupule in spp. 7 and 10.

That this tendency towards reduction is not wholly hypothetical is reflected in the fact that all of the species of series *Triflorae* possess triads of ♂ flowers, but that among the species with the most reduced cupules the male sex is also reduced to a solitary flower, viz., spp. 5 and 7.

Both tendencies, reduction of the cupular lamellae and progression in splitting of them towards more intricate ornamentation, are exhibited on the specific level. Concrescence of the cupular valves I assume to be representative of the subsectional level.

The discussion just given should be regarded as a cautious, subjective approach to a possible reconstruction of typological morphology. The interrelations were so obvious that I felt strongly invited to give some comment on morphological evolution. Unless the rather simple explanation of the origin of the cupule of *Nothofagus* is accepted, there is no possible way of explanation otherwise.

The species indicated as being illustrative of the different stages are illustrative only; it should not be concluded that I accept them as being the real way in which ancestral speciation has taken place in nature.

Nor should the relative age of the different stages of the scheme be regarded as a measure for the antiquity of the stages or species concerned. For it is quite possible that the physiological and morphological phenomena just accepted (suppressed length-growth of the inflorescence resulting in its condensation and reduction or ornamentation of cupular lamellae) have taken place during a relatively short geological period, giving the impression of having been performed simultaneously during early speciation.

Why such a peculiar reduction line is represented in New Guinea only I cannot tell, but I am satisfied that this line appears to be connected morphologically with the New Zealand 11. *N. fusca.* This fits in remarkably well with the plant geographic affinity of so many other Papuan mountain plants.

ECOLOGICAL REMARKS

As said above, *Nothofagus* is limited to a constantly cool and humid climate. It can stand even cold conditions, e.g., in South America, where its occurrence northward seems to be rather sharply demarcated at 33° SL, extending to only 35° SL in the Cordilleras, but not beyond the Aconcagua River, in the Argentine falling back to about 38° SL. Here two species of the deciduous section are found up to the timber line, according to Skottsberg (50), viz., *N. antarctica* on the west side of the Cordilleras in Chile and *N. pumilio* on the east side of the range above the former.

In South America *Nothofagus* stands occasionally seem to form the substage below *Araucaria*; it is noteworthy that the geographical area occupied by both genera is remarkably similar.

Also in New Zealand *N. cliffortioides* is found up to the timberline. In New Zealand some species show definite seed years in which fruit production is abundant, a remarkable parallel with European *Fagus*. In burnt forests saplings regenerate often freely, though repeated burning exterminates the *Nothofagus* forest (which is not fire-resistant) in favour of eucalypts in Tasmania and Victoria. The reverse proof of this balance is found in Queensland, where local *Nothofagus* stands or colonies dominated by *N. moorei*, sharply demarcated against surrounding forest types, seem to encroach upon eucalypt stands to regain their natural climate-bound territory if burning practice is discontinued. According to Herbert (27), trees of *N. moorei* are often loaded with epiphytes; in some places regeneration is scarce, but elsewhere saplings are abundant.

Generally the southern beeches are typical dominants under optimal conditions.

The Third Archbold Expedition of 1938–1939 revealed the preponderant position which *Nothofagus* species occupy in the montane rain-forests of New Guinea. Mr. Brass earmarked most species as dominants or co-dominants in the fagaceous forests, in ground that was mossy or not mossy, in deep valley or slope forest, and in the mossy forest. The co-dominants may be other species of *Nothofagus* (as at Lake Habbema *N. decipiens* and *N. bernhardi*), or sometimes other montane tree species, as *Weinmannia urdanetensis*. The mossy condition does not make much difference in the botanical composition of the forest.

On ridges and crests the species of *Nothofagus* which in valley forest may attain lofty size (40 m. by over 1 m.) grow into stunted, gnarled brushwood 2–5 m. high. Species which are found under both conditions are 11. *N. bernhardi*, 5. *N. pullei*, and 1. *N. recurva*.

A similar dominant position is occupied by *Nothofagus* in New Caledonia, according to Dr. Baumann-Bodenheim. And this social behaviour is also found in extra-Melanesian species, as is well known from the southern beeches in Chile, the Argentine, and New Zealand.

The altitude at which *Nothofagus* is found in New Guinea ranges between 1000 and 3000 m., roughly coinciding with the montane zone distinguished by me (2), penetrating into the lower part of the subalpine zone. However, 90% of the collections have been made between 1750 and 2850 m. Only one species, notably that with the largest leaves, *N. grandis*, descends to lower altitudes, ranging from 1800 m. down to 900 m. (Bele River). The specimens found at the lowest altitudes were sterile.[1] There is a possibility that they were growing here below their potential minimum contour along watercourses.

The forest type in which Papuan *Nothofagus* occurs so gregariously is the tropical rain-forest, that is, the climaxal mixed evergreen forest under equatorial everwet conditions, i.e., the rainfall is about evenly distributed through the year without any marked or prolonged period of decidedly less rainfall. The mossy facies of many of these forests mark them as often having a constantly high relative humidity.

The gregarious occurrence becomes especially conspicuous when the reddish flush appears: Brass records of 11. *N. bernhardi* that the reddish young leaves tinge and characterize the forest in February. See further under 12. *N. grandis*.

As to the period of flowering, data on anthesis can best be obtained by summarizing the dates from the male flowering, as according to Schindler the period of anthesis is of very short duration; in 12. *N. grandis* he found it to last only one week. I have combined these dates and I find that the

[1] As is found in Java in seedlings of *Myrica esculenta* Buch.-Ham. (2: p. 336).

anthesis definitely coincides with the rainy season from October to March (one record being April 9). There is only one record definitely outside this period, viz., of 12. *N. grandis* which flowered at the end of July in the Madang district, but it is likely that the seasons are reversed here.

According to Mr. Brass 11. *N. bernhardi* is protandrous, which is in accordance with the sequence in which the flowers develop on the flush: ♂ flowers are always found below the ♀ ones, and may even appear in the upper axils of the perular bracts at the base of the twig. In several cases these ♂ and ♀ flowers are subtended by the young folded budstage leaf, but in several other cases there are no leaves subtending the flowers, which are then simply sheltered by the pair of large stipules. Thus in flush the flowers of both sexes are definitely exposed to the air. In proportion as the flush develops into normal-leaved branches the maturing of the fruit is inconspicuous and unexposed.

Pollination is apparently by wind, and each ♂ flower produces quite a quantity of pollen; the relatively large anthers bungle on the threadlike, hairy, long filaments and get often entangled. In many cases I found detached flowers or triads that had dropped as a whole. As several species may be co-dominant, the possibility cannot be excluded that by means of the wind such detached ♂ flowers may act as pollinating agents.

Dr. Skottsberg observed and photographed in New Zealand drifting pollen clouds, like smoke, above *Nothofagus* forest (cf. 8, p. 175, pl. 42a), like those above *Secale* in Europe. The windy climate of New Zealand, and doubtless of other regions in the roaring forties, causes this pollen to be widely spread by wind. This has been proved by R. Licitis (60). This author made an extensive study of air-borne pollen and spores in New Zealand, where the most abundant pollens are those of *Nothofagus* and grasses. Pollen masses of *Nothofagus* were found dispersed in the air far beyond the actual distribution of the trees, at least for a distance of fifty miles. The capture of pollen shows pollen shedding on peak days in definite periods between September and January, the highest percentage being shed apparently on the last fine day before rain.

Pollination conditions are such that hybrids can be expected, such as have been described from New Zealand by L. Cockayne c.s. (29, 30, 31, 32) and H. H. Allan (33). These polymorphic hybrids are referred to the progeny of crossings *N. fusca* × *N. cliffortioides*, *N. fusca* × *N. solandri*, and *N. truncata* × *N. solandri*.

Hybrids are equally well known from South America, especially in localities where stands of two species are close or overlap. They have been reported from Fuegia (*N. antarctica* × *pumilio*). Some authors assume *N. alpina* to be a hybrid (*N. procera* × *pumilio*). Dr. E. Kausel, to whom I am greatly indebted for essential information and material generously given on Chilean beeches, assumes the type tree of *N. leoni* to represent a rather intermediate hybrid (*N. glauca* × *obliqua*).

In nearly all species the innovations are more or less covered by a greyish or yellowish resinous layer during the flush period. This is apparently mainly exuded by the glands found near the insertion of the stipules, and not by the numerous glandular punctate dots on the leaf surface itself. The immature cupules also appear sometimes wholly enveloped in resin, as in 3. *N. starkenborghi*, only the styles protruding into the free air. Part of this resin is probably produced by the sausage-shaped glands on the adaxial base of the lamellae. What the function of the resinous production is is difficult to tell. It could be imagined that it is a protection of the sexual organs against frost, but on the other hand anthesis occurs (in Papua) during the rainy season when no frost is likely to occur in the montane zone.

Also protective action could be imagined in the ecupular, very resinous 7. *N. resinosa*, the ovary of which might need protection, but resin production should then be equally abundant in other ecupular species like 5. *N. pullei*, which is not so, and no resin would be needed in 3. *N. starkenborghi*, where the cupules are found to be very resinous.

Also in the rainy season there is no urgent need for protecting the innovations against undesirable desiccation. Therefore I have abandoned the idea of a direct relation between resin production and climatic conditions.

Mr. Brass, in his field notes, has remarked on an occasional possible dioecism of some Papuan *Nothofagus* species. This has been taken over by Miss Langdon (17). The sheets referred to were in young fruit and beyond anthesis. And I assume the caducous male inflorescences had disappeared at this stage. In some cases I still found some spare, detached, old ♂ flowers caught in a twig fork or stuck in a place where some resin was left, e.g., behind a stipule. I am not sure whether these ♂ flowers belong to the same tree, as the triad may have been brought by wind from other trees. Pending additional field data, I accept all species of *Nothofagus* as monoecious.

The gregarious occurrence of *Nothofagus* supposes an abundant production of fruit and subsequent seedling reproduction. As a matter of fact I found many cupules, defective and unripe ones, attacked by animals, some of which are apparently fond of the nuts. A similar observation was made by Dr. Baumann-Bodenheim in New Caledonia. This damage is probably caused by small seed-eating birds. Reiche (19) says that the nuts are often sterile in South American species. The large nuts of *N. glauca*, which equal those of *Fagus sylvatica* in size and shape, will probably be palatable to man. In New Zealand there are marked seed years. Both in South America and New Zealand and in New Guinea mature nuts are produced about half a year after pollination.

Nothofagus forest appears to be valuable to man. In Mr. Brass' opinion Upland Papuans have mainly made their fields on the soils bearing fagaceous forests: man has followed the beeches, he says. That the trees are well known to Papuans, partly on account of their suitability as timber-producing plants, appears from the fixed native names, which in East New Guinea are apparently "generic" names, such as "ufoiya" and "ifoya" (resp. in the Anona and Aiyura dialects), further, "gripe" (Schindler), "sama" (Brass), and "unuza" (Kamano dialect, Womersley). Father

DuBuy of the Sacred Heart Mission, Ononge, who materially helped Mr. Brass in establishing friendly relations with the turbulent Papuans of the Mt. Albert Edward and Mt. Tafa areas, has used *2. N. perryi* timber in building his mission.

PARASITES OF NOTHOFAGUS

It would have been interesting if Papuan *Nothofagus* had been accompanied by typical parasites which have been described from extra-Melanesian species.

There is a notable genus *Cyttaria* (Discomycetes), of which seven species are known to be confined to *Nothofagus*, according to Prof. D. A. Herbert (9). He collected a new species on the border of Queensland and New South Wales on *N. moorei*, the northernmost known locality of the genus *Cyttaria*.

More than one species of *Nothofagus* may be attacked by the same species of fungus, while the same beech may be parasitized by more than one species of *Cyttaria*. The fungus causes big galls covered by gelatinous stromata; branch growth is retarded and its distal parts may be killed. In a dry atmosphere the stromata become leathery. Simpson and Thomson report *Cyttaria* as the greatest opponent to the forest growth of *N. menziesii* in New Zealand (10).

Darwin, in his Journal of Researches, mentioned *C. darwinii* of Tierra del Fuego as being eaten uncooked in its mature state, a delectable article of food of Araucarian Indians. Also the Tasmanian *C. gunnii* was eaten by aborigines and was known to the settlers as tree morel. Prof. Herbert found the Queensland species quite palatable. In New Zealand W. C. Davies (26) stated *Cyttaria* to be a favourite food of the native New Zealand pigeon, *Hemiphagus novae-Zelandiae.*

Recently Dr. Santesson (11) wrote a beautifully illustrated revision of *Cyttaria*. As he says that *Cyttaria* is entirely confined to *Nothofagus* as its host-tree and that it follows *Nothofagus* in its whole distributional area, it might be expected to occur in New Guinea and New Caledonia. In the material I examined I could, however, find no gall-like deformations which might be ascribed to *Cyttaria*. As *Cyttaria* is less common in Australasia than in South America, and the Queensland species was only very recently and locally found, it is certainly to be expected to occur in New Guinea. Special attention should be paid to its occurrence by those privileged to explore Papuan *Nothofagus* forests. Altitudinally *Cyttaria* does not seem to have preference.

Heim (63) gave a brief account of the mycological flora of the southern beech forest.

Another peculiar parasitic genus confined to *Nothofagus* is *Myzodendron*; this, however, is not homotopical, as it is confined to South America, according to Dr. Skottsberg (12, 13).

A few species of *Nothofagus* possess domatiae, i.e., hair-tufted pits in the axils of the primary nerves. These are found in *N. menziesii*, according to Cheeseman (39); they are also recorded in *N. fusca*. Poole says (38, p. 365): "domatiae have always been found in *N. fusca* on trees and saplings above 2–3 m. On seedlings and saplings below this height they are usually not present." Du Rietz (18) gave some comment on the occurrence of domatiae in these New Zealand species. I have not been able to find additional domatia-bearing species. Espinosa (54) mentions hairs in the nerve axils of *N. leoni* from Chile, a feature which I could verify. Similar hairs are present along the equally subhirsute midrib in *N. glauca*, and traces of insects are present in specimens of both species. These domatiae are not so distinct as in the New Zealand species. Domatiae also occur in *Fagus* species and in *Quercus* species.

It is often assumed that these domatiae are due to acari and that they are to be considered as gall-like structures in which acari find a shelter. As a matter of fact, empty skins of acari are often found between the domatial hairs, and I found them in *Nothofagus*. In many cases the occurrence of domatiae is used in taxonomy for specific distinction. No experiments are known to me to verify whether domatiae are a normal morphological character or are due to a teratological growth caused by the acari. As a matter of fact Reiche (19, p. 419) mentions from Chile that acari cause densely hairy spots on the undersurface of leaves and that Neger identified certain *Erineums* in *N. dombeyi* and on *N. obliqua*. In both species, however, domatiae are absent. The above-mentioned fact, that in very young seedlings of *N. fusca* no domatiae are found, is not proof that they represent malformations caused by acari.

Also in zoocecidiae *Nothofagus* has some peculiar associates, and several remarkable galls are found which have been described by Houard (49). He says that the galls on southern beeches "rappellent aucunement celles du Fagus sylvatica de l'hémisphère boréal."

Among Papuan specimens I found two gall-bearing numbers, viz., of *N. brassi* (*Brass 11103*) and *N. carri* (*Carr 15028*) which I turned over to the well-known cecidologist Prof. W. M. Docters van Leeuwen. Though the material is very scarce he is prepared to accept them as psyllid galls. A similar gall I found in *N. truncata* from New Zealand. Psyllid galls are common to tropical mountains but have never been found in northern *Fagus*.

EVALUATION AND VARIATION OF CHARACTERS

Habit and size: Little distinctive value can be attached to habit and size for taxonomical purposes, as both show a great phenotypical plasticity through response to external factors. On exposed stony crests and the mossy scrub of ridges 1. *N. recurva*, 5. *N. pullei*, and 11. *N. bernhardi* grow stunted and shrublike, but may attain great size on deeper soils in sheltered places on lower slopes and in valleys of New Guinea. In New Zealand a similar behaviour is recorded for *N. solandri* and in South America for *N. antarctica* (50, p. 108) and *N. pumilio* (50, p. 104).

The twigs: Little distinctive value can be found in the twigs which are terete; in single coarse species, as 2. *N. perryi*, they are somewhat flattened near the nodes. In many species they are slightly zigzag, as is often found in distichous alternate leaves. The only Papuan species which has hairy twigs is 5. *N. pullei*. The hairiness in extra-Papuan species tends to disappear with age.

The perules: The axillary perules are in some species small, but in others, especially the coarse-leaved ones, they are rather distinct; their size, of course, varies with the season. The densely imbricate, decussate bracts are ovate to triangular (with the exception of *N. moorei*, *N. procera*, *N. alessandri*, and *N. leoni*), in contrast to those in northern *Fagus*, and they are placed in four distinct orthostichies. When the flush appears they are mostly early caducous. They are often slightly varnished; on their adaxial base they possess sausage-shaped resin-exuding colleters which are placed in a transverse row.

This tallies with the occurrence of similar colleters found on the base of the stipules and proves that the perular bracts represent stipules. This conforms to the situation in *Fagus*, in which Büsgen (55) mentions the same (except the two lowermost, which represent reduced leaves).

The perular bracts are always basally attached, and though they telescope a little during the growth of the flush, the scars which they leave are found crowded at the base of the lateral twigs. On the base of the twig in flush, the lowest genuine stipular pairs are sometimes found continuous with the upper perular bracts and may bear ♂ flowers (cf. *fig. 22c*).

The basal part of the perules is always thicker than the blade, which flares out membranously; the basal part is thickened to an abnormal degree in *N. gunnii*.

The stipules: It is peculiar that mention of the stipules is seldom found in descriptions of the southern beeches. Often it is recorded only that they are caducous or deciduous. Sometimes they seem to have been confused with the perular bracts.

I find that they present marked additional specific characters (*fig. 2*).

In the Papuan species they are always distinctly peltate, which is comparable to the situation in several of the Chilean species of sect. *Calucechinus*, and their insertion is surrounded by concentric rings of sausage-shaped resinous glands. In 5. *N. pullei* they remain for a very long time on the twigs, but in most species they are early caducous after the flush has matured. At the insertion there is outside mostly a knob-like thickening. Their shape in Papuan species is always oblong to roundish, and though they are somewhat smaller in some species than in others, I have not used their shape or dimension for determination. Cf. *fig. 4b, 5b, 7b, c, e, g, 8d, 10b, c, 12b, c, 14b, 15b, 16b, 17b, 20c, e, 21b, 22b.*

This is definitely different in extra-Melanesian species (cf. *fig. 2*); *N. antarctica*, *N. betuloides*, and *N. pumilio* possess stipules like the Papuan species, *N. fusca* has very narrow, peltate stipules of which the basal part is smallest and emarginate; *N. dombeyi* has ovate stipules of which the part below the insertion is narrow; *N. obliqua* has similar but hardly peltate stipules; and *N. solandri, N. cliffortioides, N. gunnii, N. cunninghamii*, and *N. menziesii* have stipules which are not peltate, the resin glands being placed in a semicircle or row along the apical part of the insertion. But again they vary in shape: in *N. gunnii* they are small and triangular and with a strongly thickened basal saccate portion like the leaf-base of a *Sedum*; in *N. cliffortioides* they are narrow-oblong, more or less boat-shaped; in *N. menziesii* very narrow-triangular; in *N. solandri* they are elliptic; and in *N. obliqua* bluntly triangular.

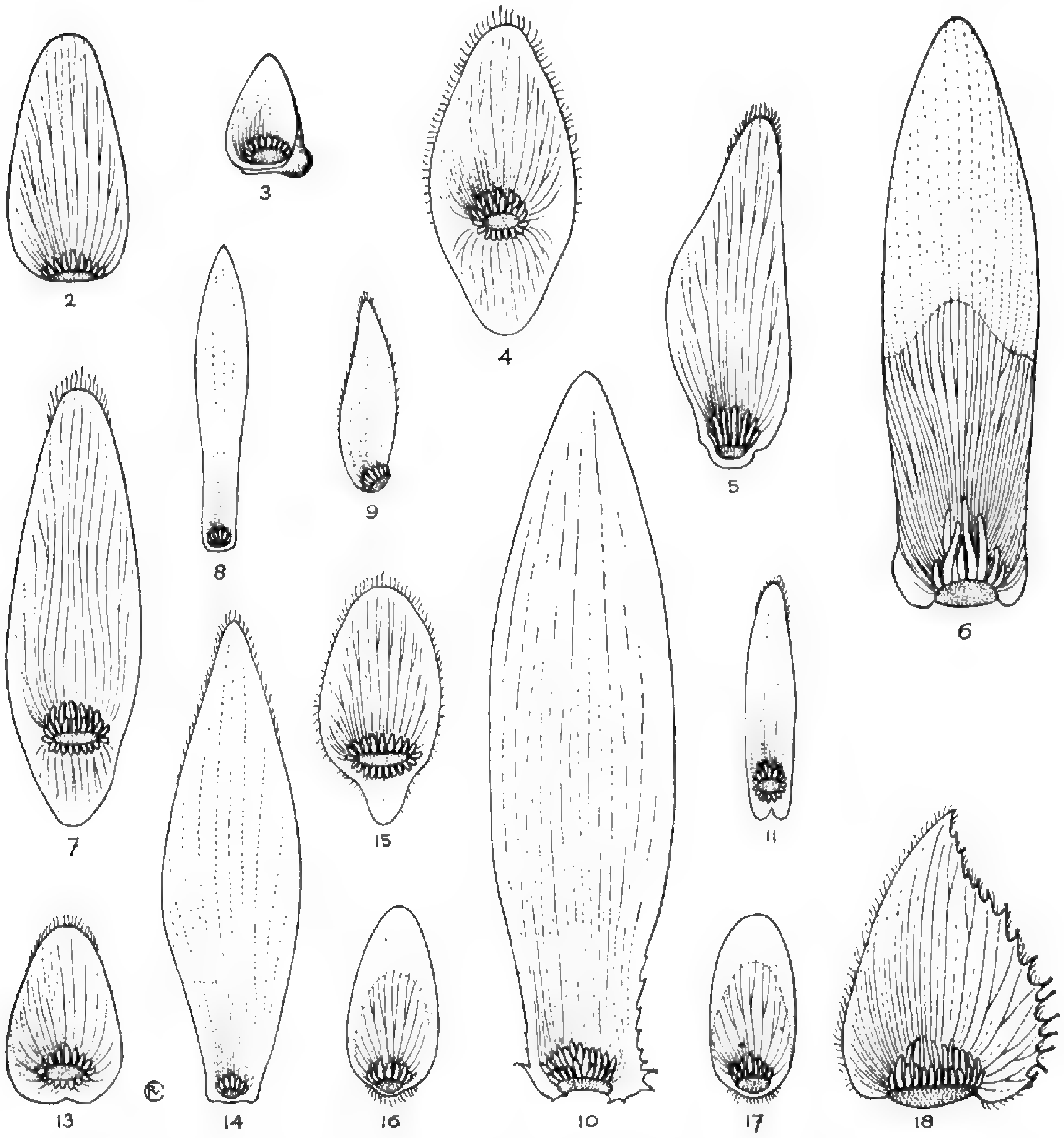

FIGURE 2. Stipules of extra-Malaysian *Nothofagus* species, the numbers corresponding with those in the key: 2. *N. obliqua*, 3. *N. gunnii*, 4. *N. antarctica*, 5. *N. alpina*, 6. *N. procera*, 7. *N. pumilio*, 8. *N. menziesii*, 9. *N. cunninghami*, 10. *N. moorei*, 11. *N. fusca*, 13. *N. betuloides*, 14. *N. nitida*, 15. *N. dombeyi*, 16. *N. solandri*, 17. *N. cliffortioides*, 18. *N. alessandri*. — All × 7.

As I have explained elsewhere, I regard these stipules s. l. as the organs from which the cupule is condensed, being homologous with the lamellae of the cupule, the inner part of which I assume to be of axile nature: a very much condensed "hollow" split twig with a condensed inflorescence.

Unfortunately the structure of the stipules does not yield characters suitable for infra-generic distinction.

The leaves: There is great variation in the leaves of *Nothofagus*, the greatest difference being between the deciduous, almost always thin-textured leaves of sect. *Calucechinus* with plicate vernation, and the persistent, flat, always coriaceous or at least firm leaves of sect. *Calusparassus*, which in bud are not plicate but flattish or folded-convex; Papuan species are consistently folded along the midrib, exposing their undersurface. In all species the innovations are varnished by resin which is partly exuded by the stipules, which mature much earlier than the leaves, and partly by the dermal, lepidote glands on the leaves themselves. In New Guinean species the very young leaves are often covered with a thick resin film. This resin is not soluble in alcohol, only partly so in turpentine, but wholly soluble in ether and acetone. The older leaves show, generally, a less varnished surface. The physiological action of this exudation is obviously associated with the flush period.

The distinctness of the glands in herbarium specimens varies rather widely and depends on the age of the leaves and on the stage of the tree from which the specimens were collected, physiological action of the glands being strongest during the flush period.

At the base of the shoot the lowest nodes often bear only stipules; between them sometimes no trace of a reduced leaf is found, but in other cases I found a tiny appendage obviously representing a much reduced leaf. It is remarkable that the upper leaves of a flush mature earlier than those lower down (cf. *fig. 7b, 12a*).

The midrib is prominent below and sulcate on the upper surface, but in all Papuan species a thin ridge runs along the centre of it on the upper surface, continuing on to the petiole. In *N. starkenborghi* there is only a groove without midrib tissue visible; here the ridge is found only on the petiole.

The spacing of the punctate-dotted glands, which are best observed on the undersurface of the leaves, is somewhat different in different species. Glandular dots on the leaves are different in number and size in different species; I have the impression that more than one type of gland occurs.

Nervation in the coriaceous Papuan species is not strongly prominent except on the undersurface. The nervation pattern and especially the way in which the nerve ends are looped or branched in connection with marginal teeth and crenations seem to differ considerably from species to species. A fossil form genus, *Parafagus*, has been based solely on this character of curved nerves branching off near the margin to a lower tooth. In *fig. 3* I have made a picture of the very different patterns of nervation of several living species from different sections and series. This might be of use to palaeontologists.

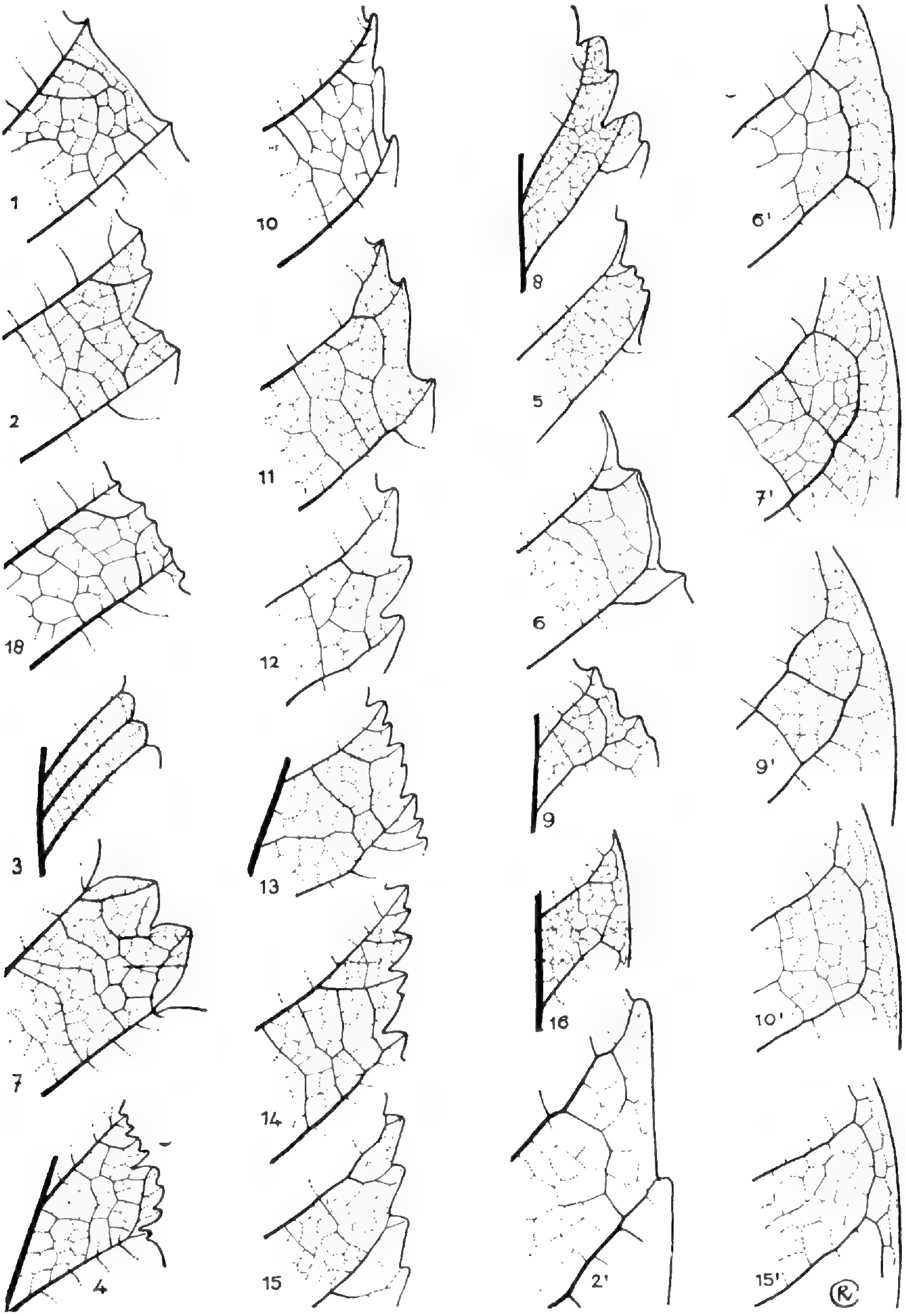

FIGURE 3. Types of nervation in *Fagus* and *Nothofagus*, the numbers corresponding with those in the key; the Papuan species marked with an accent. To be compared in the following sequence: — 1. *Fagus sylvatica*, 2. *Nothofagus obliqua*, 18. *N. alessandri*, 3. *N. gunnii*, 7. *N. pumilio*, 4. *N. antarctica*, 10. *N. moorei*, 11. *N. fusca*, 12. *N. truncata*, 13. *N. betuloides*, 14. *N. nitida*, 15. *N. dombeyi*, 8. *N. menziesii*, 5. *N. alpina*, 6. *N. procera*, 9. *N. cunninghami*, 16. *N. solandri* (same as *N. cliffortioides*), 2′. *N. perryi*, 6′. *N. crenata*, 7′. *N. resinosa*, 9′. *N. carri*, 10′. *N. cornuta*, 15′. *N. eymae*. — All × 3.

From *fig. 3* it appears clearly that the nervation pattern is rather different within the genus.

In *Fagus sylvatica* and some species of *Nothofagus* the primary side-nerves run straight and directly to the margin (in spp. 1, 2, 18, 3, 8, 5, 9). In others they do the same but give off a more or less distinct lower curved vein to a lower marginal tooth (spp. 4, 10–15). In all these cases the leaf margin is toothed or crenate, and the teeth and crenations are distinctly served by nerves or thicker veins ending in the margin.

This is distinctly different in all species which have entire leaves, viz., *N. solandri* and *N. cliffortioides* (*fig. 3*: *16*) and the Papuan species (*fig. 3*: *2′–15′*). They show distinctly looped side-nerves which do not end in the margin. It seems that the condition of the margin is bound to the nervation pattern.

Nothofagus cunninghami (*fig. 3*: *9*) occupies more or less an intermediate position between the first and third type, its open nervation showing a tendency to become looped.

As I had never thought about a correlation between these two "characters" I have looked into some other genera embracing toothed and entire leaves. Rather to my astonishment I found a similar correlation of entire leaves with looped nerves and toothed leaves with open nervation in several other genera, viz., *Viburnum*, *Gynura*, *Eupatorium*, and to a certain extent in *Osmanthus*, and some *Ficus*. In *Viburnum luzonicum* both combinations are found, even within one species (Kern, in Reinw. 1: 164. 1951). In other genera, e.g., *Evonymus*, other *Ficus*, *Ilex*, and *Symplocos*, the looped nervation is not or is only slightly affected by the marginal condition.

I wonder whether this correlation is more or less physiologically connected with the nerves serving marginal teeth for secretory function in certain stages of the ontogeny.

Palaeontologists working with leaf imprints should be on the alert in evaluating these characters.

It is satisfactory that species which are close in the key show a similar nervation, e.g., in the group *N. alpina–N. procera* (*fig. 3*: *5* & *6*) where the nerve curves upwards along the margin. There is no nervation difference between *Fagus* and *Nothofagus*; the latter genus displays a greater number of nervation types than the former.

Reticulations are often closely netted, especially in the coriaceous species, the leaves of which show a tessellate surface, e.g., in *N. solandri* and several small-leaved Papuan species. In all *Nothofagus* the areoles seem to contain a blind vein.

The cartilaginous leaf edge in Papuan species is mostly entire, but a few species have crenate-dentate leaves. The leaf margin is very often recurved, and sometimes the leaf is distinctly convex; in others, however, it is distinctly flat. The leaf-tip is always notched.

In some extra-Malaysian species domatiae have been found in the axils of the primary nerves which have been studied by Du Rietz (18), but in none of the Papuan species have I found a single indication of them. I observed them also in Northern hemisphere *Fagus sylvatica*, *F. ferruginea*, and *F. sieboldii*.

In many *Nothofagus* species the leaf shape furnishes a good specific character. The leaf size is often also to some degree rather constant. It is sometimes held that southern beeches are all microphyllous, which would make quite a contrast to the Papuan representatives. In the first place some of the Papuan species are microphyllous, and among the extra-Papuan ones several possess moderate-sized or large leaves, as *N. procera*, *N. obliqua*, *N. alessandri*, and *N. glauca* and their hybrids. The New Caledonian species possess large leathery leaves. The leaf surface is seldom hairy; in New Guinea this condition is found only in *N. pullei*. In *N. recurva* I have distinguished a microphyllous variety, but not in *N. grandis*, though here also the leaf size is rather different, which might be due partly to age, exceedingly large leaves being found on manifestly old twigs.

It is quite possible that besides distinctive specific characters, the cuticle structure may yield additional characters for a subdivision of the genus. Miss Cookson has made a tentative promise to perform this anatomical research initiated by Miss Bandulska (57).

The petiole in Papuan species is semi-terete; its flat upper surface often bears a marginal ridge, and along its centre the continuation of the midrib ridge is found. The petiole appears in some species to be slightly lepidote, but I assume this is due to traces of resin scales from the flush period.

The male flowers: Male flowers are inserted axillary on the flush, always below the female flowers. In Papuan species they seemingly appear sometimes from the upper perular bracts, but really they are placed between the lowest efoliate stipules. They are essentially placed in triads, occasionally five ♂ flowers have been found in *N. fusca*; the triad is often incomplete and reduced to two or one flower. There are no bracteoles. The shape of the tube and limb are rather variable, but will be found useful locally for furnishing differential characters.

In several Papuan species the tube is narrowed at the base into a hypanthial basal part.

In the Papuan species the limb is closed in bud and is torn apart by the growing anthers (*fig. 4c*). In several other southern species the limb is neatly (valvately) lobed, and the tube is either rotate or campanulate. In the Papuan species the tissue is glandular-punctate, and this will hold essentially for the other species.

The stamens vary considerably in number, but within certain limits they seem rather constant for the species. The size and shape of the anthers also provide characters. In many Papuan species the stamens are distinctly punctate-glandular to warty-glandular.

The filaments in northern *Fagus* are free from the base. This is also found in several southern *Nothofagus*; in *N. obliqua* and *N. dombeyi* they are slightly connate. During the lengthening in anthesis the bases of the filaments of several Papuan *Nothofagus* appear to be connate in a distinct basal column.

In some Papuan species the filaments are straight in bud (*fig. 4c′, 20d′*), in others, however, they are serpentine folded (*fig. 14d*). In all species the anthers are exserted; in the herbarium it is difficult to judge to what final degree. In the Papuan species the filaments are finally mostly very long, and the relatively large anthers bungle far out of the flower in a typical anemophile way. As the filaments are mostly hairy, they often get entangled.

As on each flush the male flowers appear earlier than the female ones, the flowering appears protandrous. The ♂ anthesis is of only a few weeks' duration, after which the flower or triad falls off as a whole, by which the twig may give the impression of being female. There is no question, however, that *Nothofagus* is dioecious, as is assumed by Helmqvist (21, p. 82).

The female inflorescences and flowers: The female inflorescences are axillary; after anthesis cupules which appear originally sessile or subsessile may show a distinct peduncle.

In some Papuan species the lowest ♀ inflorescences are clasped by efoliate pairs of stipules (*fig. 12f*).

The valves of the cupule are free from the beginning or connate to various degree, in some Papuan species even forming a cup. In the herbarium cupules open also when still immature.

At the base of the lamellae resinous colleters are found. The lamellae themselves are very varied in shape, entire or split into horizontal, inverted-V-shaped or curved rows of appendages, and are often good differential characters. The appendages themselves may be entire or fringed (*N. procera* and *N. alpina*), and they are often gland-tipped. In one Papuan species the lamellae appear to be absent (*fig. 14c*); this condition is also ascribed (wrongly) to *N. montagni.* In two Papuan species the cupule is absent, and the solitary female flower is embraced solely by the stipules (*fig. 12f, 15b*).

The growth of the lamellae is distinctly centripetal, and in flower it sometimes appears that the inner lamellae are wholly concealed by the outer one; they subsequently telescope from behind one another (*fig. 16c*).

The female flowers are inserted at the base of the cupule; judging from the scars in fruit they appear somewhat tortuous in the three-flowered species by mutual pressure. In principle the central flower appears to be 2-merous, the laterals 3-merous. If the cupular valves are narrow the wings of the lateral flowers may fit in neatly between the valves, but in other cases they are pressed in various ways. In a single species, *N. glauca,* from Chile, the lateral 3-merous flowers stand distinctly apart through the pairwise connation of the basal part of the valves: the lateral nuts are here remote from the central one and stand candelabra-like upright, each clasped by the free apical portions of two valves.

In *N. alessandri* seven flowers are closely packed; the central flower is 2-merous, the two lateral flowers are 3-merous; besides there is one 2-merous flower attached to the base of each of the four valves.

Occasionally the number of nuts per cupule differs, e.g., in *N. solandri* one, two, or three, but usually there are two in that species.

The perianth of the ♀ flower is connate to the ovary wall but forms wings along the margins by which the apical limb is often produced above the style base as a shoulder. In a single Papuan species two other lobes of the limb are hornlike, produced from the sides of the flower (*fig. 15c*). In *N. pumilio* according to Helmqvist (21) coalescence of ♀ flowers is found sometimes, resulting in a 3–7-winged perianth.

In 2-merous species the ovary is 2-celled, in 3-merous species 3-celled, corresponding respectively with two and three styles and two and three wings on the flower.

Each cell contains two apical hanging ovules, but only one ovule develops into seed; the dissepiments disappear. In many cases the fruits in the herbarium are wholly sterile, though the pericarp is well developed. A similar situation is found in European *Fagus*, where many fruits are barren.

The vascular tissue in the dissepiment leading towards the ovules is distinctly developed and appears in fruit as a false funicle. This vascular tissue may be forked in the upper part, each fork feeding two ovules.

The fruit: Properly this is morphologically an achene and not a nut. Its morphology is essentially similar to that of *Fagus*. Still it is common usage to call it a nut, and this has been followed here. The pericarp and perianth tissue develops horny and is glabrous inside in contrast to *Fagus*. In ripe seeds one still finds the abortive ovules at the apex of the seed near the attachment of the false funicle. Cotyledons are distinctly folded and contain fat reserve instead of starch, as in *Fagus*. The hypocotyl develops at the apex of the seed, splitting the pericarp (*fig. 18d, e*).

Poole (38, p. 503) speaks about the parthenocarpic development of fruit; he found growth of the fruit without pollination. However, no seed was formed in his experiments.

The setting of the fruit appears both in southern *Nothofagus* and in Papuan species to take about half a year. Reiche (19, p. 400) found in *N. obliqua* that germination occurred two months after the seeds had been placed. Germination is epigeic. According to Dr. Kausel, the fully developed cotyledons of seedlings are subreniform in *N. glauca, N. obliqua,* and *N. procera*.

GENERIC DIFFERENCES BETWEEN FAGUS AND NOTHOFAGUS

Though at present *Fagus* and *Nothofagus* are generally regarded as distinct genera, it seems worth while to list their generic characters:

Fagus	Nothofagus
Perulae elongate, very acute; bracts without colleters.	Perulae roundish to ovate, very rarely elongate; bracts with colleters at the adaxial base.
Stipules never peltately inserted.	Stipules mostly peltately inserted but the basal wing sometimes narrow or reduced.

Stipules ligulate, flaccid, firmer towards the apex.	Stipules very rarely ligulate, scarious towards the apex.
Stipular insertion not surrounded by sausage-shaped resinous colleters.	Stipular insertion surrounded by sausage-shaped resinous colleters.
Leafblade not glandular-dotted.	Leafblade distinctly punctate-glandular dotted.
♂ flowers in long-peduncled, globular, many-flowered, hanging inflorescences.	♂ flowers sessile to short-peduncled, solitary or in triads.
Anthers not apiculate, eglandular.	Anthers apiculate, often glandular.
Pollen with 3 furrows.	Pollen with 5 or more furrows.
Cupular appendices irregularly placed, without resin glands.	Cupular wings or appendices distinctly lamellar, very often with resin glands and basal adaxial resinous colleters.
♀ triad normally without a central flower.	♀ triad always with a central flower, lateral flowers sometimes reduced.
Styles elongate, tip papillose.	Styles short, stigmatic arms papillose over their length.
Nut sharp-angled but not winged.	Nut generally winged.
Endocarp hairy.[1]	Endocarp glabrous.[1]
Wood rays several cells wide.	Wood rays 1–2 cells wide.
Wood fibres with bordered pits.	Wood fibres with simple pits.

Few comments are needed on this table. Solereder (22) was originally responsible for the data on the differences in wood structure. He examined several species; his distinction was confirmed for eleven additional species examined by Krasser (36, p. 161). See also the figures by Mouranche (62) and Wagemann (67) who made an extensive anatomical study of Chilean *Nothofagus*.

According to Metcalfe & Chalk the wood of *Fagus* and *Nothofagus* is most closely allied within the Fagaceae (47).

The character of the narrow or broad rays is possibly of less value than it seems, as it is said that in both *Pasania* and *Quercus* broad and narrow rays seem to occur in one genus.

Yatsenko-Khmelevsky (from 47, p. 1314) studied the wood of *Nothofagus* and concluded that it diverged very early from related genera and that the wood of its most primitive representatives probably resembled that of *N. cunninghami.*

The glandular nature of *Nothofagus* is also expressed in several species with punctate-glandular dotted stipules, ♂ perianths, and distinct glands on the anthers.

The pollen character has been advanced by Miss Cranwell (8) and has been further elaborated by Miss Cookson (4, 5, 45).

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[1] Not tested in all species.

SUBDIVISION OF THE GENUS NOTHOFAGUS WITH A KEY TO THE SPECIES

Among those interested in the *Nothofagus* problem there has temporarily been a feeling that the Papuan and New Caledonian species should represent a new genus, distinct from *Nothofagus*. It is true that they possess a pollen type of their own, and the wood is slightly different from that of other *Nothofagus*. Also the leaves, especially in the New Caledonian species, are generally larger than those of the South Pacific.

However, Miss Cookson, who has unrivaled knowledge about *Nothofagus* pollen, maintains that their pollen definitely is that of a *Nothofagus*, and she quite agrees with an infra-generic status of the Papuan-New Caledonian taxon.

The same view is held by Prof. I. W. Bailey, who, in Dec. 1939, on invitation of Dr. E. D. Merrill, made some anatomical research on Papuan *Nothofagus*. His notes, contained in two letters, were kindly put at my disposal. He wrote: "The pollen of the new plants are typical of *Nothofagus*. The general structure of the stamens and anthers likewise resembles *Nothofagus*. Furthermore, in clearing the leaves for study, I note that both sets of leaves yield a similar reddish pigment. When one takes into consideration the structure of the bark, of the nodes, of the xylem, of the pollen, etc., it seems to me that one should proceed with considerable caution in setting up a new genus. It seems to me that a new section of the genus *Nothofagus* is all that is warranted by the evidence that I have examined. In fact the structure is just about what one would expect in a species of *Nothofagus* from a tropical montane habitat."

A similar view is held by Miss Langdon in her valuable detailed account of the anatomy (17).

To gain an insight into the structure of the genus and the characters which may lead to a subdivision of the genus I have also studied extra-Papuan species, though by no means intending to monograph the whole. It appears that the characters common to all species are many and essential; the taxon is a very coherent one.

Several attempts have been made to subdivide it, even though it was originally included in *Fagus*. Mirbel (24, p. 472) divided the genus *Fagus* into two groups, one with plicate leaves (incl. *Fagus* s. str. and *N. obliqua*) and one with nonplicate leaves, and though *Fagus* s. str. has later been split off from the first group, the essence has been to keep the vernation character as the main point. Mirbel was followed in 1840 by W. J. Hooker (28), in 1847 by Endlicher (34), in 1864 by A. de Candolle (16), in 1871 by Oerstedt (15), who was the first to treat *Nothofagus* species in the present circumscription, in 1883 by Solereder (22), in 1896 by Krasser (36), in 1897 by Reiche (19), in 1947 (to a certain extent) by Miss Langdon (17), by myself (14), and by Miss Camus (61).

As said above, De Candolle fitted the deciduous, plicate-nerved *Nothofagus* species into *Fagus* subgen. *Eufagus*, which included thus both northern and southern hemisphere beeches. This was corrected by Bentham & Hooker (35), who accepted *Nothofagus* as a section, cf. Blume's circumscription of 1850, under *Fagus*.

In 1842 another generic name had been proposed by Spach (64), viz., *Fagaster* Spach, typified by "Fagus dombeyi et quelques espèces voisines, indigènes de l'Amérique australe; ces végétaux diffèrent des vrais Fagus, principalement par leur involucre, qui est partagé en lanières étroites, ne recouvrant point les noix." Phytographically this description is that of a *nomen semi-nudum*, but formally we cannot avoid taking it into consideration for priority. No specific combinations were made by Spach. The name is proposed here as a *nomen rejiciendum*.

Two other generic names were proposed for *Nothofagus* in the Atlas Bot. Dicot. of the voyage of the "Astrolabe" and "Zélée" by Hombron & Jacquinot,[1] viz., *Calucechinus* Hombr. & Jacq. for the deciduous species and *Calusparassus* Hombr. & Jacq. for the evergreen ones.

Pritzel states that this Atlas was published in 1853, and this date is also printed on the title page. However, it is certain that the Atlas (or parts thereof) was distributed at a much earlier date. As early as 1846 Lindley (Veg. Kingd. 291) mentioned both generic names *Calucechinus* and *Calusparassus*, and both were cited a little later by Walpers (Ann. 1: 636. 1848–1849) with exact reference to the details of the plates. In cases such as this one never knows whether the author(s) have occasionally distributed manuscript copies or proof sheets to befriended colleagues who, with or without permission, have used these for their own works.

This is, however, not the end of the story. Additional data were provided most liberally by Mr. W. T. Stearn of the British Museum in a letter dated June 4, 1953. Mr. Stearn says that in ascertaining the publication dates of these French Voyages many difficulties arise from the fact that the publishers often issued a livraison of plates, without text, in an undated or even wrongly dated wrapper. According to B. D. Jackson, who consulted a copy of the questioned Atlas having the wrappers preserved (cf. Jour. Bot. 26: 269–272. 1883), the plates were issued in thirteen livraisons between 1844 and 1853. Unfortunately the wrappers themselves were not dated. Also it is not known exactly how the Atlas was issued, whether each part separately, or occasionally in issues containing more than one part.

The plates concerning *Nothofagus* are Phan. Dicot. 6, 7, and 8. It appears that plate 6 (wrongly lettered "Monoc.") was issued in livr. 6, and plates 7 and 8 in livr. 8. The latter was acquired by the British Museum on Jan. 17, 1845, and may have been issued in 1844, but livr. 6 was not acquired by the British Museum until 1853. Apparently it was "missed in publication" and was acquired later to complete the work. This plate also was probably issued in 1844 or 1845, since Walpers was acquainted with it by 1849.

For the validity of the generic names *Calucechinus* and *Calusparassus*

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[1] Decaisne, who wrote the text of the vascular plants of this work (1855) cites only Hombron's name; he did not accept the two proposed generic names, reducing them to *Fagus*.

it was of paramount importance to know whether livr. 6 had appeared before livr. 8 or whether they appeared simultaneously, or whether livr. 8 had appeared earlier than livr. 6. In both latter cases the genera would not have been proposed as monotypic and should be neglected for purposes of priority.

However, Mr. Stearn found a review (in Hooker's London Jour. Bot. **3**: 128. 1844) which establishes conclusively that livr. 6, containing tab. 6 (*Calucechinus antarctica* and *Calusparassus forsteri*), appeared before livr. 8, as the latter, containing tab. 7 & 8, was reviewed later in the same serial (l.c. **4**: 28. 1845).

Hence, both generic names take their publication as to the names of monotypic new genera from tab. 6 (1844) and *Nothofagus* must be conserved against them, which is here accordingly proposed.

In 1858 Turczaninow (37) described a fruiting specimen from Chile as a new genus of the Sapindaceae, viz., *Lophozonia heterocarpa* Turcz.

In 1940 Dr. Hatusima collected with Prof. Kanehira a species on Mt. Arfak, West New Guinea, accepted by him to represent a new genus of the Hamamelidaceae allied to *Distylium*, but in 1943 he agreed with me that it was a *Nothofagus*; Miss Langdon (17, p. 353) wrongly stated that this hamamelidaceous genus, the name of which was found on herbarium labels, had been published during the war in Java.

Though W. J. Hooker, in 1840, and Oerstedt, in 1871, had given keys, no infrageneric taxa were described until Krasser (36) gave a comprehensive survey of the genus in 1896, a work which unfortunately escaped my attention when publishing the preliminary note (14).

Krasser's main aim was to study differential characters between *Fagus* and *Nothofagus*, for which he mastered the literature and made some anatomical and taxonomical research, which he concluded by giving a conspectus. This contains several new infrageneric epithets and seven new binomials antedating Reiche's transfers by one year. There is nothing new in his division, it is entirely based on that given by Oerstedt, but his names have been considered and taken care of. Some were as yet not entered in Index Kewensis and have been overlooked by later authors. Mr. Bullock affirms their validity.

Among the fossils of New Zealand quite a few *Nothofagus* species have been described from the Tertiary. Rather recently Oliver (48) described several new species of *Fagus* and *Nothofagus*, and even a new (form) genus, *Parafagus*. He based his work mostly on the nervation and the way in which nerves end in crenations along the margin. This new genus is distinguished mainly by the curved nerves, but these are found equally in the New Guinean species. It is quite possible that *Parafagus* is a straight synonym of subsect. *Bipartitae*, as pollen grains conformable to those of the living Papuan species have also been found in New Zealand. According to the drawing in Oliver's paper, the fossil New Zealand *Parafagus otakonia* Oliver is almost an exact replica of the living Papuan *N. perryi* Steen. Among living *Nothofagus* there are several types of nervation as shown in *fig. 3*, so that there is no place for a distinct genus *Parafagus* based only on this character. I reduce it to *Nothofagus*, but will refrain from transferring the species described under fossil *Fagus* and *Parafagus* to *Nothofagus*. If I had living leaf fragments in a state comparable to those fossil leaf imprints for identification, I should strongly advise the wastebasket as their proper disposition.

In the deciduous species the leaves are plicate in bud along the lateral nerves (as in *Fagus*) and are later soft in texture (with a single exception). In the evergreen species they are not plicate but are either flattish or (as in all New Guinean species) folded along the midrib, pressing the upper halves against each other and exposing the undersurface.

As to the cupule, the Melanesian group possesses 2-valved cupules, a character shared by *N. pumilio* from South America, which also has only one 3-merous ♀ flower. However, this species does not seem closely related to the Melanesian ones, as it possesses deciduous, plicate leaves.

All other species possess 4-merous cupules, two New Zealand species with 3-merous cupules excepted.

As to the ♀ flowers of the Melanesian species which are consistently 2-merous, it is noted that in the southern species with 3-merous flowers the central flower is also nearly always 2-merous. There is, though, some individual variation, as the lateral flowers are in single cases also, one or both of them, 2-merous. I also sometimes found all three flowers 3-merous.

Independently of Reiche (19), I have come to the conclusion that the number of ♀ flowers of the cupule represents a constant character, though of less value than the structure of the cupule.

As to the ♂ flowers, there is quite a variation, but the androecium appears to me unimportant for infrageneric value. The Papuan species all have typically tubular perianths; in several southern species these are more campanulate or even wider in shape, but this character, with the number of ♂ flowers (one or three), and the number of stamens in each flower — which is rather constant for each species and ranges between about (5–) 8 and 40 (–90) — is too irregular to serve for infrageneric distinction.

After long considering the desirability of subdividing the genus, thereby making a *lapsus calami* in wrongly typifying one of the sections (14, p. 146) and making it still worse by a clumsy, superfluous attempt to correct this error (14, p. 316), moreover, overlooking Krasser's paper, I have come to the conclusion that the characters do not warrant a distinction of subgenera, only of sections and minor divisions. Interrelationships appear to be reticulate in several cases. It is out of the question that more than one genus is represented.

It remains to be seen how far this division of the genus is also reflected in anatomical characters (wood, epidermis, pollen). That the Papuan-New Caledonian species deserve a special taxon on the basis of anatomy has already been made clear by Miss Cookson and Dr. Dadswell.

It would have been very welcome if the differences in structure of the pollen of *Nothofagus* had wholly coincided with its morphological characters. This is, however, only true to a certain degree. Miss Cranwell (8) distinguished in New Zealand *Nothofagus* two types, viz., the *menziesii* type and the *fusca* type. This is sustained by Miss Cookson for pollen of living Australian species (4, 5). She found both types also among the fossil pollens. The *menziesii* type includes *N. menziesii, N. cunninghami,* and *N. moorei,* which are also found close together in my key, but also the deciduous *N. obliqua*. And the *fusca* type embraces in addition to the evergreen *N. fusca, N. truncata, N. solandri, N. cliffortioides* also the deciduous *N. gunnii,* which I regard as a taxonomically remote species, as well as the majority of South American species of which several are deciduous. Therefore it seems to me that the pollen type is not a good criterion for taxonomic infrageneric distinction.

It would have been equally welcome if an infrageneric grouping of all species could be made on wood-anatomical characters. This may be promising, as according to Dr. Dadswell the species of subsection *Bipartitae* appear to be mutually close and differ from other *Nothofagus*. Dr. Dadswell was even inclined to regard this subsection as of higher rank. A forthcoming paper on the subject by Dr. Dadswell will certainly be of great interest, especially if it contains data on many southern species.

Taxonomically it has never been endeavoured to correlate the species into infrageneric taxa with a single key to the representatives of different countries. Though a monographic treatment falls outside the scope of this study, I feel that such a provisional conspectus may be useful. Unfortunately, some types have been unavailable, and also I could not obtain in time material of two newly described Chilean species.

The difficulties in identifying types are greatly extended by the fact that of the about twenty extra-Melanesian species no less than eight have been based on completely sterile material, while six others were typified by sheets in which only one sex was represented.

However, I have some hope that in general the structure of the key and the main distinctive characters will be acceptable. In several cases I have expressed a provisional opinion about specific delimitation.

Quite a number of misidentifications have not been accounted for here; I have limited myself to the interpretation of type names.

Of some species many varieties have been distinguished, e.g., in *N. antarctica*; these minor varietal names have not been included. Also names of hybrids have been omitted.

Summarizing, this key to extra-Melanesian species should be regarded as a first attempt towards a provisional basis for future work.

Nothofagus Blume,[1] Mus. Bot. Lugd.-Bat. 1: 307. 1850; Oerstedt, in Vidensk. Selsk. Skr. ser. 5, **9**: 354. 1871; Prantl, in Engler & Prantl, Nat. Pfl. Fam. **3**, 1: 52. 1893, nom. conserv. propos.

Fagaster Spach, Hist. Nat. Vég. Phan. **11**: 142. 1842, nom. rejic. propos.

Calucechinus Hombr. & Jacq., in Dumont d'Urville, Voy. Pol Sud & Oc. (Astrolabe & Zélée) Bot. Atlas, Dicot. t. 6Θ. 1844; t. 7Z, 8Π. 1845, nom. rejic. propos.

[1] No binomials were proposed by him under *Nothofagus*.

Calusparassus Hombr. & Jacq. l.c. t. 6Σ. 1844; t 7Γ, 8Ψ. 1845, nom. rejic. propos.
Lophozonia Turcz., in Bull. Soc. Imp. Nat. Moscou 1858, **1:** 396. 1858.
Fagus subg. *Calusparassus* Miq., Ann. Mus. Bot. Lugd.-Bat. **1:** 103. 1863.
Fagus subg. *Calucechinus* Miq., l.c.
Fagus sect. *Eufagus* A. DC. in DC., Prodr. **16,** 2: 117–123, pro parte, pro spp. 4–8.
Fagus sect. *Nothofagus* A. DC., l.c., emend. Benth & Hook. f., Gen. Pl. **3:** 410. 1880.
Nothofagus subg. *Lophozonia* Krasser, in Ann. Hofmus. Wien **11:** 162. 1896.
Nothofagus subg. *Molischia* Krasser, l.c.
Parafagus Oliver (gen. foss. Nov. Zel.), in Trans. & Proc. Roy. Soc. New Zeal. **66:** 292. 1936.

Deciduous or evergreen, glabrous or short-hairy, perular, trees or shrubs. Innovations generally varnished by exuded resin. Bracts of the perules in four orthostichies, at their adaxial base with resinous colleters. Leaves distichous, alternate, in bud either folded along the midrib exposing either their inner or outer surface or flattish or plicate along the lateral nerves, entire or variously toothed or crenate, thin or firm in texture, with lepidote, resinous punctate-dotted glands, tip mostly emarginate; midrib flat or sulcate, in the Papuan species sulcate and provided on the upper surface with a fine, prominent ridge, at least at the base, or if a midrib is invisible on the upper surface this ridge is distinct on the petiole; veins reticulate, areolae with a blind vein. Petiole semiterete, margins often elevated. Stipules often large, roundish to linear, mostly distinctly peltate, provided on the adaxial side around the insertion with mostly several rows of radiating resinous colleters, often soon caducous, sometimes long-persistent. Flush appearing from the perules; nodes often leafless at the base, or with a rudiment of a leaf between the stipules. ♂ flowers at the base of the flush, axillary, sometimes between efoliar stipules, solitary or in triads, sessile to short-pedicelled or short-peduncled. Perianth closed in bud, later splitting rather irregularly or valvately lobed, often glandular dotted, lower portion often constricted. Stamens (5–) 8 to about 40 (–90), filaments either free or with their base more or less connate into a column, in bud straight or more or less serpentine-rolled, at first short, later exserted, during anthesis sometimes much elongated, threadlike. Anthers mostly linear, sometimes oblong, basifixed, often glandular, 2-celled, cells splitting lengthwise laterally, connective apiculate. ♀ inflorescences axillary, sessile to short-peduncled. Cupular structure 2- or 3- or 4-valved, connate to various degree, sometimes the valves almost free; valves consisting of an inner woody lining bearing lamellae which may be entire or are split to various degree into often glandular-tipped appendages and often bear colleters on the adaxial side mostly near the base; in some cases a cupular structure is reduced. ♀ flowers solitary or in triads, rarely 7, middle flower generally 2-merous, lateral flowers either 2- or 3-merous (sometimes one lateral flower reduced), all sessile and inserted at the base of the cupule, in a single species a solitary 3-merous flower. ♀ flower with a 4- or

6-merous perianth connate to the ovary resp. fruit, mostly forming wings along the fruit. Ovary 2- or 3-celled, each cell 2-ovuled. Style rather short, often subpersistent; stigmas 2 or 3, papillose over their surface. Ovules anatropous, hanging from the top of the dissepiment, distinctly connected with the base of the ovary by a threadlike bundle of vessels in the central part of the dissepiment; this bundle sometimes forked in its upper part; only one ovule per fruit developing into a seed; dissepiments disappearing in fruit. Nut (achene) more or less distinctly winged, one-seeded. Endocarp not hairy inside. Seed exalbuminous, hanging from the top of the hardened vessel-bundle, of which the apex is still provided with the 3–5 abortive ovules. Testa membranous. Cotyledons thin, folded, with fat reserve. Germination epigeic, the hypocotyl possibly appearing on top of the fruit as in *Fagus*.

Species about forty, in temperate South America, Fuegia, Falkland Islands, and other South Pacific subantarctic islands, New Zealand, Tasmania, Victoria, New South Wales and South Queensland, New Caledonia, and New Guinea.

I. Sect. **Calucechinus** (Hombr. & Jacq.) Krasser, in Ann. Hofmus. Wien **11**: 163. 1896.

Calucechinus Hombr. & Jacq. in Dumont d'Urville, Voyage Pol Sud & Oc. Bot. Atlas, Dicot. t. 6Θ. 1844; 7Z. 8Π. 1845.
Lophozonia Turcz. in Bull. Soc. Imp. Nat. Moscou 1858, **1**: 396. 1858.
Nothofagus subg. *Lophozonia* (Turcz.) Krasser, l.c. 162.
Nothofagus sect. *Deciduae* Steen. in Blumea **7**: 146. 1952.
Nothofagus sect. *Plicatae* Steen., l.c. 306, laps. cal.

Leaves deciduous, plicate in bud, texture almost always thin. — LECTOTYPE: *N. antarctica* (G. Forst.) Oerst.

DISTRIBUTION: South America to Tasmania.

Subsect. 1. **Antarcticae** subsect. nov.

Cupula 4-partita, 3-flora. — TYPE: *N. antarctica* (G. Forst.) Oerst.

DISTRIBUTION: South America to Tasmania.

1. Lamellae entire or appendages simple and short.
    2. Lamellae split into or provided with flat, erect or slightly recurved, simple, sometimes gland-tipped appendages. ♂ flowers solitary; stamens 20–90. Leaf-margin duplicate-serrate.
        3. Cupule to 1 cm. peduncled, 20–25 mm. long. Lamellae 2 or 3. Lateral (trigonous) nuts 15–16 × 10 mm., not winged though with a marginal ridge. Stamens 40–90. Basal part of the cupule deeply split, flat, narrow, the lateral nuts leaving a semilunar scar below the lanceolate, acute-acuminate valves proper, the whole candelabra-shaped, scars ca. 1.5 cm. apart. Valves proper ca. 2 cm. long, 5–6 mm. broad at the base. ♂ flower 1 cm. pedicelled, perianth flattened, densely short-pubescent. Anthers hairy at the apex. Leaf underside glaucous, petiole (ca. 5 mm.) and undersurface of midrib hirsute, leaf-axils appearing bearded. Blade 4.5–8 × 3–5 cm., base subcordate, nerves ca. 10 pairs, straight, nervation open. Bark papery. *Fagus glauca* Phil., *N. megalocarpa* Reiche. Mts. of Central Chile

[Prov. Santiago (Cerros de Aculeo) to Prov. Nuble]. . . . . 1. *N. glauca* (Phil.) Krasser.

3. Cupule subsessile to 3 mm, peduncled, 5–8 mm. long, short-hairy, lamellae 4–6. Nuts 5–6 mm. long (or in var. *macrocarpa* DC. to 10 mm.), distinctly winged. ♂ perianth subglabrous, pedicels puberulous. Stamens 20–40, anthers glabrous. Leaves elliptic-oblong, 2–5 cm. long, base generally cuneate, subglabrous, nerves 8 or 9 pairs. *Fagus obliqua* Mirb., *Fagus valdiviana* Phil., *Lophozonia heterocarpa* Turcz. Chile, The Argentine. . . . . 2. *N. obliqua* (Mirb.) Oerst.

2. Lamellae entire.

4. Leaves ovate-oblong, base broadly rounded to subtruncate, 5.5 × 3.5 to 13.5 × 8–9 cm.; nerves 11–13, parallel, straight, ending unbranched in the finely dentate margin. Stipules hairy, either auricled or not at the base. ♂ flowers in triads, short-pedicelled, with 10–20 exserted stamens. Cupule short-peduncled, hairy, 10–13 mm. long, 7-flowered; valves 9–11 × 4.5–5 mm., with 5–7 lamellae. Nuts 6.5–7.5 mm. long. Chile (Mts. of Prov. Talca and Maule, according to Dr. Kausel). . . . . 18. *N. alessandri* Espinosa.

4. Leaves much smaller, with fewer nerves. Cupular lamellae 3–4; valves subglabrous. Cupules much smaller, with 3 ♀ flowers.

5. Leaves distinctly bullate-plicate, roundish-ovate, 1–1.5 cm. diam., marginal crenate incisions coinciding with the ends of very regularly parallel primary nerves. Twigs short yellow-hairy. Cupule 8–9 mm. long. Lower perular bracts and stipules with a strongly thickened saccate base. *Fagus gunnii* Hook. f. Tasmania. . . . . 3. *N. gunnii* (Hook. f.) Oerst.

5. Leaves roundish ovate to oblong, often sub-lobed, 1.5–4.5 cm. long, margin with more than 2 teeth between the less regularly parallel primary nerves. Lower perular bracts without a very thickened base. Cupule ca. 5–7 mm. long. Stipules thin, oblong, very peltate. Nucular wings not shouldered but ending at the style base, ciliate towards the apex. ♂ flower with 8–13 stamens. *Fagus uliginosa* Phil., *Fagus antarctica* Forst., *Calucechinus antarctica* Hombr. & Jacq., *Calucechinus montagni* Hombr. & Jacq.,[1] *N. montagn(e)i* Reiche. Chile, The Argentine. . . . . 4. *N. antarctica* (Forst.) Oerst.

1. Lamellar appendages fringed to multifid, fringes gland-tipped.

6. Nuts high-shouldered, hairy especially at the top. Cupular bracts with an intricate pattern of rather thickish appendages. Leaves 2–3 × 1–1.5 cm. *Fagus alpina* Poepp. & Endl. The status of this species needs further study. Chile. . . . . 5. *N. alpina* (Poepp. & Endl.) Oerst.

6. Nuts high-shouldered. Cupular valves with long, pinnately fimbriate, green, gland-tipped, thin appendages. Leaves 4–12 cm. long, oblong, blunt, not undulate. *Fagus procera* Poepp. & Endl., *Fagus nervosa* Phil., *N. nervosa* (Phil.) Dimitri & Milano.[2] Chile, The Argentine. . . . . 6. *N. procera* (Poepp. & Endl.) Oerst.

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[1] This was figured with lamellar cupular valves; Reiche accepted it wrongly as elamellar.

[2] Index Kewensis listed an earlier *Fagus procera* Salisb. Prodr. Stirp. 391. 1796 (= *Castanea sativa* Mill.) which Dimitri & Milano (25, p. 7) accepted to have priority

DUBIOUS

19. **Nothofagus leoni** Espinosa, in Rev. Chil. Hist. Nat. **30**: 268. 1926; ibid. **32**: 175–187, *t. 8, 9,* fig. 31–37. 1929.

This is, according to Dr. Kausel's most instructive information, a natural hybrid between *N. glauca* and *N. obliqua*. Dr. Kausel examined both the type specimen and additional material of the original tree from which it was obtained. It has several features in common with *N. glauca*; the bark shows a little of the remarkable papery structure of the latter but does not peel. The cupules possess four rows of lamellar appendages and appear intermediate, as are the leaves. The nuts are larger than in *N. obliqua* var. *macrocarpa* (10–13 mm.) but smaller than in *N. glauca* and are distinctly winged as in *N. obliqua*. The tree is located in a region where both *N. glauca* and *N. obliqua* occur and where their areas overlap. Mr. Wagemann who knows the type-locality very well told Dr. Kausel that there are only 8–10 individual trees of *N. leoni* known to occur.

It is quite possible that this hybrid is identical with *N. obliqua* var. *macrocarpa*, but the latter might also represent a separate species. Additional collections are necessary to clarify this point.

Subsect. 2. **Pumiliae** subsect. nov.

Cupula 2-partita, valvae lineares. Flos ♀ unica, 3-mera. — TYPE: 7. *N. pumilio* (Poepp. & Endl.) Krasser. *Fagus pumilio* Poepp. & Endl., *Calusparassus pumilio* Hombr. & Jacq.

DISTRIBUTION: Chile, The Argentine.

NOTE: This has been reduced by some authors to *N. antarctica* but appears to me quite apart. Cf. also Philippi, Linnaea **33**: 237. 1864; Reiche, in Verh. Deut. Wiss. Ver. Santiago de Chile **3**: 409. 1897.

The leaf margin shows two teeth between the primary nerves; the latter are appressed-hairy on the lower surface, and the midnerval zone is often haired on the upper surface. This regular nervation is not found in *N. antarctica,* in which the dentation incision is principally the same but double-crenate. The regular nervation reminds one of *N. gunnii,* which, however, has only a single internerval tooth.

II. Sect. **Calusparassus** (Hombr. & Jacq.) Krasser in Ann. Hofmus. Wien **11**: 163. 1896.

Calusparassus Hombr. & Jacq. in Dumont d'Urville, Voyage Pol Sud & Oc. Bot. Atlas Dicot. t. 6Σ. 1844; t. 7Γ. 1845, pro parte.
Nothofagus sect. *Sempervirentes* Steen. in Blumea **7**: 146. 1952.
Nothofagus sect. *Planae* Steen., l.c. 306, laps. cal.

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over *Fagus procera* Poepp. & Endl. Mr. Forman, Kew, was so kind as to copy Salisbury's reference for me. It appears that "procera" was merely an indication of its habit but not a specific epithet; even if this interpretation should not be accepted, it is a superfluous *nomen nudum* given in synonymy, which, hence, cannot be used for purposes of priority.

Leaves persistent, not plicate in bud but flattish or folded along the midrib exposing the undersurface or the upper surface, with firm texture. — LECTOTYPE: *N. betuloides* (Mirb.) Oerst.

DISTRIBUTION: South America to Queensland and Melanesia.

Subsect. 3. **Quadripartitae** Steen., l.c.

Cupule 4-parted, lamellae subentire to lobed, parted or divided into appendages. Lateral ♀ flowers normally 3-merous. — TYPE: *N. betuloides* (Mirb.) Oerst.

DISTRIBUTION: South America to Queensland.

1. Fruiting cupular valves with several lamellae each bearing or presenting a row of recurved, linear, glandular-tipped processes. ♂ flower solitary.
  2. Leaves roundish, under 2 cm. long, with few coarse teeth or crenations. Cupule 5–6 mm. long. Stipules 2–4 mm. long.
    3. Fimbriae arising from rather decidedly scale-like lamellae. ♀ perianth hornlike produced far above the top of the carpel, wings acuminate, in the sinus with spinous processes. Leaf underside with at least 2 basal domatiae; leaf margin thick, texture thick. *Fagus menziesii* Hook. f. New Zealand. . . 8. *N. menziesii* (Hook. f.) Oerst.
    3. Appendages flatter, horizontally attached from less decided scale-like lamellae. ♀ perianth not reaching above the top of the style, wings bluntish without spinous processes in the sinus. Domatiae absent, texture and margin less thick comparatively. *Fagus cunninghami* Hook. f. SE. Australia, Tasmania. .... 9. *N. cunninghami* (Hook. f.) Oerst.
  2. Leaves ovate-oblong, acute, (1.5–) 3–6 (–11.5) cm. long, serrate. Cupule 8–10 mm. long. Stipules 1–1.5 cm. long, reflexed. Lamellae several, attached in inverted V-shape pattern. *Fagus carroni* C. Moore, *F. moorei* F. v. M. South Queensland and New South Wales ....10. *N. moorei* (F. v. M.) Krasser.
1. Fruiting cupular valves not with such regular lamellar rows of recurved, linear, glandular-tipped processes. ♂ flowers 1–3.
  4. Cupule with 2–4 entire or shortly ciliate lamellae on each valve; valves rather broad-ovate, pubescent.
    5. Leaves with 4 or 5 pairs of primary nerves, the margin on either side with 6–8 deep acuminate teeth. Domatiae present. *Fagus fusca* Hook. f. 1840 p.p., em. 1854, pro Hook, Ic. Pl. t. 631. New Zealand ....11. *N. fusca* (Hook. f.) Oerst.[1]
    5. Leaves with 5 or 6 pairs of primary nerves, leaf margin with 8–12 shallow blunt teeth. Domatiae absent. *Fagus truncata* Colenso. *Fagus fusca* Hook. f. p. p., Hook. Ic. Pl. 630. *Fagus fusca* var. *colensoi* Hook. f. 1854. New Zeland.......................... ....12. *N. truncata* (Colenso) Cockayne.[1]

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[1] Cockayne, whose specific distinctions are followed here for the New Zealand species (as extracted from Poole's work, lit. 38) regards *N. blairii* (Kirk) Krasser and *N. apiculata* (Colenso) Krasser as belonging to the hybrid groups formed between *N. fusca* and other species.

The difference between *N. fusca* and *N truncata* as given by Poole (38, p. 370–371) is not very convincing for a specific status of these two species, as it is practically limited to vegetative characters.

4. Lamellae provided with one or two tooth-like erect appendages (laciniae); valves narrow, glabrous. Leaves glabrous, serrate. Twigs hairy.
    6. ♂ flowers solitary, pedicelled. Stamens 10–16, filaments exserted. Leaves ovate-elliptic. This and the following two species are apparently closely related. *Betula antarctica* (Forst. Comm. Goett. **9**: 45. 1789, nom. nud.) Willd. Sp. Pl. **4**, 1: 466. 1805. *Fagus betuloides* Mirb. 1827, *Fagus dubia* Mirb. 1827, *Fagus forsteri* Hook. 1840, *Calusparassus betuloides* et *C. forsteri* Hombr. & Jacq., *N. patagonica* Gandoger. Chile, The Argentine. .... 13. *N. betuloides* (Mirb.) Oerst.
    6. ♂ flowers in triads. Leaves ovate-lanceolate, acutish, 2–3 cm. long. Cupular valves on the back with short tooth-like appendages.
        7. ♂ flowers with 5–8 stamens; pedicels yellow-hairy. Leaves ovate-oblong-triangular, 2.25–3.5 × 1.25–2 cm., in sicco brownish. Nerves and veins at the leaf-base fanned-subtripli-nerved. Filaments as long as the perianth. *Fagus nitida* Phil. Chile, The Argentine. .... 14. *N. nitida* (Phil.) Krasser.
        7. ♂ flowers with ca. 8–15 stamens, triads peduncled. Filaments exserted. Cupular valves shorter than the nut. Leaves ovate-oblong to ovate-lanceolate, 2–3 × 0.75–1.5 cm., in sicco mostly greenish yellow. *Fagus dombeyi* Mirb. Chile, The Argentine. .... 15. *N. dombeyi* (Mirb.) Oerst.

Subsect. 4. **Tripartitae** subsect. nov.

Cupula 3-partita, lamellae indivisae, lamina integra, supra tessellata, infra tomentosa. — TYPE: *N. solandri* (Hook. f.) Oerst.

DISTRIBUTION: New Zealand.

1. Leaves blunt.[1] Flowering cupule 2 × 1.5 mm., very hairy. Tall, at low altitude. *Fagus solandri* Hook. f. New Zealand. .... 16. *N. solandri* (Hook. f.) Oerst.
1. Leaves acute.[1] Flowering cupule 1 × 1 mm., viscous, glabrous except for sparse hairs at the base. Low, at high altitude. *Fagus cliffortioides* Hook. f. New Zealand. .... 17. *N. cliffortioides* (Hook. f.) Oerst.

Subsect. 5. **Bipartitae** Steen., l.c. 146.

Cupule 2-valved, valves free to almost wholly connate, but in several cases the cupule is partly or wholly reduced. Lamellae entire. ♀ flowers 1 or 3, all 2-merous, flat. — TYPE: *N. brassi* Steen.

DISTRIBUTION: New Guinea and New Caledonia.

A. Series **Triflorae** Steen., l.c. 146.

Cupule with 3 ♀ flowers. ♂ flowers in triads. — TYPE: *N. brassi* Steen.

DISTRIBUTION: 4 species in New Guinea and 5 in New Caledonia.

B. Series **Uniflorae** Steen., l.c. 146.

Cupule with a solitary ♀ flower, sometimes very small or wholly suppressed. ♂ flowers in triads or solitary. — TYPE: *N. pullei* Steen.

DISTRIBUTION: 12 species in New Guinea.

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[1] This difference holds only for very typical specimens, but there are many atypical specimens. The differences given by Cockayne (cf. Poole, lit. ref. 38, p. 366, 373–374)

SPECIFIC DISTINCTION IN PAPUA

It is, in an unexplored group of species, often a puzzle how to delimit them if the material at hand is limited. In the case of Papuan *Nothofagus* the inadequacy of the material formed a formidable obstacle for an easy definition. For example, there is not a single collection among the fifty I had at my disposal which has both flowers and mature fruit. As is explained elsewhere in this paper, this is caused by the short duration of the period of anthesis and by the rather prolonged lapse of time between the flush and the fruiting stages. In many of the sheets female flowers are exceedingly scarce. Under such conditions one is tempted to describe too many species. There are marked additional vegetative characters for a number of species, but from the key based on vegetative characters only, it appears that there are some groups of species which agree closely in gross vegetative characters. On the other hand, some species, as, for example, 4. *N. brassi* and 16. *N. dura* are vegetatively exceedingly alike, but their cupular structures are widely different. It is possible that anatomical structures, e.g., the epidermal patterns, may yield microscopical distinctive characters, a task Miss Cookson has in view as a future project of research. Generally, sterile specimens are very difficult to place.

Though it is not unknown in the phytography of New Guinea that some genera have swarmed and show a rich speciation, as *Corybas*, *Tecomanthe*, *Trachymene*, *Xanthomyrtus*, *Drimys*, and *Sericolea*, I felt rather uneasy about specific delimitation of *Nothofagus*. It seemed to me that the distinctions that I made were finer and less marked than those found in the southern beeches. Mr. Brass wrote me Feb. 22, 1952, that, when he first looked over my conclusions and saw sixteen species described, including nine from the Archbold Expedition collections, he was a bit startled, but on marshalling his memories and going through his field notes, he thought I was probably right. In the necessarily narrow strip of country Mr. Brass covered on the Snow Mountains Expedition in 1938–1939, he recognized two or three species in different camp localities in the field. When species representation is like this in small areas, there is reason to think that *Nothofagus* has "swarmed" in New Guinea, and what might be the total number of species on that great island!

Mr. Brass wrote further "that the trees look pretty much alike in most cases, except for bark characters which may not be constant in a species that grows under varied habitat conditions and may change with the age of the trees, and except for their young-leaf colours, which are not always on display."

Mr. Brass then stated his opinion, based in the field on the number of species he found different in each locality, and his numbers match exactly those of mine obtained independently on the basis of herbarium work.

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are meagre. I believe these two species represent rather geographical vicarious subspecies of one specific population.

There are also other indications that my fears about distinguishing too many species are possibly not justified. I find to my satisfaction that of 7. *N. resinosa* I have two exactly matching collections, but one is from West New Guinea, the other from East New Guinea, places very wide apart. The same holds for 5. *N. pullei* which is known from Mt. Hellwig in West New Guinea, the only other collection being known from the Morobe District in East New Guinea. Also 12. *N. grandis* has been collected in both West and East New Guinea.

Another fact putting my conscience at ease is that Dr. Baumann-Bodenheim recognized in the field five species in New Caledonia with which I agreed at first sight.

As to the characters of the ♂ and ♀ flowers, I am of the opinion that the female flowers, the cupule, and the nuts provide the most reliable characteristics for specific delimitation. My drawback here has been that in a number of species only the flowering stage was represented and not the mature cupule and nut.

In those species with very much reduced cupular structures (species no. 5, 7, 8, 9, 10) there is no certainty whether and how mature cupules will develop. There is still a chance that these reduced cupules represent, by exception, what in silviculture is known as "Fehlschlagen," i.e. abnormalities falling outside the normal variability which may occur at the very beginning or at the end of the flowering season. For the present I have accepted them as normal characters.

Miss Cookson and Dr. H. E. Dadswell, both of Melbourne, have checked my species as far as possible with respect to the pollen structure and the wood anatomy, but the result is, unfortunately, not conclusive. In some cases these anatomical structures agree with gross morphological distinctions, but in other cases no distinction can be found, and in some cases no distinctions were found in what I regard certainly as good species on the basis of gross morphology. Both scientists agree that they themselves do not claim the characters obtained along their lines as finally decisive for specific delimitation.

As appears from the key the differential characters are not small; however, the question is whether they are good and will hold. Some new large-leaved collections have come to hand since the key was composed, and these could be easily placed, but the future will show whether this will also hold for the small-leaved ones.

With the material at hand I had the choice of describing a few very completely known distinct species and leaving the bulk unnamed, or endeavouring to work out all sheets to the best of my ability with the chance that a few species may have to be reduced later. I have preferred to accept the latter chance.

For future exploration it will be necessary, I think, to follow the Koorders method of numbering trees in the field (56) and making collections from these individual trees at different seasons of the year, in order to preserve for the herbarium a complete set of developmental stages from a year's cycle.

KEYS TO AND DESCRIPTIONS OF THE PAPUAN SPECIES

It is with some hesitation that the following key for determination of the Papuan species has been constructed. I found the characters of the ♀ sex the most valuable for this purpose, but I have as far as possible also made use of vegetative characters. My hesitation is mainly due to the fact that this study unfortunately had to be based on a rather meagre assemblage of material, though it comprises all which has been collected up to the present. The condition of the material is such that every specimen is in a certain stage of development, and as yet in hardly any species are all developmental stages of the cupule represented. Of single species only are mature cupules and nuts known. The number of ♂ flowers may represent a good additional character; however, in several species the male sex is unknown. Further, it is difficult to judge, from the herbarium, whether a cupule or female flower is full-grown, as the cupules, when dried, open in the immature stage. Therefore, the characters of the cupule and nuts are sometimes not wholly comparable. Some of the reductions in cupules might be ascribed to "Fehlschlage" and be abnormal. These are known to occur in *Fagus*, according to Celakovsky (42) and have occasionally been described in *Nothofagus*, e.g., one of the lateral ♀ flowers in *N. cliffortioides* 2-merous or one of the lateral ♀ flowers absent; in *N. cunninghami* Miss Langdon found a cupule with a central ♀ flower and two lateral ♂ flowers. On the basis of the present Papuan material no opinion can be offered in that respect. The scantiness of the material further excludes formulating an idea on the variability of the characters used for specific distinction. The reader is, therefore, obliged to verify his identification of future accessions by checking the result of his keying with the descriptions.

It would be well if there were a possibility of distinguishing all species by vegetative characters only. This seems to me to be out of the question. Several species show distinctive vegetative characters, but several others are very similar vegetatively. As far as such a key may be possible I have made one, following the present key.

TENTATIVE KEY FOR FERTILE MATERIAL

1. Cupule 3-flowered. Series TRIFLORAE.
  2. Leaves distinctly crenate, 5.5–7 × 2.75–3.25 cm. . . . . 2. *N. perryi.*
  2. Leaves entire.
    3. Cupule distinctly recurved. . . . . 1. *N. recurva.*
    3. Cupule erect or suberect.
      4. Midrib on the upper surface indicated by a groove but its proper tissue absent. Leaves rather thin-coriaceous, flattish, apex acutish. Nerves not sunken above. Reticulations distinct on the lower surface. Petiole medium. . . . 3. *N. starkenborghi.*
      4. Midrib distinct on the upper surface, sulcate, with an elevated ridge at least in the lower half of the blade. Leaves distinctly convex, hard-coriaceous, apex rounded. Nerves shallowly sunken above. Reticulations absent on either side. Petiole thick. . . . . 4. *N. brassi.*

1. Cupule 1-flowered. Series UNIFLORAE.
   5. Twigs of the flush and preceding growth period distinctly[1] densely reddish-brown hairy. Stipules persistent. . . . . 5. *N. pullei.*
   5. Twigs glabrous[1] or nearly so.
      6. Leaves crenate, at least towards the apex of the leaf, flat, ovate-oblong, acutish, 2.75–4 × 1.25–2 cm. . . . . 6. *N. crenata.*
      6. Leaf margin entire (or rarely very obscurely subcrenate in spp. 7 and 8 which possess a waxy leaf undersurface and rounded or obtusish leaf apex).
         7. Leaves of flowering twigs distinctly covered with a grey or yellowish waxy film, flat, chartaceous.
            8. ♀ flowers without cupule. Habit a bit coarser than that of the following species. . . . . 7. *N. resinosa.*
            8. Fruit with a 1-lamellar, oblong cupule splitting to the base. Habit more slender than in the preceding sp. . . . . 8. *N. pseudoresinosa.*
         7. Undersurface of leaves of flowering twigs without such a cover.
            9. Leaves obovate, margin hardly recurved. ♂ flowers in peduncled triads, truncate-campanulate, with a distinctly constricted base. Cupule in flower reduced to 2 elamellar appendages, distinctly stalked. . . . . 9. *N. carri.*
            9. Leaves ovate-oblong or elliptic. Cupule absent or at least with 2 or 3 lamellae.
               10. ♀ flower ovate or ovate-oblong.
                   11. Cupule absent, its perianth limb specially produced towards the apex as rather patent appendages. Lateral sides of the ♀ flower with a central prominent rib at the tip of which is a small, sometimes glandular appendage. . . . . 10. *N. cornuta.*
                   11. Cupule distinct, with ca. 3 lamellae, narrow, 6–7 × 2–2.5 mm., in flower shorter than the ♀ flower, in fruit about as long as the nut. . . . . 11. *N. bernhardi.*
               10. ♀ flower and nut about as long as broad.
                   12. Cupule ca. 12–15 × 7–12 mm., split halfway, with 3 or 4 lamellae. Nut rhomboidal, ca. 10 mm. through. Leaves large, ca. 3.5–7.5 × 2–4.5 cm. . . . . 12. *N. grandis.*
                   12. Cupule at most 10 by 5 mm., split somewhat deeper. Nut roundish, 4–5 mm. through. Leaves smaller, up to 2–4.5 × 1.5–2.5 cm.
                       13. Maturing ♀ flowers 3–5 mm. pedicelled, pedicels very distinct, recurved. Leaves small, ca. 2.5 × 1.5 cm., elliptic. ♂ flowers in 4–5 mm. peduncled triads. . . . . 13. *N. decipiens.*

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[1] The waxy film on the young parts in some species is sometimes covered by dark-coloured, patent sporophores of Fungi apparently belonging to the sooty moulds. In 1949 I sent a sample to Mr. Mason of the Imperial Mycological Institute at Kew asking detailed information, but there has been no answer as yet.

13. ♀ flowers sessile or at most 1.5 mm. pedicelled, erect. ♂ flowers in sessile or subsessile triads.
    14. Style long, persistent, hence nutlets beaked. . . . . 14. *N. rubra.*
    14. Style short or not persistent, nutlets not beaked.
        15. Leaves elliptic, less than twice as long as broad, coriaceous. . . . . 15. *N. eymae.*
        15. Leaves ovate-oblong, 2–2.5 times as long as broad, hard-coriaceous, distinctly concave. . . 16. *N. dura.*

Tentative Key Based on Vegetative Characters

1. Leaves crenate in the upper half, ovate-oblong, acutish.
    2. Leaves firmly coriaceous, 6–7 × 2.5–3.5 cm. Prominent ridge in the midrib on the upper surface indistinct in the upper half. Petiole strong, ca. 0.75 cm. . . . . 2. *perryi.*
    2. Leaves thinly coriaceous, 3–4.5 × 1.5–2 cm. Prominent ridge extending to the leaf apex. Petiole thin, 0.25–0.5 cm. . . . . 6. *crenata.*
1. Leaf margin entire or almost so.
    3. Twigs distinctly hairy (stipules long-persistent). . . . . 5. *pullei.*
    3. Twigs glabrous.
        4. Undersurface of young but full-grown leaves distinctly covered with a grey or yellowish waxy film, flat. Margin very faintly crenate.
            5. Leaf texture thickish. . . . . 7. *resinosa.*
            5. Leaf texture thin. . . . . 8. *pseudoresinosa.*
        4. No such waxy film. Leaves flat or convex.
            6. Tissue of midrib on upper surface not visible within the groove, a fortiori without a prominent ridge. . . . . . . 3. *starkenborghi.*
            6. Tissue of midrib at least visible up to half its length and provided with a prominent ridge.
                7. Leaves thick-coriaceous, ovate-oblong, acutish, convex. Lateral nerves rather distinct. . . . . 1. *recurva,* 2. *brassi,* ?14. *rubra,* and 16. *dura.*
                7. Leaves thin to thick-coriaceous, broad-elliptic to obovate (if ovate-oblong then not convex), flat or at least not distinctly convex though margin often recurved.
                    8. Leaves generally large, 5–10 × 2.5–5.5 cm. . . . . 12. *grandis.*
                    8. Leaves smaller, up to 3–4 × 2–2.5 cm.
                        9. Leaves generally obovate. . . . . 9. *carri.*
                        9. Leaves elliptic or broad-elliptic. . . . . 1a. *recurva* var. *microphylla,* 10. *cornuta,* 11. *bernhardi,* 13. *decipiens,* 14. *rubra,* and 15. *eymae.*

1. **Nothofagus recurva** Steen. in Blumea 7: 146. 1952. — Fig. 4.

Monoecious, glabrous shrub or small tree 2–10 m. Twigs rather strong. Perules roundish, not much elongating. Leaves oblong to ovate-oblong, or

FIGURE 4. *Nothofagus recurva* Steen. a. twig with cupule, apical flush with ♂ flowers, b. stipule from inside, c. triad of ♂ flowers, c'. insertion of stamens in bud, d. two cupules, styles of ♀ flowers exserted, e. two mature cupules, f. two nuts. (After *Kostermans 2384*; a. nat. size, b–f. × 4.)

elliptic, coriaceous, margin entire not strongly recurved, 4–7 × 2–3 cm., older ones up to 8 × 3.5 cm.; nerves 7–9 pairs, visible on the upper surface, very prominent below; reticulations indistinct above, slightly prominent beneath; glands mostly 0.5–0.75 mm. spaced. Petiole strong, 4–6 mm. Stipules caducous, large, oblong, 7–10 × 3 mm., thin except the concave insertion, attached at one third of their length. ♂ inflorescences on the basal part of bare short-shoots, in shortly peduncled or subsessile triads. Perianth tubular, many-veined, minutely puberulous, 7–9 mm. long. Stamens ca. 15, filaments with scattered, patent hairs; anthers 5–7 mm. ♀ inflorescence 5–7 mm. stalked, 3-flowered, recurved, peduncle stout, thickened towards the apex; only the styles protruding above the roundish cupule 4–5 mm. in diam. ♀ flower roundish, including the thick wings more or less rhomboid; style 1 mm., distinct. Mature cupule ca. 10 mm. stalked on a stout, recurved peduncle, usually one found above the ♂ flowers, 7–10 × 5–9 mm.; lamellae 3, besides some indistinct apical ones. Nut (ripe?) broad-elliptic to ovate or rhomboid in outline, acute, 6 × 4 mm.

NORTHWEST NEW GUINEA: Mt. Arfak, Angi Gita Lake, *Kostermans 2384* (BO, TYPE; L), 9–22 Oct. 1948, tree 10 m., flowers white; ibidem, 2000 m., *Kostermans 2321* (BO, L), shrub 2 m., flowers white.

Apparently closely allied to 2. *N. perryi* but differs in the entire leaves and recurved cupular stalk. Both species are the largest-leaved among the Papuan representatives. The two specimens cited are exactly identical.

1a. **Nothofagus recurva** var. **microphylla** (Steen.) comb. nov. — FIG. 5.

Nothofagus pseudoresinosa var. *microphylla* Steen. in Blumea 7: 147. 1952.

Treelet, 6 m. Leaves elliptic-oblong, 2.5–4 × 1.5–2 cm., less coarse than in the species, side-nerves less prominent below.

NORTHWEST NEW GUINEA: Mt. Arfak, summit ridge of Mt. Kubré, 2000–2300 m., *Kanehira & Hatusima 14052* (label on branch reads *14056*), (A, TYPE; BO), April 9, 1940, treelet 6 m., flowers white, gregarious in burnt open forest especially in the vicinity of Iray, near Lake Angi Gita.

This is apparently a microphyllous form of exposed ridges. Though the leaves are very different in habit from those on the type of the species there are no additional differences and it may turn out to represent a phenotypic form of it. The ♂ triad is here 1–3 mm. peduncled, the ♂ perianth only 5 mm. long; according to Dr. Hatusima it has the following additional characters: tree 10–15 m., less than 30 cm. diam.; stamens 15–20; anthers 3.5–4 mm.; nuts narrowly winged, 6 × 3 mm.

It certainly resembles 13. *N. decipiens*, but has 3 ♀ flowers in each cupule, a thicker cupule, and short-peduncled ♂ flowers.

By a typing error this has earlier been referred to as a variety of *N. pseudoresinosa.*

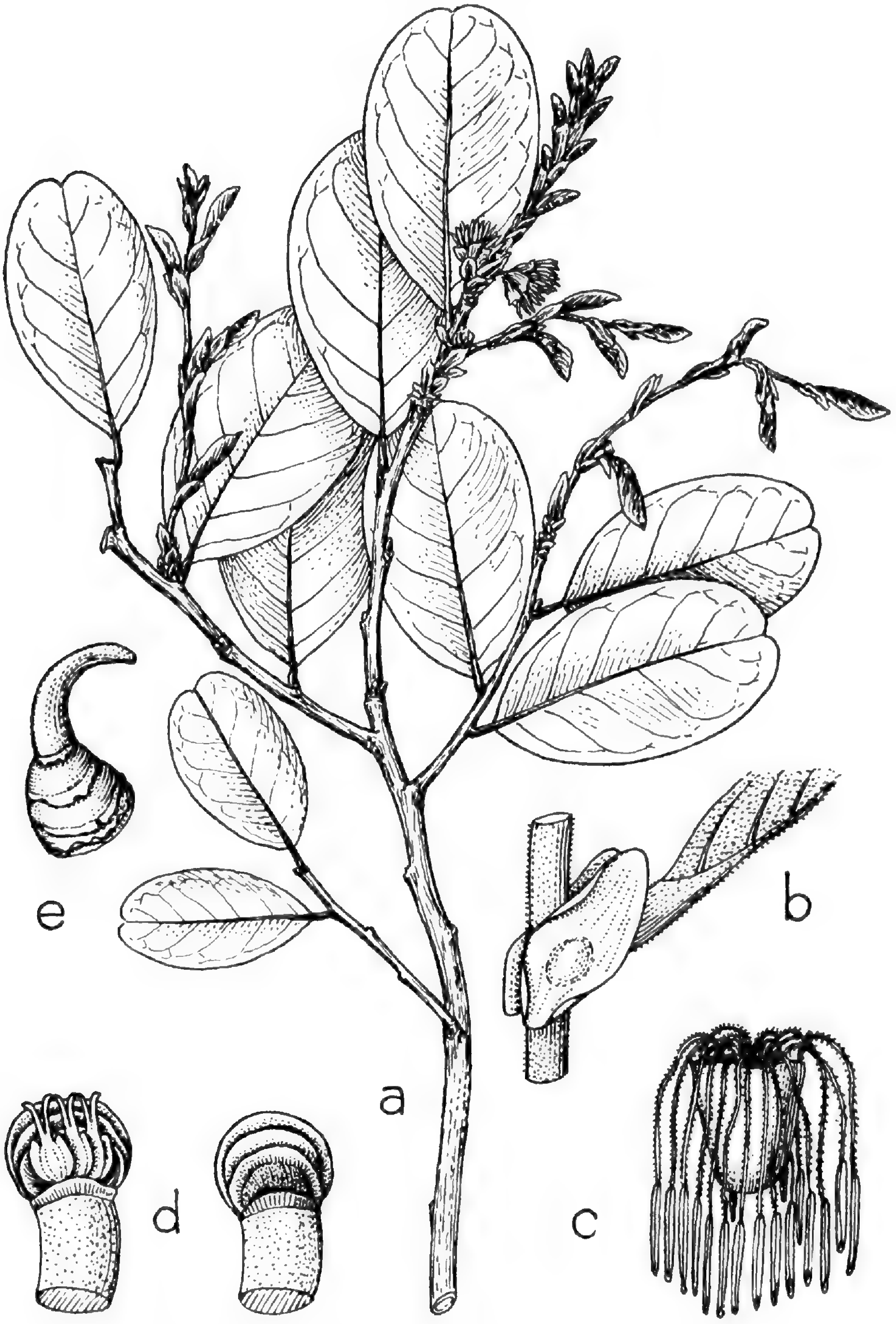

FIGURE 5. *Nothofagus recurva* var. *microphylla* (Steen.) Steen. a. flowering twig, b. insertion of leaf with stipules, c. ♂ flower, d. ♀ inflorescence, left, one valve of cupule removed, right, from outside, e. ?mature cupule. (After *Kanehira & Hatusima 14056*; a. nat. size, b–e. enlarged.)

2. **Nothofagus perryi** Steen. in Blumea 7: 146. 1952. — Fig. 3, 6.

Glabrous tree. Ultimate twigs slightly zigzag, subapplanate. Perules roundish, 3 mm. long, elongating. Leaves ovate-oblong, coriaceous, 5.5–7 × 2.5–3.75 cm.; margin distinctly crenate except in the basal part, edge cartilaginous; base broadly cuneate; apex acutish, tip subemarginate with a mucronulate midrib; midrib sulcate above with a distinct elevated ridge in the lower two thirds; nerves 6–8 pairs, rather straight, obliquely patent, distinctly prominent on the lower surface, indistinctly so on the upper surface, each ending in a crenation; reticulations distinct below, less distinct above; glands mostly 0.75–1 mm. spaced. Petiole 4–6 mm. Stipules unknown, apparently caducous. Flowers unknown. ♀ inflorescences apparently distinctly peduncled. Mature (?) cupule 3–6 mm. peduncled, erect, roundish in outline, split over two thirds of its length, the larger ones 7–9 × 6–8 mm., fully grown apparently 11 × 13 mm., 16 mm. peduncled, hardly split; lamellae 3. ?Ripe nut flattish on one side, thickened on the other, rather irregular by mutual pressure, roundish, (including the 0.33–1 mm. broad wing), base truncate, apex broadly rounded with 4–5 curved slightly prominent longitudinal veins on either side, 4–5 mm. diam.

EAST NEW GUINEA: Papua, Central Division, Ononge, vern. *sama* (Fuyuge language), East Mt. Tafa, near Nemodi, 2100 m., *L. J. Brass 5057a* (A, TYPE), July, (collected by *Father F. DuBuy*); ditto, 2350 m., *L. J. Brass 5057* (not seen), sterile, Sept. 17, 1933, dominant tree of tall forests towards Nemodi, fine large rough-barked, usually buttressed tree with dense crown of shortly spreading branches, leaves grey below, minutely toothed.

TERRITORY OF NEW GUINEA: Chimbu, *J. Gilmore*, (LAE, L), fruct. Dec. 1952.

The large leaves and regular nerves give a *Fagus*-like appearance to this species. The specimens are said to be supplementary to *Brass 5057*, which number I have not encountered among the loans. For the affinity cf. sub 1. *N. recurva.*

The fruits and twigs I hope belong together; they were detached. Vegetatively, the Gilmore collection matches the type exactly; it has one attached cupule which is much larger than the loose ones of the type, with four lamellae, and a very long peduncle (see above and compare *fig. 2e*). The species is named in honour of Miss L. M. Perry in appreciation for her help in securing the material for this paper and out of respect for her valuable contributions towards the flora of New Guinea.

3. **Nothofagus starkenborghi** Steen. in Blumea 7: 146. 1952. — Fig. 7.

Apparently monoecious tree up to over 30 m. tall, over 1 m. diam. Twigs minutely puberulous, glabrescent. Perule minute. Leaves oblong, subcoriaceous, 3–5.5 × 1.25–2.25 cm., generally ca. 2½ times as long as broad, flat, tip emarginate, base broad-cuneate, margin cartilaginous, feebly recurved; midrib sulcate on the upper surface, without an elevated ridge, strongly prominent beneath; nerves ca. 6–8 pairs, indistinct on both

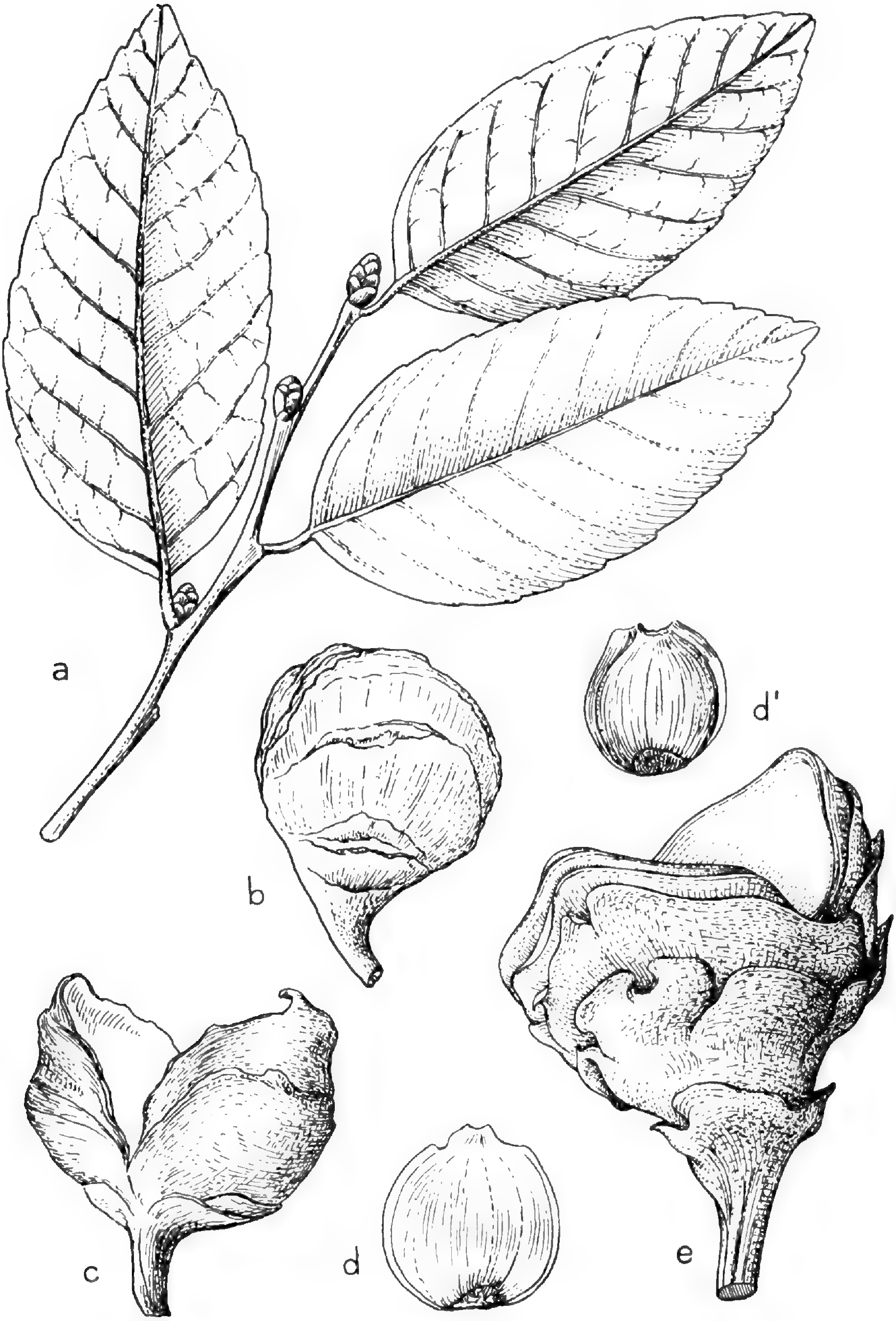

FIGURE 6. *Nothofagus perryi* Steen. a. twig, b–c. cupules, d–d′. two nuts, e. cupule. (After *Brass 5057a*; a. nat. size, b–d. × 4; e. after *Gilmore s. n.*, × 4.)

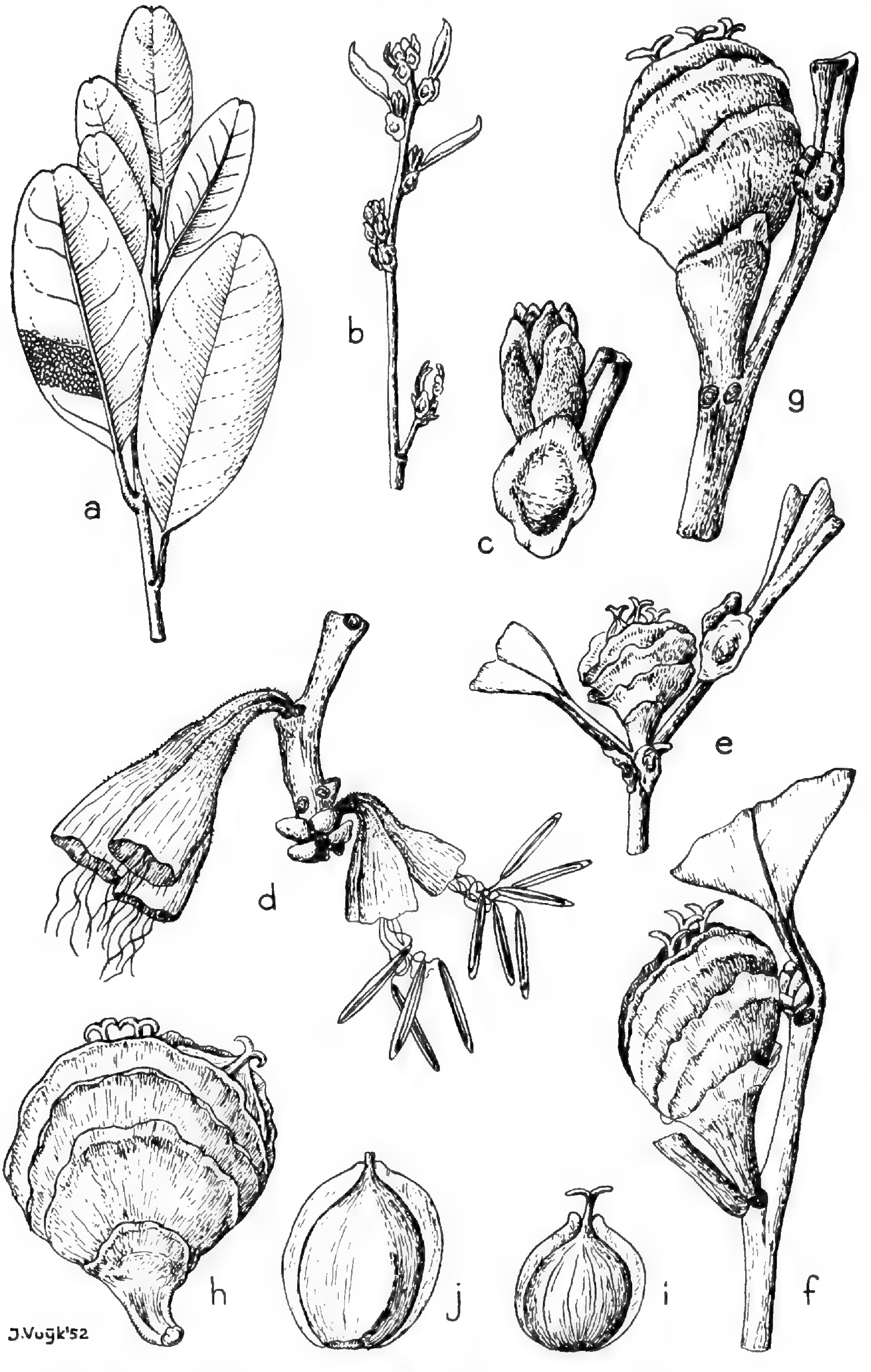

FIGURE 7. *Nothofagus starkenborghi* Steen. a. twig, b. flush, c. stipule with perule, d. ♂ flowers, e. young cupule, f–h. older cupules, i. ♀ flower, j. immature nut. (a–d., g, j. after *Brass 11369*, b, c. after *Brass 11202*, e, f, h, i. after *Brass 11563*; a, b. nat. size, c. × 5, d–j. × 4.)

sides; reticulations indistinct on the upper surface, somewhat prominent on the lower surface; glands on the lower surface ca. 0.5–1 mm. spaced. Petioles 4.5–7 mm., terete, upper surface sulcate with an elevated ridge. Stipules peltate, ovate, not very soon caducous, 2.5–4 × 1–2.5 mm. ♂ flowers (all detached) in recurved triads; pedicels nearly free from the base or over 2 mm. connate in a short peduncle; constricted basal portion of the perianth angled, ca. 2 mm. long, minutely hairy; perianth above the constriction campanulate-tubular, truncate, 2–4 mm. high, or more tubular 4–5 mm. high. Stamens ca. 12; staminal column reaching halfway the perianth-tube, filaments minutely hairy; anthers ca. 3 mm., nearly 0.75 mm. broad when open, apex and base minutely papillose-hairy, connective thickened-apiculate. ♀ inflorescence erect. Cupule ca. 3–4 mm. stalked, rounded, 7–9 mm. diameter; lamellae 2 or 3. ♀ flower broad-elliptic or roundish, ca. 6 × 4 mm., rather broadly winged, wings surrounding the basal part of the style; style 0.5–1.25 mm.

WEST NEW GUINEA: 18 km. NE of Lake Habbema, Camp at Bele River, 2200–2400 m., *L. J. Brass 11369* (L, TYPE; A, BO), November 1938, dominant tree on lower slopes of valley, up to over 30 × 1 m., trunk often spur-buttressed, bark pale grey-brown, lenticellate, shedding in hard thin sheets or larger scales, young leaves red, loose ♂ flowers belong to this tree (immature ♀); ibid., 2250 m., *Brass & Versteegh 11107*, (A, L), dominant in primary forest, on slope of ridge, crown not wide-spreading, young leaves reddish brown, tree 22 m. × 53 cm., bark 1 cm. thick, gray scaly, outer wood rose, inner brown, young fruit green, ♀; ibid., *Brass 11563* (A, L), ♀; ibid., *Brass 11202* (A, L), very abundant and dominant at 2250 m. in gorge below camp, material from small tree 20 m. × 30 cm., yellow-grey close bark peeling horizontally in thin small flakes, ♀.

The material is singularly homogeneous, all specimens being, unfortunately, in approximately the same stage of development. The longish flat leaves are typical. Its closest ally is apparently 4. *N. brassi.*

The name of this tree is respectfully dedicated to His Excellency, Jhr. Mr. A. W. C. Tjarda van Starkenborgh Stachouwer, the last Governor General of the Netherlands Indies, 1936–1945, who was also one of the noblest of the Dutch administrators and regents in the Service, and to Mrs. Tjarda, whose brave, unselfish, and exemplary behaviour during the Japanese occupation was a beacon of faith to the P. O. W.'s and internees in their misery in the Japanese camps. Under his term of office several important expeditions were sent to New Guinea for botanical exploration of the island.

4. **Nothofagus brassi** Steen. in Blumea 7: 146. 1952. — FIG. 8–9.

Nothofagus sp. Langdon in Bot. Gazette **108:** 358, *fig. 14–17*. 1947.

Monoecious tree up to 40 m. by over 1 m. diam., twigs coarse, faintly zigzag, internodes slightly flattened. Perules ovate, ca. 4 mm. Leaves elliptic-oblong, 3.5–5.5 × 1.5–2.25 cm., entire hard-coriaceous, the margin strongly recurved, upper surface glossy, apex somewhat acutish; midrib

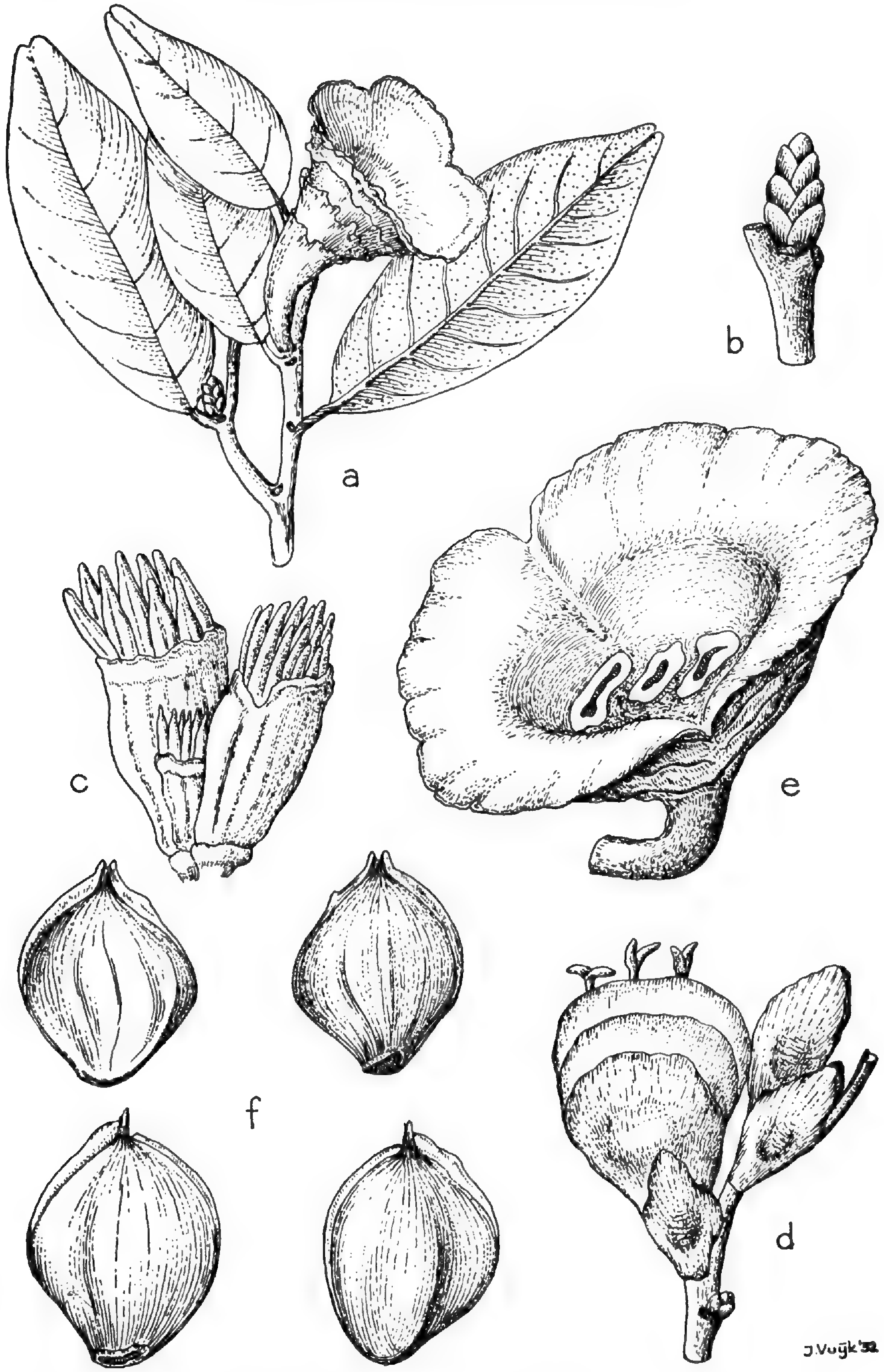

FIGURE 8. *Nothofagus brassi* Steen. a. fruiting twig, b. perule, c. triad of ♂ flowers, d. flowering cupule, e. mature cupule, f. nuts. (After *Brass 11115*; a. nat. size, b–f. × 4.)

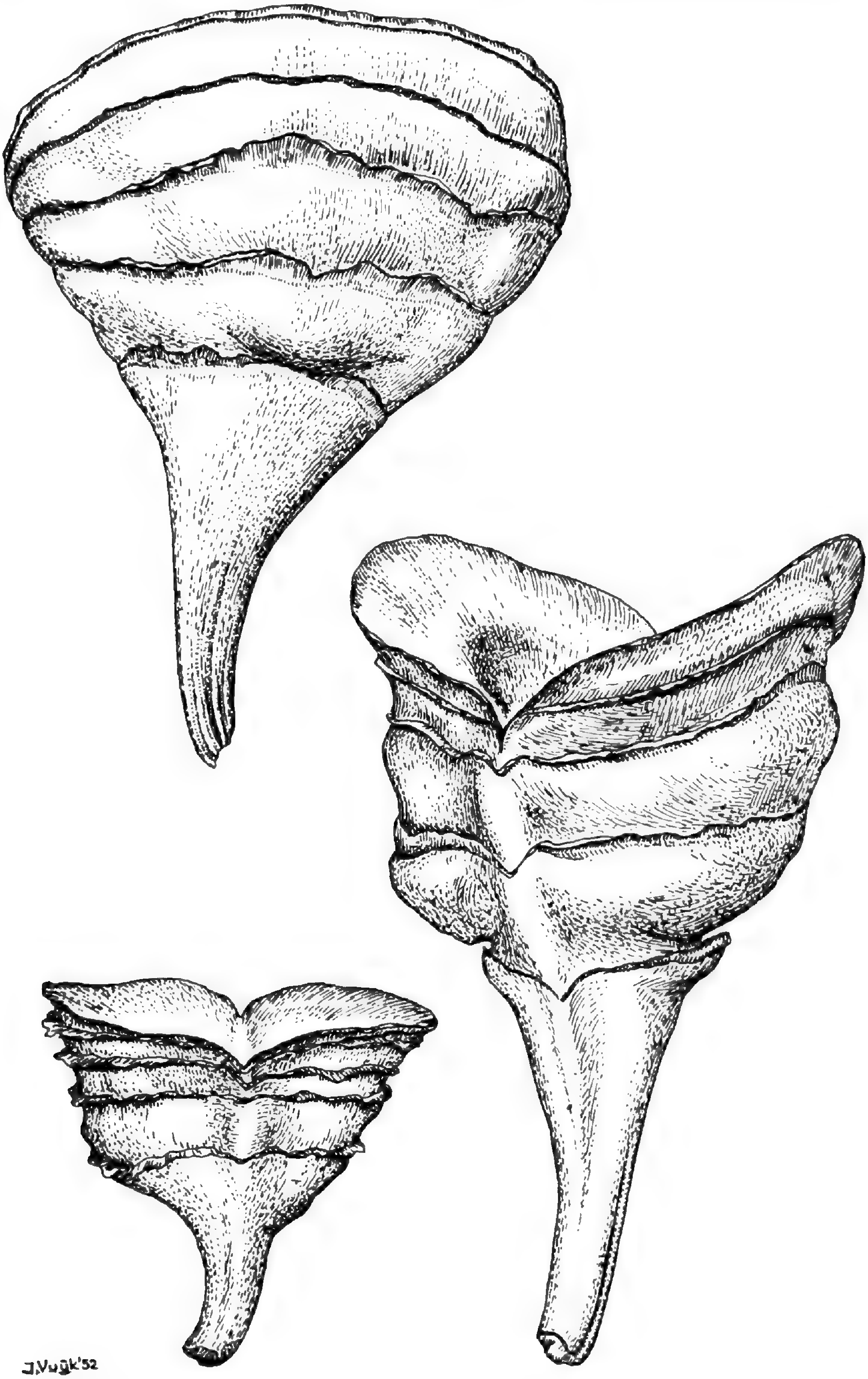

FIGURE 9. *Nothofagus brassi* Steen. Three cupules seen from various angles, × 4. (After *Brass 11115*.)

strongly prominent underneath, terete, on the upper surface sulcate with a prominent ridge; primary nerves 7 or 8 pairs, slightly sunken on the upper surface, distinct but faintly prominent underneath; reticulations on the upper surface absent, indistinct underneath; glands distinct on the lower surface, 0.5–0.75 mm. spaced. Petiole stout, ca. 0.5 cm. Stipules peltate, acute-oblong, 5–6 × 2.5 mm., early caducous, attached in the lower part. ♂ flowers (not seen by me, hardly any observed by Miss Langdon, l.c.) in triads, orange (acc. to Brass), rather tubular, ± sessile, limb truncate 3-toothed; anthers ca. 15. ♀ inflorescence erect, peduncled; flowers 3 (1 or 2 laterals sometimes abortive and sterile), ovate, wings surrounding the style-base; style 1–2.5 mm. Cupule about as large as the ♀ flowers, roundish, split halfway down, when young ca. 1 cm. peduncled, and 1 cm. broad, later when ripe ca. 1.25 cm. peduncled, ca. 1.5 cm. through, distinctly 4–5-lamellate, thick woody. Nuts very different in shape by mutual pressure, often partly abortive, ovate to broad-ovate, or suborbicular, distinctly winged towards the apex, averaging 6 × 6 to 9 × 6 mm., the largest ones ovate, 10 × 6 mm. inclusive of apical wings.

WEST NEW GUINEA: Bele River camp 18 km. NE of Lake Habbema, ca. 2300 m., *Brass & Versteegh 11115*, (L, TYPE; A, BO), November 1938, dominant tree in forests of upper slopes, up to 40 m. by over 1 m., ♂ flowers orange, ♀ flowers red, fruit brown-green, bark 1 cm. thick, rough, brown, fissured, scaly, outer wood brown, inner wood red-brown; ibid., 9 km. NE of Lake Habbema, 2680 m., *Brass & Versteegh 11103* (A, BO, L), October 1938, dominant tree of rain-forest on slope of ridge, tree 27 m. by 39 cm., crown not wide-spreading, bark 8 mm., rough, scaly, fissured, outer wood brown, inner wood red-brown, fruit brown.

The two collections cited agree markedly. This species occurs apparently in the same area as 3. *N. starkenborghi*, but at higher altitude. It can readily be distinguished from the latter species by its hard, more convex leaves showing a distinct ridge on the sulcate midrib. Possibly there are additional characters of the fruit which are not yet known in *N. starkenborghi*.

This species is named after Mr. L. J. Brass in honour of his unrivaled collections of New Guinean plants in general and of *Nothofagus* in particular. In returning from the Third Archbold Expedition he had recognized the identity of the Papuan trees.

5. **Nothofagus pullei** Steen. in Blumea 7: 146. 1952. — FIG. 10.

Monoecious. Shrub, widely branched treelet, 2–4 m. high, or tall tree; bole up to 30 cm. diam. Twigs terete, densely brown-pubescent, hairs persistent. Flush light green, the very young leaves thickly covered with orbicular, thickish scales. Perules roundish, 1–1.5 mm. diam. Leaves hard-coriaceous, elliptic-oblong, 1.75–3 × 1–1.75 cm., both ends rounded, margin entire, recurved, cartilaginous; upper surface smooth, subglossy, eglandular, midrib sulcate, with a distinct elevated ridge at least in the lower half; undersurface sparsely hairy on the thick, very prominent midrib; primary nerves ca. 6 pairs, distinct; reticulations dense, distinct on the lower surface, not so above; glands on the undersurface 0.33–0.5 mm. spaced. Petiole 1–3 mm. Stipules ca. 4–5 × 2 mm., persistent, oblong, attached below the middle. ♂ flowers solitary, erect; perianth subcampanulate, ca. 6–7 mm. long. Stamens ca. 15; filaments slightly hairy; anthers ca. 4 mm. long, glandular on the back. ♀ inflorescence sessile. Immature cupule with unequal valves, both of which are narrower and shorter than the ovary, one valve straight, roundish, entire or toothed, the other curved and with glandular-tipped lobes or teeth, ca. 3.5 × 2.5 mm., both with one lamella. ♀ flower ovate to ± elliptic, with distinct perianth wing, ca. 5 × 2.5 mm.; style distinct, thick, ca. 1.5 mm.; stigmas thick, 1 mm. Mature cupule and nut unknown.

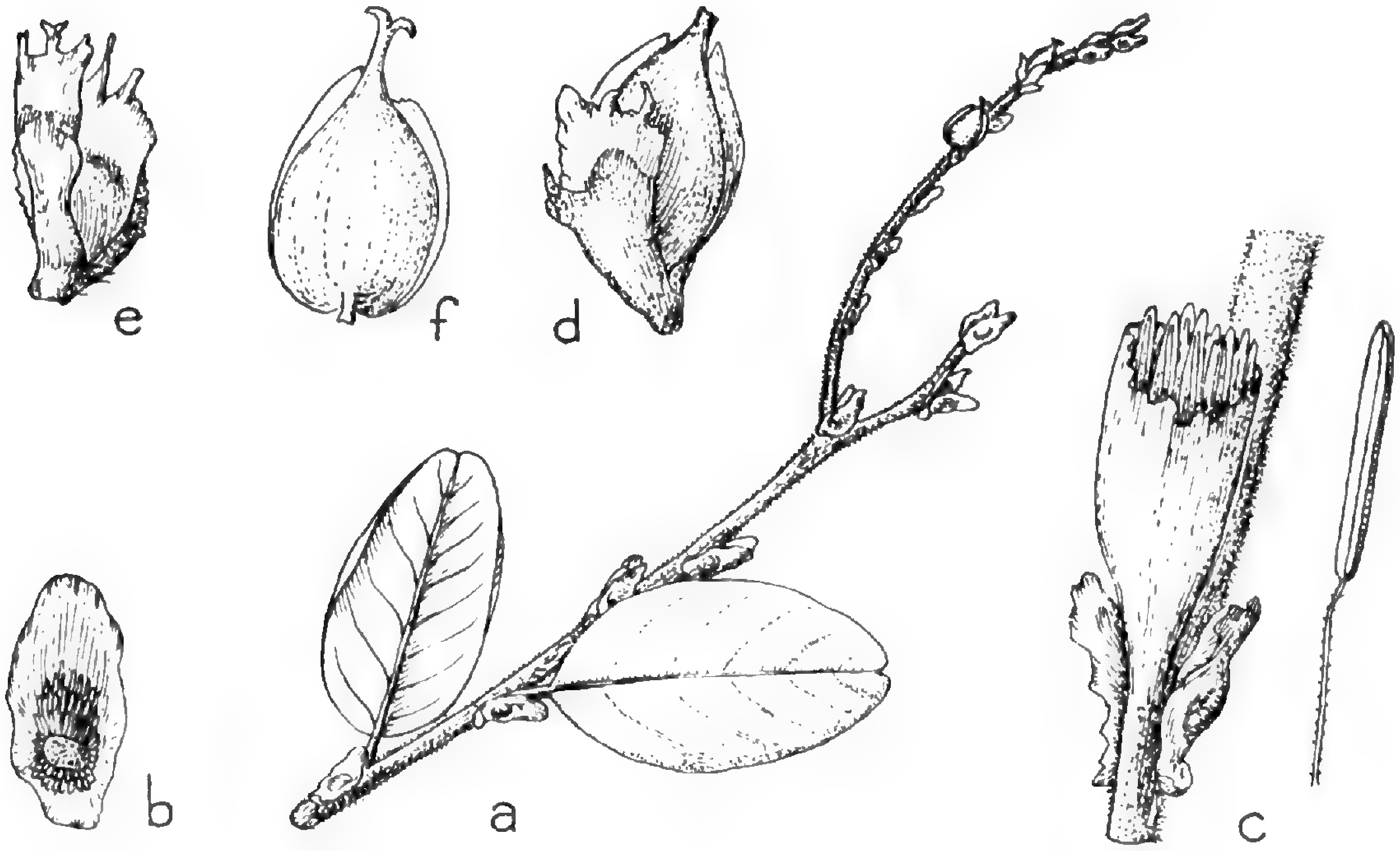

FIGURE 10. *Nothofagus pullei* Steen. a. twig with flowering flush, b. stipule (underside), c. ♂ flower and stamen, d. cupule with ♀ flower, e. same cupule with flower removed, f. ♀ flower separately. (After *Pulle 909*; a. nat. size, b–f. × 4.)

WEST NEW GUINEA: Mt. Hellwig, 2600 m., *A. A. Pulle 909* (BO, TYPE; L, U), January 4, 1913, scrub on ridge, shrub or treelet, 2–4 m. high.

NORTHEAST NEW GUINEA: Morobe Distr., Masalk River, at base of Mt. Sarawaket, *Clemens 7510* (A, L), mountain forest, tall tree, 30 cm. diam., stamens vivid blood-red, filaments white.

This species has the reduced cupule (in flower) in common with 7. *N. resinosa*, 9. *N. carri*, and 10. *N. cornuta*, and it seems to be most closely allied to the last species, of which some specimens show a faint hairiness on the youngest parts, rather long-persistent stipules, and a similar nervature. It differs from *N. cornuta* in its conspicuous indumentum, terete twigs, and a different shape of the cupular valves.

The East New Guinean specimens agree in flower with those of West New Guinea, but the leaves are somewhat rounder, 1.5–2 × 1.25–1.75 cm.; they possess many ♂ flowers and show no ♀ ones, whereas the West New Guinean specimens had more ♀ than ♂ flowers.

This species has been named in honour of Prof. Dr. A. A. Pulle, who was the first to collect a *Nothofagus* in New Guinea.

6. **Nothofagus crenata** Steen. in Blumea 7: 147. 1952. — FIG. 3, 11.

Glabrous tree, up to 40 by over 1 m. Perules roundish, ca. 1 mm. Leaves flat, thinly coriaceous, ovate-oblong, symmetric or suboblique, 2.5–5 × 1.25–2 cm.; base cuneate; apex attenuate; margin towards the apex shallowly crenate-sinuate, with a caducous, minute, sausage-shaped appendage mostly inserted at the nerve-ends; primary nerves 5–6 pairs, faint; veins on the upper surface somewhat prominent, on both surfaces tessellate-reticulate; glands 0.5–1 mm. apart. Petiole 4–5 mm. Stipules early caducous, ovate, 5 × 2 mm. ♂ flowers (only loose stamens found, not with certainty belonging to the species); filaments sparsely pubescent; anthers 5 mm. ♀ inflorescences (after anthesis) in all the leaf-axils of the young shoots, erect, ca. 5 mm. stalked, stalk thickened towards the apex. Immature cupule split to the base, glabrous, finally as large as the flower, about orbicular in outline, 4.5–6 × 5–6 mm.; lamellae ca. 3 or 4, the lowermost loose. ♀ flower solitary, ± orbicular, distinctly winged, apical

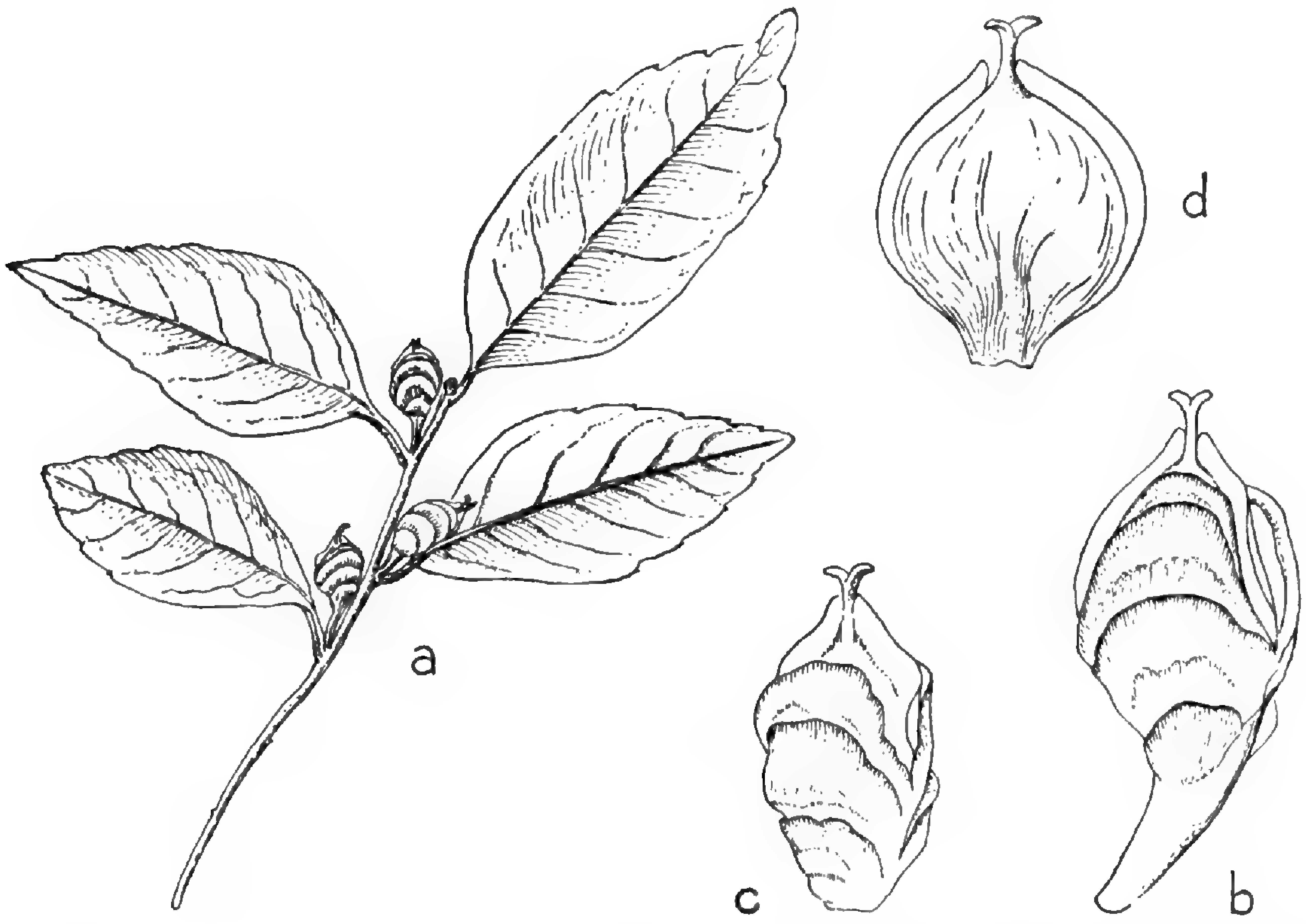

FIGURE 11. *Nothofagus crenata* Steen. a. ♀ flowering twig, b–c. cupules with ♀ flower, d. ♀ flower. (After *Brass 11335*; a. nat. size, b–d. × 4.)

teeth reaching the style-base, ca. 5 × 4 mm.; style 0.5 mm.; stigmas 0.5 mm. Mature cupule and nut unknown.

CENTRAL WEST NEW GUINEA: Bele River, 18 km. NE of Habbema Lake, 2400 m., *Brass 11335* (L, TYPE; A, BO), fl. November 1938, vern. *n'gi*, common in forests, large tree, up to 40 by over 1 m., bark gray-brown, thinly scaly.

Not obviously allied to any other species, as the only other one with distinctly crenate leaves, viz., 2. *N. perryi*, possesses 3 ♀ flowers in the cupule. It is uncertain whether the ♂ flowers belong to the specimen; if so, the ♂ flowers are apparently inserted close to the axils of the perular bracts.

7. **Nothofagus resinosa** Steen. in Blumea 7: 147. 1952. — FIG. 3, 12.

Monoecious. Glabrous tree up to over 40 m. high, more than 1 m. diam.; twigs brownish. Perules roundish, 2–3 mm. Lower surface of the leaves, stipules and flush conspicuously covered by a pale, slightly yellowish, waxy exudation. Leaves elliptic, coriaceous, rounded at both ends, flat, margin cartilaginous and practically entire, blade ± symmetric to ± unequal-sided, 4.5–7 × 2–4 cm., in fruit up to 10 × 5 cm.; upper surface smooth; primary nerves ca. 9 pairs, feebly prominent on the under surface, as are the inconspicuous reticulations; glands 0.5–1 mm. apart. Petiole 5–8 mm. Stipules elliptic, caducous, 4–6 mm. long. ♂ flowers solitary, erect, on naked short twigs and axillary, subsessile to 1 mm. pedicelled, minutely puberulous, trumpet-shaped, 6–7 mm. long. Stamens ca. 13, filaments sparsely hairy; anthers 3–4 mm. ♀ inflorescence consisting of an ecupular, solitary, erect, sessile, ovate-oblong, minutely puberulous flower, ca. 6–7 × 3.5–4 mm.; wings narrow, reaching the style-base; style very short; stigmas 1.5 mm. Nut flat, broadly elliptic, 9–10 × 6.5–7.5 cm., wings shouldering the style base; conical apex 1 mm.; style persistent, 1 mm. Cupule a roundish, not hardened, flat basal appendage 2 mm. through.

CENTRAL WEST NEW GUINEA: 9 km. NE of Lake Habbema, 2680 m., *Brass & Versteegh 10479* (L, TYPE; A, BO), October 1938, dominant tree in rain-forest on ridge, up to 35–40 by more than 1 m., crown fairly wide-spreading, bark 7 mm. thick, rough fissured, outer wood brown, inner red-brown, ♂ flowers soft yellow.

NORTHEAST NEW GUINEA: Morobe Distr., Samanzing, 2100–2400 m., *Clemens 9457* (A), January 7, 1939, tall tree, meadow camp, mossy bush, sterile, perules just developing; Finschhafen Subdistrict, Joangen to Yunzaing, 1500 m., *Womersley N. G. F. 5134* (LAE, L), fruiting April 25, 1953.

DOUBTFUL SPECIMEN: West New Guinea, 9 km. NE of Habbema Lake, 2800 m., *Brass & Versteegh 10448* (A, L), October 1938, occasional tree of tall forest, 23 m. by 38 cm., crown not wide-spreading, bark 6 mm. thick, scaly, gray, outer wood white, inner brown.

This species shows in both specimens a comparatively strong exudation of a yellowish resin, especially on the flush, the perules, the undersurface of the leaves and the inner side of the stipules. It is this character to which the specific name alludes. This resinous layer is often overgrown by a black fungus apparently belonging to the sooty moulds. The sporangiophores are branched at their apex and give superficially a dark velutinous appearance. Whether this resin is conspicuous only in certain stages of development is not known; it is very typical. A doubtful sterile specimen which apparently belongs here does not show it distinctly; it is presumably taken from a young tree.

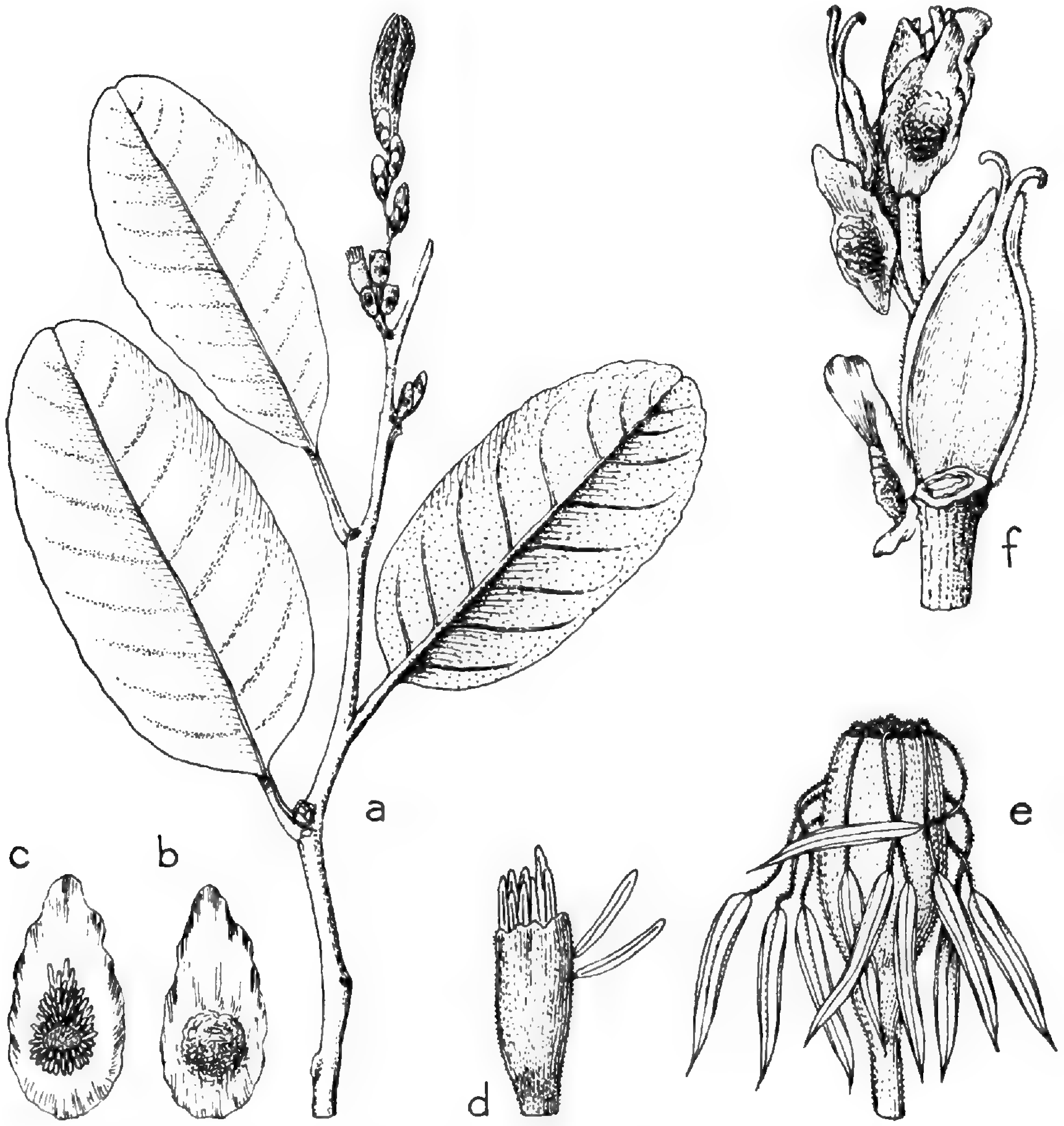

FIGURE 12. *Nothofagus resinosa* Steen. a. twig with flowering flush, b. stipule, outside, c. ditto, inner surface, d. immature ♂ flower, e. ♂ flower, f. flush with two ♀ flowers, lower one in front clear, one stipule removed. (After *Brass 10479*; a. nat. size, b–e. × 4.)

The only species with which to compare it is 8. *N. pseudoresinosa.* In the foliage it shows some resemblance to certain sheets of 12. *N. grandis*, but the ♀ flower is very different from the one in that species, and the ♂ flower is solitary.

The two flowering collections match exactly, though collected at a great distance.

The collection in fruit by Womersley is apparently conspecific, and the reduced cupule supporting the nuts is typical; it does not show, of course, the waxy flush, and the leaves are naturally somewhat larger than in the type.

8. **Nothofagus pseudoresinosa** Steen. in Blumea 7: 147. 1952.— FIG. 13.

Glabrous tree. Twigs comparatively thin. Perules round, 2 mm. Leaves densely placed, elliptic-oblong, flat, thinly coriaceous, 2.5–5 × 1.25–2.5 cm., base broadly cuneate, apex broadly cuneate to rounded; underside yellowish grey by a distinct resinous coat; midrib sulcate with an elevated ridge in the lower half, distinctly prominent beneath; nerves ca. 8 or 9 pairs, slightly more prominent than the reticulations; reticulations dense, prominent on both surfaces. Petiole more or less laterally compressed, 4–6 mm. long. Stipules early caducous, comparatively small, 3–4 × 1.5 mm. ♂ flowers unknown. Cupule sessile, 7–8 by 4–5 mm., split to the base, with one lamella halfway and another indicated higher up, obovate-oblong,

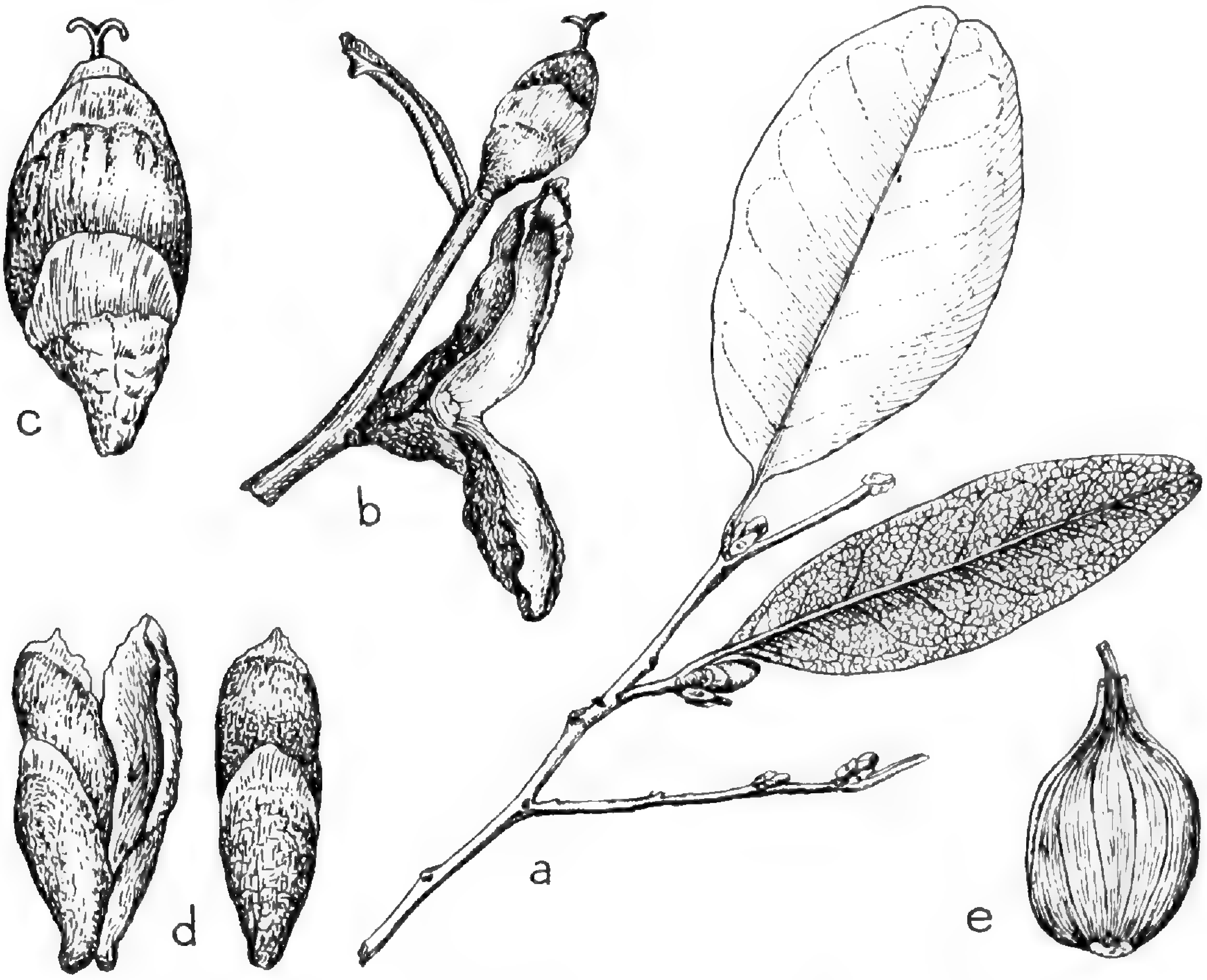

FIGURE 13. *Nothofagus pseudoresinosa* Steen. a. twig, b. ditto with flowering cupule and mature one, c. flowering cupule, d. older cupules, e. mature (?) nut. (After *Clemens 5849*; a. nat. size, b–e. × 4.)

widely gaping when dry. ♀ flower roundish ovate, acuminate, 4–5 × ca. 2.5–4.5 mm. Sides with 4 longitudinal nerves. Wing distinctly developed and produced above the insertion of the style; style distinct, ca. 1.5 mm.; stigmas 0.5 mm., feebly 2-lobed at the apex. Ripe nut unknown.

NORTHEAST NEW GUINEA: Morobe Distr., Mt. Sarawaket, 2400–2700 m., *M. S. Clemens 5849* (A, TYPE), April 1937.

DOUBTFUL SPECIMEN: ibidem, 1800–2400 m., *M. S. Clemens 7553* (A), November 9, 1937, big tree, 45 m., sterile specimen.

The type has only female flowers, as the tree was apparently beyond anthesis. The closest ally of this species is 7. *N. resinosa*, which it resembles very much vegetatively. The structure of the female flower is, however, constant in all flowers examined and differs greatly from that of *N. resinosa*, which is ecupular.

9. **Nothofagus carri** Steen. in Blumea 7: 147. 1952. — FIG. 3, 14.

Monoecious, glabrous tree, 20–33 m. tall. Twigs subglabrous. Leaves obovate, ± flat, coriaceous, rounded at both ends, 2–4.5 × 1–2.5 cm., margin entire, feebly recurved; nerves ca. 5–7 pairs, indistinctly prominent on both sides; reticulations dense and fine but hardly prominent; midrib with an elevated ridge only in the lower half; glands 0.5–1 mm. apart. Petiole 2.5–5 mm. Stipules early caducous, oval mostly oblique, 2–2.5 × 1.25–1.75 mm. ♂ flowers sessile in 1–3 mm. peduncled, patent triads on short efoliate twiglets, perianth hypanthium-like contracted at the base, campanulate or urceolate, 3.5–4 mm. long. Stamens ca. 10; filaments 8–10 mm., minutely papillose; anthers 2.5–3 mm. ♀ inflorescences erect, 1.5 mm. peduncled, very few. Immature cupule much shorter and narrower than the ovary, entire; valves unequal, oval to oblong, simple (i. e., without lamellae), 2–3 mm. long. ♀ flower solitary, flat, ovate, attenuate towards the apex, narrowly winged, 5 × 3 mm., wings reaching the style-base; style 1.5 mm. long. Mature cupule and nut unknown.

SOUTHEAST NEW GUINEA: below The Gap, 2100 m., *Carr 15028* (L, TYPE), January 8, 1936, in forest, tree 30 m., flowers green suffused red, stamens red (only ♂ flowers found); ibidem, 1950 m., *Carr 13766* (L), December 13, 1935, tree 21 m., flowers red (only ♂ flowers found); ibidem, *Carr 15076* (L), January 13, 1936, tree 24 m., flowers red.

TERRITORY OF NEW GUINEA: Chimbu, *J. Cavanaugh N. G. F. 3328* (LAE, L), February 1950, sterile, vern. *gripe*; ibidem, *J. Cavanaugh N. G. F. 3330* (LAE, L).

The three numbers of Carr match exactly.

10. **Nothofagus cornuta** Steen in Blumea 7: 147. 1952. — FIG. 3, 15.

Subglabrous tree. Twigs distinctly angular. Perules oval ± 2 mm. diam. Leaves broadly elliptic or slightly ovate, ± flat; margin entire, not or only slightly recurved; base broadly cuneate or rounded, apex rounded 2.5–4

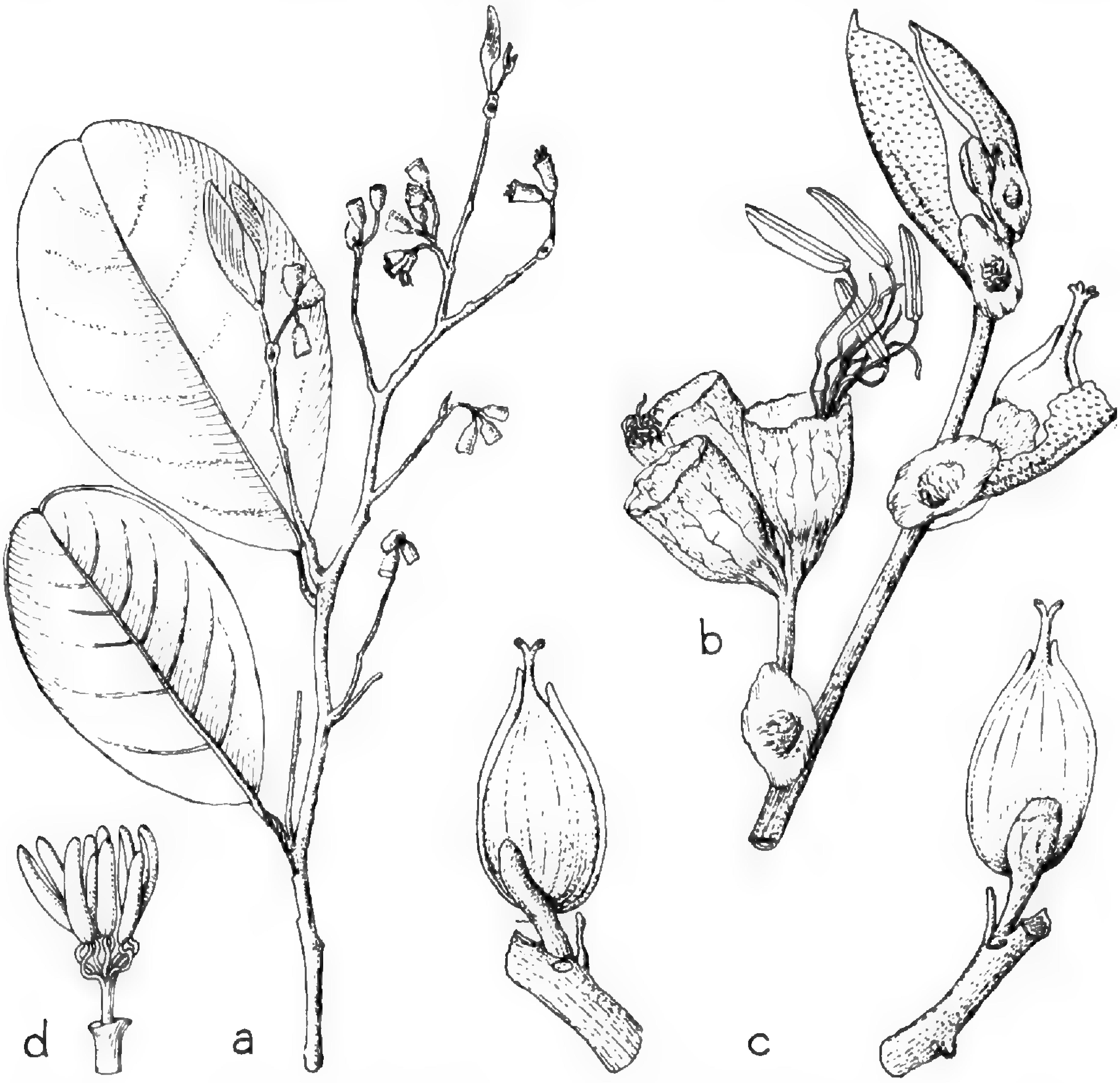

FIGURE 14. *Nothofagus carri* Steen. a. twig with flowering flush, b. detail of flush with one triad of ♂ flowers and one ♀ flower in a higher axil, c. ♀ flower from two sides, d. stamens in bud (perianth removed). (After *Carr 15028*; a. nat. size, b–c. × 4.)

× 1.5–2.25 cm.; midrib not sulcate above, consisting of a prominent ridge, distinctly prominent beneath; nerves ca. 6 pairs, slightly prominent above, faintly so below as are the reticulations, which are dense and prominent at both sides; underside of the immature leaf of the flush densely set with scales. Petiole 2–3 mm. Stipules rather long-persistent, 3–4 × 1.5 mm. ♂ flowers (two small detached ones found) apparently subsessile, tube trumpet-shaped, 3.5–4 mm. long; anthers 2 mm. ♀ inflorescence sessile, without cupule. ♀ flower oblong, 4.5 × 2 mm., with obscure wings, the limb produced as two horn-like rather patent appendages; flat sides of the flower with a prominent midrib producing a glandular, short perianthal appendage below the limb; style 0.5 mm.; stigmas 0.75 mm. Nut unknown.

WEST NEW GUINEA: Wissel Lake region, base of Bubeiro and Enarotali, 1750 m., *Eyma 5122* (L, TYPE; BO), August 1939; ibidem, 1750–1810 m., *Eyma 4870-ter* (BO), April 13, 1939, sterile; ibidem, *Eyma s.n.* (BO, L), sterile.

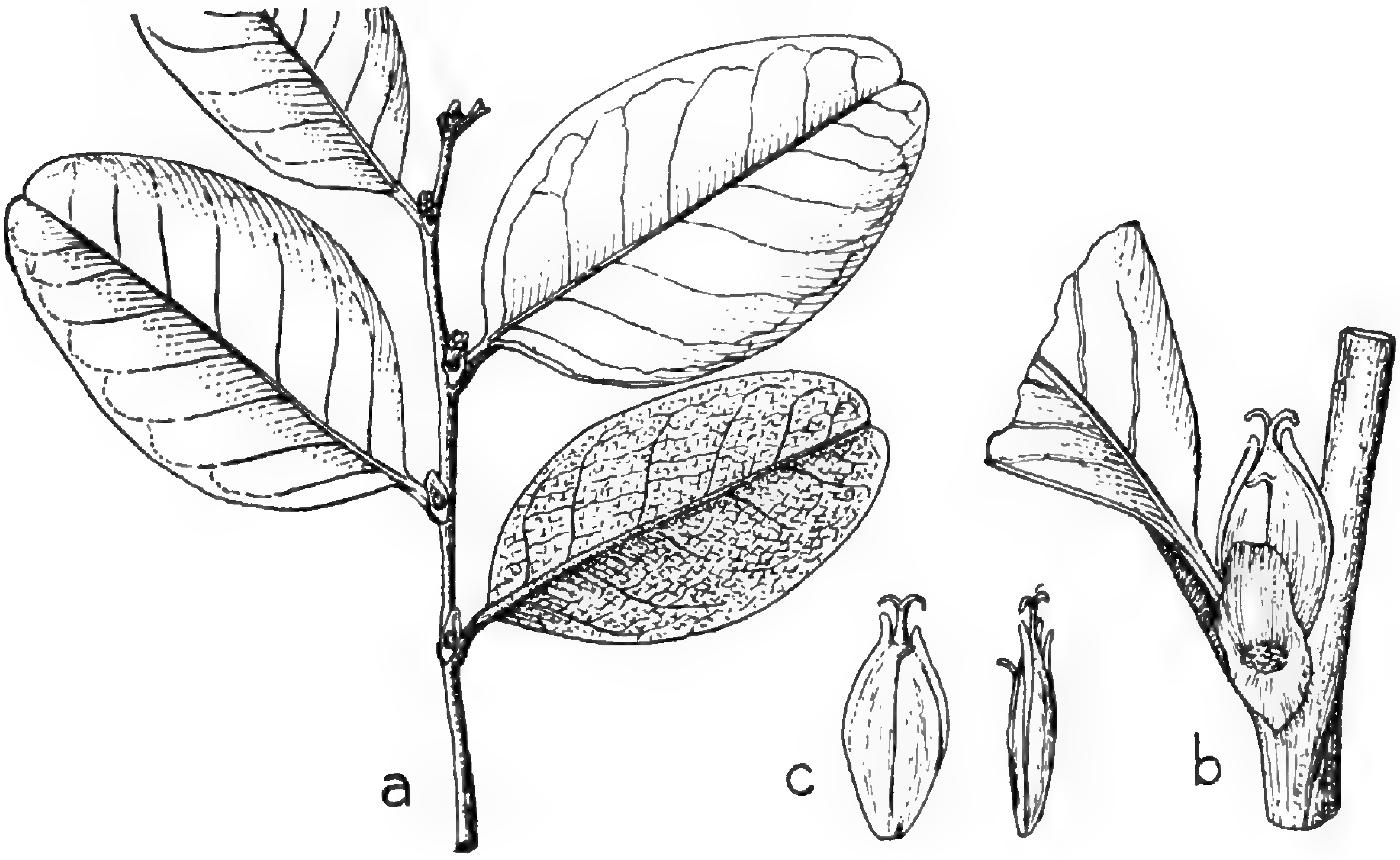

FIGURE 15. *Nothofagus cornuta* Steen. a. twig, b. ♂ flower partly hidden by stipule, c. ♀ flower. (After *Eyma 5122*; a. nat. size, b–c. × 4.)

I have found only two ♀ flowers; their scarcity points to a stage beyond anthesis, and their peculiar cupular structure might be due to a "Fehlschlag," though otherwise both flowers have a normal appearance. The few ♂ flowers were not attached to the twig; whether they stand in triads I do not know with certainty; I assume them to be inserted in that manner.

The species is apparently common in the Wissel Lake region. It is allied to 5. *N. pullei*, and shows in some of the flush a faint hairiness but differs in the distinctly angular glabrous twiglets, in the absence of a cupule, and the presence of minute perianthal appendages on the flat sides of the ovary.

In foliage it resembles 15. *N. eymae*, and some other small-leaved species.

11. **Nothofagus bernhardi** Steen. in Blumea 7: 147. 1952. — FIG. 16.

Gnarled, stiff, glabrous, monoecious, large tree, or a shrub 3–5 m. tall; flush red. Leaves oblong-elliptic, rounded at both ends, hard-coriaceous; margin entire, strongly recurved, thick; apex shallow-emarginate, 2.5–3.5 × 1.25–2 cm.; midrib sunken above with elevated ridge, strongly prominent and very sparsely minutely puberulous beneath; nerves ca. 5–7 pairs, hardly visible, not prominent; glands on the underside distinct, 0.5–1 mm. spaced. Petiole 2.5–5 mm. long, thick, semi-terete, margins elevated. Stipules obovate-oblong, inserted below the middle, early caducous, 7 × 3–3.5 mm. ♂ flowers red, numerous, mostly in the axils of perular bracts on the defoliate base of the flush, in triads, middle flower first in bloom; pedicels short, coalescent, 1–2 mm. long; perianth tubular, glandular, ca. 5 mm. long, limb shortly 3-lobed. Stamens ca. 10; filaments minutely hairy, up to 2.5 cm. long; anthers linear, 3–3.5 mm. long, minutely puberulous, connective tip developed. ♀ inflorescences solitary, erect, very few in number above the ♂ ones. Flowering cupule smaller and narrower than the developing flower, flat, with free valves ca. 4 mm. long; lamellae 2 or 3, the inner ones initially hidden under the outer one. Unripe nut ovate, neck elongate, perianth forming a distinct wing reaching up to the style, finely puberulous, 2 mm. stalked, the largest seen 8 × 4 mm.; style 2 mm. long; stigmas thick, flat, short. Infructescence (after *Brass 10243*) sessile, erect, cupule split to the base, gaping, much narrower than the nut, with 2 lamellae of which the upper is thin, the lower thicker than the upper one, minutely puberulous, 5–6 × 1.5–2 mm. Nut minutely puberulous, 4–6 × 2.5–3 mm.

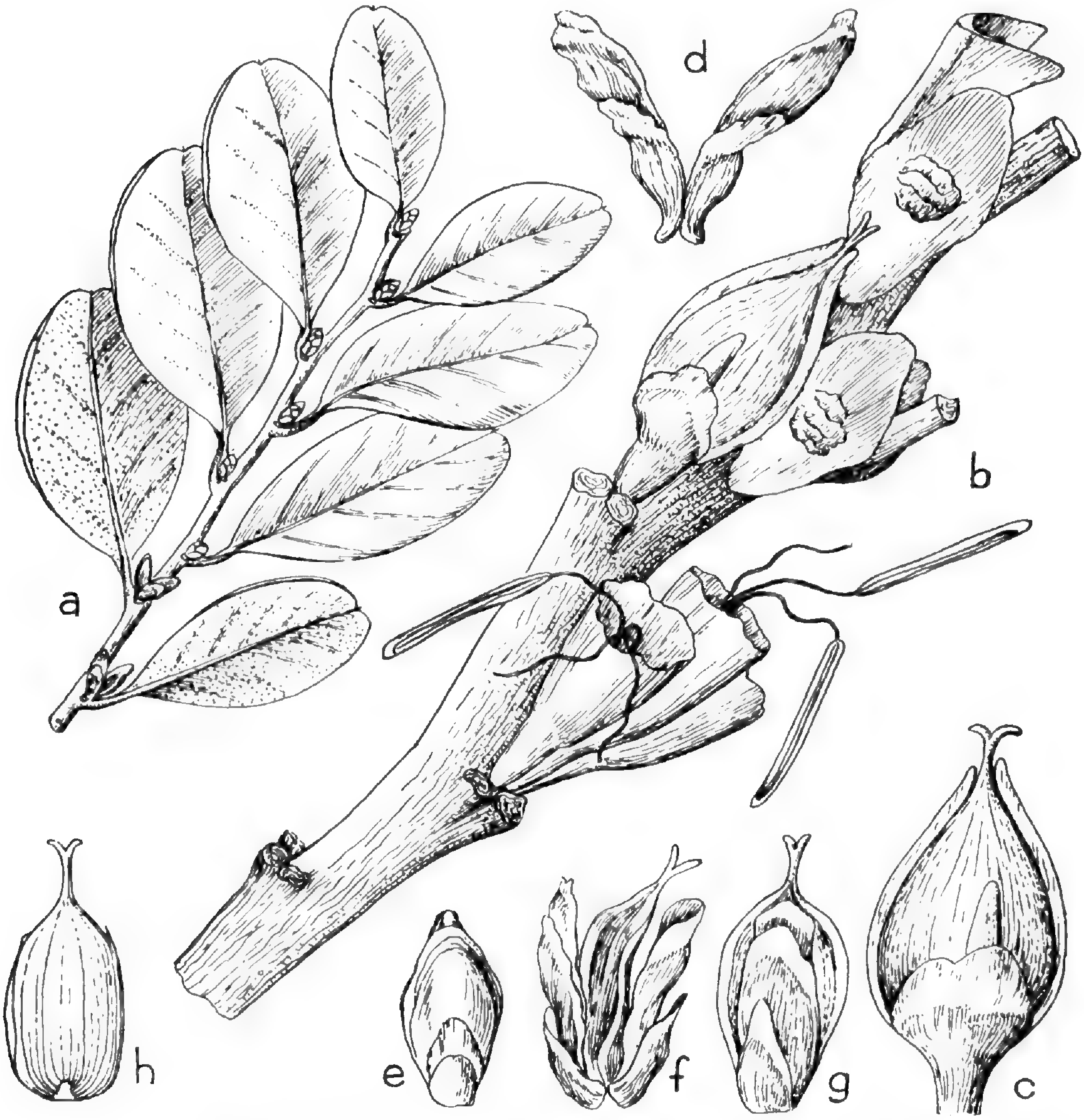

FIGURE 16. *Nothofagus bernhardi* Steen. a. twig, b. part of flush enlarged with a triad of ♂ and 1 ♀ flower, c. ♀ flower, d. mature (?) cupule, opened, e. ditto, laterally, f–g. cupule with ?immature nut, h. ?immature nut. (a–c. after *Brass 12453*, d–h. after *Brass 10243*; a. nat. size, b–h. × 4.)

WEST NEW GUINEA: 18 km. SW of Bernhard Camp, Idenburg River, 2150 m., *Brass 12453* (L, TYPE; A, BO), February 1939, major component of low mossy forest scrub on exposed summit, gnarled stiff tree 2–5 m., leaves very stiff, convex, young ones reddish, tinging and characterizing the forest, anthers pink, ♂ and ♀ protandrous flowers; ibidem, 9 km. NE of Lake Habbema, 2800 m., *L. J. Brass 10243* (A, L, BO), November 1938, characteristic tree of tall valley forests, fine large tree 30–40 m. by over 1 m., trunk shortly flanged or spur-buttressed at base (flying buttresses sometimes developed under very mossy conditions), bark rough, dark gray, irregularly scaly, wood hard, red, ♀ tree, in young fruit; ibid., *L. J. Brass 10244* (A, L, BO), November 1938, sapling 20 m. by 20 cm., midrib of leaves red below.

The fruiting and flowering specimens differ a little according to the stage at which they were collected. As Mr. Brass found no ♂ flowers in the fruiting specimens he assumed the tree to be dioecious; however, in these specimens there are naked axils below the fruits on each twig which may have been occupied by the ephemeral ♂ flowers (as in *Brass 12453*). I have no hesitation in referring the fruiting specimens to the same species as the flowering ones.

The short pedicel of the peduncle of the flowering cupule disappears in the fruiting stage through the thickening of the woody base of the latter.

In very young ♀ flowers the lamellae of the cupule are packed, they telescope apart later.

12. **Nothofagus grandis** Steen. in Blumea 7: 147. 1952. — FIG. 17, 18, PL. I.

Tall tree. Twigs greyish, angular. Perules ca. 2 mm., obovate. Leaves entire, coriaceous, elliptic-oblong to broad-elliptic, 4.5–7 × 2–4.5 cm. (of saplings larger), flat, margin hardly recurved; midrib sulcate with an elevated ridge, prominent below; nerves ca. 7–8 pairs, somewhat prominent above but less so beneath; reticulations fine, slightly prominent on both sides; glands on the lower surface ca. 0.3–0.5 mm. spaced. Petiole 3–7 mm. Stipules early caducous, 5–6 × 3–3.5 mm., attached in the middle. ♂ flowers (coll. Schindler) in triads in the axils of perular bracts and a little higher; perianth club-shaped, tubular, 5–6 mm. mostly splitting spathaceously, rarely 5-lobed. Stamens 12–17; filaments hairy; anthers 3.5–4 mm., apiculate. ♀ inflorescences erect. Cupule roundish, with 2 lamellae. ♀ flowers (after Schindler) somewhat larger than the cupule, roundish, ca. 3 mm. long; style 1 mm. Ripe cupule woody, sessile, erect, split halfway, broad-obovate, apex nearly truncate, 12–13.5 × 7.5–10 mm. Nut distinctly rhomboid, narrowly winged, 7–10 × 9.5–10 mm.

EAST NEW GUINEA: Territory of New Guinea: Aiyura, rainforest, beside hillside gully, near Kuminankira, ca. 1500 m., *L. S. Smith N. G. F. 1098* (A, TYPE; LAE, BRI), October 1944, tree 36 m. overall, bole 24 m., narrowly buttressed, and channelled to 8 feet, diam. at breast height 2 feet, bark 9–18 mm. thick, outer shedding, in large, oblong flakes or strips of several of these united to form large irregular scales, after shedding surface very rough, inner bark red, with pale or green-tinged streaks on the back, sapwood

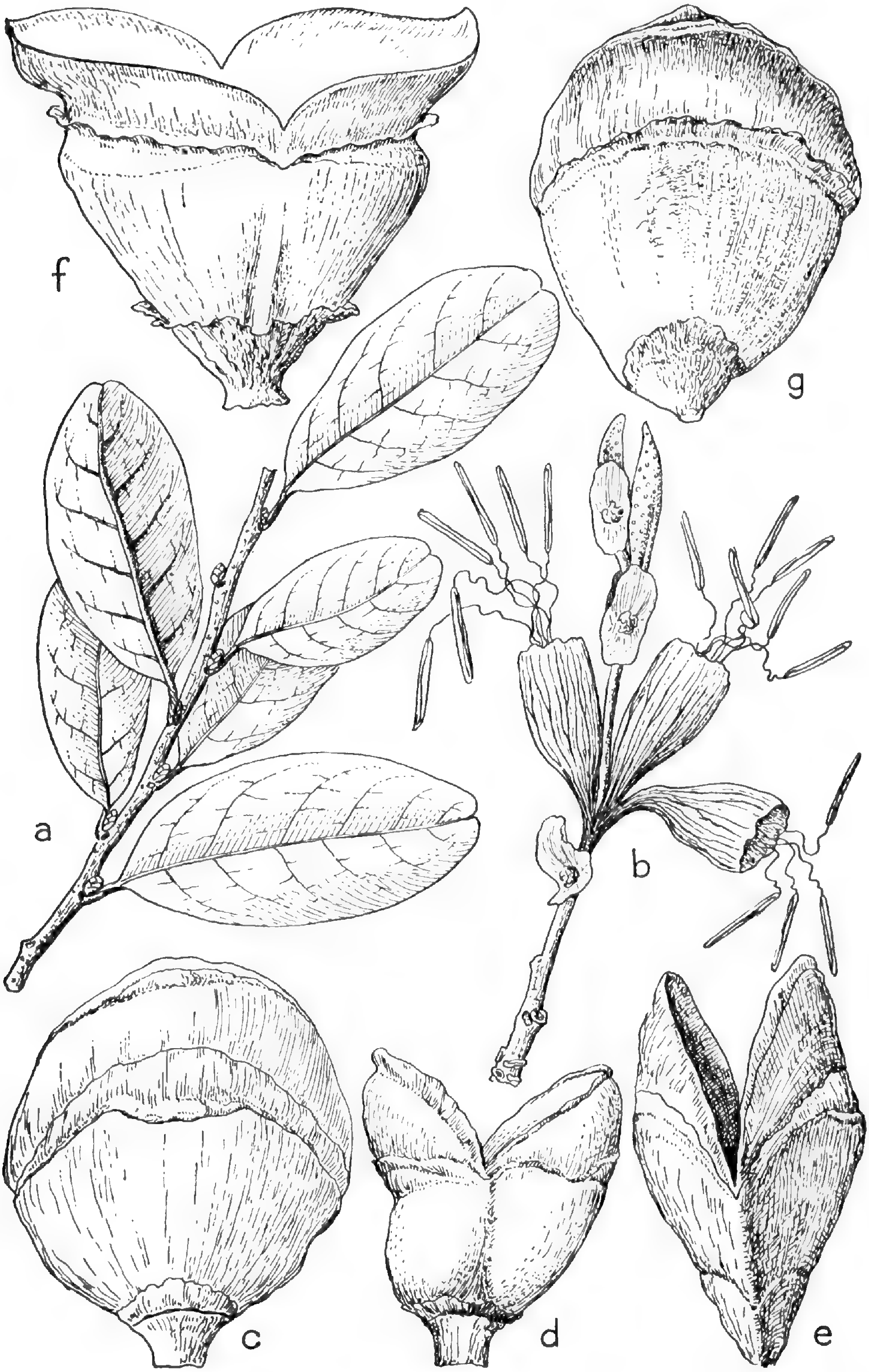

FIGURE 17. *Nothofagus grandis* Steen. a. twig, b. ♂ flowers on flush, c–g. cupules. (After *L. S. Smith NGF 1098*; a. nat. size, b–g. × 4.)

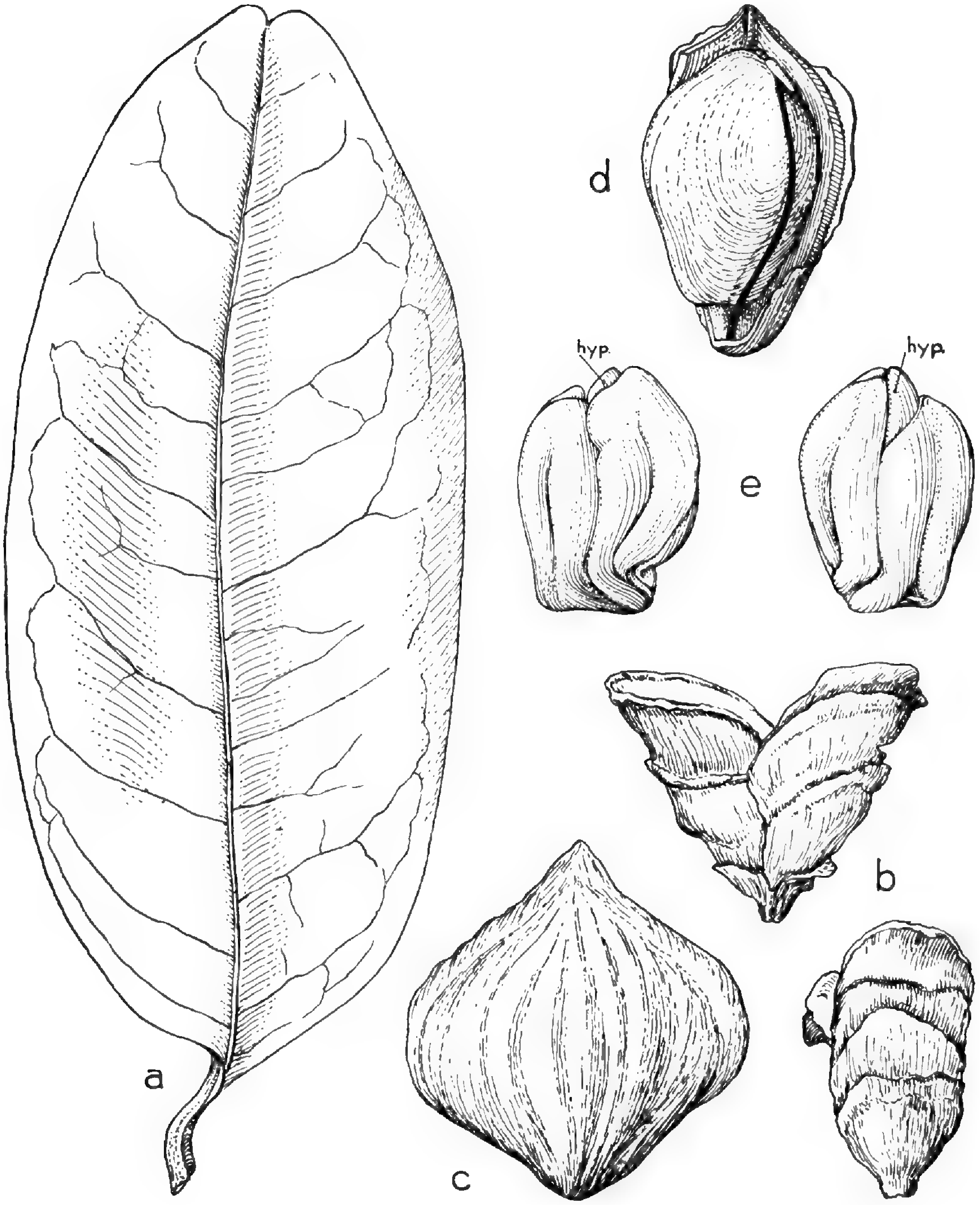

FIGURE 18. *Nothofagus grandis* Steen. a. leaf, b. two stipules, c. nut, d. one fruit shell with a seed on it, attached to the pseudo-raphe, at the top two aborted ovules visible, e. mature embryo from two sides, with folded cotyledons, hypocotyl directed apically. (After *Womersley NGF 3389*; a. nat. size, b–d. × 4).

5–7.5 cm. thick, pale, heartwood brown (hard and said to be durable), flush pink to red, vern. *ufoiya* (Anona and Aiyura dialects), ripe fruit; Madang Distr., Aiyura, rain-forest, 1500 m., *A. J. Schindler s. n.* (LAE, BRI), September 1947, vern. *ifoiya*, young fruit; ibid. *A. J. Schindler s.n.* (LAE, BRI), July 1948, flowers appearing with flush in the end of July, flowering period appeared to last one week, ♂ and ♀ flowers and flush; Central Highlands, Aiyura, ca. 1800 m., *J. S. Womersley N. G. F. 3389* (LAE, L), November 26, 1950, tree 80 feet, bole 60 feet, girth 3 feet, not buttressed, fruits green, bark grey slightly scaly, underbark white, inner bark red-brown, becoming pale brown near the sapwood, sapwood white, heartwood brown, vern. *ifoya* (Aiyura dialect), *unuza* (Kamano dialect), fruiting; Mt. Hagen, *J. Cavanaugh N. G. F. 3320* (LAE, L), January-February 1950, sterile, probably from sapling, vern. *gripe*.

WEST NEW GUINEA: 6 km. SW of Bernhard Camp, 1140 m., *Brass & Versteegh 12553* (A), rare tree on ridge, in primary forest, tree 24 m. by 45 cm., crown not wide-spreading, bark brown, scaly, fissured, 7 mm. thick, sapwood light brown, heartwood dark red, sterile; ibid., 4 km. SW of Bernhard Camp, Idenburg River, 900 m., *Brass & Versteegh 13147* (A, L), March 1939, common tree of mossy forest on ridge, 25 m. by 51 cm., bark 1 cm. thick, dark brown, scaly, sapwood rose, heartwood red, crown fairly wide-spreading, sterile.

The material is very satisfactorily homogeneous. The name has been chosen on account of the large nuts and large leaves.

Mr. J. S. Womersley, Forest Botanist, Lae, writes, March 17, 1953, that *N. grandis* produces such a desirable wood that they are hoping to develop a silvicultural technique for its propagation under plantation conditions. He kindly transmitted an extract from a report by Mr. E. Gray, Forest Officer, on observations near Aiyura, which is of interest to mention here.

Mr. Gray wrote: — "I encountered some very dense but scattered stands of *N. grandis* between Agunamura and Sophano where it attains a height of 45 m. and a D. B. H. of 105 cm. in many places. Even in the oldest and largest trees the heart is quite sound. Furthermore the bole is straight and cylindrical before it breaks into a large, rather untidy crown. A tendency to stag-headedness was noted in the over-mature trees.

"Unlike Territory rain forests in general, this species is found growing in practically pure stands in many instances. Regeneration of all ages is evident throughout these stands, in places quite dense. Unfortunately time did not permit of more than a cursory examination of the tree in its natural habitat, but I would say from what I saw that timber stand improvement work such as the felling of mature and over-mature stems would result in a very fine forest indeed.

"The stands are at present located mainly on the slopes and ridges in this country. The valley bottoms are grassland, undoubtedly high forest at one time, so it is impossible to say whether this species would naturally inhabit the lower reaches or not.

"The timber is favoured for building, bridge-decking and palings for gardens. It splits well and is durable in the ground for at least a number of years according to the local native inhabitants. I had another report of its durability from Mr. Fleil of the Lutheran Mission at Raipinka. He told me that this same wood had been used as house stumps for sixteen years, removed and used a second time for the same purpose on a new building. The stumps showed little or no signs of decay when they were taken from the ground. Further, the wood is very attractive with a rich red heart and contrasting paler coloured sapwood. The tree seeds prolifically and there would be little difficulty in obtaining several pounds of seed annually."

13. **Nothofagus decipiens** Steen. in Blumea 7: 147. 1952. — FIG. 19.

Glabrous tree up to 25 × 1 m. Perules rounded, 1–1.75 mm. Leaves elliptic-oblong, coriaceous, 1.75–2.75 × 1–1.5 cm.; margins not very much recurved in the herb., both ends rounded, tip emarginate; midrib sulcate with an elevated ridge, very prominent on the undersurface; primary nerves ca. 5 or 6 pairs, slightly prominent above, indistinct below. Reticulations fine-tessellate above, indistinct beneath; glands on undersurface 0.5–1 mm. spaced. Petiole 3–5 mm., semi-terete, margins elevated. Stipules early caducous, with a membranous margin, inserted distinctly below the middle, 6–7 × 2.5 mm. ♂ flowers (all detached), nearly sessile, or 1–1.5 mm. pedicelled, in 4–5 peduncled triads, erect, red, long-tubular, angular, perianth ca. 5 mm. long, with a constricted lower portion 1–1.25 mm. long. Stamens ca. 18; filaments sparsely hairy often mutually spirally twisted, longer than 2 cm., connate at the base; anthers linear, ca. 4 mm. long, connective glandular, tip apiculate. ♀ inflorescences on 6–7 mm. long recurved peduncles, peduncle slightly thickened towards the apex. Flowering cupule about as large as the ♀ flower, 2–3 lamellate. ♀ flower

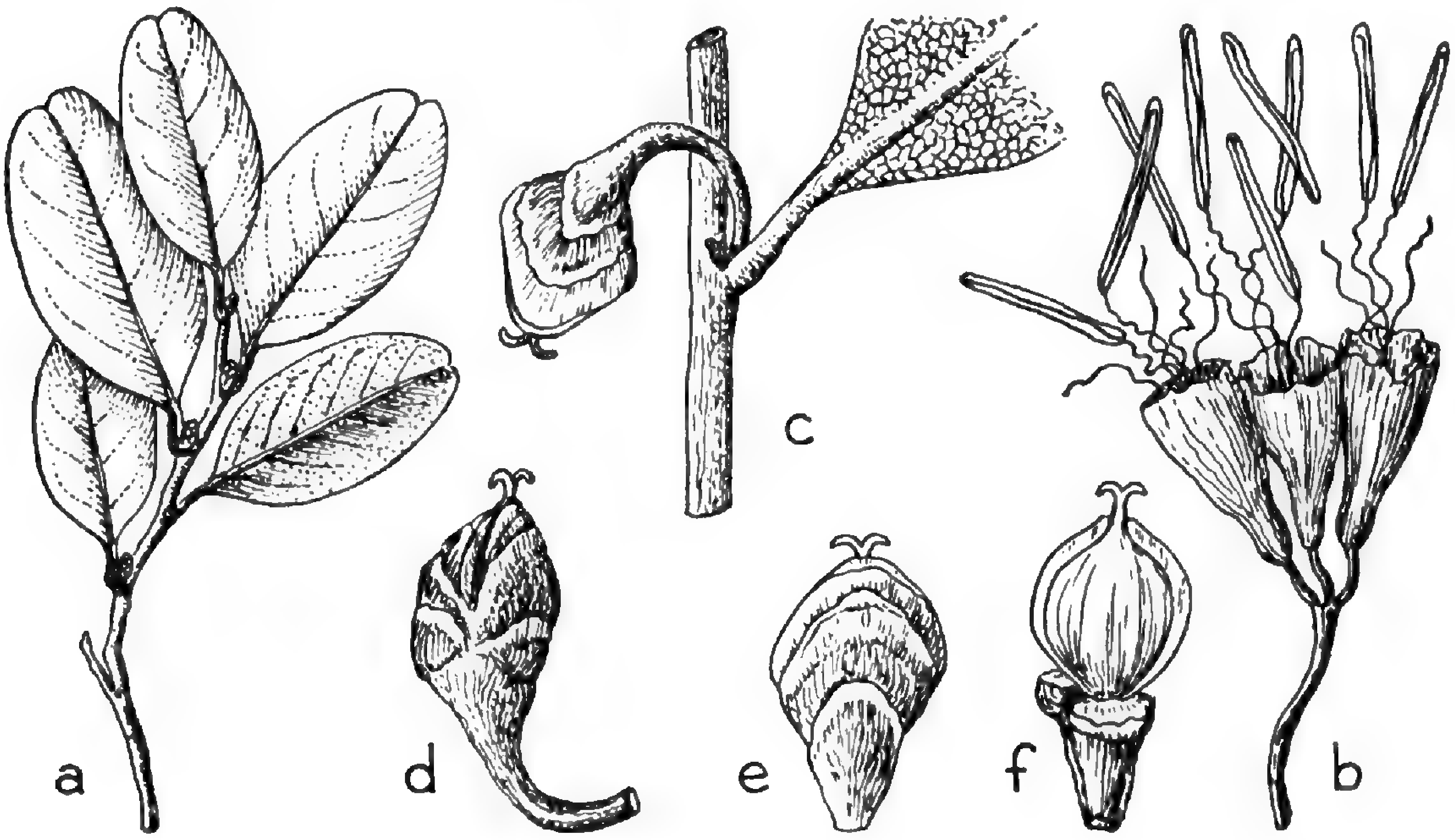

FIGURE 19. *Nothofagus decipiens* Steen. a. twig, b. triad of ♂ flowers, c–e. ♀ inflorescence, f. ♀ flower, cupule removed. (After *Brass 12675*; a. nat. size, b–f. × 4.)

glabrous, rounded, ca. 3 mm. through, wing broad, enclosing the base of the 0.5–0.75 mm. long style; stigmas broad. Ripe cupule and nut unknown.

WEST NEW GUINEA: Central part: 18 km. SW of Bernhard Camp, Idenburg River, 2150 m., *L. J. Brass 12675* (L, TYPE; A, BO), February 1939, dominant tree in mossy forest, co-dominant with *N. bernhardi* in these forests, on slopes of ridges, up to 25 m. tall, 1 m. diam., branches thinly foliaged and somewhat flat-spreading, leaves reddish when young, ♂ and ♀ flowers and young fruit, male flowers red.

I found no male flowers attached to the twigs, all were loose as if they had dropped from above and had been caught by the leaf axils or the resinous sticky parts of the foliage. It could be, of course, that these wind-dispersed male flowers belong to another species growing in the same forest. I do not assume the tree to be dioecious.

Habitually this species closely resembles 7. *N. cornuta* but differs in the long-peduncled, recurved, 2–3-lamellate cupules and roundish female flowers. It also resembles 1. *N. recurva* but possesses only one female flower per cupule and long-peduncled male flowers (if they belong to it). Thirdly it resembles 15. *N. eymae* but differs in the long-peduncled, early and distinctly recurved cupules.

14. **Nothofagus rubra** Steen. in Blumea 7: 147. 1952. — FIG. 20.

Glabrous tree, up to 23 m. and 64 cm. diam.; twigs rather stout. Perules coarse, distinctly imbricate, 5–6 × 2.5 mm., quadrangular, long-persistent about the base of the twigs. Leaves ovate-oblong, hard-coriaceous, margin entire, ± recurved, 2.5–4.5 × 1.5–3 cm., apex and base both rounded, upper surface smooth not reticulate, undersurface with fine-netted but not prominent reticulations; nerves ca. 6 pairs; glands (0.5–) 0.75–1 mm. apart. Petiole 4–5 mm. Stipules oblong, rather early caducous, 5–8 × 2.5–3 mm. ♂ flowers in erect, sessile or subsessile triads on efoliate short-shoots or on twig ends with leaves. Perianth tubular, later slightly widened, 5–6 mm. long, the central flower of the triad sometimes pedicelled, with a short cupular limb 3 mm. long. Stamens 10–12; filaments at least 2 cm. long, sparsely pubescent towards the apex; anthers 4 mm. ♀ inflorescences very few, erect, sessile. Flowering cupule narrower and shorter than the ovary, very convex, with free, unequal valves, one entire, the other sometimes irregularly lobed, 5.5–6 × 2.5–3 mm.; lamellae 2. ♀ flower solitary, orbicular, rather thick, hardly winged, perianth-shoulder ending far below the style-base, 6–7 mm. diam.; style thick, 2 mm.; stigmas 0.5 mm. Nut (?mature) orbicular, 4 mm. diam.; style 1.5 mm., persistent.

WEST CENTRAL NEW GUINEA: 18 km. SW of Bernhard Camp, Idenburg River, 2200 m., *Brass & Versteegh 11997* (A, TYPE; L), February 1939, abundant tree in primary forest on slopes of ridges, tree 23 m., 64 cm. diam., crown not wide-spreading, fruit brown-green, bark 12 mm. thick, dark brown, fissured, scaly, rough, sapwood brown, heartwood brown; ibid., *Brass & Versteegh 11997a*, February 1939, tree abundant in primary forested ridges, flowering material of no. *11997*, ♂ flowers rose, female reddish green. Wissel Lake region:

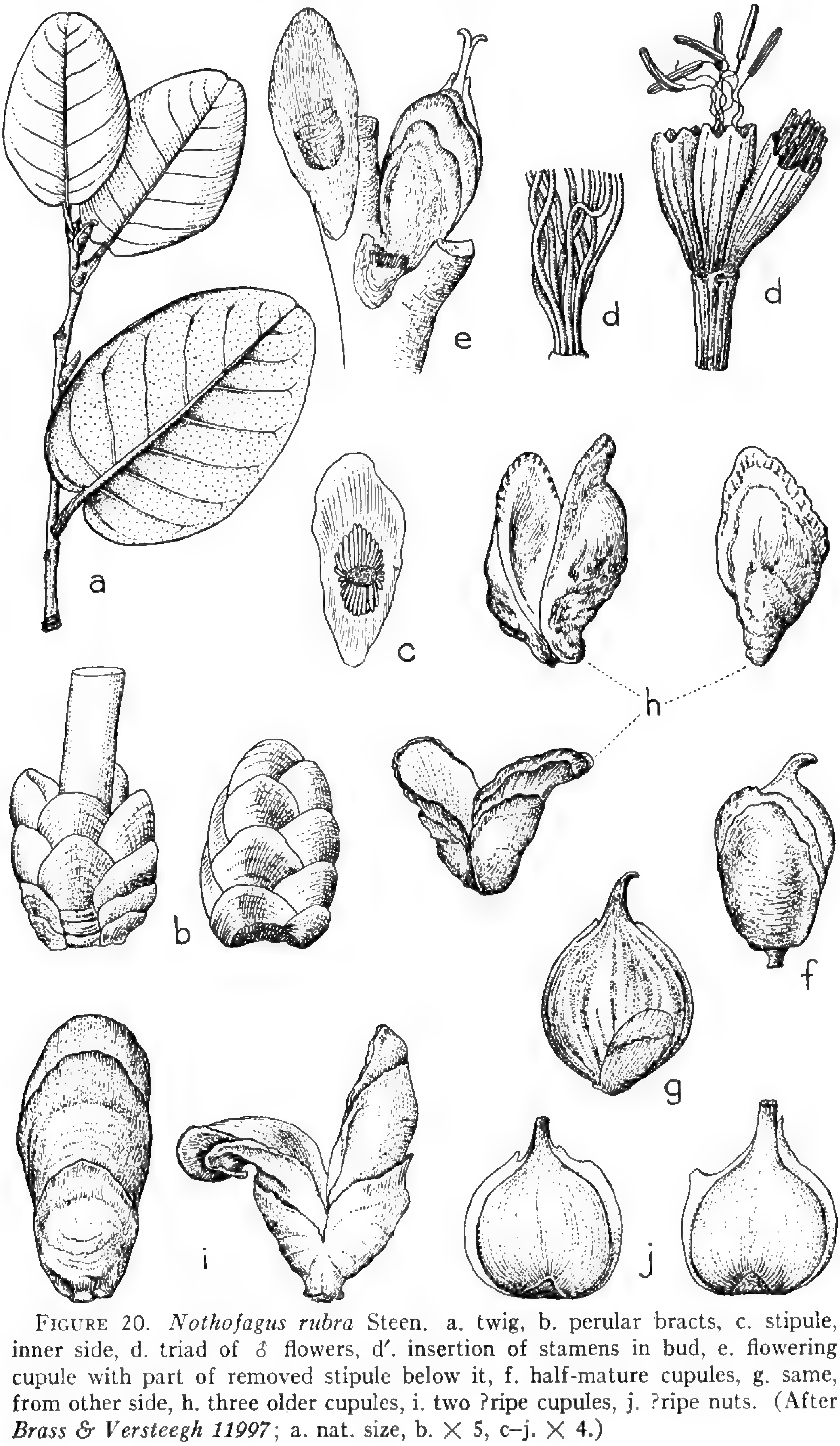

FIGURE 20. *Nothofagus rubra* Steen. a. twig, b. perular bracts, c. stipule, inner side, d. triad of ♂ flowers, d′. insertion of stamens in bud, e. flowering cupule with part of removed stipule below it, f. half-mature cupules, g. same, from other side, h. three older cupules, i. two ?ripe cupules, j. ?ripe nuts. (After *Brass & Versteegh 11997*; a. nat. size, b. × 5, c–j. × 4.)

Bivouac Digatara Pass, *Eyma 5387* (L, BO), October 1939, sterile; ibid., Bubeiro, 1750–1810 m., *Eyma 4870* (BO, L, A, K, SING, BM, P, CAL, BISH), April 13, 1939, sterile.

15. **Nothofagus eymae** Steen. in Blumea 7: 147. 1953. — FIG. 3, 21.

Monoecious glabrous ?tree. Twigs subterete. Perules roundish, 1.5 mm. Leaves about elliptic, rounded at both ends, coriaceous, shining above, 2–3.25 × 1.25–1.75 cm., margin rather distinctly recurved, apex distinctly emarginate; midrib sulcate with elevated ridge; side-nerves ca. 5 pairs, slightly prominent on both sides; reticulations indistinct on both surfaces; glands rather wide apart on the lower surface, 0.75–1.5 mm. spaced. Petiole 2–5 mm. Stipules only on the flush, oblong, 4–5 × 2–3 mm., attached in the lower part. ♂ flowers in subsessile triads, sessile, narrow tubular, ca. 4–5 mm. long, limb truncate. Stamens ca. 12, filaments slightly puberulous, anthers small, 2–2.5 mm. long, tip apiculate. ♀ cupule ± sessile, ± oblong, 5–6 mm. long, valves with 2 distinct lamellae. ♀ flower roundish, 4 × 3.5 mm., winged towards the apex; style enveloped by the perianth limb, very short; stigmas 0.5 mm. Ripe cupule possibly erect, not known. Nut unknown.

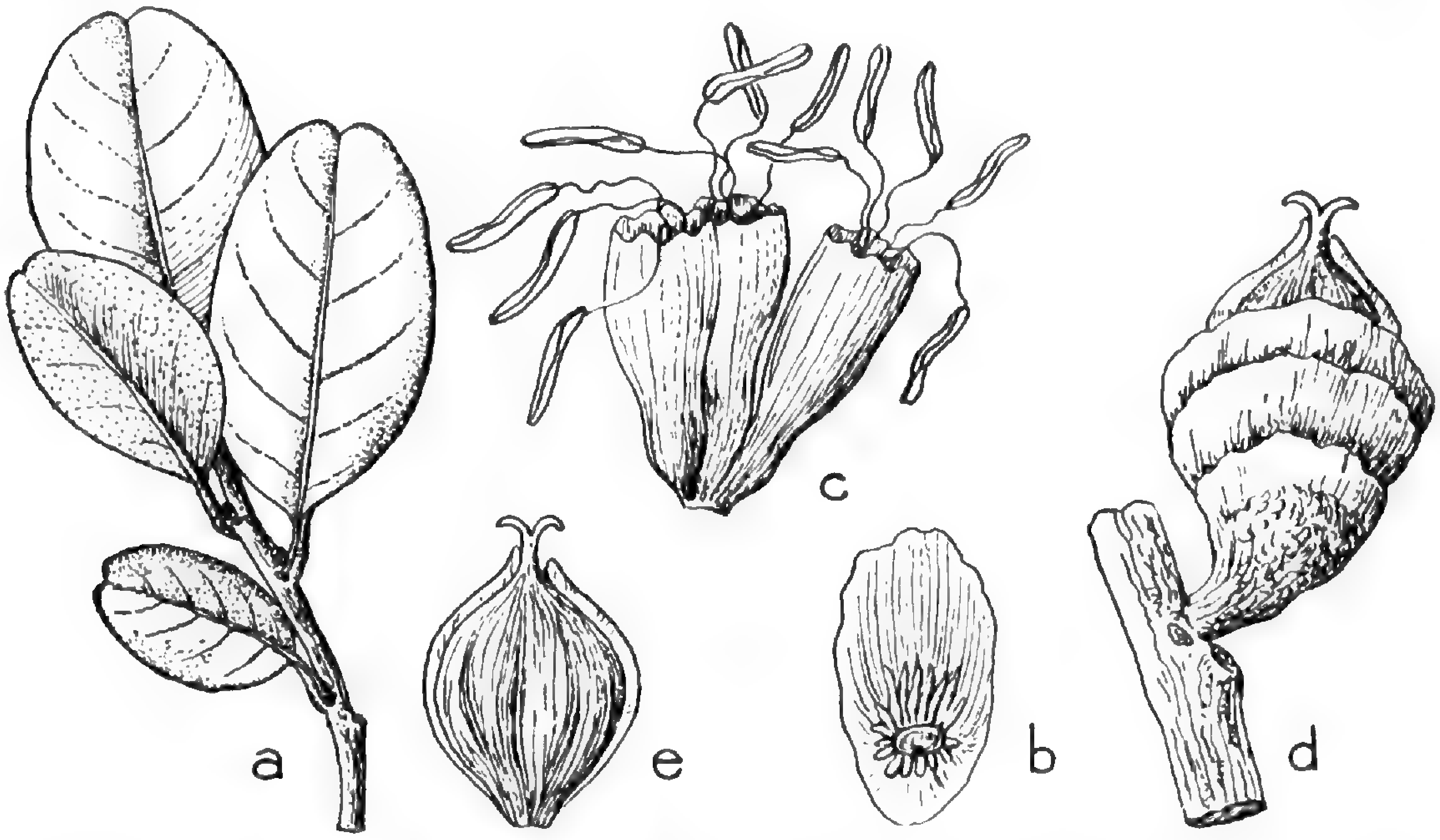

FIGURE 21. *Nothofagus eymae* Steen. a. twig, b. stipule, inner side, c. triad of ♂ flowers, d. flowering cupule, e. ♀ flower. (After *Eyma 4800*; a. nat. size, b–e. × 4.)

WEST CENTRAL NEW GUINEA: Wissel Lake region, observed between Enarotali to Kugapa and Egogitoagapa to Enarotali, *Eyma 4800* (BO, TYPE; L), March 29, 1939; 15 km. SW of Bernhard Camp, Idenburg River, 1760 m., *Brass & Versteegh 11963* (A, L), January 1939, abundant tree of primary forest on slope of ridge, mossy forest, co-dominant with *Weinmannia urdanetensis* Elmer, tree 26 m. × 43 cm., crown not wide-spreading, bark 8 mm. thick, gray, scaly, wood brown, sterile.

This species resembles 1a. *N. recurva* var. *microphylla*, but the cupule is one-flowered, ± sessile and not recurved. It also resembles 5. *N. pullei* but is glabrous. It shows most resemblance to 11. *N. bernhardi*, but the cupule is different in the early stage, and later the female flowers are not ovate-oblong.

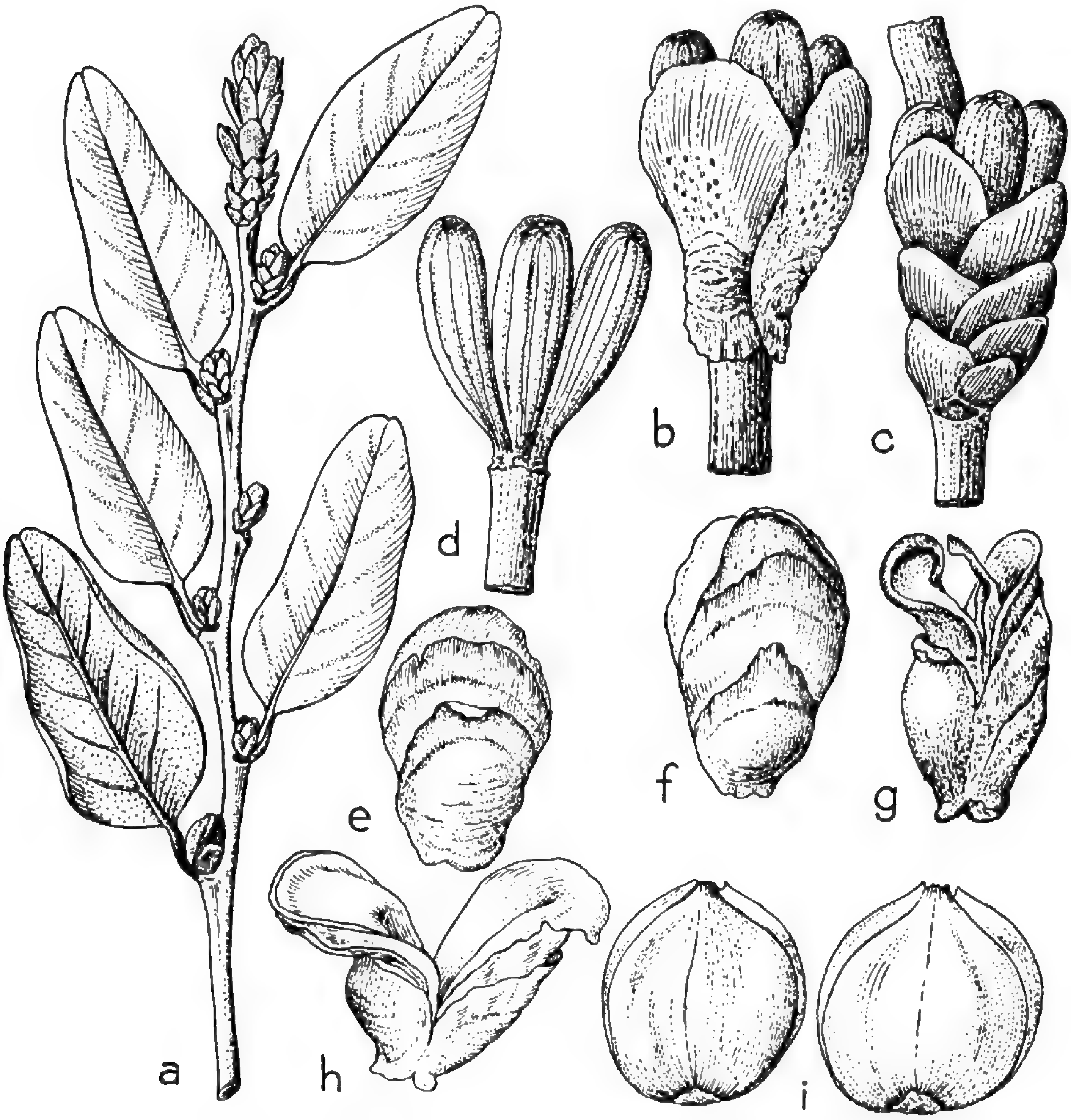

FIGURE 22. *Nothofagus dura* Steen. a. twig, b. triad of ♂ flowers on base of flush enclosed by 2 stipules, c. ditto, in axil of higher perular bracts, d. triad of ♂ flowers, e–h. cupules, i. two nuts. (After *Brass & Versteegh 10443*; a. nat. size, b–i. × 4.)

16. **Nothofagus dura** Steen. in Blumea 7: 147. 1952. — FIG. 22.

Monoecious tree up to 33 m. high, 0.5 m. diam. Twigs brownish, rather stout. Perules roundish, 2 mm. diam. Leaves hard-coriaceous, ovate-oblong, base cuneate to rounded, margin entire, recurved, 2.75–4.5 × 1.25–1.75 cm.; nerves ca. 7 pairs, distinct on the lower surface, hardly visible on the upper surface; reticulations not visible above, dense, slightly prominent below; glands 0.5–1 mm. apart. Petiole 4–5 mm. Stipules not very early caducous, 8–9 × 4 mm. ♂ flowers in triads, sessile, at the base of the flush, partly in perular axils; perianth 6 mm. Stamens 12; anthers 4–5 mm. ♀ inflorescences probably sessile, 1-flowered. ♀ flower unknown (in one aborted flower the style 1.5 mm.). Mature cupule sessile, split at least halfway, oblong, ca. 8–10 × 4–5 mm., hard, woody; lamellae 2. Nut suborbicular, 5–6 mm. diam., the basal part thickened.

WEST CENTRAL NEW GUINEA: 9 km. NE of Lake Habbema, 2840 m., *Brass & Versteegh 10443* (L, TYPE; A, BO), Oct. 1938, dominant in mossy forest, tree 38 m. × 47 cm., crown not wide-spreading, ♂ flowers rose, fruit brown, bark rough, gray-brown, 8 mm. thick, fissured, scaly, outer wood white, inner red-brown.

This species resembles 1. *N. recurva* in habit but is very different in the sessile (not recurved), 1-flowered cupule. It differs from 4. *N. brassi* in the sessile, much smaller, 1-flowered cupule, and from 15. *N. eymae* in the leaf shape.

SPECIES DUBIA

Nothofagus sp.

EAST NEW GUINEA: Mt. Hagen, *J. Cavanaugh N. G. F. 3323* (LAE), January–February 1950, vern. *gripe*.

This sterile specimen resembles 3. *N. starkenborghi* in leaf shape, but the leaf differs in the distinct prominent ridge on the sulcate midrib. The material is too imperfect for identification.

BIBLIOGRAPHICAL REFERENCES

(1) Bot. Jahrb. **63**: 325. 1930. — (2) Bull. Jard. Bot. Buitenzorg ser. iii, **13**: 329. 1934. — (3) Tijd. Kon. Ned. Aardr. Genootsch. **55**: 731–732, *fig. 2*. 1938. — (4) Proc. Linn. Soc. N. S. W. **71**: 49–63, *2 pl.* 1946. — (5) Nature **170**: 127. 1952. — (6) Ber. Geobot. Inst. Kübel (Zürich) **1947**: 46–83. 1948. — (7) Bot. Jahrb. **59**: 61–79, 538–539. 1925. — (8) Rec. Auckl. Inst. Mus. **2** (4): 175–196. 1939. — (9) Proc. R. Soc. Queensl. **41**: 158–161. 1930. — (10) Trans. & Proc. New Zeal. Inst. **59**: 326–342. 1928. — (11) Svensk. Bot. Tidskr. **39**: 319–345. 1945. — (12) Pflanzenreich **IV-68**: 10. 1914. — (13) Natürl. Pfl.-Fam. ed. 2, **16b**: 92. 1935. — (14) Blumea **7**: 146–147, 306. 1952. — (15) Vidensk. Selsk. Skr. ser. 5, **9**: 354. 1871. — (16) Prodr. **162**: 117–123. 1864. — (17) Bot. Gaz. **108**: 349–371. 1947. — (18) Svensk. Bot. Tidskr. **24**: 504–510. 1930. — (19) Verh. Deut. Wiss. Ver. zu Santiago de Chile **3**: 402. end of 1897 or 1898. — (20) Notizbl. Berlin-Dahlem **13**: 1–22. 1936. — (21) Bot. Notiser Suppl. vol. **2** (1): 82–83. 1948. — (22) Ueber den systematischen Wert der Holzstructur. München 253–259. 1883. — (23) Bot. Jahrb. **8**: 323, 331. 1887. — (24) Mém. Mus. Hist. Nat. Paris **14**: 465–472, *t. 23–26*. 1827. — (25) Las Plantas Cultivadas en la Republ. Argentina **8**: 6–14. 1950. — (26) Bull. Roy. New Zeal. Inst. Hort. Nov. 1947 (Banks lecture). — (27) Queensl. Naturalist **10**: 8–10. 1936. — (28) Hook. Journ. Bot. **2**: 147–157. 1840. — (29) New Zeal. State For. Serv.

Bull. no. 4. 1926. — (30) Act. Forest. Fenn. 34. 1929. — (31) Genetica **8:** 1–43, 126 fig. 1926. — (32) New Zeal. State For. Serv. Bull. 1928. — (33) Genetica **11:** 501. 1926. — (34) Gen. Pl. Suppl. IV, pars II: 29. 1847. — (35) Gen. Pl. **3:** 410. 1876. — (36) Ann. Naturh. Hofmus. **11:** 149–163. 1896. — (37) Bull. Soc. Imp. Nat. Moscou 1858, **I:** 396. 1858. — (38) Trans. & Proc. R. Soc. New Zeal. **78:** 363–380, 502–508. 1950. — (39) Manual New Zeal. Flora 1906. — (40) Versuch einer Entwicklungsgeschichte, etc. **2:** 96. 1882. — (41) Blütendiagramme **2:** 22, 25–26. 1878. — (42) Sitz. Ber. Kön. Böhm. Ges. Wiss. 12 Nov. 1886; cf. refer. in Bot. Centr. Bl. **30:** 10–12. 1887. — (43) Jahrb. Wiss. Bot. **21:** 128–162, *t. 5.* 1890. — (44) Ann. Bot. **28:** 509–526. 1914. — (45) Proc. R. Soc. Vict. new ser. **58:** 1–2. 1947. — (46) New Zeal. Sci. Rev. **9:** 5. 1951. — (47) Metcalfe & Chalk, Anat. Dicot. **2:** 1309–1315. 1950. — (48) Trans. & Proc. R. Soc. New Zeal. **66:** 292. 1936. — (49) Les zoocécidies des plantes de l'Amérique du Sud et de l'Amérique centrale 34–36. 1933. — (50) Kon. Sven. Vetensk.-Akad. Handl. **56** (5): 203. 1916. — (51) Act. Phytogeogr. Suec. **13:** 215–282. 1940. — (52) Proc. Roy. Geogr. Soc. London **22:** 428, 441. 1878. — (53) Trans. R. Soc. South Austr. **71** (1): 95. 1947. — (54) Rev. Chil. Hist. Nat. **32:** 187. 1928 (1929). — (55) in Kirchner, Loew & Schroeter, Lebensgesch. Blütenpfl. Mitt.-Eur. **2** (1): 48. 1911. — (56) For. Bur. (Philip.) Bull. **1:** 56–69. 1903. — (57) Journ. Linn. Soc. Lond. **46:** 427. 1924. — (58) Textbook Paleont. N. Y. 161, 180. 1939. — (59) New Zeal. Journ. Sci. Techn. B, **29** (1): 32. 1948. — (60) New Zeal. J. Sci. & Techn. B **34** (4): 296–297, 306, 310. 1953. — (61) Rev. Int. Bot. Appl. & Agric. Trop. **31:** 71–84, pl. 4 (1951) 1952. — (62) op. cit. 84–90, pl. 5–8. — (63) op. cit. 54–69, 3 pl. — (64) Hist. Nat. Vég. Phan. **11:** 142. 1842. — (65) Veg. Kingd. 291. 1846. — (66) Ann. Bot. Syst. **1:** 636. 1848–1849. — (67) Lilloa **16:** 263–375, 29 pl. (101 fotos.). 1948.

FLORA MALESIANA FOUNDATION,
LEYDEN, THE NETHERLANDS.

INDEX TO FAGACEOUS NAMES

THE MORPHOLOGY AND RELATIONSHIPS OF THE CHLORANTHACEAE

B. G. L. Swamy

With three plates and sixty-four text-figures

INTRODUCTION

The recent discovery of the retention of a primitive, vesselless xylem in *Chloranthus glaber* (Thunb.) Makino (= *C. brachystachys* Bl.) and *C. hainanensis* P'ei, of the Chloranthaceae raised the question whether these plants actually belong in the typically vessel-bearing genus *Chloranthus*. A totality of evidence obtained from a study of stem, node, leaf, bark, flower, pollen, etc., of the putative species of the genus strongly warranted the resurrection of the genus *Sarcandra* Gardn. to accommodate the two vesselless species (Swamy and Bailey, 1950). A detailed and intensive comparative study of the family Chloranthaceae as a whole has become necessary in order to determine whether *Sarcandra* should be retained within the family or excluded from it. Such an investigation is also very desirable for a clearer understanding of the relationships of the Chloranthaceae and its presumed allies.

With the segregation of the vesselless species in the genus *Sarcandra*, the family is at present constituted of three other genera — *Chloranthus, Ascarina*, and *Hedyosmum*. Herbarium specimens of 12 out of the nearly 16 species of *Chloranthus*, all 10 species of *Ascarina*, and 37 out of the approximately 45 species of *Hedyosmum* have provided material for observations on the early formed secondary xylem, bark, pith, node, leaf, floral structure, and pollen. Old wood samples of five species and nine collections of *Ascarina*, and of 20 species and nearly 40 collections of *Hedyosmum* were available for study.

A summation of morphological and anatomical data obtained through a careful re-examination of the type specimens indicates that *Chloranthus kiangsiensis* Metcalf and *Ascarina alticola* Schlechter should be excluded not only from the respective genera, but also from the family, and so these two species have not been considered in the present account. Detailed observations and arguments that have prompted the dissociation of the two plants from the Chloranthaceae will be presented in subsequent contributions.

A perusal of the literature reveals that the interests of earlier investigators on the anatomy of chloranthaceous plants were casual. Most of the accounts contain meagre references to only a few minor aspects of anatomy, and lack a comprehensive outlook. Solereder (1899) has brought together the salient observations of these authors, adding some of his own, in his admirable treatise, "Systematische Anatomie der Dicotyledonen." The only important contribution subsequent to this publication is the observations of Thierry (1912), which are primarily concerned with the description of histological details of some species of *Chloranthus*, *Ascarina*, and *Hedyosmum*.

I am indebted to the following institutions for their cordial cooperation in sending herbarium specimens on loan: Arnold Arboretum and Gray Herbarium, of Harvard University, New York Botanical Garden, University of California (Berkeley), United States National Herbarium, and the Royal Botanic Gardens of Indonesia, Bogor, Java. To Drs. Robert W. Hess of Yale University, Theodore Just of the Chicago Museum of Natural History, and Mr. W. N. Watkins of the Smithsonian Institution, Washington, D.C., I am obliged for their courtesy in sending me cuttings of mature wood specimens from their respective collections.

It was a rare privilege to me to have initiated studies on the comparative morphology and relationships of ranalian families under the inspiring guidance of Prof. Irving W. Bailey of Harvard University. I have been greatly benefited by his stimulating discussions, cooperation and understanding. I am deeply grateful to him for the unending encouragement that I have been receiving from him.

I also wish to express my gratitude to the National Institute of Sciences of India, Prof. T. S. Sadasivan, and the Madras University for giving me opportunities to pursue this and other investigations.

VEGETATIVE STRUCTURES

Xylem: The outcome of surveys of anatomical characters of the xylary tissues of dicotyledons as a whole during the past 35 years clearly demonstrates, among other significant conclusions, that a complete series of stages in the origin and trends of specialization of vessels from a primitive vesselless condition are preserved in the representatives of extant floras, and that certain families or groups exhibit specific ranges of successive phylogenetic stages. Thus, families like the Monimiaceae and Icacinaceae provide an unusually wide spread of such stages, whereas some others show only specific restricted parts of the gamut. The family Chloranthaceae illustrates one such restricted part of the series — initial steps in the organization of vessels.

The genus *Sarcandra* (Swamy and Bailey, 1950; Swamy, 1953a) has preserved a type of vesselless xylem derived from a primitive cambium. The fusiform initials are pronouncedly elongated in a vertical direction and possess extensively overlapping ends. The fusiform cambial initials and their derivatives are nearly 2 mm. long during the fourth year's growth, and as may be seen in transections, conform to a relatively undisturbed radial seriation as in other living representatives of vesselless dicotyledons. The inter-tracheary pitting is confined to the radial facets and is typically uniseriate scalariform in the later formed elements of the primary xylem. A similar type of pitting occurs in the tracheids of the earlier formed secondary xylem of the first year and also in the first formed ones (about three to five rows) of succeeding years. The remaining tracheids of the secondary xylem exhibit transitions to, and establishment of, uniseriate circular bordered pitting. The vascular rays are of two kinds, (i) uniseriate rays in the intra-fascicular parts, and (ii) multiseriate rays (four to five cells wide) radiating from the inter-fascicular parts of the primary xylem. Both kinds of rays are vertically extensive, and their constituent cells are elongated and upright. Wood parenchyma is distributed in a diffuse pattern and on the whole is rather scantily developed; it may be almost absent in some specimens.

The other genera of the family are all vessel-bearing. The majority of species of *Chloranthus* are perennial or annual herbs, only *C. officinalis* and *C. spicatus* being somewhat suffrutescent and having a vascular cylinder of three or four year's growth. *Ascarina* and *Hedyosmum* are generally large woody shrubs, often growing to the size of small trees. The tracheary elements of the metaxylem region of all the species of *Chloranthus* are very long and possess exclusively uniseriate scalariform pit-pairs on the lateral walls as well as on the steeply tapering overlapping facets. The pit-pairs retain full borders and pit membranes, that is, the pits are imperforate, and the cells typically tracheids. This character of the metaxylem in the vessel-bearing species of *Chloranthus* recalls that of the vesselless *Sarcandra*.

The primary xylem of *Ascarina* and *Hedyosmum* presents a more advanced evolutionary level than that of *Chloranthus*. The specialization pertains to the dissolution of pit membrane and to the complete elimination of the borders of pit-pairs that are distributed on the deeply inclined facets of the metaxylem elements. These changes result in the development of vessel members possessing pronouncedly inclined perforated facets with numerous slender transverse scalariform bars.

The tracheary derivative tissues of the cambium in the suffrutescent species of *Chloranthus* exemplify early steps in the organization of a vessel-bearing xylem, although the type of vessel-ray pitting indicates certain obviously precocious modifications as will be explained later. In conformity with the highly significant conclusion of Bailey (1944), the development of vessel-bearing xylem is promptly accompanied by an appreciable reduction in the length of vessel members as compared with that of their phylogenetically ancestral tracheids. It is obvious that the shortening of vessel members must have been foreshadowed in the fusiform initials of the cambium itself. The following measurements * of tracheary cells of the genera of the Chloranthaceae as given in TABLE I illustrate the point.

The vessels of *Chloranthus* are relatively long and possess extensively overlapping ends. The steeply inclined end walls of vessels bear very numerous (100–150) scalariform perforations that retain full borders

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* The measurements were obtained where possible from cells in the 4th year's zone of growth. The oldest available specimens of *Sarcandra* and *Chloranthus* show a growth of about five years. In order to render the results comparable, figures for *Ascarina* and *Hedyosmum* were obtained from equivalent numbers of specimens of corresponding age.

Table I showing the average length of tracheids and vessel members

GENERA	AVERAGE LENGTH OF TRACHEIDS IN MICRA	AVERAGE LENGTH OF VESSEL MEMBERS IN MICRA
Sarcandra	1986	—
Chloranthus	922	856
Ascarina	954	823
Hedyosmum	947	834

(PLATE III, FIG. 9). The lumen of the vessels is only slightly larger than that of the tracheids in cross-sectional area and the outline conforms generally to that of a rectangle with slightly longer radial diameter and somewhat arched radial walls as seen in transection. The relatively undisturbed radial alignment of tracheary cells as in *Sarcandra* and other vesselless dicotyledons becomes less regular in the vessel-bearing *Chloranthus,* especially in the neighborhood of vessels, possibly due, among other factors, to the increase in the cross-sectional area of the vessel members however little it may be. The wood is typically diffuse porous (PLATE I, FIG. 2). The inter-vascular pit-pairs are extremely rare, due to the isolated distribution of vessels; however, in exceptional cases two longitudinal series of vessels do contact each other and the pitting on such walls is characteristically of the uniseriate scalariform type. The pit-pairs are large and retain full borders. When the radial wall of a vessel lies in contact with ray cells, the scalariform pits "break up" into circular bordered ones, and align themselves in two or three longitudinal series on the contacting facet. The pit-pairs are half-bordered, the overhanging secondary wall (constituting the pit border) having been retained by the vessel. The ray system closely parallels the condition of *Sarcandra.* However, the multiseriate rays of *Chloranthus* are less extensive vertically and the ends taper into one- to three-seriate "wings" as seen in tangisections. The constituent cells of the rays fluctuate in form from upright with narrow tangential diameter to almost cubical dimensions. The uniseriate rays consist exclusively of upright cells. The scantily developed parenchyma is apotracheal and occurs in a diffuse fashion. With the acquisition of a vessel-bearing xylem, the imperforate tracheary elements show a rather sudden morphological change. This consists in the development of pit-pairs on the tangential, as well as the radial, walls. The tracheidal wall in *Chloranthus* is slightly thicker than that of the vessel members, and circular bordered pit-pairs are scattered in a single series on all four longitudinal facets, although the number of pits per unit area is considerably greater on the radial walls. The pit aperture is largely "included," only occasionally extending beyond the limits of the border, which perhaps is due to the helical cracking of the secondary wall along the aperture. The over-all characters of the imperforate tracheary cells lean more toward that of a fibre-tracheid, and this opinion is reinforced by the fact that a large percentage of the cells are septate.

The secondary xylem of *Ascarina* and *Hedyosmum,* as in the case of the primary xylem of these genera, shows slightly but definitely advanced trends of structural specialization over *Chloranthus*. Although the tracheary derivatives of the cambium tend to be nearly as long as those of the latter genus (see TABLE I), the vessels exhibit certain specific evolutionary modifications. Thus, the perforate tracheary cells of *Ascarina* and *Hedyosmum* exhibit conspicuously larger cross-sectional areas than those of *Chloranthus*. As between *Ascarina* and *Hedyosmum*, the latter genus exhibits a pronounced tendency to undergo a greater degree of radial and tangential expansion during ontogeny (TABLE II). The vessels of both of the genera possess relatively thin walls and those of *Ascarina* retain a rather conspicuously angular outline in cross-section, while in *Hedyosmum* the contour is nearly circular or oval (PLATE I, FIGS. 1, 3). The pores in the earlier formed part of secondary xylem of both genera occur generally in radial chains, which arrangement soon shifts over to the diffuse porous type during subsequent ontogenetic stages. In the later formed secondary xylem of *Hedyosmum nutans* (PLATE I, FIG. 3) and *H. glabratum*, the pores sometimes exhibit a grouping in short radially oriented series and in that of *H. scabrum* in clusters of three or four. The perforated facets extensively overlap and contain very numerous (150–200) scalariform perforations that are totally devoid of borders; the intervening bars are rather tenuous (PLATE III, FIG. 8). The intervascular pitting (very rare in *Ascarina*) fluctuates between uniseriate scalariform (occasional) and transitional and opposite (frequent), the ratio of each type being variable often on the facets of a single cell; so also the size, shape, and degree of retention of the borders of pit-pairs. The vessel-ray and vessel-parenchyma pit-pairs present a similar range of form and distribution; the individual pit-pairs have reduced borders and are relatively widely spaced.

Table II showing the average cross-sectional area of vessels in square micra from comparable specimens

GENERA	4 YEARS OLD	10–15 YEARS OLD
Chloranthus	960	—
Ascarina	2640	3440
Hedyosmum	3420	16200

The ray systems of *Ascarina* and *Hedyosmum* belong to the same fundamental category — the so-called heterogeneous type I — as in the other genera already described. However, the two arborescent genera under consideration exhibit slightly divergent trends in ontogenetic sequences. In the earlier formed secondary xylem of *Ascarina* the uniseriate and multiseriate rays (3–4 cells wide) are distinctly visible and the constituent cells are upright, although the average height of the cells composing the multiseriate rays is slightly lower than that of the uniseriate ones (PLATE II, FIG. 4). During later stages of ontogeny, the multiseriate rays widen (10–12 cells) * and the constituent cells attain a square or slightly procumbent form, appearing as isodiametric in tangisections (PLATE II, FIG. 5). Irrespective of these cellular modifications in addition to (i) the normal breaking up of the tall uniseriate and multiseriate rays into shorter ones, and (ii) the formation of secondary rays of both kinds, the mature wood retains relatively the same ratio of uniseriate and multiseriate rays as compared with the earlier formed part of secondary xylem. In the young secondary xylem of *Hedyosmum,* in relative contrast to the situation in *Ascarina,* the multiseriate rays are slightly wider (4–6 cells) and occur in a larger proportion in relation to the uniseriate rays (compare PLATE II, FIGS. 4, 6). Ontogenetic development does not disturb the shape of the constituent cells in any appreciable degree, thereby nearly all of the cells retain an upright form as seen in tangisections (compare the form of mature ray cells of *Ascarina* in FIG. 5 with that of *Hedyosmum,* in FIG. 7 of PLATE II), although the ray width may attain a diameter of nearly 1 mm. (width of 20–22 cells). The radial sections also reveal a larger proportion of upright cells as compared with the square ones. Again, unlike the old wood of *Ascarina,* that of *Hedyosmum* contains essentially multiseriate rays, the uniseriate ones occurring only sporadically.

As in the other genera of the family, the wood parenchyma is poorly developed in *Ascarina* and *Hedyosmum.* However, the amount developed fluctuates considerably not only between species but also between different specimens of the same species collected from diverse localities. In *Ascarina,* the parenchyma is apotracheal, and the cells are distributed in diffuse to diffuse-in-aggregate patterns (PLATE I, FIG. 1), with a tendency to form short tangential uniseriate rows of three to four cells in some specimens of *Ascarina lanceolata* collected from the Samoan Islands. The amount of parenchyma in the mature woods of *Hedyosmum* is much smaller than in *Ascarina,* and is paratracheal, being confined to a few cells abutting the vessel members (PLATE I, FIG. 3). In some specimens of *H. bonplandianum* and *H. glabratum,* parenchyma appears to be almost absent.

The imperforate tracheary cells of *Ascarina* in general exhibit more tracheid-like characters. The pitting is more numerous and the pit borders are larger on the radial than on the tangential walls; the apertures are "included." In contrast, the corresponding cells of *Hedyosmum* exhibit characters that are more nearly characteristic of fibers. Thus, although the cell wall remains as thick or sometimes slightly thicker than that of

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* The number of cells that make up the width of a multiseriate ray, the upright or square form of the constituent cells, the relative proportions of these cell types in a single ray, etc., are factors that appear to vary considerably not only between species, but also in the different collections of a single species, and perhaps in different specimens obtained from diverse parts of a single tree. To determine these ranges of variability, an analysis of a vast quantity of adequately sampled material is necessary. This not having been accomplished at present, the morphological descriptions given here should be looked upon as being *general trends* rather than as distinctive characters.

Ascarina, the pitting is less frequent; the borders are conspicuously reduced and the apertures well "extended." *Hedyosmum calloserratum* and *H. glabratum* show abundant development of septate-fibers.

Bark: The material available for examination consisted of young twigs. In all genera the bark is relatively thin. Groups of sclerenchymatous fibers confront the fascicular parts of the xylem and the phloem ray cells become modified into heavily lignified and sclerosed stone cells in *Sarcandra*. Species of *Chloranthus* and *Hedyosmum* present a similar structure excepting for the absence or scanty development of sclerosis of the phloem ray cells. The bark of *Ascarina* is relatively thicker than in the other genera, a large proportion of the outer cortical cells being parenchymatous. The sclerenchymatous sheaths of cells confronting the fascicular parts are much dissected and more numerous, and the tissue between these and the secondary xylem shows incipient stratification of thin and thick walled cells as seen in transections. The multiseriate rays of the phloem undergo excessive "flaring" due to conspicuous dilation of the component cells, which remain thin walled.

Nodal anatomy: Two distinct strands of vasculature that are related to a single lacuna of the vegetative axis are concerned in supplying the leaves of *Ascarina* and *Hedyosmum* (TEXT-FIGS. 1, 3), and therefore the nodal anatomy is typically of the *unilacunar* type. The primary vascular system as seen in the internodal regions of *Ascarina, Hedyosmum,* and *Chloranthus* consists of four vascular strands (see the bottom ends of TEXT-FIGS. 2, 4, 6). In *Ascarina*, each strand bifurcates * at the subnodal level into larger and smaller strands. The two pairs of smaller strands are opposite to each other and subtend the opposite leaves at the nodal level. The remaining four larger strands continue through the succeeding internode and at the next node undergo similar behavior (TEXT-FIG. 2).

The young stems of *Hedyosmum* exhibit a basically similar plan of vasculature, with a slight modification in the behavior of the leaf traces. In the subnodal region, the two pairs of leaf traces bifurcate. The two smaller branches of the bifurcation soon fuse to form a single intervening strand between the two larger branches, which in turn split into two (TEXT-FIG. 4). Thus, in transections taken at upper levels of the node, the "foliar buttress" as well as the petiole shows five vascular strands (TEXT-FIG. 5), the slender one occupying a median position with a pair of larger strands on either side.

The vasculature of the stems of *Chloranthus*, as also of *Sarcandra* (Swamy and Bailey, 1950; Swamy, 1953a), is of a modified unilacunar type. In these genera, the internodal vasculature of the stem also consists of four bundles (TEXT-FIG. 6). At the subnodal level each of these gives off two branches so that the stem at this level contains 12 vascular strands, — four larger and eight smaller, the latter being placed one on either side of the

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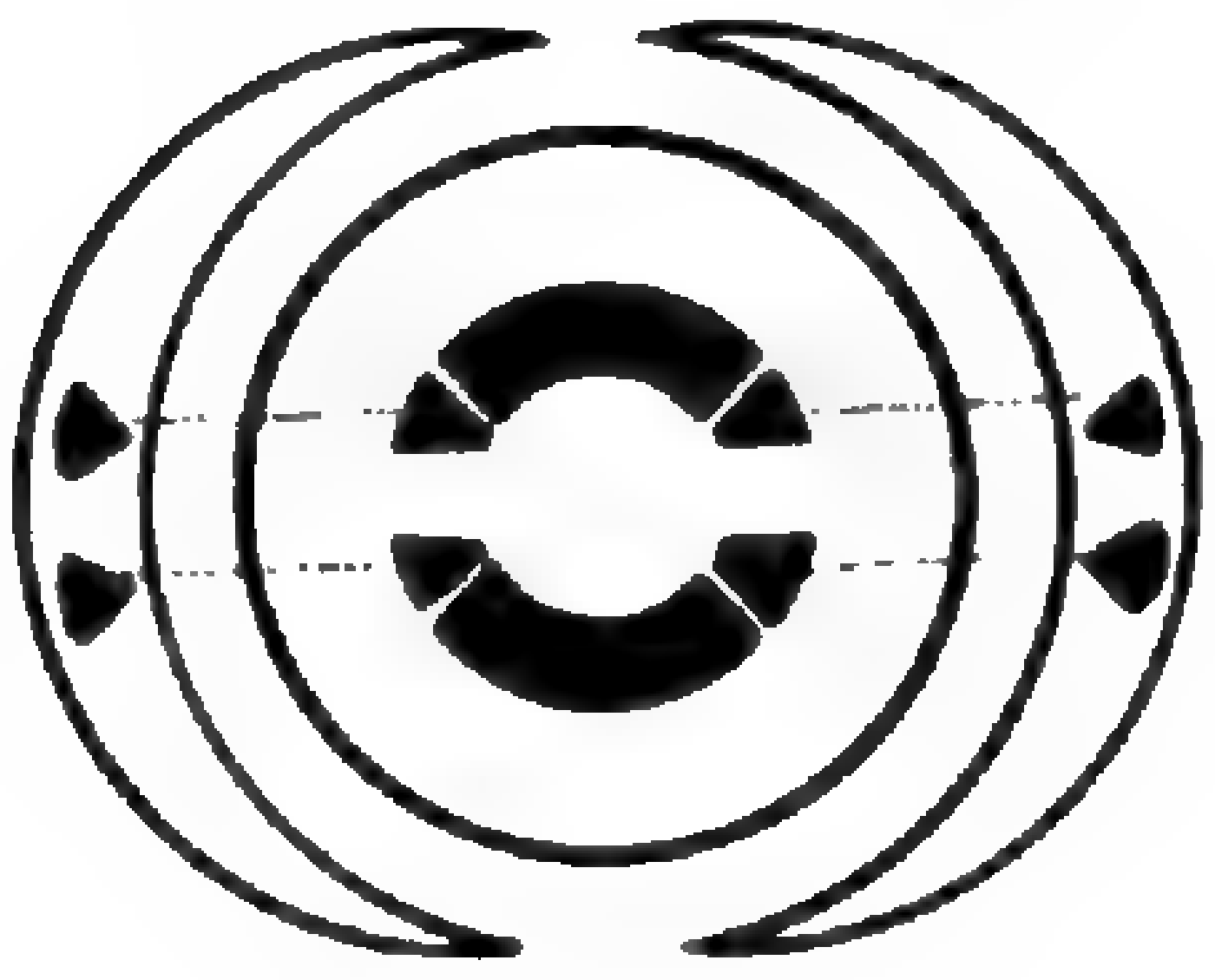
* The terms "bifurcates," "runs," "continues," "splits," etc., in connection with the vasculature of vegetative or reproductive structures have been employed in this paper only to describe the pattern of behavior of vascular strands as seen in serial transections, and *do not* involve any ontogenetic implications.

larger bundles. The two smaller bundles that are subjacent to the subtended leaves above bifurcate, the median two branches unite into one, and the resulting three strands form the median vein of the corresponding leaf (TEXT-FIGS. 5, 6). The remaining four smaller strands, placed at right angles (as seen in transection, TEXT-FIG. 5) to the petiolar axis of the opposite leaves, constitute the marginal veins, two veins entering each of the corresponding foliar appendages (TEXT-FIG. 5). It is usual for the two adjacently placed lateral veins, however, to exhibit fusion to varying distances during their course through the preceding internode, and in TEXT-FIG. 6, the fused condition is shown to extend throughout its length. Thus, the median vein (constituted of two larger strands and an intervening smaller one) of the leaf is related to one "gap" and the four marginal veins (two for each of the oppositely arranged leaves) arise from two "common gaps," in contrast to the typical trilacunar nodal situation where the four marginal strands (of two leaves) confront a corresponding number of independent "gaps." Therefore, the type of nodal structure in *Chloranthus* and *Sarcandra* (as also in the representatives of the family Calycanthaceae among the Ranales) cannot be assigned either to a strictly unilacunar type or to a typically trilacunar one. However, it appears reasonable to consider the nodal structure of *Chloranthus*, *Sarcandra*, and the like, as being a modification of the unilacunar type on account of their sporadic occurrence always among representatives that possess predominently unilacunar nodal anatomy.

Leaf: The leaves of all four genera of the family are simple with varying types and degrees of serrated margins, and are penninerved. As mentioned above, transections taken nearer to the basal end of the petiole show two leaf strands in *Ascarina* (TEXT-FIG. 1), five (two pairs of larger strands with an intervening smaller one) rather closely aggregated strands in *Hedyosmum* (TEXT-FIG. 3), and again five (two larger strands and three smaller ones) in *Chloranthus* and *Sarcandra*; in the latter two genera, three of the strands (two larger and an intervening smaller one) occupy a median position and the remaining two smaller ones are on either lateral extremity of the petiole (TEXT-FIG. 5). During their course through the petiole to the base of the lamina, no significant changes are encountered either in regard to orientation of the individual strands or to their splitting. Thus, transections towards the distal end of the petioles reveal approximately similar configuration of vasculature as compared with sections from basal levels. The medianly situated groups of strands of the petiole (two in *Ascarina*, five in *Hedyosmum*, and three in *Chloranthus* and *Sarcandra*)

TEXT-FIGS. 1–9. FIGS. 1–6. DIAGRAMS TO ILLUSTRATE NODAL ANATOMY: FIGS. 1, 2. *Ascarina*; FIGS. 3, 4. *Hedyosmum*; FIGS. 5, 6. *Chloranthus*. FIGS. 1, 3, and 5 are diagrammatized from transections at nodal levels; FIGS. 2, 4, and 6 illustrate the vasculature of two successive nodes as split longitudinally and spread in one plane. FIGS. 7–9. TRANSECTIONS OF STOMA. FIG. 7. *Ascarina lanceolata*, × 400. FIG. 8. *Chloranthus officinalis*, × 400. FIG. 9. *Hedyosmum racemosum*, × 400.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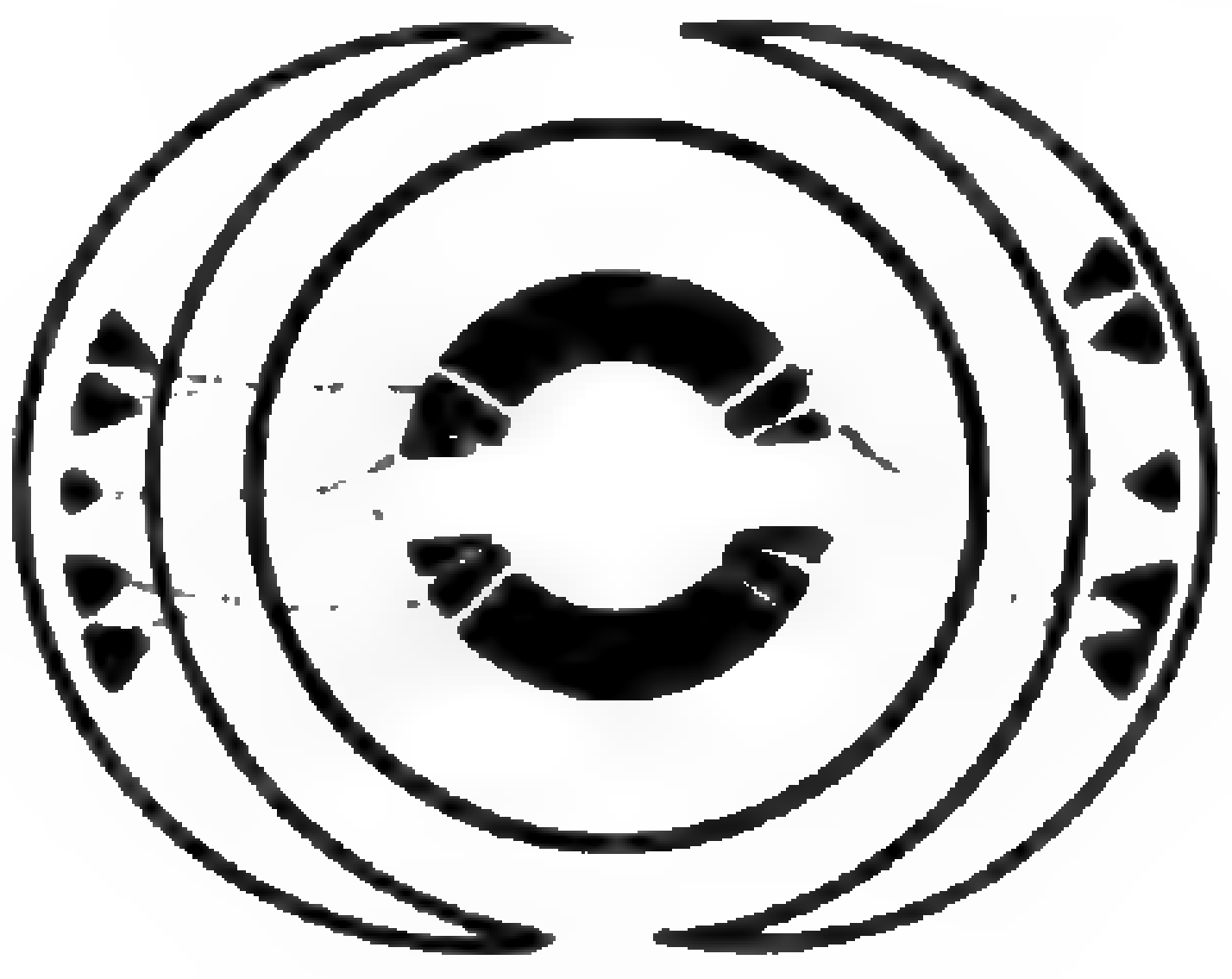
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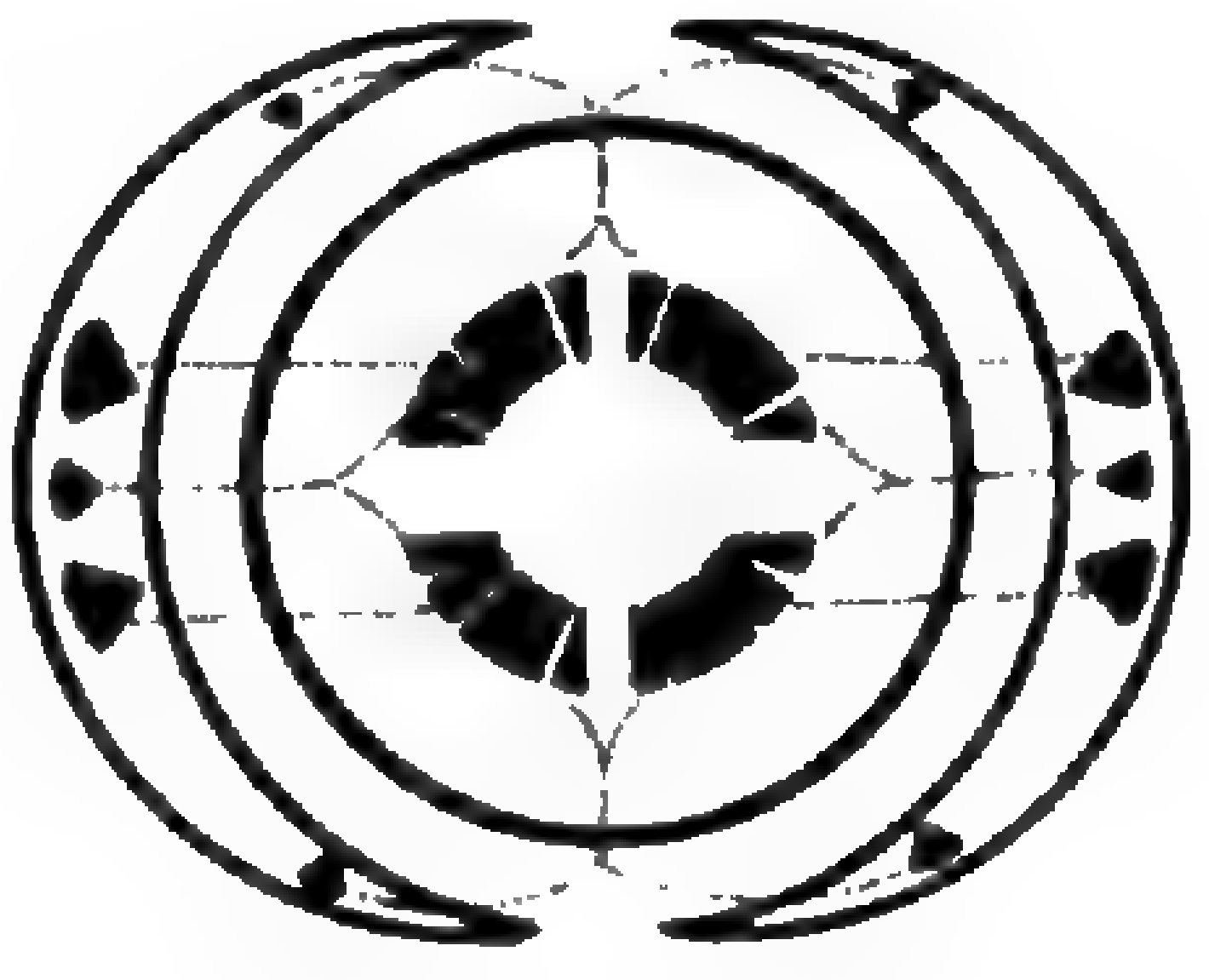
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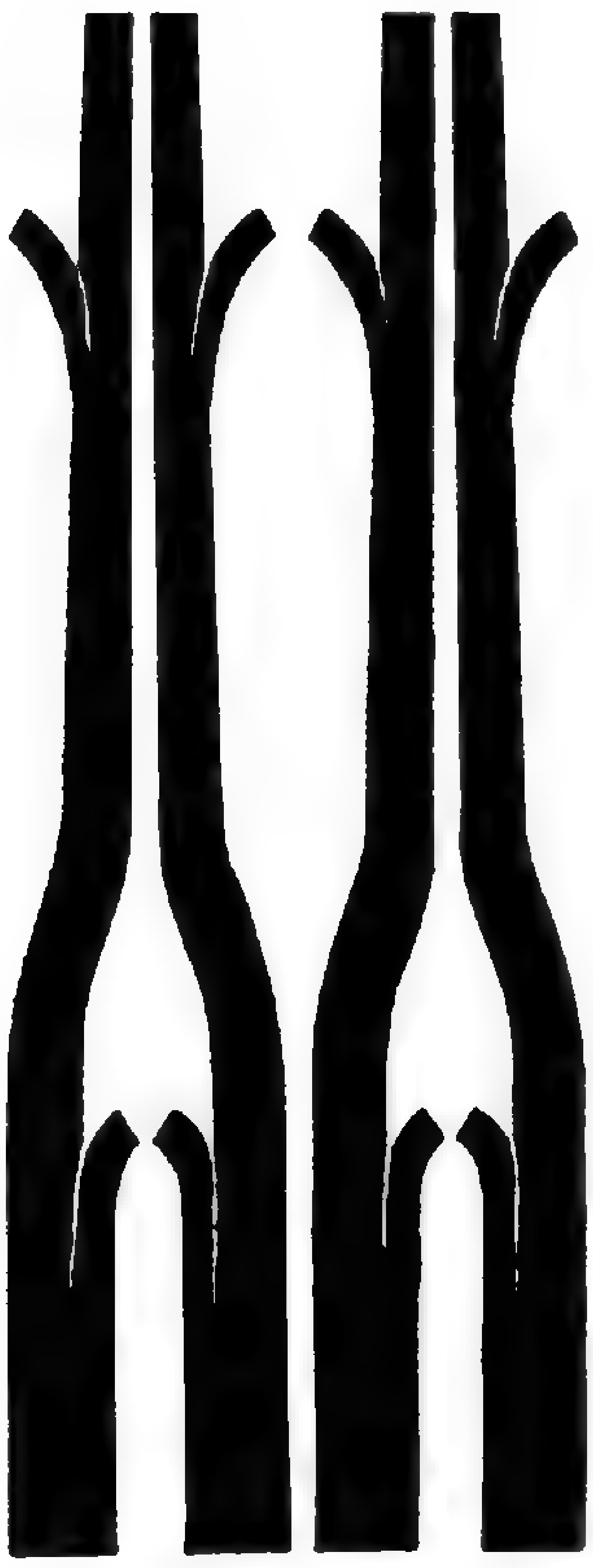
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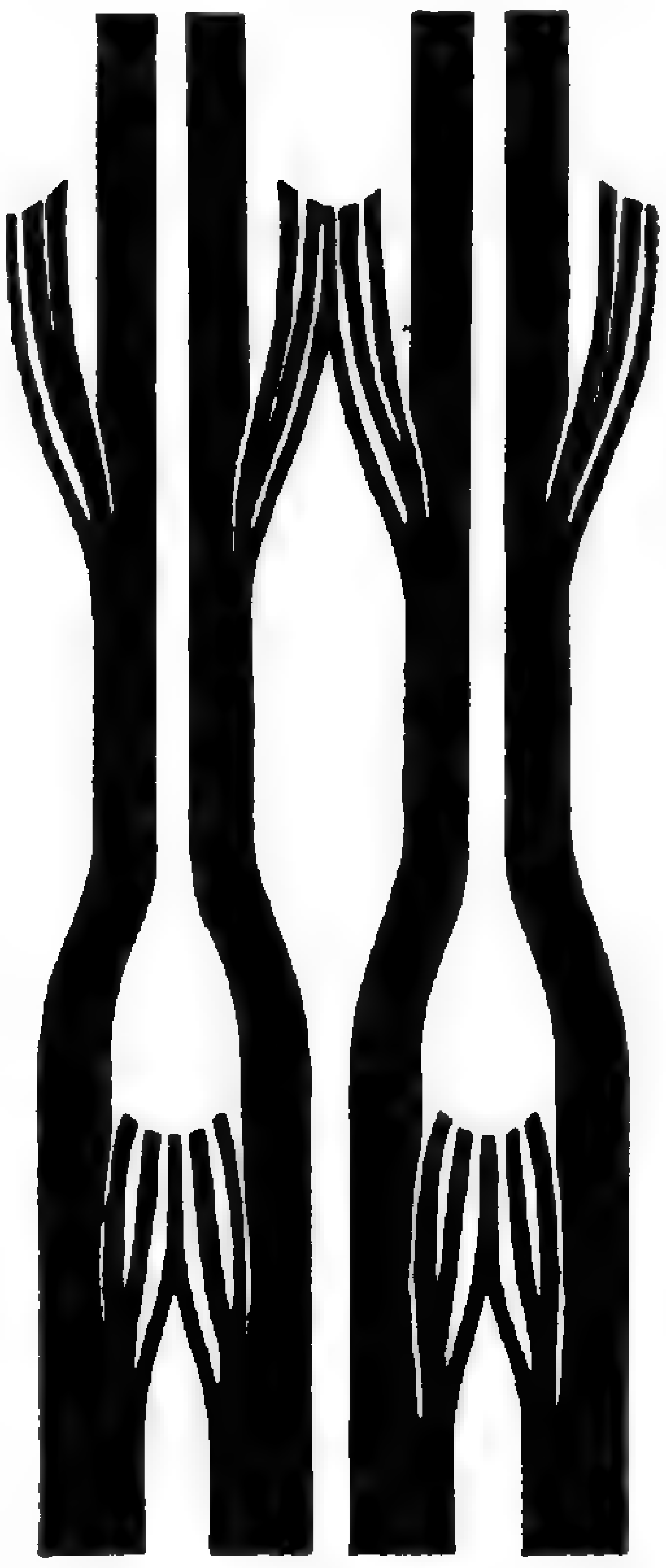
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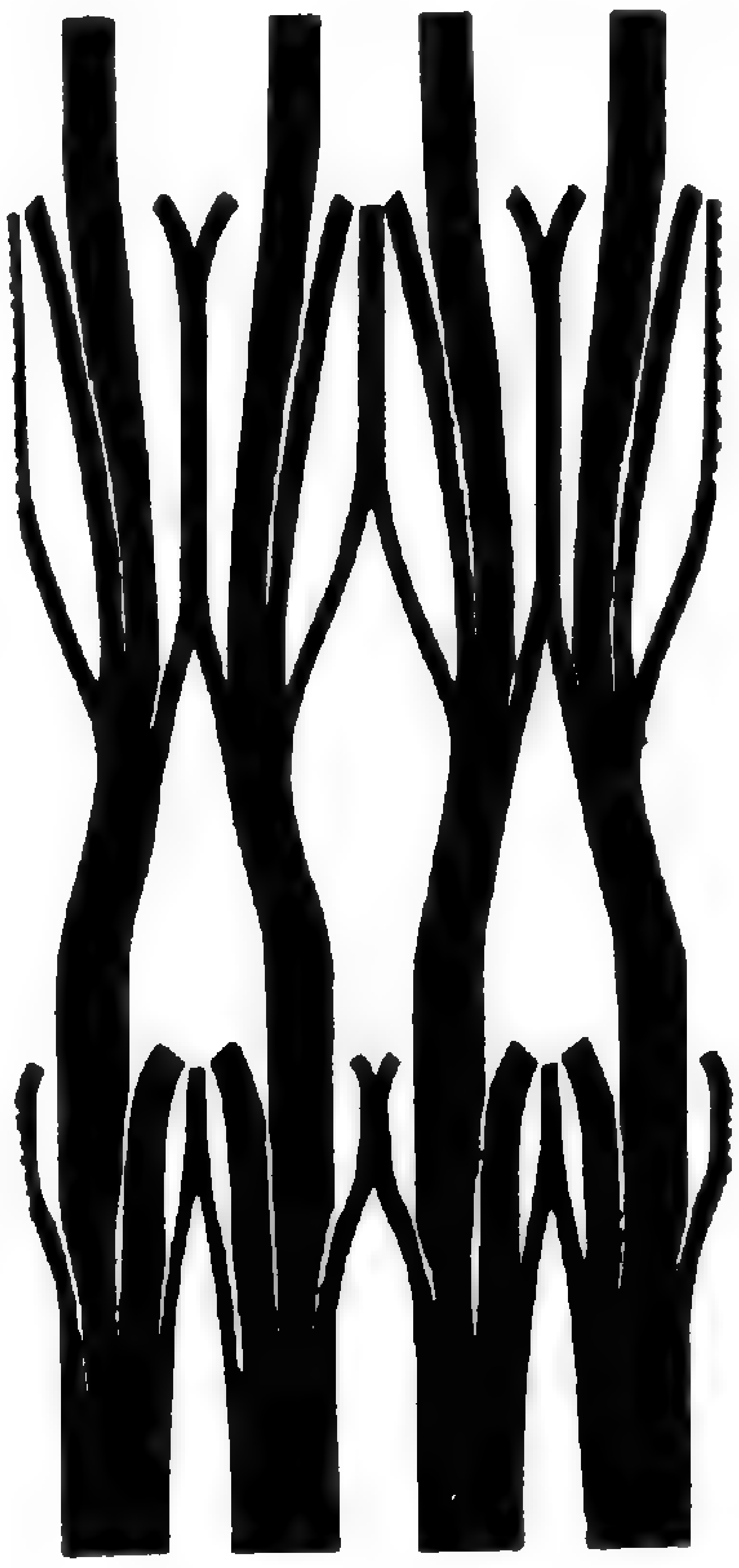
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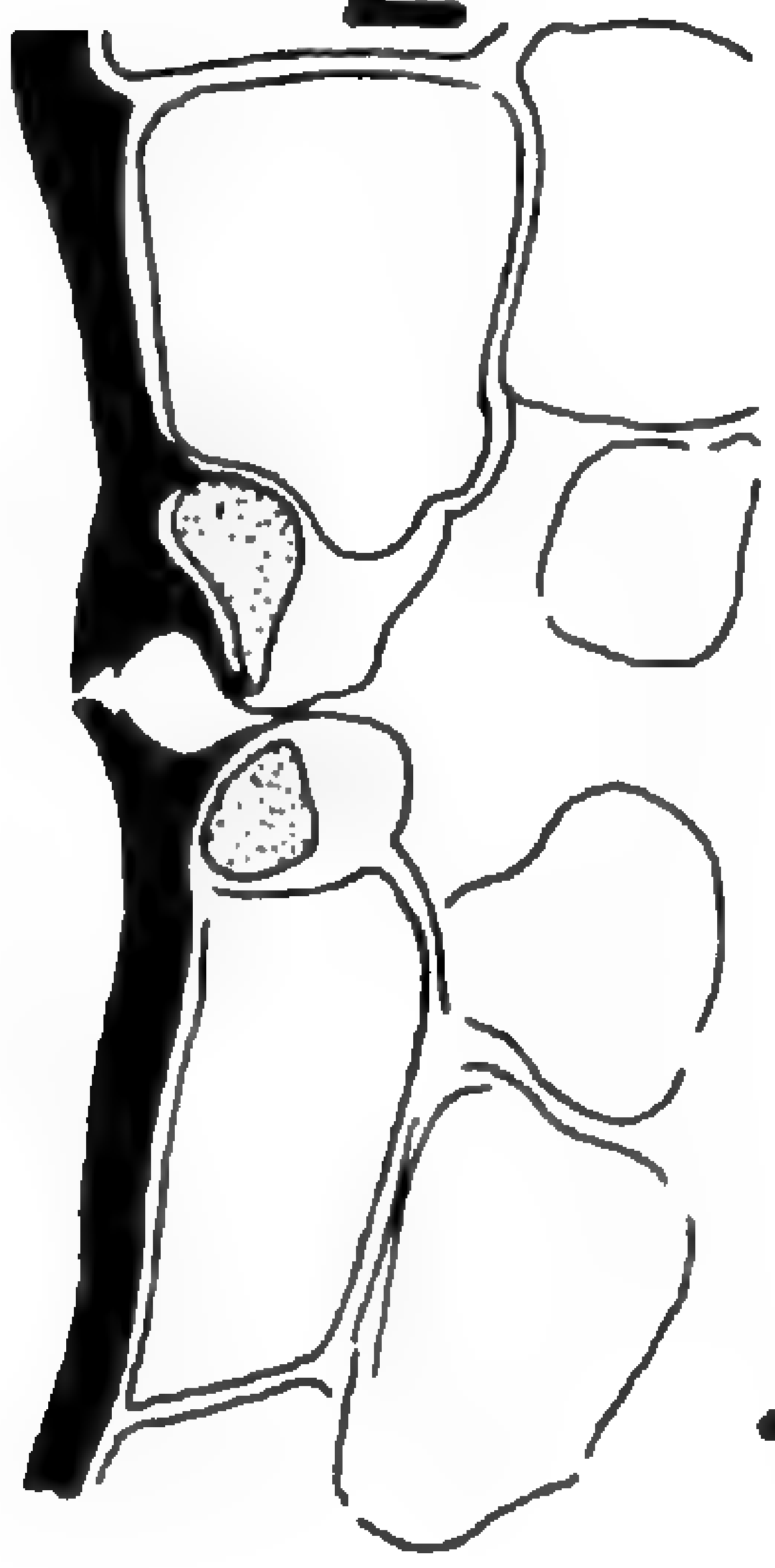
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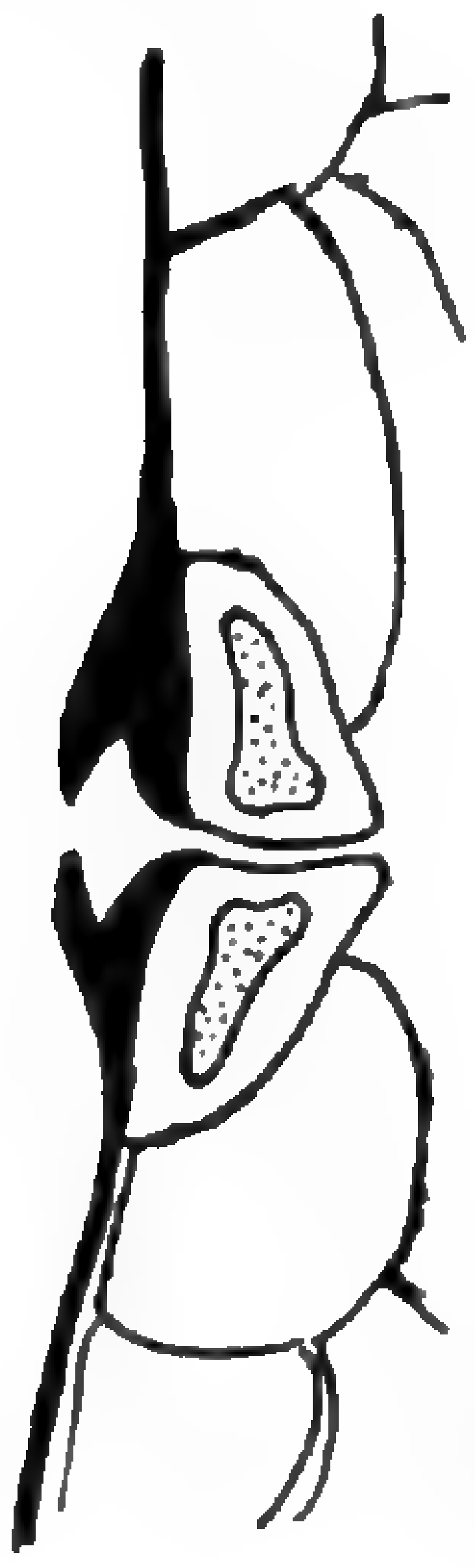
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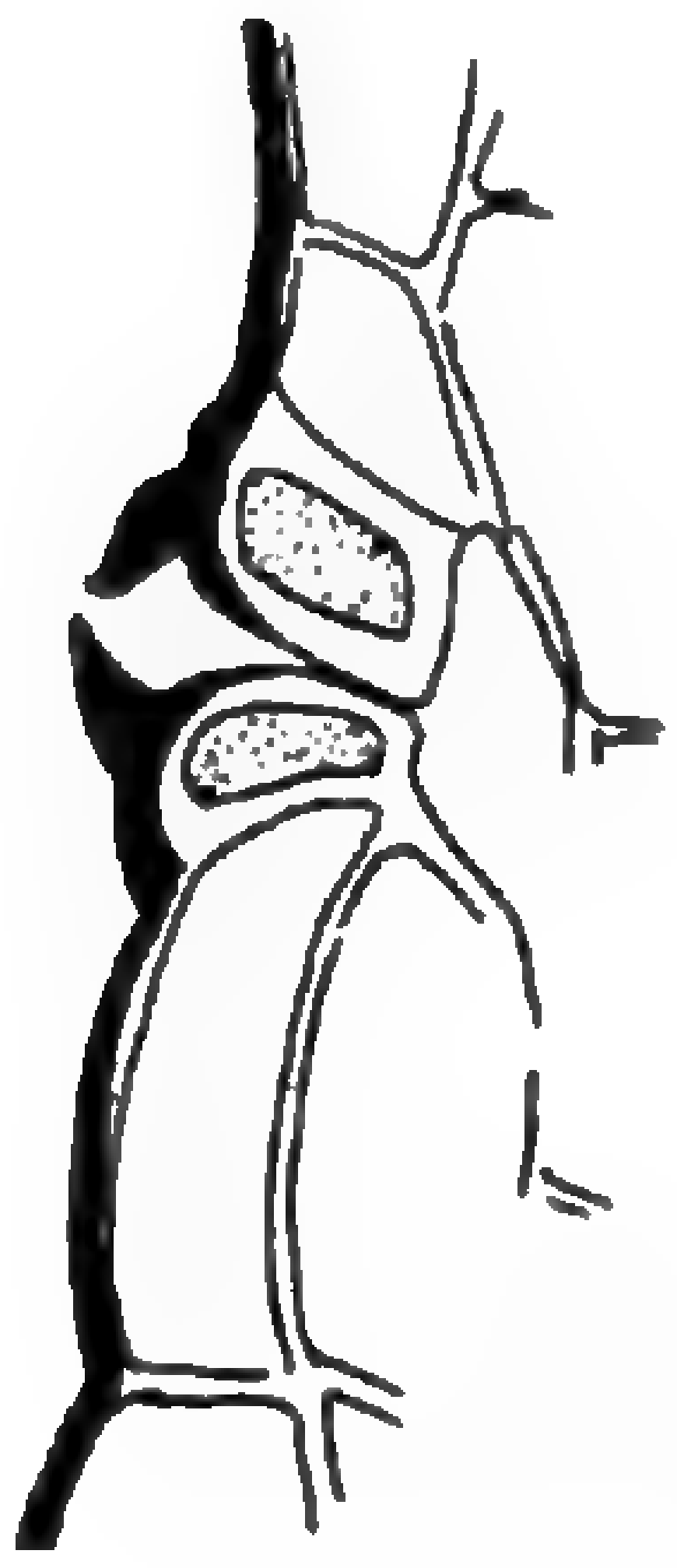
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constitute the midrib bundles of the leaves of the respective genera. In the earlier stages of ontogeny, the larger bundles of the midrib generally remain distinct throughout the length of the lamina, but in later stages they appear to have undergone approximation or fusion at varying distances from the apex of the leaf. Particularly in *Ascarina* the two bundles maintain distinctiveness for a greater distance in the leaf, and in such instances it is very clear that each longitudinal half of the leaf is vascularized by ramifications derived from the individual bundle lying on the corresponding side. In *Hedyosmum,* the basal half of the blade derives its vasculature from the branches of the outermost larger bundles, and the distal half from the two centrally located ones. The small central strand remains rather slender and disappears after traversing about half of the costa. The larger bundles of the midrib strand in the leaves of *Chloranthus* and *Sarcandra* take part in organizing the major vasculature of the blade; the intervening smaller bundle of the costa as well as the laterally situated weakly developed bundles proceed into the blade only for a short distance and finally disappear or undergo fusion with one of the adjacently situated bundles.

The pattern of smaller veins and veinlets of the leaf is typically reticulate. In texture, the lamina fluctuates between chartaceous and coriaceous, depending upon factors such as the thickness of cuticle, the number of layers and the size of component mesophyll cells, the degree of reticulation of the veinlets, the coarse or slender character of the veinlets, the occasional occurrence of sclerenchymatous cell clusters in the mesophyll (species of *Hedyosmum*), etc. Although these characters, in varying proportions and combinations, are subject to variation often among the leaves of the same species (for example, as between sun-leaves and shade-leaves, or between specimens obtained from lower altitudes and higher altitudes, etc.), a generalized statement may be made to the effect that: (i) the foliage of *Chloranthus* and *Sarcandra* tends to be thin with a rather loosely reticulated venation; (ii) the leaves of a few species of *Ascarina* and several of *Hedyosmum* are relatively thicker with a comparatively denser reticulation of the veinlets; and (iii) the lamina of certain other species of *Hedyosmum* exhibits a system of relatively coarser veinlets with generally dilated endings and denser reticulation. In some species, the toughness becomes exaggerated due to the presence of isolated or clustered groups of stone cells in the epidermis and subjacent mesophyll tissues.

The lamina of several species of *Ascarina* and *Hedyosmum* possesses a hypodermal layer; in a few other species of these genera, as also in some species of *Chloranthus,* the distribution of such a layer tends to be restricted to the neighborhood of veins. A hypodermis may be absent in *Sarcandra.* As observed by Solereder (1899), Thierry (1912), and others, a morphologically typical palisade tissue is characteristically wanting in all the genera. Its place and function, however, is taken over by muricate cells. Relatively large secretory cells, the "ethereal oil cells," are freely scattered throughout the mesophyll tissues of the leaves, as also generally in young cortex, pith, and in floral appendages. Mucilage ducts are present in *Hedyosmum arborescens* (see also Skutch, 1927) and a few allied but as yet unidentified species. Crystals occur only occasionally — as small, solitary bodies in the epidermal cells of some specimens of *Chloranthus spicatus,* and as druses in the cortex of *Hedyosmum brasiliense.*

In general, the cell walls of dorsal and ventral epidermal layers are uniformly straight in *Ascarina,* wavy in *Chloranthus,* and straight in some species of *Hedyosmum* but wavy in others. The subsidiary cells of the stomata in *Sarcandra* and *Chloranthus* are oriented parallel to the guard cells (the so-called "rubiaceous type"); one or both guard cells occasionally show a septation at right angles to the longer axis, thereby indicating a division having taken place. This type of stomatal structure is specific for the above two genera. On the other hand, *Ascarina* and *Hedyosmum* are characterized by stomata that are surrounded by a varying number (between four and six) of ordinary cells forming a rosette. In *Chloranthus* and *Sarcandra,* the guard cells rest partially on the subtended parts of constituent epidermal cells (TEXT-FIG. 8), whereas in *Ascarina* and *Hedyosmum* they are set more or less in line with the epidermis (TEXT-FIGS. 7, 9). In all four genera, the cuticle is excessively thickened around the stomatal opening to form a vestibule-like structure with overhanging borders (TEXT-FIGS. 7–9).

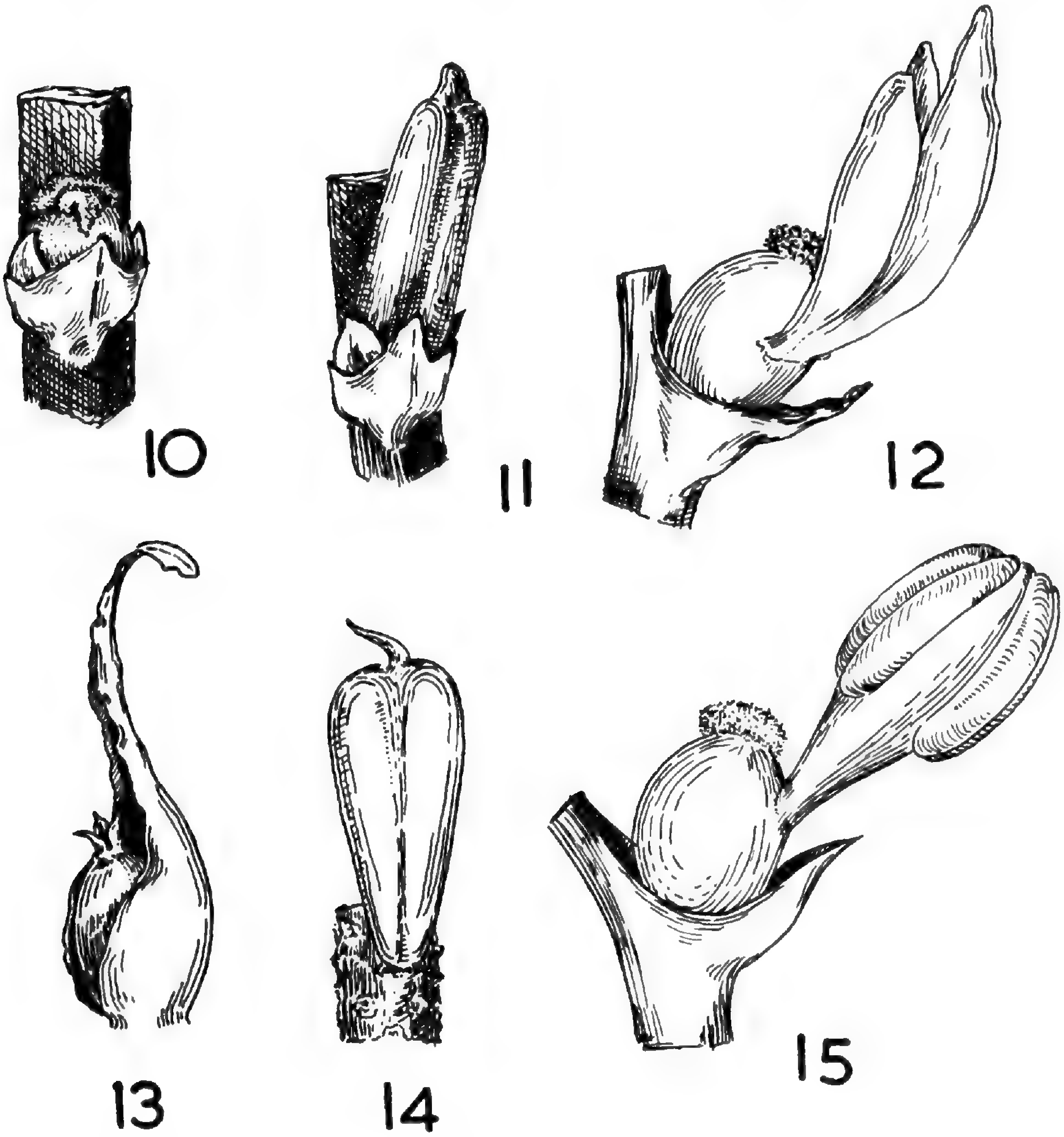
REPRODUCTIVE STRUCTURES

External morphology: In all four genera of the family, the flowers are borne on compound spikes that are axillary or terminal. In *Hedyosmum Artocarpus,* the individual flowers are so closely approximated and partly fused, not only among themselves but also with the axis, that they appear as an aggregated structure.

The flowers of *Sarcandra* and *Chloranthus* are bisexual; those of *Ascarina* and *Hedyosmum* unisexual. Furthermore, the former genus is dioecious while the latter often bears distinctly male and female inflorescences on one and the same plant. Although the flowers of these genera have received elaborate descriptions in taxonomic papers, a comparative summary of salient features is given below to enable the reader to get a clearer picture of the interrelationships of individual floral parts as well as of the flowers of different genera.

The individual flowers of *Sarcandra* and *Chloranthus* are subtended by a single, somewhat keel-shaped, lanceolate bract. A solitary pistil with a capitate, tufted stigma and no style is inserted in the axil of the bract (TEXT-FIGS. 12, 15). In *Sarcandra,* a single fleshy stamen with a quadrilocular anther is attached at the middle height of the pistil on the abaxial side (TEXT-FIG. 15). In *Chloranthus* (TEXT-FIG. 12), it suffices at present to note that the attachment of the tripartite androecium to the pistil has the same relation as in *Chloranthus,* but that its form, number and degree of development of the thecae, etc., are variable in different species. A detailed treatment of these structures will be found on a subsequent page.

The unisexual flower of *Ascarina,* in some species, is subtended by three deltoid bracts, a larger outer and two smaller inner ones (TEXT-FIGS. 10, 11); in the remaining species, the bract is single and nearly of the same size and form as that of the outer bract of the former set of species. This feature, in association with others, forms a very significant criterion in recognizing two distinct groups of species within the genus (Swamy, 1953b). The styleless solitary pistil with an unequally bilipped tufted stigma occupies the axil of the bract or bracts (TEXT-FIG. 10). In the male flower of the three-bracteate species a single stamen is present, while in the one-bracteate species, a single flower bears two stamens. In either case, the stamen is sessile, cylindrical, with four longitudinally extensive thecae (TEXT-FIG. 11).



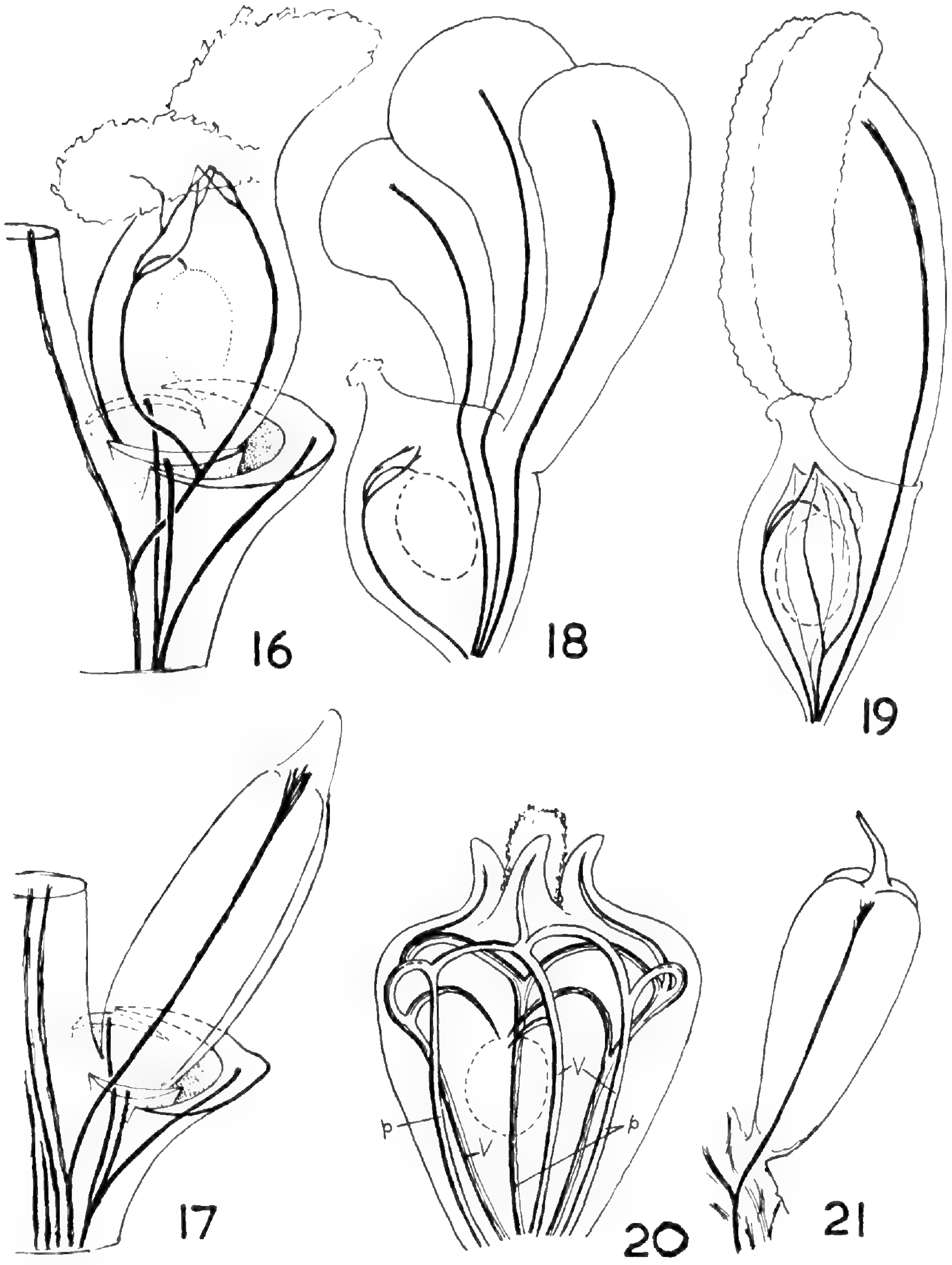
TEXT-FIGS. 10–15. FIG. 10. *Ascarina lanceolata*, female flower. FIG. 11. Same, male flower. FIG. 12. *Chloranthus Henryi*, flower. FIG. 13. *Hedyosmum orientale*, female flower. FIG. 14. Same, male flower. FIG. 15. *Sarcandra glabra*, flower.

The flowers of ***Hedyosmum*** differ from those of the other three genera in two important respects: (i) the male flower has no subtending bract or any other corresponding structure (TEXT-FIG. 14), and (ii) the female flower shows the presence of a cupuliform structure that encloses the solitary pistil and slightly projects beyond in the form of three deltoid emergences which have been generally believed to represent a perianth (TEXT-FIG. 13). The cupuliform perianth is free from the ovary wall for the most part, but is fused with the carpel along the three ridges and also at the substigmatic level. Such a flower is subtended by a relatively conspicuous bract, whose shape and size are subject to considerable variation; in some species it undergoes profound modifications into a tubular structure that almost completely envelops the flower (e.g. *H. calloserratum*); in *H. Artocarpus*, the bracts become distinguishable only with difficulty due to the extreme concrescence or fusion between the adjacent flowers and inflorescence axis. The pistil is sessile, styleless with a short, stumpy, tapering, hairy stigma. However, the characters of the latter structure generally vary between species. Unlike the other genera, the stigma is caducous in *Hedyosmum*.

Vasculature: The vascular anatomical features of the flowers of *Sarcandra* having already been described elsewhere (Swamy and Bailey, 1950), they will be referred to at present only when needed for comparison with the situation in other genera. In all the genera, the bract is vascularized by a single bundle that remains unmodified within the structure.

In *Chloranthus*, four bundles commonly traverse the flower — three on the abaxial side and one on the opposite side. The latter constitutes the ventral bundle, the extremity of which trifurcates, the median branch supplying the ovule and the other two diverging in the apical tissues of the pistil beneath the stigma; the former three abaxially disposed bundles run in the wall of the carpel, and at the point of attachment of the androecium deviate into the corresponding lobes and traverse almost the entire length of the structures (TEXT-FIG. 18). There is no vasculature corresponding to a dorsal bundle (Armour, 1906; Swamy and Bailey, 1950).

The pattern of vasculature in the flowers of *Chloranthus multistachys* deserves consideration here because of the presence of a single stamen with a quadrilocular anther as in the vesselless *Sarcandra*, in contrast to the trilobed staminal appendage with one quadrilocular anther and two bilocular ones as in the other species of *Chloranthus*. The dorsal bundle in this species also is absent; the stamen is supplied with just one bundle. The origin and behavior of the ventral bundle and the mode of vascular supply to the ovule conforms to the same pattern as in the other species of the genus. But the ovary contains two other bundles, each occupying a position in the wall between the bundle that supplies the stamen and the ventral bundle (TEXT-FIG. 19). These additional bundles soon bifurcate and the branches reach the apical extremity of similar branches of the ventral bundle and form anastomoses. In occasional cases, the flowers of this species bear a pair of small degenerate anthers one on either side of the larger median one (TEXT-FIG. 36). In such cases the median lobe is supplied with a single bundle as in the normal flowers, and two weakly de-



TEXT-FIGS. 16–21: GENERALIZED RECONSTRUCTIONS ILLUSTRATING PATTERNS OF VASCULATURE OF: — FIG. 16. Female flower of *Ascarina lanceolata*. FIG. 17. Male flower of the same. FIG. 18. Flower of *Chloranthus Oldhami*. FIG. 19. Flower of *Chloranthus multistachys*. FIG. 20. Female flower of *Hedyosmum nutans*. FIG. 21. Male flower of the same.

veloped bundles traverse the degenerate lobes to varying distances; and significantly, the lateral bundles in the ovary of such flowers are characteristically absent. This situation suggests, in all probability, that the lateral bundles in the ovary of normal flowers of *C. multistachys* may indeed represent the vasculature of the lateral lobes of the stamens which now, however, have been eliminated in this particular species, but are present in all the remaining species of the genus.

In the flowers of *Ascarina*, the bract or bracts (depending upon the species) receive(s) a single bundle each. A vascular strand of the inflorescence axis enters the female flower, and at the base of the pistil splits into two. One of the branches constitutes the dorsal bundle which generally exhibits a slender forking beyond the upper level of the locule. The other branch forms the ventral bundle whose behavior is similar to the situation in *Chloranthus*. At the base of the stigma, the branchlets of the dorsal and ventral bundles undergo anastomoses (TEXT-FIG. 16). In the male flower, the single stamen is supplied with one bundle that traverses the entire length of the connective and in the region of the conical apex, undergoes slight widening (TEXT-FIG. 17). In those species of the genus where the male flower bears two stamens, the strand for each stamen is independent and does *not* arise as a branch of any single strand of the inflorescence.

The female flowers of *Hedyosmum* exhibit a range of variability in structure, not only in relation to those of the other genera, but also among different species of the genus. The material that was available for present study consisted of only six species and no specimens of highly modified flowers, as those of *H. Artocarpus*, could be secured. Even the small number of species studied was enough to indicate that the number is inadequate as a basis for reliable conclusions in view of the variations shown by the vascular pattern. Therefore, the observations recorded here are of a provisional nature.

Transections at the base of the flower show six equidistantly arranged bundles in the form of a ring. As shown by Edwards (1920), three of these traverse the three corners of the so-called perianth (*p* in TEXT-FIG. 20). The remaining set of three occupies an alternating position with the outer set and run in the wall of the carpel (*v* in TEXT-FIG. 20). These are probably homologous with the ventral bundles of the carpels in other genera. At the fused level of the perianth (with the ovary wall) each of the six bundles bifurcates and the branches diverge to anastomose with similar adjacent members. From the point of bifurcation of the carpellary bundles, a short branch enters the deltoid apex of the perianth. The ovule receives three traces, one from each of the carpellary bundles (TEXT-FIG. 20), in sharp contrast to the single-trace situation in the other genera. The vascularization of the male flower closely parallels that of *Ascarina* — a single bundle traversing the entire length of the connective (TEXT-FIG. 21).

The salient trends in the floral vasculature of the four genera may be summarized as follows:

1. In the flowers of *Sarcandra*, the stamen is supplied with two bundles that originate *not* as a result of a dichotomy of a single strand, but independently of each other. Such an origin may be traced even from the lowest levels of floral axis, and often from a considerable distance in the inflorescence axis. Likewise, the ventral bundle of the carpel also has a "double" origin and similar course throughout the length in *S. glabra*; in *S. hainanensis*, however, the ventral bundle is single from the beginning (FIGS. 5–8, in Swamy and Bailey, 1950). The ovular supply is derived directly from the ventral bundle. The dorsal bundle of the carpel is also "double."

2. In the flowers of *Chloranthus*, the carpel does not possess a dorsal bundle; a single ventral bundle is present which trifurcates at the extremity, the median branch supplying the ovule. Each of the three lobes of the androecium receives a single bundle; these again are *not* the products of splitting of any single vascular strand of the inflorescence axis, but have independent origins.

3. In the female flower of *Ascarina*, the vasculature consists of a dorsal bundle and a ventral one, both arising by a simple forking of a strand from the inflorescence axis. The ventral branch, as in *Chloranthus*, splits into three at its apex, the median branch supplying the ovule. In the male flower the stamen receives a single bundle.

4. The stamen of *Hedyosmum* is supplied only with a single bundle much in the same manner as in *Ascarina*. The vasculature of the female flower is slightly complicated, obviously in conformity with the floral structure. The gynoecium is triangular in cross-section and receives three bundles, each running in a flat side of the wall; the ovule receives a small branch from each one of these bundles. Three bundles traverse the corners of the cupuliform structure (external to and partly fused with the gynoecium) that has been interpreted to be the perianth. The corners of this structure and of the gynoecium are opposite to each other but their respective bundles occupy alternating positions.

Such a situation in *Hedyosmum* raises two important considerations:

1. The morphological nature of the external cupular covering of the gynoecium. Clarke (1858), Solms (1869), Eichler (1878), Bentham and Hooker (1880), and others contend that this structure is of perianthial nature. Baillon (1871), while referring to the deltoid lobes as "wings," feels that their true nature is by no means decided. Edwards (1920) postulates that this whorl may represent three modified stamens, in view of the alternating arrangement of the vascular bundles belonging to the two categories of structures; but he himself rejects this hypothesis saying that "there is no definite evidence in favor of this view, since the earliest phases of the developing perianth show no essential peculiarities common to the perianth and to the stamens." It must be emphasized here, in view of the considerable range of morphological variability of floral structure evidenced in the genus as a whole, that the homology of this structure

cannot be clearly understood by the study of a limited number of species. An intensive investigation of wider representative material, both from ontogenetic and comparative aspects, may yield valuable data that would help towards a clearer understanding of the concerned structure.

2. The three corners of the gynoecium as well as of the enclosing cupular sheath have a corresponding number of vascular bundles in each; the ovule also receives three traces. Could these facts be employed to suggest a basically trimerous plan of construction of the flower? The floral structure in the other genera of the family does not provide evidence either for or against such a suggestion. It is interesting to note in this connection that the androecial structures in *Chloranthus* are also three. A study of families as Lauraceae, Gomortegaceae, Hernandiaceae, etc., may yield useful data towards a cogent explanation.

Have the flowers of Chloranthus a perianth?: Eichler (1878) claimed to have seen a small scale at the base of the insertion level of the staminal structure in some species of *Chloranthus*, and interpreted the scale as a perianth. Later, Čelakovsky (1900) expressed a similar view, however, adding that the structure was incomplete and reduced. Armour (1906) has identified a similar structure in *C. chinensis* (= ?*C. officinalis*) and believes it to be just a short outgrowth of the carpellary wall itself. She aptly observes that "in the structure of this minute scale nothing appears to justify giving it such importance." In the numerous specimens of almost all of the putative species of *Chloranthus* examined in the course of this investigation, no structure similar to a *scale* on the carpel or anywhere else on the flower has been observed. Some species that bear a relatively large staminal appendage (e.g. *C. Fortunei*, *C. angustifolius*, *C. multistachys*, etc.) often show a slight abaxial deformation of the carpel in the form of a minute projection or fold beneath the point of attachment of the stamen. This feature is seen in an exaggerated degree in *Sarcandra Irvingbaileyi* (Swamy, 1953a), where the wall of the carpel surrounding the base of the large stamen appears as a cushion. When such flowers are subjected to drying, the deformed part becomes much more pronounced and at times may appear as a small protuberance. The structures reported by Eichler and Čelakovsky are obviously such "artifacts." The features in the vascular anatomy of the flowers also fail to provide evidence for the presence of a rudimentary perianth. Therefore it becomes obvious that the existing flowers of *Chloranthus* do not bear any structures that could be identified or interpreted as perianth.

Are the flowers of Chloranthus and Sarcandra reduced inflorescences?: Cordemoy (1863) considered that a single flower of *Chloranthus* is in reality an inflorescence, in which the axis bears at its extremity a single female flower composed of a naked ovary, and laterally in the axil of the bract a little glomerulous (biparous sessile cyme) of male flowers, represented by a bilocular stamen, or by unilocular stamens. An essentially similar view has been maintained by Hooker (1890), but in a slightly modified version — that the male inflorescence is reduced to a single flower (in contrast to a biparous sessile cyme of Cordemoy). As long ago as 1869, Solms ascribed a hermaphroditic nature to the flowers of *Chloranthus* (in which was included *C. brachystachys* = *Sarcandra glabra*), a view which was accepted by Baillon (1871) and by a number of later botanists.

It may be pointed out here that, if the individual flower represents an extremely reduced inflorescence, the axis of the flower (which should be homologous with the inflorescence axis itself) often reveals the presence of either modified supernumerary structures externally, or abnormal behavior in the course of vascular bundles, or various combinations of these features. For example, the view that the so-called male and female flowers of *Cercidiphyllum* (Swamy and Bailey, 1949) as found today are, in reality, vestiges of once elaborate inflorescences is amply supported not only by data provided by comparative morphology, but also by the invariable presence of supernumerary vasculature; furthermore, additional confirmatory evidence has come from palaeobotanical findings. In *Chloranthus*, one fails to see any arguments for upholding the views of Cordemoy and Hooker. Although it is true that the vasculature of the flowers is, in general, much reduced and simplified — as also external floral structures which have disappeared — this does not necessarily imply that a single flower should represent the sole vestige of an inflorescence; nor that the flower is a fused product of highly reduced male and female inflorescences. Therefore, in the absence of critical and convincing evidence in favor of Cordemoy's interpretation, and in light of the presence of a well organized compound spike type of inflorescence in the extant representatives, it appears rational to consider (as a majority of botanists do) that the existing flowers are individual bisexual flowers, which of course have undergone reduction with reference to the perianth whorl, but are not reduced or composite inflorescences.

Pollen: The pollen grains of *Chloranthus* are subspherical, measuring on an average 22.5 × 30.0 μ along the shorter and longer diameters. The grains of the other genera are mostly spherical, 28 μ in diameter in *Sarcandra*, 30 μ in *Ascarina* and 35 μ in *Hedyosmum*. The grains of *Sarcandra* have no special germinal areas, and hence are acolpate. Those of *Ascarina*, on the other hand, show a typically monocolpate structure. The germinal furrow or colpa extends to the poles and is of a rather uniform width throughout with bluntly rounded off polar extremities. The pollen grains of *Chloranthus* show a polycolpate condition with considerable modifications. The number of colpa per grain varies between three and five in *C. serratus* and six and eight in *C. angustifolius*. The extent of furrow is rather restricted both in longitudinal and latitudinal dimensions. Although in a few instances the furrows may reach the polar regions (e.g. *C. Fortunei*) they often stop short at varying distances, appearing as slender, unsculptured, wavy, meridional streaks. In some species as *C. serratus*, the furrows can be distinguished only as very faint, tenuous, short zig-zag lines. In *Hedyosmum* also the grains are generally polycolpate, the characters of the germinal furrows resembling those of *Chloranthus*. However, modifications appear to have progressed along two lines: (i) localization of furrows towards either one pole whereby often the ends become contiguous, or towards a restricted facet of the sphere whereby the furrows place themselves close together (e.g. *H. domingense, H. calloserratum*, etc.); and (ii) reduction in the number and size of the furrows resulting in acolpate grains (e.g. *H. nutans*, certain collections of *H. arborescens*). The intine of *Ascarina* pollen is relatively thick excepting at the region of the furrow. The exine exhibits a minute, faint, rather uniformly distributed pitted-reticulate sculpturing; the external surface of the furrow (intine) shows mildly speckled protuberances. The grains of *Sarcandra* possess a coarsely reticulate pattern of sculpturing on the exine; those of *Chloranthus* (see illustrations in Swamy and Bailey, 1950) and *Hedyosmum* show successively finer grades of reticulate-pitted sculpturing.

THE ANDROECIUM IN CHLORANTHUS

The possession of vessel-bearing xylem, of bisexual flowers, and of a three-partite androecium distinguish *Chloranthus* from the other generic units of the family. As mentioned on a previous page, the androecial appendage is subject to considerable morphological variability, the types of variations being one of the major criteria in segregating the species. Detailed accounts of these structures are contained in taxonomic or regional monographs issued from time to time, the most recent one being that of P'ei (in Sinensia, IV [1935] 665) wherein he has included all of the Chinese representatives of *Chloranthus*. Therefore, only the salient points of structure will be mentioned here.

In general, the androecium is essentially a three-lobed structure, the median lobe bearing a "full"-anther (four-celled when young and bilocellate at maturity) and each lateral lobe a "half"-anther (two-celled when young and unilocellate at maturity). The lobes are placed adjacent to one another on the abaxial side of the carpel. Variations of this norm are brought about by one or several of the following factors: (i) the mature length and shape of the individual lobe; (ii) the degree of cohesion of the basal region of the lobes; (iii) the width between the pairs of sporangia on the median lobe; (iv) the location of sporangia on the lobe; (v) the degree of fertility of the sporangia on the median or on the lateral lobes; and (vi) the fleshy or foliose character of the lobes, etc.

The individual lobes of the androecium in *C. Oldhami* and *C. Henryi* (Text-figs. 44, 45, 22, 23) are completely free from one another and each lobe, although differing in general outline in the two species, bears a striking resemblance to a stamen of *Austrobaileya* (Bailey and Swamy, 1949). Thus, the microsporophyll is ovate or broad-lanceolate in outline, somewhat fleshy, and the slightly protuberent sporangia are situated nearer to the base; the median lobe in particular shows a greater degree of similarity to the stamen of *Austrobaileya* in possessing two pairs of sporangia. In *C.*

Henryi all the four sporangia lie close together (TEXT-FIG. 23) and in *C. Oldhami* (TEXT-FIGS. 44, 45) the two pairs are slightly separated.

The staminal appendages of *C. serratus* (TEXT-FIGS. 27, 28) exhibit an early step in the cohesion of the adjacent lobes. The individual lobes have the same general form as that of the two species just mentioned, but the two pairs of sporangia on the median lobe occupy a position nearer to the apex of the microsporophyll (TEXT-FIG. 28). The lobes have concave adaxial and convex abaxial surfaces and all the three lobes together form an incipient hood over the pistil (TEXT-FIG. 27). A much more important modification lies in the cohesion of the basal parts of the three lobes (TEXT-FIG. 28). This tendency finds an extreme expression in the androecial structures of *C. officinalis* (TEXT-FIGS. 24–26) and *C. spicatus* (TEXT-FIGS. 31–33). Here, the anthers of the middle lobe are disposed nearer to the apex, and although the basal cohesion has not progressed much farther, the hood-formation has reached such a pronounced development as to envelop the distal half of the pistil almost completely. In *C. officinalis*, the median lobe has a single pointed apex, while that in *C. spicatus* has a mildly tridentate apex (compare text-figs. 26 and 32) — only a small difference morphologically, but a major criterion in the segregation of the two species.

The androecium of *C. multistachys* appears to illustrate the end product of another trend of modification. The median lobe alone is represented normally (TEXT-FIGS. 34, 35) and the microsporophyll is extremely reduced, being restricted only to the abaxial side and delimited by the outline of the sporangia. The anther, however, is quadrilocular as in the median lobe of other species. The lateral lobes develop only occasionally (TEXT-FIG. 36), but remain free, insignificant, and sterile. Another minor trend associated with the anther of this species is the possession of a papillate epidermis over the sporangia.

Chloranthus angustifolius, *C. Fortunei*, and *C. japonicus* reveal still another line of morphological modification. The androecial lobes become comparatively much more elongated than in other species, and their confluent base becomes rather pronounced (TEXT-FIGS. 29, 30, 41, 42). In *C. Fortunei*, the pairs of sporangia on the median lobe occupy a position

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TEXT-FIGS. 22–45. ILLUSTRATIONS OF FLOWERS OF *Chloranthus* SPECIES WITH PARTICULAR REFERENCE TO ANDROECIAL STRUCTURES. FIG. 22. *Chloranthus Henryi*, abaxial view. FIG. 23. Same, adaxial view. FIG. 24. *C. officinalis*, abaxial view. FIG. 25. Same, side view. FIG. 26. Same, adaxial view. FIG. 27. *C. serratus*, side view. FIG. 28. Same, adaxial view. FIG. 29, *C. Fortunei*, abaxial view. FIG. 30. Same, adaxial view. FIG. 31. *C. spicatus*, abaxial view. FIG. 32. Same, adaxial view. FIG. 33. Same, side view. FIG. 34. *C. multistachys*, side view. FIG. 35. Same, adaxial view. FIG. 36. Same, adaxial view of an abnormal flower with additional sporangia. FIG. 37. *C. japonicus*, adaxial view of a flower with sterile sporangium on the median lobe. FIG. 38. Same, abaxial view. FIGS. 39, 40. Same, with sporangia only on the lateral lobes, adaxial view. FIG. 41. *C. angustifolius*. adaxial view. FIG. 42. Same, abaxial view. FIG. 43. *C. Oldhami*, abaxial view. FIG. 44. Same, adaxial view. FIG. 45. Same, individual lobes.


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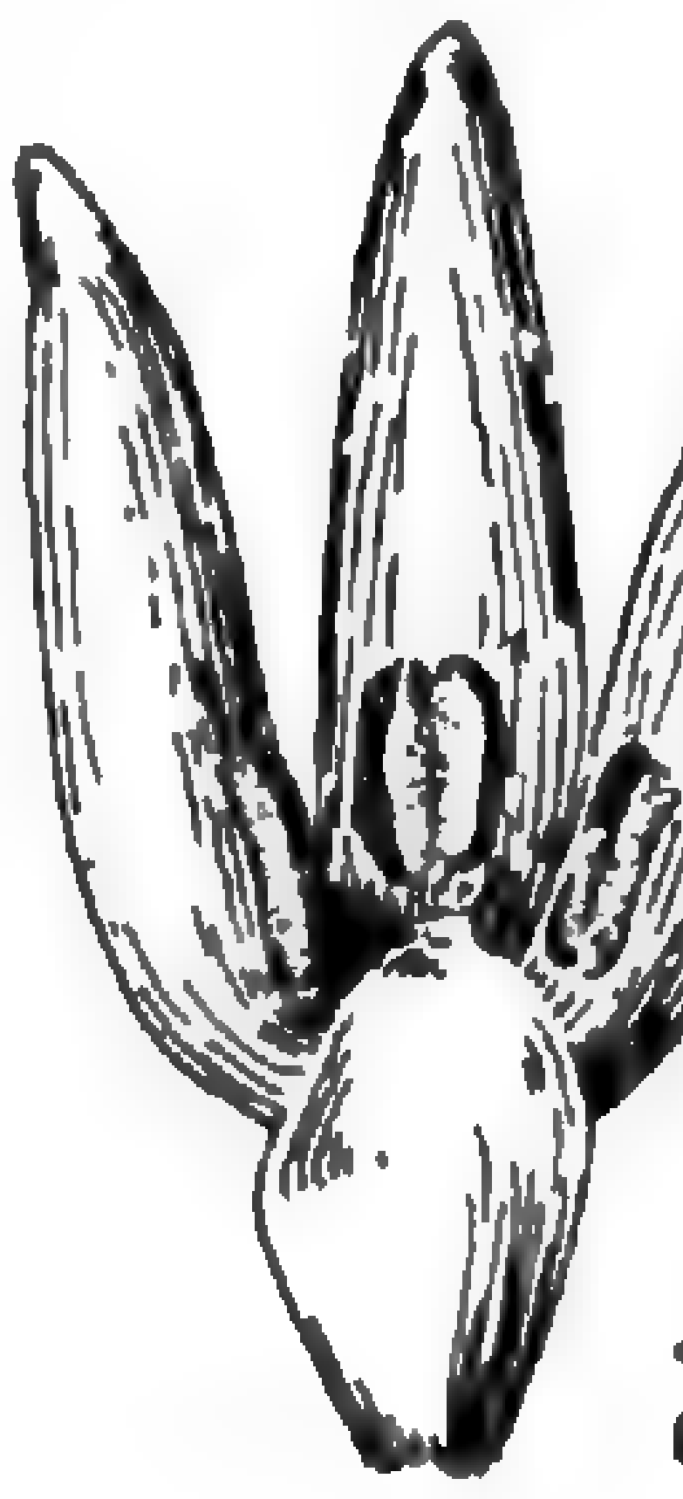
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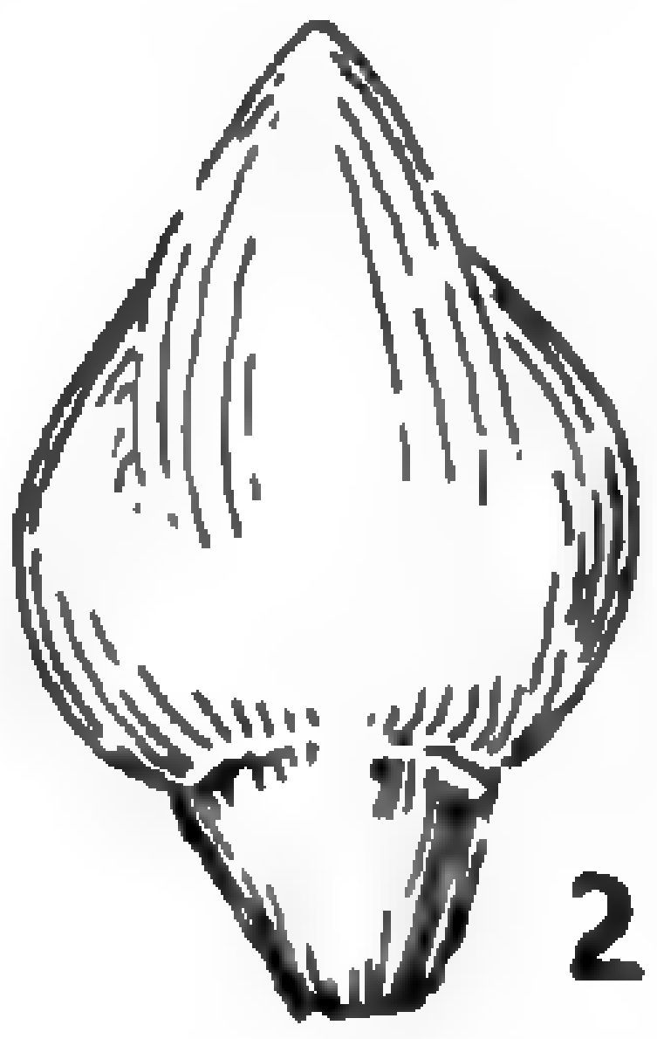
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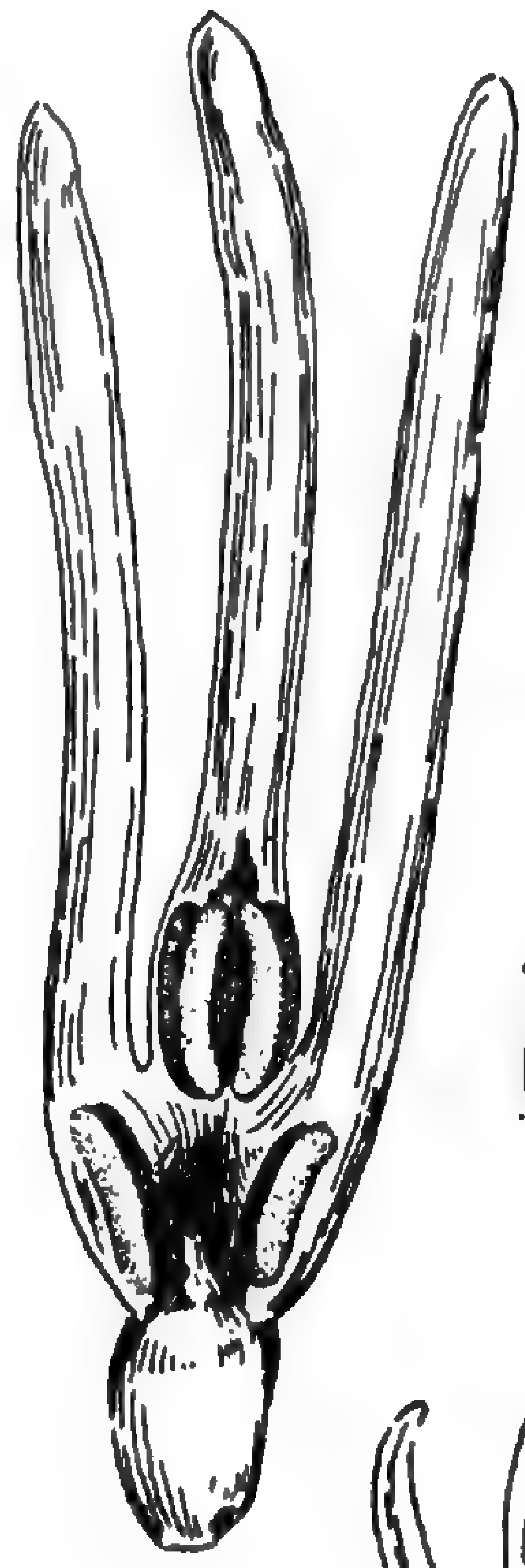
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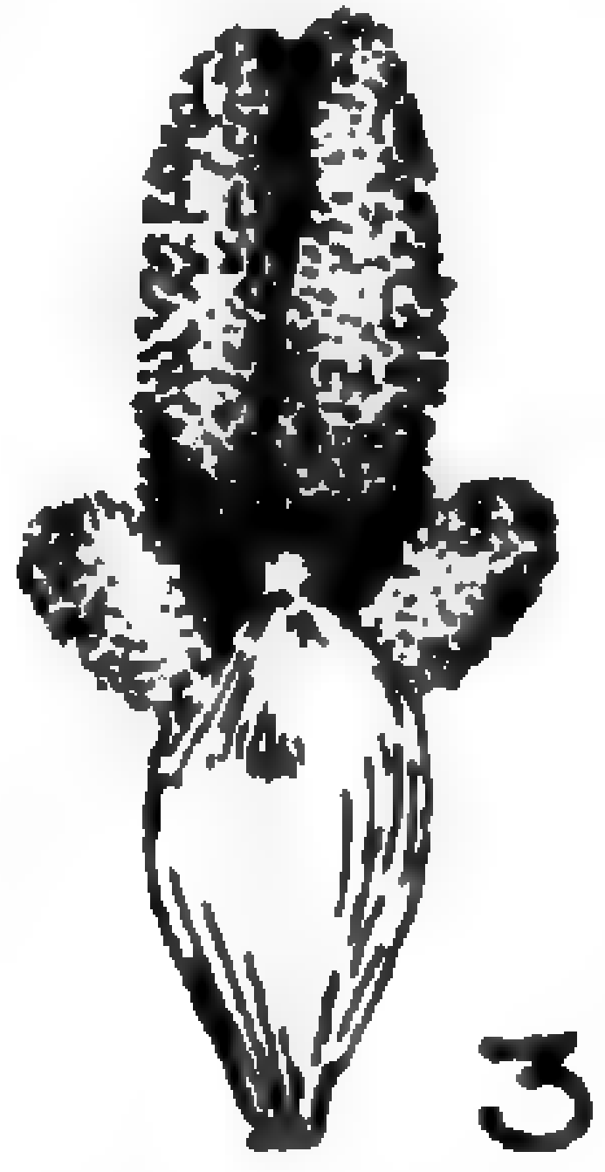
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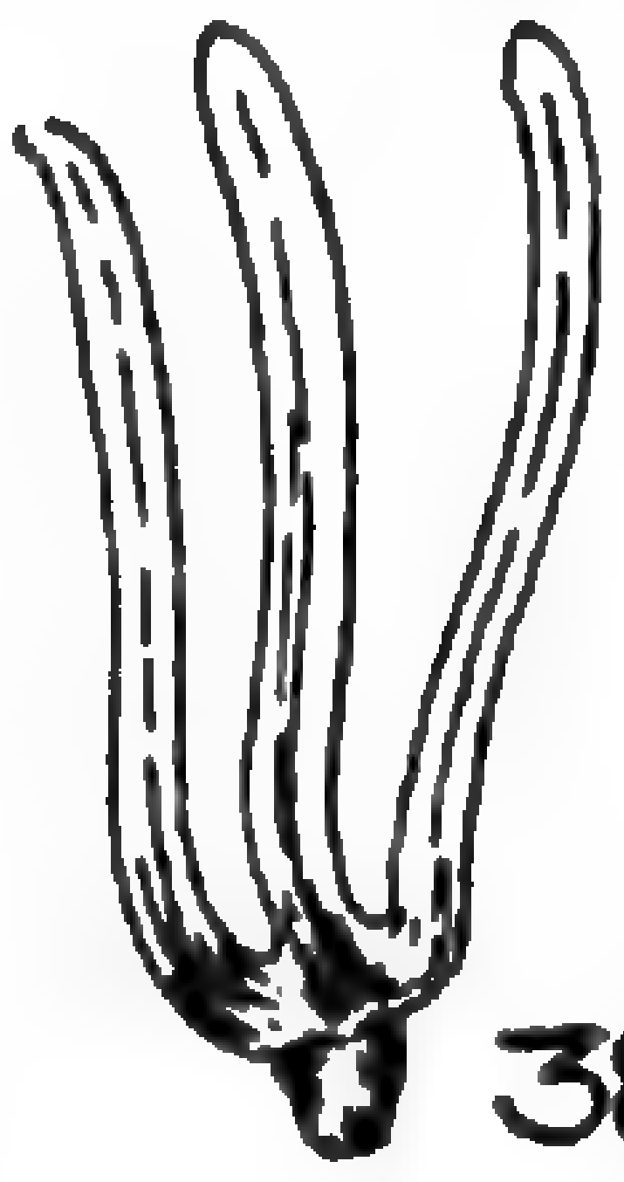
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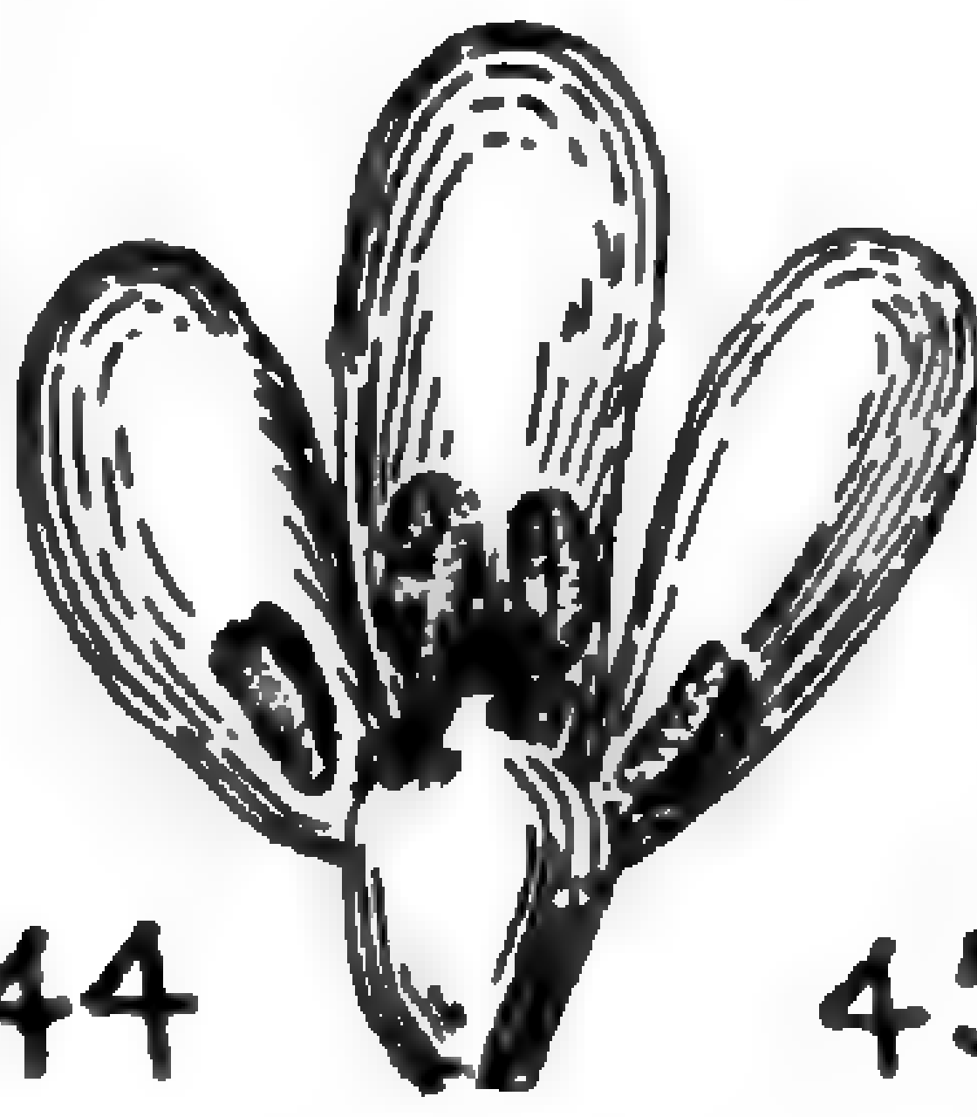
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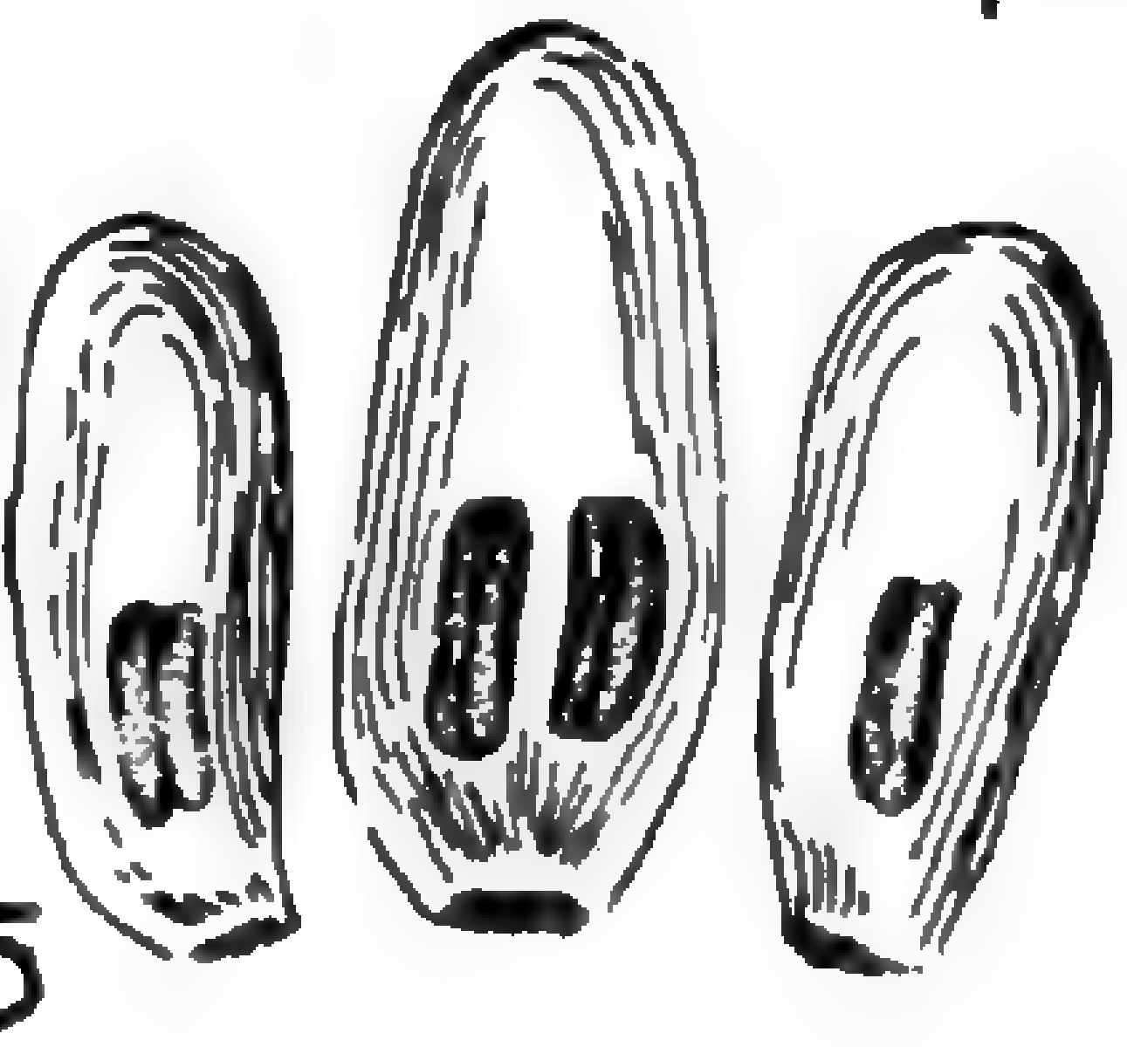
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on the adaxial surface (TEXT-FIG. 30); all the four pairs of sporangia are of the same size, develop to maturity, and produce fertile pollen. The two pairs of sporangia on the median lobe of *C. angustifolius* are small, degenerate, and sterile, only the larger "half"-anthers being functional (TEXT-FIG. 41). This tendency attains a further degree of accentuation in the androecium of *C. japonicus*. Thus, the median lobe bears a single pair of degenerate sporangia only occasionally (TEXT-FIG. 37), the general condition being its total absence; the sporangia borne on the lateral lobes are the functional ones (TEXT-FIGS. 37, 39, 40).

The androecial structures of other species of the genus not mentioned here fit into one or other of the modifications mentioned above.

Whether the androecium of *Chloranthus* represents a single stamen with four pairs of sporangia or three independent stamens that have undergone fusion with one another towards their base, has remained a major controversial issue. A critical perusal of taxonomic descriptions of the different species (which is the only source of information available on this topic) clearly demonstrates that the words stamen and anther have been employed in highly ambiguous and indiscriminate usages. Understanding *stamen* to mean "one of the pollen-bearing . . . organs of the flower," and *anther* to mean "polliniferous part of a stamen" (as defined by Asa Gray in his "Elements of Botany," 1877, and by many other classical writers), there appear to be the following opinions expressed in regard to the morphological nature of the androecium:

(1) that it consists of a *single stamen* which has developed three lobes, the median lobe bearing two pairs of sporangia and each of the lateral lobes a single pair (Nakai, Fl. Sylvat. Koreana, XVIII [1930] 16; and others).

(2) that it consists of *three stamens* that are connate towards the base, the number and distribution of sporangia similar to the above condition in (1) (Bentham and Hooker, Gen. Pl. III [1880] 134; Cordemoy in Adans. III [1863] 296; Hemsley in Jour. Linn. Soc. Bot. XXVI [1891] 367; Asa Gray in Perry, Jap. Exped. II [1857] 318; etc.).

(3) that it consists of *three anthers* (= a single stamen as in (1) ?) fused at the base; the median one is bilocular and the lateral ones unilocular (Hamilton in Edinb. Jour. Sci. II [1825] 11; Solms, in DC. Prodr. XVI [1869] 476; etc.).

(4) that it consists of a *single tripartite anther* (= one stamen as in (1) ?) (Oliver in Hook. Ic. XXII [1886] *t. 1580*; Pampanini in Nuovo Giorn. Bot. Ital. N.S. XXII [1915] 272; etc.).

(5) that it consists of a *three-lobed filament* (= of a single stamen as in (1) ?) (Wight, Ic. IV [1853] *t. 1945*).

Merrill (Philipp. Jour. Sci. Bot. VII [1912] 259; ibid. X [1915] 3) uses the non-committal term "*anther scale* . . . divided nearly to the base into three lobes" or "antheriferous scale 3-partite," possibly implying that the androecium is made up of a single stamen. P'ei (Sinensia, IV [1935] 666) uniformly designates the male structures by the phrase, "anthers connate by connectives." This epithet is rather unfortunate (from the morphological point of view) as there is no certainty as to the number of stamens involved.

However, leaving aside the ambiguous instances as in the preceding paragraph, as well as the clauses (3) to (5) above, the consensus of opinion is divided between two schools that deserve further consideration. The first school contends that the androecium is represented by a single stamen (see (1) above) bearing four pairs of sporangia, two on the median lobe and one on each of the lateral lobes. According to this postulate, it is necessary to assume that the immediate ancestral type of stamen (whatever its exact shape might have been) possessed four pairs of sporangia, that the trifurcation commenced at the apex, that the cleavage progressed basipetally and between the lateral pairs of sporangia to result in a median quadrilocular and one bilocular lobe on either side (see the upper series of diagrams in text-fig. 46). According to the second school (see (2) above), the starting point would be an androecium consisting of three independent stamens, the median one lodging a quadrilocular anther and the lateral ones bearing bilocular anthers; during phylogeny, the bases of the stamens have become fused to result in the existing form (see the lower series of diagrams in text-fig. 46).

Both these views leave certain points unanswered. For example, how did the eight-locular stamen — the ancestral form according to the first school, or the two two-locular stamens — the starting point for the second school originate? Are these necessarily the true ancestral norms or do they in reality represent products of preceding phylogenetic changes? An answer to such questions would be only futile speculation. Of course, the advocates of the "Telome theory" may come forward with a ready explanation for the origin of the eight-locular stamen, that it represents a sort of a syntelomic modification which has resulted in response to the interplay of one or several of the principles that have been believed to be the operating factors in phylogenetic specialization, perhaps planation and fusion of two or more basic telomes in the present case. It is obvious that we do not have any evidence to make an *a priori* assumption of this nature, particularly where angiosperms are involved. It must be observed that the supposed existence of three independent stamens as the starting point (as envisaged by the proponents of the second school) obviously does, in all probability, represent a derived stage of preceding evolutionary modifications. The evidence for this statement is exemplified in the lateral stamens each of which bears only a bilocular anther, the other counterpart having become eliminated. It must be emphasized in this connection that such a tendency towards the degeneration or elimination of anthers is seen also among some living species of *Chloranthus* (e.g. *C. angustifolius*, *C. japonicus*, etc.).

Now, in regard to the actual steps involved in the derivation of the extent situation either from an eight-locular stamen (first school) or from three independent stamens (second school), let us consider the available evidence: —

First school: There are several serious obstacles to acceptance of such a method of derivation:

(i) The starting point as well as the second stage (see the upper series of diagrams in text-fig. 46) are purely hypothetical.

(ii) The trend of development does not explain why the cleavage should have taken place only between the lateral pairs of sporangia.

(iii) The pattern of vasculature of the androecium is not in keeping with the "split" or "partite" nature of a single stamen.

(iv) Ontogenetically, the androecial primordium does not start out as a single growing point and trifurcate at a later date,* as one may reasonably expect to be the situation according to this school of thought.

(v) The sequence of events is rather complicated and illogical.

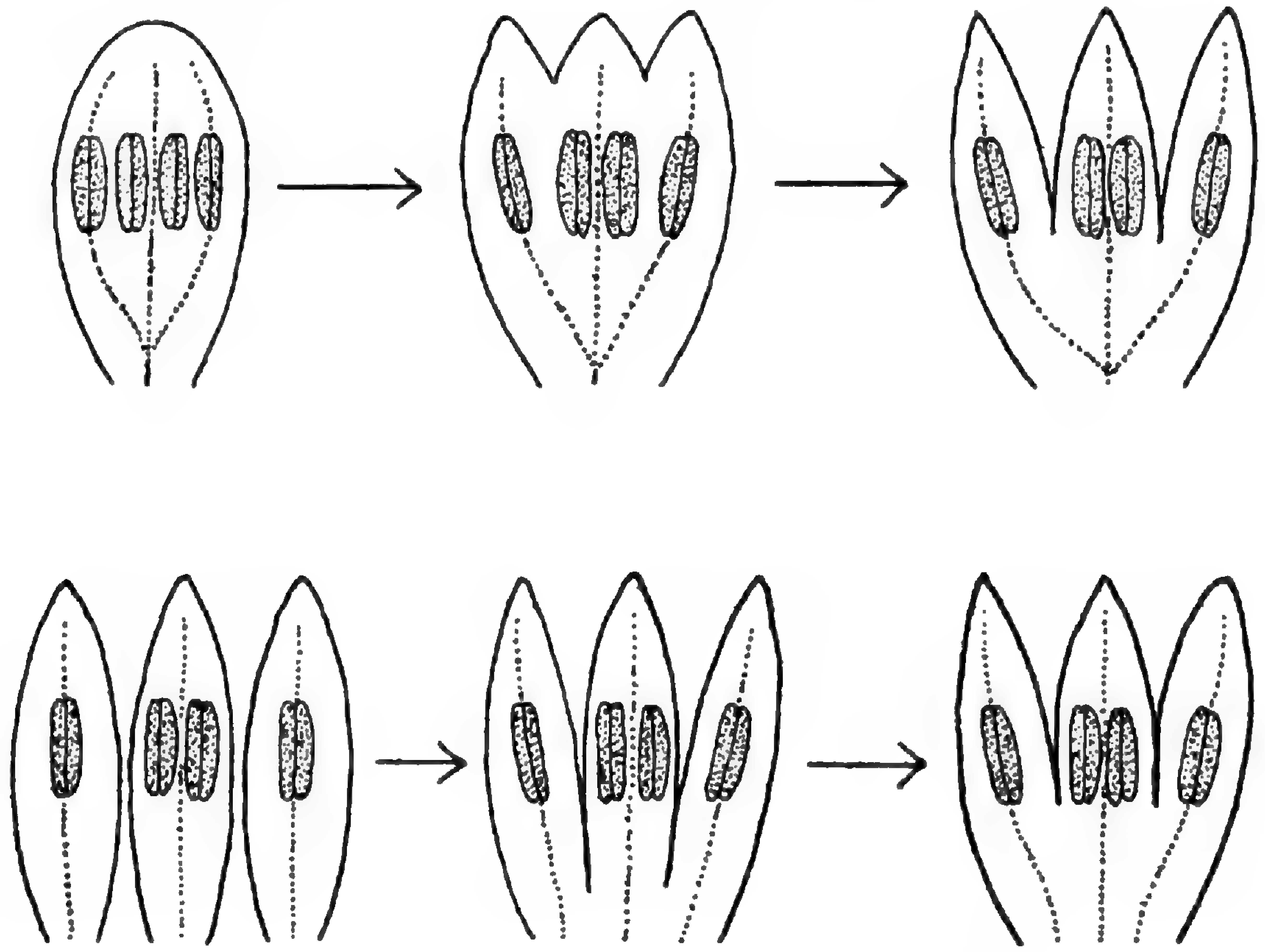

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FIG. 46. Diagrams to illustrate the derivation of the androecium of *Chloranthus* according to the two current schools of thought. For explanation, see text.

Second school: There appear to be a number of features in favor of this type of derivation:

(i) All the stages depicted in the lower series of diagrams in text-fig. 46, are actually the existing conditions among the several species of the genus, and no hypothetical steps are involved.

(ii) The trilobed appearance can be easily explained as being a resultant of lateral fusion of the bases of the three stamens.

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* Payer, 1857, p. 422; also unpublished observations by the author on *C. spicatus* and *C. japonicus*.

(iii) Each of the three stamens receives one vascular bundle; the bundles have independent origins in the eustele of the inflorescence axis, and are not branches of any one single "fascicular strand."

(iv) Ontogenetically, the primordia of the three stamens are separate from the beginning, the basal cohesion becoming apparent only during later stages.*

(v) The sequence of events is relatively simple, direct, least involved and in harmony with other types of evidences.

Thus, a totality of available evidence appears to afford considerable support for the second school of thought, — that is, to regard the androecial structure of *Chloranthus* as being constituted of three stamens. Whether this interpretation would help towards an understanding of the morphological nature of the "stamens" and "staminal appendages" that are encountered in the families Monimiaceae, Gomortegaceae, and Lauraceae, or whether the so-called appendages of the stamens in these families are *"de novo"* structures as proposed by Kasapligil (1951) for *Umbellularia* and *Laurus* of the latter family, will be discussed in future contributions.

COMPOSITION OF THE FAMILY

The exomorphic and endomorphic characters of both vegetative and reproductive structures in the family exhibit diverse levels of evolutionary modifications. Thus, while the xylem of *Sarcandra* has retained a vesselless nature and that of other genera a decidedly low level of structural specialization, the reproductive structures of all four genera illustrate in general advanced stages of phylogenetic modifications involving a total loss of perianth whorls (excepting perhaps in *Hedyosmum*), and a reduction in the number of essential organs per flower. The rather lax arrangement of flowers on the inflorescence axis in *Sarcandra, Chloranthus,* and *Ascarina* has shifted over to a more compact aggregation in *Hedyosmum,* and in some species of this genus this tendency culminates in the fusion of individual flowers with one another and with the inflorescence axis. In all the genera, the gynoecium is represented by a single pistil, and the androecium, by three stamens (*Chloranthus*), or two (species of *Ascarina*), or one (species of *Ascarina,* and *Hedyosmum*). The flowers of *Chloranthus* and *Sarcandra* are bisexual, whereas those of the other two genera are unisexual. Although the pollen grains of *Sarcandra* are acolpate with a coarsely reticulate sculpturing of the exine, a tendency towards the elimination of the germinal furrows and towards the development of finer grades of similar sculpturing are strongly seen in *Chloranthus* and *Hedyosmum*; *Ascarina* possesses typically monocolpate pollen. Structural characters of the vegetative parts of the different genera also exhibit several trends of modification. The leaves of *Ascarina* are supplied with two strands of vascular tissue from a single "gap"; in *Hedyosmum*, the two strands undergo precocious splitting and recombination so that there are five leaf-

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* See foot-note on the preceding page.

strands at the nodal level; in *Chloranthus* and *Sarcandra*, not only this tendency is present, but also the addition of marginal strands originating from two "common gaps." The stipules of *Sarcandra, Chloranthus,* and *Ascarina* are small and denticular, whereas those of *Hedyosmum* are comparatively larger and variously fringed. The stomata of *Sarcandra* and *Chloranthus* have their subsidiary cells oriented parallel to the guard cells, while those of *Ascarina* and *Hedyosmum* have a rosette of ordinary epidermal cells. Although the evolutionary gap between the vesselless xylem of *Sarcandra* and the vessel-bearing xylem of the other genera is considerable, in the latter group the general level of specialization of the tracheary cells has remained relatively primitive. Among the many tissues of the xylem also there are minor divergences; for example, the retention of essentially erect cells in the mature multiseriate rays and the vasicentric distribution of wood parenchyma in *Hedyosmum*.

Furthermore, there are the following characters or trends shared by all the four genera: decussate phyllotaxy; petiolar bases of opposite leaves fused to form a vaginate sheath; serrate-dentate leaf margin; absence of typical palisade tissue in the leaf; unilacunar node or a type derived therefrom; an essentially "double" median strand of the leaf; presence of "ethereal oil cells" in the parenchymatous tissues of stem, leaf, and flower; a fundamentally similar type of inflorescence with little or no variation; highly reduced floral parts with a single pistil of a uniform shape and construction; absence of perianth; single orthotropous ovule with two integuments and massive nucellus, hanging from the apex of locule; seed with a relatively small embryo and abundant endosperm.

It will be clear from the account in the preceding two paragraphs that the relative rates of specialization of the different organs and tissues in the four genera are by no means synchronized. Every one of the genera exhibits a combination of most of the characters or trends as mentioned above; also, it often happens that one or two characters or trends may be lacking in any one genus while they are always, either as such, or with slight modifications, present in the other genera. This situation is indicative of a relatively intimate reticulate relationship among the generic units. Therefore any attempt to remove from the Chloranthaceae either *Sarcandra* solely upon the basis of its having a vesselless xylem, or *Hedyosmum* on account of its possession of a so-called perianth, or any other genus upon some other slender basis, would be unwarranted. Nor is it justifiable to arrange the genera in a definite sequence to imply that one is directly derived from the other. In other words, all the available evidence emphasizes the desirability of treating the four genera as members of a single family.

Whether the genera should be further classified under sectional heads within the family, or should be left as such depends largely upon the degree of emphasis given to the taxonomic characters employed by the proposer. It should be noted, however, that there are several characters that may be employed as sectional criteria, if one is intent upon such a classification. But any such classification is bound to be artificial, because the relative rates of evolutionary modifications in the different parts and tissues of the four genera are at variance, and the interrelationships of the genera are profusely reticulate. Furthermore, the number of genera in the family being small, there do not appear to be cogent reasons for recognizing categories within the ranks of the family.

However, an artificial key for the ready identification of the genera is by no means undesirable. Four examples are given below, which further exemplify the reticulate nature of the interrelationships:

I. **Key based on the type of sex-expression and on floral structure.**

- Flowers bisexual.
  - Stamen 1. . . . . . . *Sarcandra.*
  - Stamens 3. . . . . . . *Chloranthus.*
- Flowers unisexual.
  - Male flowers bracteate. Female flowers naked. . . . . . . *Ascarina.*
  - Male flowers ebracteate. Female flowers enveloped by a cupule. . . . . . . *Hedyosmum.*

II. **Key based on the habit and characters of the xylem.**

- Habit suffrutescent, or herbaceous.
  - Xylem vesselless. . . . . . . *Sarcandra.*
  - Xylem vessel-bearing. . . . . . . *Chloranthus.*
- Habit arborescent or shrubby.
  - Cells of mature multiseriate rays square to procumbent, appearing as somewhat isodiametric in tangisection. . . . . . . *Ascarina.*
  - Cells of mature multiseriate rays upright to square, appearing vertically elongate in tangisection. . . . . . . *Hedyosmum.*

III. **Key based on the characters of the androecium and the pollen.**

- Stamens 1, club-shaped or discoid; anther quadrilocular.
  - Pairs of sporangia separated by connective; pollen acolpate with a coarsely reticulate exine. . . . . . . *Sarcandra.*
  - Pairs of sporangia close together, latrorse; connective ending in a conical or pointed apex.
    - Pollen grains monocolpate. . . . . . . *Ascarina.*
    - Pollen grains polycolpate to acolpate. . . . . . . *Hedyosmum.*
- Stamens 3, basally connate; median one bearing two pairs of sporangia, and each of the laterals a single pair; pollen polycolpate. . . . . . . *Chloranthus.*

IV. **Key based on the nodal anatomy and characters of the pith.**

- Nodes typically of the unilacunar type.
  - Vascular strands of the leaf two, of equal size (at the nodal level). . . . . . . *Ascarina.*
  - Vascular strands of the leaf five, lateral pairs larger, median strand smaller (at the nodal level). . . . . . . *Hedyosmum.*
- Nodes of a modified unilacunar type.
  - Clusters or diaphragms of stone cells absent in the pith. . *Chloranthus.*
  - Clusters or diaphragms of stone cells present in the pith. . . *Sarcandra.*

The distinctive combination of characters of each genus may be briefly mentioned as follows:

1. **Ascarina** Forst. Trees, dioecious; xylem vessel-bearing, but retaining a relatively unspecialized level; node unilacunar and related to two

leaf strands; no stone cells in pith; flowers subtended by 1 or 3 bracts; perianth absent; male flower: stamen 1; female flower: pistil 1, with an unequally bilipped sessile stigma; pollen monocolpate with minutely reticulate-pitted exine and warty-papillate intine in the region of colpa.

GEOGRAPHICAL DISTRIBUTION: The Philippines, Malaysian and Polynesian Islands.

2. **Chloranthus** Sw. Suffrutescent or perennial to annual herbs; xylem vessel-bearing, but retaining a relatively unspecialized level; node of a modified unilacunar type, the marginal strands of opposite leaves originating from two "common gaps"; three leaf strands related to the median "gap"; no stone cells in pith; flower bisexual, subtended by a single bract; pistil 1, stigma capitate and sessile; stamens 3, basally confluent and partly adnate to pistil; median stamen with two pairs and lateral ones each with a single pair of sporangia; pollen polycolpate with ill-defined, irregularly distributed, and somewhat reduced germinal furrows; sculpturing of exine finely reticulate-pitted.

GEOGRAPHICAL DISTRIBUTION: Essentially in South-eastern China, two or three species extending eastwards into Japan and southwards into the Philippines, Burma and Indonesia.

3. **Hedyosmum** Sw. Trees or shrubs; xylem vessel-bearing, but retaining a decidedly low level of specialization; node unilacunar, related to five leaf strands; flowers unisexual; subtending bract in the male flower absent; stamen 1; female flower: "perianth" cupular, adnate at the neck of the pistil; pistil 1, style absent, stigma short, tail-like, papillose; pollen polycolpate to acolpate; colpa ill-defined and reduced; sculpturing on the exine finely reticulate-pitted.

GEOGRAPHICAL DISTRIBUTION: Essentially in Central and Latin America, only one species in the Far-east.

4. **Sarcandra** Gardn. Suffrutescent; xylem vesselless; nodal structure as in *Chloranthus*; subtending bract of flower 1; flower bisexual; pistil 1; stigma sessile, capitate; stamen 1, quadrilocular, partly adnate to pistil; pollen acolpate; exine with a coarsely reticulate sculpturing.

GEOGRAPHICAL DISTRIBUTION: Southern China, Japan, the Philippines, Malay Peninsula and Archipelago, Assam, Indo-China, South India, Ceylon.

AFFINITIES OF THE FAMILY

An historical resume of the family with particular reference to its presumed relationships suggested from time to time has been given by Thierry (1912). A synoptic review of literature reveals that prior to the establishment of the family Chloranthaceae by Bentham and Hooker (Gen. Pl. [1880] 134), *Chloranthus* was relegated to the Loranthaceae by Jussieu, and to the Caprifoliaceae by Sprengel; and that after the creation of the family to accommodate the three genera, *Ascarina*, *Chloranthus*, and *Hedyosmum*, the following views have been expressed as to the relationships of the family:

(1) Brongniart placed it in his Santalinae, stressing the similarity be-

tween the two groups as evidenced in the absence of corolla, single ovary, calyx adnate to ovary, and suspended ovules. The last character is obviously unfortunate because, in the Santalales, the ovules are suspended from the apex of a basal pillar-like placental column, whereas in the Chloranthaceae the ovules arise directly from the roof of the locule.

(2) Endlicher, because of the presence of naked flowers, unilocular ovary with an orthotropous ovule, and drupaceous fruit treated the family as being related to the Ceratophyllaceae. Cordemoy also agreed with this view.

(3) Van Tieghem classified the family (together with the Ceratophyllaceae) among the apetalae, distinguishing the Platanaceae and Chloranthaceae only on the possession of an achene in the former family and of a drupe in the latter.

(4) Lindley placed the family in his 39th group, the Piperales, the segregation being based upon the possession of erect ovule and of opposite or alternate leaves with or without stipules in the "Piperinae," and the possession of suspended ovule and opposite leaves with intermediate stipules in the Chloranthaceae. *This view has been universally maintained ever since by botanists in general.*

(5) Hallier also first (1905) followed Lindley, but in a later contribution (1912) suggested a relationship to the Monimiaceae.

Almost all proposals mentioned above in regard to the affinities of the family are based upon characters obtained through a study of specific selected parts of plants, and with an especial emphasis on similarities of such parts between the groups concerned. It is becoming increasingly evident that any proposal involving the phylogeny of an individual or of a group not based upon a summation of evidence from *all* parts of the plant in the first case, or in addition, from at least a majority of representatives in the second case, is unreliable. Likewise, an excessive emphasis on mere resemblances between two groups in attributing natural relationships deliberately ignores the fact that similarities commonly are due to parallel evolutionary trends.

It is true that specific parts of the chloranthaceous genera bear similarities to homologous parts of the families that are suggested to be its nearest relatives. But a totality of evidence fails to support such proposals. The possession of monocolpate pollen or of types phylogenetically derived therefrom, and of "ethereal oil cells" by the representatives of the Chloranthaceae rule out the possibility of bringing the family in relationship with any of such families as the Loranthaceae, Caprifoliaceae, Santalaceae, Ceratophyllaceae, or the families of the Urticales. At the same time, this combination of features of the Chloranthaceae speaks of a decidedly ranalian affinity. Within the Order Ranales (*sensu lato*), the Chloranthaceae may be associated with the Piperaceae, Saururaceae, and Lactoridaceae, implying a rather intimate phylogenetic bond among the families.

Whether these four families really represent as natural an assemblage as has been assumed to be until now — or to be more specific, does the Chloranthaceae fall in line with the other three families — remains to be critically examined. The Chloranthaceae exhibits, in addition to the vesselless xylem in one genus, a decidedly primitive cambium composed of very long fusiform initials with extensively overlapping ends in the other three genera; the derivative tissues of the cambium on the xylem side show comparatively slight phylogenetic specialization. Thus, the vessels are long with steeply inclined end walls that bear very numerous scalariform perforations, and the other xylary tissues, on the whole, also exemplify a relatively unmodified primitive condition. The xylem of the Piperaceae, Saururaceae, and Lactoridaceae, on the other hand, bears distinct evidences of a rather highly evolved type: the fusiform initials of the cambium as well as their derivatives are comparatively very short, as also the vessel members that have conspicuously truncated ends with typical porous perforations; there is a predominant tendency for the almost complete elimination of the uniseriate rays; the imperforate tracheary cells are of the fiber or of the libriform type; in the Piperaceae, cortical and medullary bundles and anomalous secondary growth are of very general occurrence; and in the woody representatives of this family the cambium and one or more of its derivative tissues are often stratified. Such a conspicuously wide gap existing between the over-all primitive organization of the cambium and xylem of the Chloranthaceae on the one hand, and the general highly advanced situation of the corresponding tissues of the Piperaceae, Saururaceae, and Lactoridaceae on the other, serve to question the wisdom of including the Chloranthaceae in alliance with the latter families.

The occurrence of conspicuously wide rays in the Chloranthaceae has been frequently mentioned as an evidence of relationship of this family to the Piperaceae. This character by itself does not provide a reliable basis, as such rays are known to occur sporadically throughout the dicotyledonous families (Dadswell and Record, 1936); furthermore, a strong tendency towards excessive widening of rays characterizes certain genera of the Lauraceae, Monimiaceae, Berberidaceae, etc., in the Order Ranales itself.

The nodal anatomy in the Chloranthaceae (as also in the Lactoridaceae, the morphology and relationships of which will be discussed in a future contribution) is of the unilacunar type or of a derived pattern of this category; in sharp contrast, the situation in the Piperaceae and Saururaceae is typically of the multilacunar type. Furthermore, the median leaf strand in the Chloranthaceae (and Lactoridaceae) is invariably "double" in origin, although the two strands may subsequently dichotomize and reunite to result in an odd number of bundles. But, in the other two families, the corresponding strand shows specialized trends of modification resulting in a single strand that splits into three bundles in the base of the petiole.

The pollen of the Piperaceae and Saururaceae appear to have undergone a particular trend of specialization that has resulted in the formation of uniformly small-sized grains with very faint or no sculpturing on the exine, and with a single germinal furrow. Although the pollen grains of *Ascarina* are monocolpate, those of the other genera show a polycolpate condition with a strong tendency towards the elimination of germinal furrows. This trend has culminated in the acolpate grains of *Sarcandra* and of some species of *Hedyosmum*; the exine in all genera exhibits a reticulate-pitted sculpturing of varying grades; the grains in general are relatively large.

Undue emphasis has been given in the past to certain similarities in the floral structure of the Chloranthaceae and Piperaceae. The most important of such characters are the apetalous nature and the presence of a single orthotropous ovule. That an apetalous nature of flowers in not always a trustworthy and decisive criterion in determining natural affinities is becoming more and more obvious by detailed investigations of all parts of plants and by critical evaluation of summations of the data thus obtained. To mention an example from the Ranales itself: "such strange bedfellows as *Eucommia, Cercidiphyllum, Euptelea,* and *Trochodendron*" were included by a large number of botanists in the Trochodendraceae, the decision to do so being "based largely, if not entirely, upon the absence of a perianth" (Nast and Bailey, 1946). But a careful analysis of all pertinent characters has emphasized the high degree of diversified evolutionary modifications among these genera and has yielded convincing evidence to establish independent families to accommodate the respective genera. In regard to the presence of an orthotropous ovule, it must be admitted that this feature need not necessarily indicate a true relationship. The very fact that orthotropous ovules occur in many unrelated families suggests that its development may as well be due to parallel evolutionary trends.

Unfortunately, the utilization of such characters as the opposite or alternate phyllotaxy, presence or absence of stipules, pinnate or palmate venation of the leaves, "haplocheilic" or "syndetocheilic" type of stomata, differentiation of a hypodermis, etc., in phylogenetic considerations is at present handicapped by a lack of proper understanding in regard to their evolutionary trends of specialization. Instances are numerous where pairs of such differential characters are present in one and the same family or even in the same genus. For example, in the Monimiaceae (Money, Bailey and Swamy, 1950) both types of stomata and also some intergrading conditions occur; a hypodermis of one, two, or three layers is differentiated in some, but not in other genera. Until extensive surveys of such features are accomplished on angiosperms *as a whole*, and information obtained as to the probable phylogenetic tendencies in the modification of these characters, it is inadvisable to employ indiscriminately such features in discussions of putative relationships.

Although the available embryological information on the Chloranthaceae is rather meagre to allow detailed comparisons with the Piperaceae and Saururaceae, it provides certain significant points of differences that merit consideration. The female gametophyte in the Chloranthaceae develops according to the *Polygonum*-type (Armour, 1906; Edwards, 1920), whereas in the Piperaceae, the development follows the tetrasporic types. The endosperm in the latter family fluctuates between nuclear (in *Piper, Hackeria*) and cellular (in *Peperomia*) types; that in the Chloranthaceae is cellular. Furthermore, the first and next few divisions of the primary endosperm nucleus in *Hedyosmum* result in wall formation that are predominantly transverse, while in the Piperaceae (*Peperomia*) the first division results in the formation of a vertical wall. Again, in the Piperaceae, the first wall in the zygote is vertical, and that in the Chloranthaceae transverse. A much more consistent and reliable point of difference between the Chloranthaceae on the one hand, and the Piperaceae and Saururaceae on the other, occurs in the mature seed. In the seeds of the Chloranthaceae, the endosperm is abundant, the embryo being embedded in this tissue; and there is no perisperm. In the seeds of the Piperaceae and Saururaceae, the embryo is embedded in a relatively insignificant quantity of endosperm; and the major bulk of the seed cavity is filled with perisperm.

As suggested in a previous paper (Money, Bailey and Swamy, 1950), the ranalian families possessing monocolpate pollen and phylogenetically derived dicolpate, polyporate and acolpate pollen, and having "ethereal oil cells" fall into two distinct categories:

Category I: NODES UNILACUNAR

Austrobaileyaceae
Trimeniaceae
Amborellaceae
Monimiaceae
Gomortegaceae
Hernandiaceae
Chloranthaceae
Calycanthaceae
Lactoridaceae

Category II: NODES TRILACUNAR OR MULTILACUNAR

Winteraceae
Degeneriaceae
Himantandraceae
Magnoliaceae
Annonaceae
Myristicaceae
Eupomatiaceae
Canellaceae
Piperaceae
Saururaceae

A summation of cumulative evidence — in particular, a decidedly low level of structural specialization of the cambium and xylem, the essentially unilacunar nodal anatomy, and the nonperispermous seeds — not only provides valid negation to aligning the Chloranthaceae with the Piperaceae and Saururaceae, but also affords positive evidence for placing the family in category I.

CONCLUSIONS

Morphological:

(1) The general level of structural specialization of the cambium and the tissues of the xylem derived therefrom is relatively primitive

(2) The nodal anatomy is of the unilacunar type or a modification therefrom.

(3) The flowers in general appear to have undergone reduction both in regard to the number of floral parts and vasculature.

(4) Pollen of the monocolpate type and two of its derived types — polycolpate and acolpate — occur in the family.

(5) There is no evidence at present either to regard the flowers of *Sarcandra* and *Chloranthus* as possessing a reduced perianth or to interpret the individual flowers as reduced or composite inflorescences.

(6) Conclusive evidence is wanting to attribute a perianthial nature to the cupular envelope of the gynoecium in *Hedyosmum.*

(7) Available evidence appears to afford considerable support to the view that the androecium of *Chloranthus* is constituted of three stamens, rather than that it represents a single stamen split into three parts.

Systematic and phylogenetic:

A totality of evidence obtained through a study of exomorphic and endomorphic characters warrants the following observations:

(8) The included genera — *Ascarina, Chloranthus, Hedyosmum,* and *Sarcandra* — of the family exhibit profuse reticulate interrelationships, and as such there are no valid reasons to remove any of them from the family.

(9) The Chloranthaceae exhibit significantly diverse trends of phylogenetic modification as compared with the Piperaceae and Saururaceae. Therefore, the Chloranthaceae deserve to be dissociated from their present piperaceous alliance.

(10) The nearest relatives of the Chloranthaceae are those families of the ranalian affinities that possess monocolpate pollen, "ethereal oil cells," and unilacunar nodes.

LITERATURE CITED

ARMOUR, H. 1906. On the morphology of *Chloranthus.* New Phytol. **5**: 49–55.

BAILEY, I. W. 1944. The development of vessels in Angiosperms and its significance in morphological research. American Jour. Bot. **31**: 421–428.

BAILEY, I. W., and B. G. L. SWAMY 1949. The morphology and relationships of Austrobaileya. Jour. Arnold Arb. **30**: 211–225.

BAILLON, H. 1871. Histoire des Plantes. Vol. III.

BENTHAM, G., and J. D. HOOKER 1880. Genera Plantarum.

ČELAKOVSKY, L. 1900. Über den phylogenetischen Entwicklungsgang der Blüthe und über den Ursprung der Blumenkrone, II. Sitzungsber. Böhm. Ges. Wiss. Math.-Nat. Kl. Prag. (reprint).

CLARKE, B. 1858. On the structure and affinities of Myricaceae, Platanaceae, Altingiaceae and Chloranthaceae. Ann. and Mag. Nat. Hist. Ser. III. **1**: 100–109.

CORDEMOY, J. C. DE 1863. Monographie du groupe des Chloranthacées. Adansonia **3**: 280–310.

DADSWELL, H. E., and S. J. RECORD 1936. Identification of woods with conspicuous rays. Trop. Woods No. **48**: pp. 1–30.

EDWARDS, J. G. 1920. Flower and seed of *Hedyosmum nutans.* Bot. Gaz. **70**: 409–424.

EICHLER, A. W. 1878. Blüthendiagramme, Pt. II. Leipzig.

HALLIER, H. 1905. Provisional scheme of the natural (phylogenetic) system of flowering plants. New Phytol. **4**: 151–162.

HALLIER, H. 1912. L'origine et le système phyléteque des angiospermes exposés à l'aide de leur arbre généalogique. Arch. Néarld. Sci. Exact. et Natur. Sér. III. **1:** 146–234.

HOOKER, J. D. 1890. Flora of British India. Vol. V. London.

KASAPLIGIL, B. 1951. Morphological and ontogenetic studies of *Umbellularia californica* Nutt. and *Laurus nobilis* L. Publ. in Bot., Univ. Calif. **25:** 115–240.

MONEY, L., I. W. BAILEY, and B. G. L. SWAMY 1950. The morphology and relationships of the Monimiaceae. Jour. Arnold Arb. **31:** 372–404.

NAST, C. G., and I. W. BAILEY 1946. Morphology of Euptelea and comparison with Trochodendron. Jour. Arnold Arb. **27:** 186–192.

PAYER, J. B. 1857. Traité d'organogénie comparée de la fleur. Paris.

SKUTCH, A. F. 1927. Peculiarities in the structure of the stem, related to the leaf-sheath, in Hedyosmum. Ann. Bot. (London) **41:** 715–730.

SOLEREDER, H. 1899. Systematischen Anatomie der Dicotyledonen. Stuttgart.

SOLMS, H. A. 1869. Chloranthaceae, in D. C. Prodromus Systematis Naturalis Regni Vegetabilis, **14:** 472–485.

SWAMY, B. G. L. 1953 a. *Sarcandra Irvingbaileyi*, a new species of vesselless dicotyledon from South India. Proc. Nat. Inst. Sci. India **19:** 301–306.

SWAMY, B. G. L. 1953 b. A taxonomic revision of the genus *Ascarina* Forst. Proc. Nat. Inst. Sci. India **19:** 371–388.

SWAMY, B. G. L., and I. W. BAILEY 1949. The morphology and relationships of Cercidiphyllum. Jour. Arnold Arb. **30:** 187–210.

SWAMY, B. G. L., and I. W. BAILEY 1950. Sarcandra, a vesselless genus of the Chloranthaceae. Jour. Arnold Arb. **31:** 117–129.

THIERRY, R. 1912. Contribution a l'etude anatomique des Chloranthacées. Diss. Paris, pp. 1–158.

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EXPLANATION OF PLATES

PLATE I

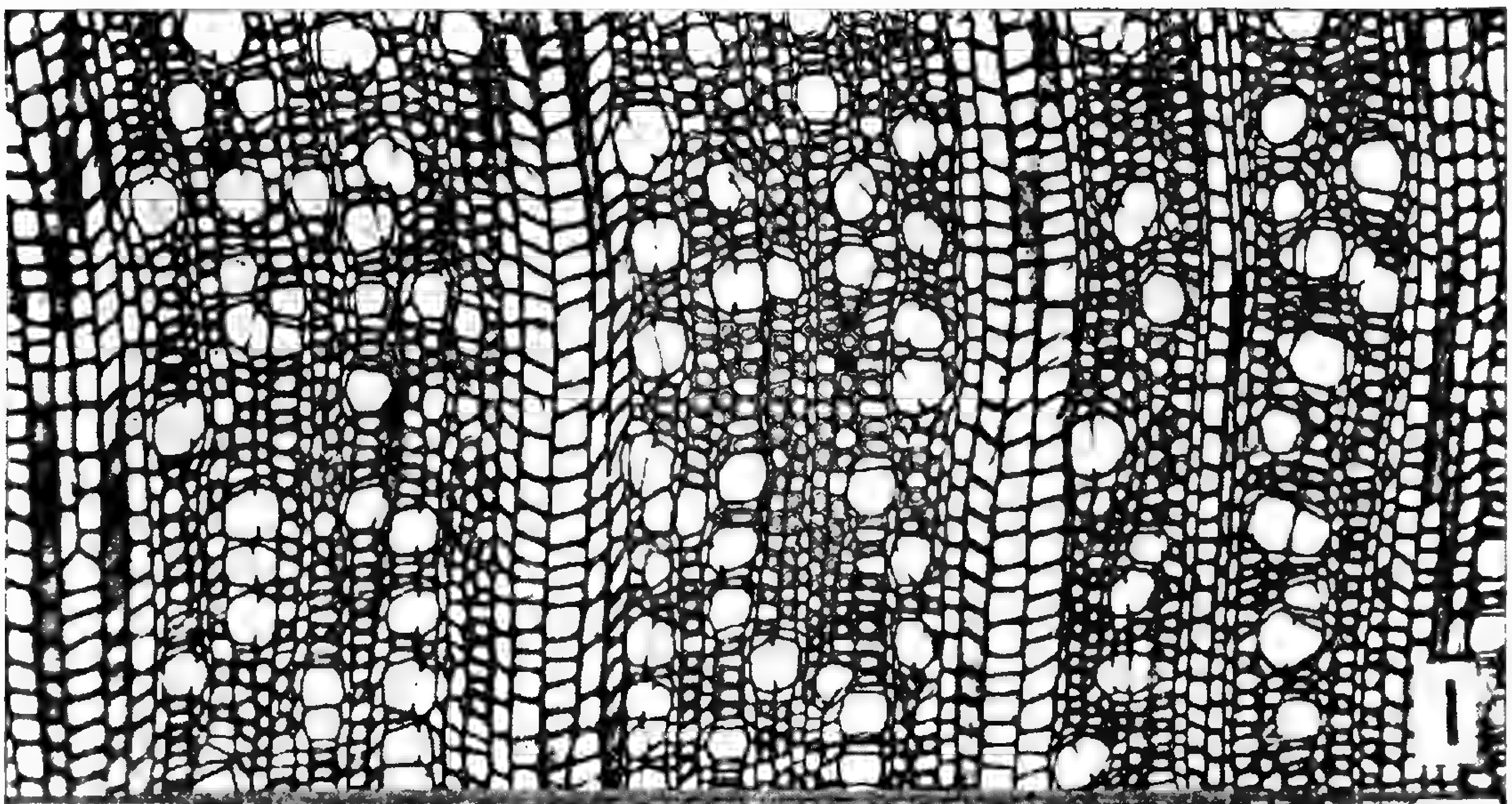
FIG. 1. Transection of secondary xylem of *Ascarina lanceolata*, × 50. FIG. 2. Transection of secondary xylem of *Chloranthus officinalis*, × 50. FIG. 3. Transection of secondary xylem of *Hedyosmum nutans*, × 50.

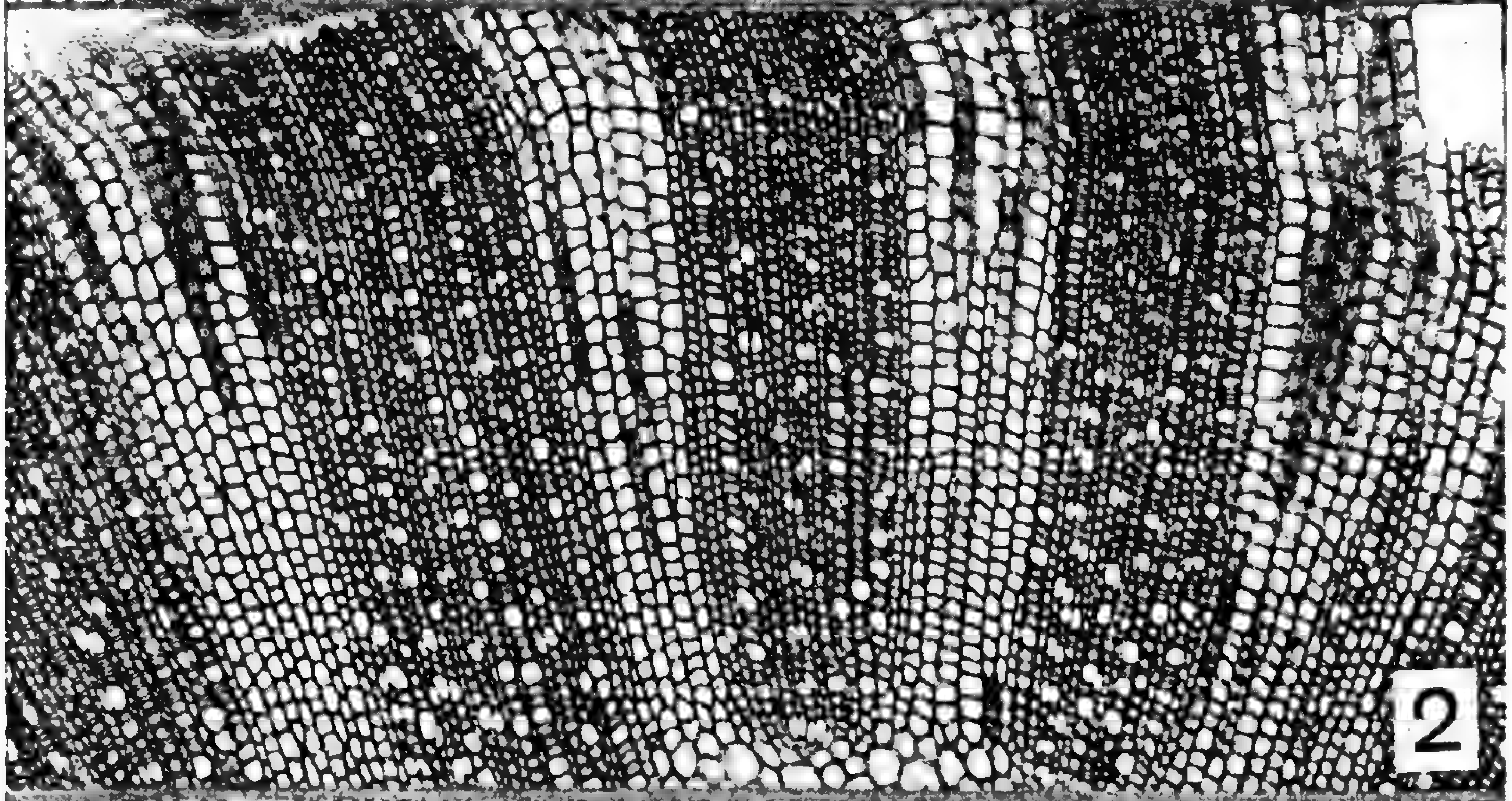
PLATE II

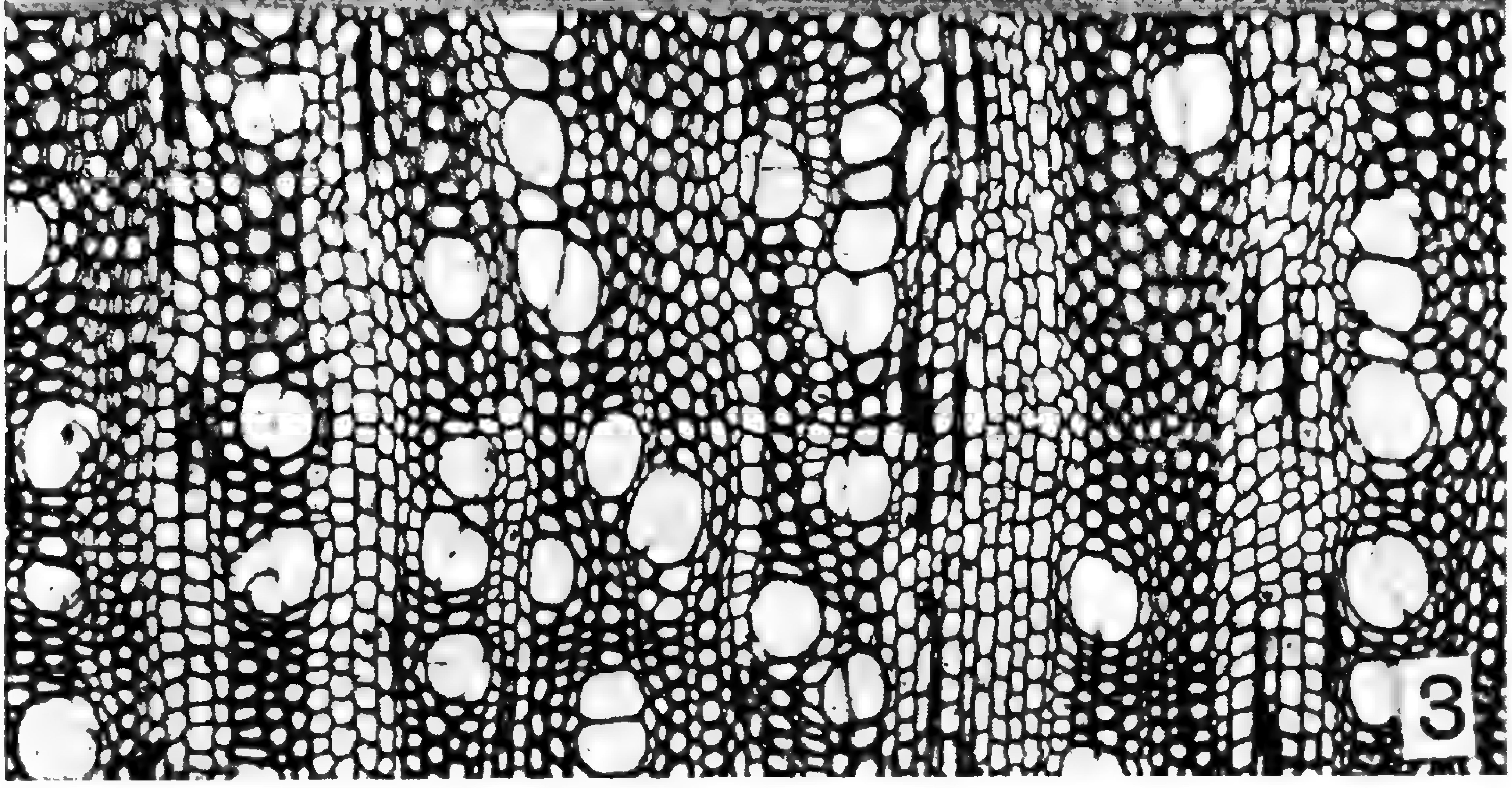
FIG. 4. *Ascarina lanceolata*, tangisection through the earlier formed part of secondary xylem. FIG. 5. Same, through later formed secondary xylem. FIG. 6. *Hedyosmum scabrum*, tangisection through the earlier formed part of secondary xylem. FIG. 7. Same, through later formed part of secondary xylem. All photographs, × 60.

PLATE III

FIG. 8. Radial-longisection through mature secondary xylem of *Hedyosmum nutans*, × 60. FIG. 9. Radial-tangisection through mature secondary xylem of *Chloranthus officinalis*, × 75.







SWAMY, MORPHOLOGY OF THE CHLORANTHACEAE


4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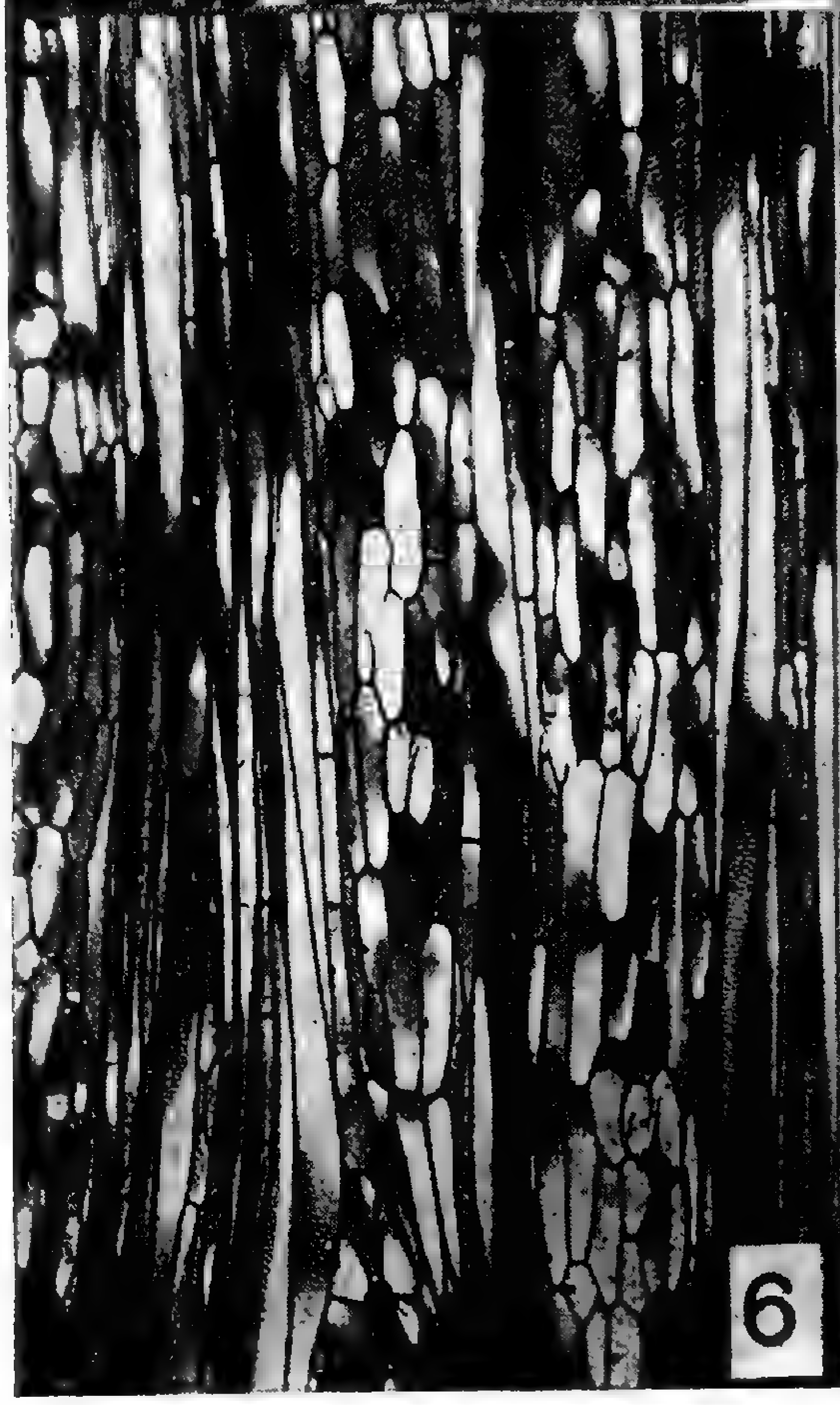
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Swamy, Morphology of the Chloranthaceae

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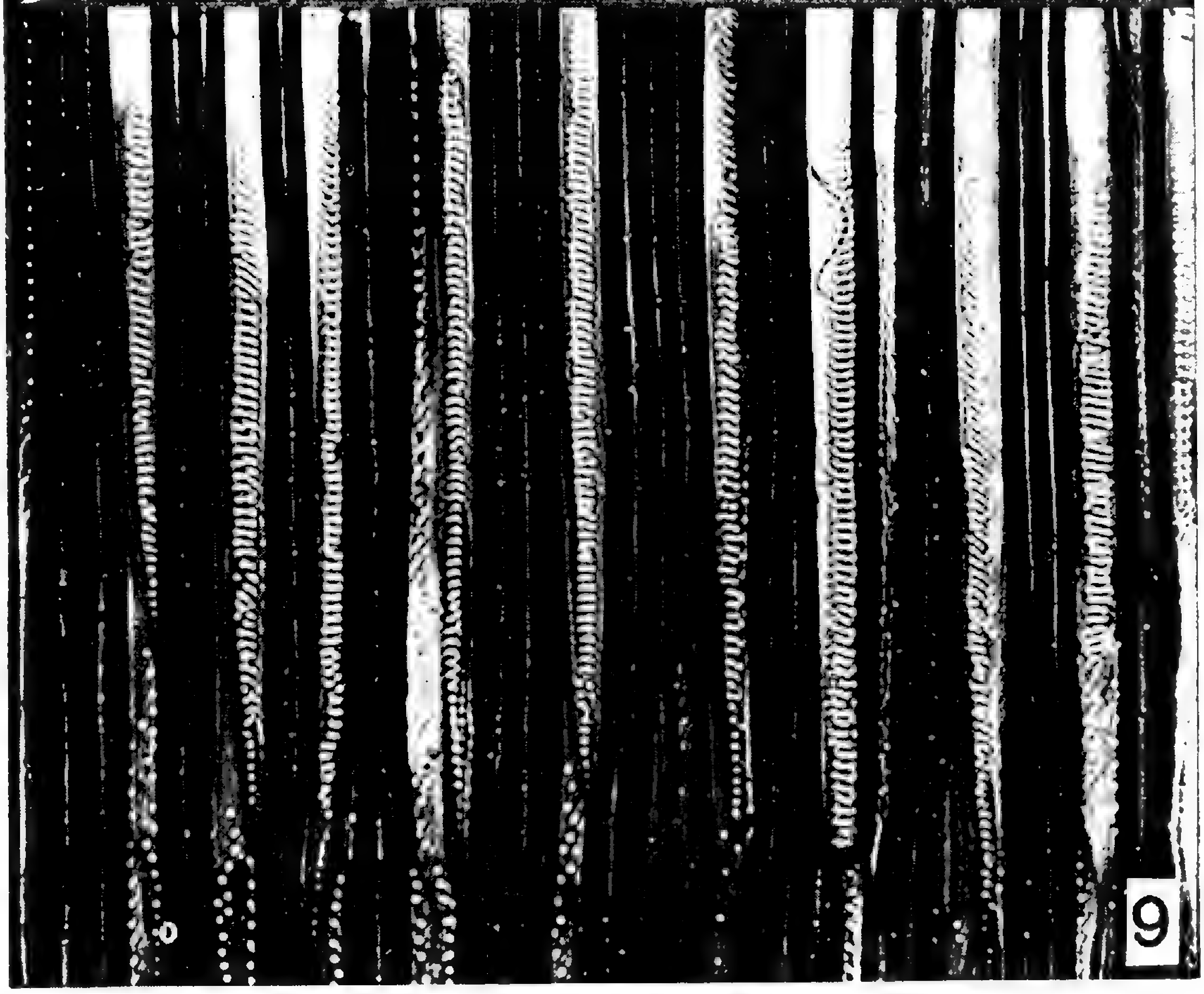

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Swamy, Morphology of the Chloranthaceae

THE ARNOLD ARBORETUM DURING THE FISCAL YEAR ENDED JUNE 30, 1953

Horticulture. — The renovation of the living collections of trees and shrubs included the transfer of some of the larger shrubs from the shrub collection to the Arborway bank. The construction of the Forest Hills overpass made it necessary to do some replanting near the Forest Hills gate. The trees on the north slope of Peters Hill were thinned and azaleas were planted along the Arborway wall. The Bussey bank was cleared, seeded to grass and planted with ornamental crab apples.

The fertilizing program has been continued with gratifying results. New rotary type mowers have replaced the older machines and have proved to be very efficient.

More than 400 photographs have been added to the collections. Mr. Howard also made about 250 Kodachrome slides and fifty 11 × 14 inch enlargements of the more interesting photographs of Arboretum trees and shrubs. These were exhibited at the National Shade Tree Conference held in Boston in August 1952. The cabinets of Ektachrome pictures were displayed at the Spring Flower Show and National Shade Tree Conference.

Dr. Wyman and his associates exhibited a pruning demonstration at the Spring Flower Show of the Massachusetts Horticultural Society. This display won a first prize and the Bulkley Medal of the Garden Club of America, awarded each year to the most educational exhibit in the Show.

Dr. Wyman conducted a class in plant materials at the Arboretum for students from Harvard's School of Landscape Architecture on Saturday mornings during the late winter and spring months. About fifty people attended the field classes held each year during the flowering season. The Massachusetts Horticultural Society, many Garden clubs, and several national horticultural groups have held meetings at the Arboretum during the year.

The Ground Cover demonstration plot at the Case Estate was enlarged and is now practically completed with 150 different kinds of plants. Mrs. Frances Williams provided many of the ground cover plants. The Cabot Foundation and the Bussey Institution continue to use the facilities of the Case Estates, but due to curtailments in the Department of Landscape Architecture the cooperative work with that department will be terminated in the fall of 1953.

Propagation. — A total of more than 4,000 scions, cuttings and young plants were sent to institutions in various parts of the world. In addition several hundred seed collections were distributed in North America and Europe. The Arboretum received nearly 3,500 lots of plant material and several hundred packets of seeds from various countries.

Under the open-door policy of the propagating department, volunteer workers recruited through the auspices of local garden clubs, agricultural schools, 4-H Clubs and handicapped veterans are learning practical plant propagation. Participating in this project were eleven garden clubs, two agricultural schools and ten veterans from the Veterans' Hospital in Jamaica Plain. The results have been most gratifying with these boys.

The Arnold Arboretum, through Mr. Lipp and in collaboration with the Massachusetts Horticultural Society conducted a contest in the form of an essay to be written on the subject of "Why We Must Preserve Our Parks and Gardens." The response was most gratifying with the receipt of 58 essays. The ten best essays were given the little book "Bonsai, Miniature Potted Trees" and a well-established rooted cutting of *Chamaecyparis obtusa* taken from a 200-year old Bonsai tree in the valuable Larz Anderson collection at the Arnold Arboretum.

A simple horticultural development which not only speeds up plant propagation of rooting cuttings but requires only one watering and no further attention for as long as a month, was developed by the propagator of the Arboretum. This plastic tent of polythene film and its operation is so simple any home owner can multiply plants indoors or under filtered light outdoors. This same feature could be used successfully by the professional nurserymen by covering a complete bench of cuttings with cheese cloth attached to polythene film. It has attracted wide publicity.

Experimental Horticulture. — Interesting segregates of *Forsythia* and *Philadelphus* have been obtained by growing progeny from triploid plants. These plants are extremely variable and many are unique. The Arnold Dwarf *Forsythia* produced about 10 years ago was recommended only as a ground cover since it was not expected to flower. However, it did flower this year, and is an excellent variety for many purposes.

The apple hybrids involving *Malus Sargenti* are most promising. Various methods have been used to produce dwarf types of the various ornamental flowering crabs. The Bechtels Crab was made to flower the second year by budding onto *Malus sikkimensis* rootstocks. A small collection of dwarf ornamentals has been planted on the Bussey bank.

A number of ornamental trees and shrubs were irradiated to produce mutations. The beta source used was provided by the Brookhaven National Laboratory.

Crosses between catawbiense and Fortunei Rhododendron hybrids have produced several hundred progeny, most of which have flowered. These segregates vary greatly in resistance to insect pests and resistant types have been selected for propagation.

Dr. Sax taught his course in Cytology at Harvard during the fall term and supervised graduate students throughout the year.

Comparative Morphology. — Professor Bailey spent considerable time during the last summer in the preparation of papers which were read in two symposia at the A.I.B.S. meetings held in Ithaca, September 8–10. One invitation paper, which dealt with the "Evolution of the tracheary tissue of land plants," was read in a symposium on the "Evolution of tissues and tissue systems in plants" sponsored by the Paleobotanical and General

Sections of the Botanical Society of America with the Society for the Study of Evolution. The second invitation paper, dealing with "The anatomical approach to the study of genera" was given in a symposium on "Plant Genera, Their Nature and Definition" sponsored by the American Society of Plant Taxonomists and the Systematic Section of the Botanical Society of America.

Subsequently, Professor Bailey has been spending considerable time in revising some of his previous work for publication in book form. Ing. Domingo Cozzo, Guggenheim Fellow from Argentina, completed his investigations on storied structures in dicotyledonous woods and returned to Argentina early in February. Mr. Chi Ling Chen is continuing his investigations of the Sapotaceae for the Doctorate. Miss M. P. F. Marsden is making an intensive study of the vasculature of the cotyledons, leaves and floral appendages of *Clerodendron trichotomum* Thunb. Professor Bailey gave his course in Plant Morphology at Harvard during the fall term.

The Herbarium. — During the year 6570 specimens were mounted and added to the herbarium, which now contains 671,559 sheets. A total of 17,267 specimens were sent out in exchange, 12,999 to foreign and the remainder to American herbaria. New collections received number 12,233, about two-thirds of these coming to the Arboretum from other institutions in continuation of exchange. Most of this new material represents the flora of Asia and Malaysia and constitutes very significant additions to the herbarium. The representation of this flora now available at the Arboretum is the largest in America. Among the accessions worthy of special mention are 1777 collections of trees and shrubs of Japan, 1125 from Asiatic parts of the USSR, 447 from Yunnan (woody plants of the McLaren collectors), 814 from the India-Burma frontier (collections of Kingdon Ward), 410 from Tibet and the eastern Himalaya (mostly collections of Ludlow & Sherriff), 3150 from Malaysia, and 937 from the northwestern corner of Australia.

A total of 2484 specimens were sent out on loan, ten lots, totaling 623 specimens, to ten different American institutions, and eleven lots, totaling 1861 specimens, to seven institutions abroad. For use of the Arboretum staff 1249 specimens were borrowed; 315 sheets in eight different lots from American establishments, and 934 sheets in eight lots from five foreign institutions.

During the early summer of 1952 Dr. Johnston visited herbaria at London, Kew, Oxford, Edinburgh, Leiden, Brussels, and Paris. Types and critical specimens of Asiatic Boraginaceae were studied at the herbaria visited, and herbarium problems and matters relating to inter-institutional exchange of specimens were discussed with the directors and staff. In the fall he lectured at Harvard and continued his critical study of the relations of *Lithospermum*.

Dr. Kobuski continued his work in Theaceae. He finished work on the genus *Adinandra* for Flora Malesiana and has begun work on the Asiatic members of *Ternstroemia*.

Dr. Perry completed her study of the many previously very confused species of Papuan *Macaranga.*

Dr. Hu continued her study of the Chinese flora and progressed on her monograph of *Philadelphus.*

Dr. Merrill has continued work on various Malaysian and Polynesian problems, concentrating especially on a study of the status of several hundred Malaysian species proposed by William Roxburgh (1814–1844). Another wider problem that has claimed his attention is the actual significance of the first botanical collections made in the Pacific Islands, especially those of Banks and Solander and the two Forsters, Captain Cook's first and second voyages, 1769–1775. This study of various unpublished manuscripts at the British Museum, prepared by Dr. Solander, including a Flora of Tahiti, casts much more than a shadow of doubt on the validity of various theories proposed and vigorously supported by specialists in other fields.

The Library. — During the fiscal year ended June 30, 1953, there were 303 bound volumes added to the library by gift, purchase or binding; there are now 48,401 volumes on the shelves. One hundred forty pamphlets were catalogued and filed, all gifts; the pamphlet collections now stand at 15,204. Four hundred thirty-three catalogue cards were added to the main catalogue, and 2044 cards were added to the Gray Herbarium species cards.

Interlibrary loans have been about the same as in previous years, in many cases typed descriptions, microfilms and photostatic copies have saved the actual travel wear and tear on the older or rarer volumes.

Four hundred photographs were added to the photograph files.

Bibliography of the Published Writings of the Staff and Students
July 1, 1952–June 30, 1953

Bailey, I. W. Evolution of the tracheary tissue of land plants. Am. Jour. Bot. **40**: 4–8. 1953.

——— & Smith, A. C. A new Fijian species of Calyptosepalum. Jour. Arnold Arb. **34**: 52–64. *pl. 1, 2.* 1953.

——— & Swamy, B. G. L. The morphology and relationships of Idenburgia and Nothuysia. Jour. Arnold Arb. **34**: 77–85. *pl. 1, 2.* 1953.

Hu, Shiu-ying. Ilex in Taiwan and the Liukiu Islands. Jour. Arnold Arb. **34**: 138–162. 1953.

Johnston, Ivan M. Studies in the Boraginaceae, XXIII. A survey of the genus Lithospermum. Jour. Arnold Arb. **33**: 299–366. *pl. 1–3.* 1952.

——— Studies in the Boraginaceae, XXIV. A. Three genera segregated from Lithospermum. B. Supplementary notes on Lithospermum. Jour. Arnold Arb. **34**: 1–16. 1953.

Kobuski, C. E. Studies in the Theaceae, XXVII. Miscellaneous new species in Theaceae. Jour. Arnold Arb. **34**: 125–137. 1953.

——— Theaceae. In: Steyermark, J. A. Contributions to the flora of Venezuela. Fieldiana Botany **28**: 380–384. 1952.

——— & Sandwith, N. Y. Contributions to the flora of Tropical America:

LIII. A South American species of Symplococarpon. Kew Bull. **1952:** 249–251. 1952.

LIPP, LEWIS F. Let's strike it right. Horticulture **30:** 424, 427. 1952.

——— Slow-growing white oak. Horticulture **31:** 20, 21. 1953.

——— Trees to plant. Horticulture **31:** 190. 1953.

Merrill, E. D. The fugitive place names "Hamoa" and "Romoa" in Roxburgh's Flora Indica errors for Honimoa-Saparua. Taxon **1:** 124, 125. 1952.

———. William Jack's genera and species of Malaysian plants. Jour. Arnold Arb. **33:** 199–250. *1 pl.* 1952.

SAX, KARL. The Arnold Arboretum during the fiscal year ended June 30, 1952. Jour. Arnold Arb. **33:** 403–409. 1952.

———, KING, E. D. & SCHNEIDERMAN, H. A. The effects of carbon monoxide and oxygen on the frequency of X-ray induced chromosomes in Tradescantia. Proc. Nat. Acad. Sci. **38:** 34–43. 1952.

SCHWARTEN, LAZELLA. Index to American botanical literature. Bull. Torrey Bot. Club **79:** 339–349, 415–425, 491–503. 1952. **80:** 102–112, 145–153, 234–245. 1953.

WYMAN, D. The Arnold Arboretum. Bull. Gard. Club America **49**(6): 11–17. illus. 1952.

——— Autumn color. Arnoldia **12:** 53–59. 1952. Reprinted in Trees Mag. **13**(1): 9, 10, 14, 16. 1952.

——— British gardens and woody plants that make them. Proc. Nat. Shade Tree Conference **1952:** 89–93. 1953.

——— Evergreens for the small place. Horticulture **31:** 92, 93, 119. illus. 1953.

——— For the record. Arnoldia **13:** 37–40. 1953.

——— The Hunnewell Arboretum, 1852–1952. Arnoldia **12:** 61–84. *pl. 13–17.* 1952.

——— Layering plants in Holland. Arnoldia **13:** 25–28. 1953.

——— Metasequoia in modern times. Pop. Gardening **4:** 42, 67–69. illus. 1952.

——— Pruning ornamental shrubs and trees. Arnoldia **13:** 21–24. 1953.

——— Some of the best vines and ground covers for Massachusetts gardens. Arnoldia **13:** 1–19. 1953.

——— Some winter-killing of certain shrubs, as a result of the winter of 1951–52. Arnoldia **12:** 49–52. 1952.

——— Topiary — a lost art. Flower Grower **40:** 70–72. illus. 1953.

——— Trees and shrubs — a two way view. Home Garden **19**(1): 17–19. 1953.

——— Trees of the Arnold Arboretum. Trees Mag. **12**(5): 8, 9, 28, 34. 1952.

——— Trimming hedges. Plants and Gardens **8:** 125–129. 1952.

——— Two months of Azalea bloom. Arnoldia **13:** 29–35. 1953.

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Director

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1952–1953

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