REVISION OF THE GENUS ENDOSPERMUM BTH. (EUPHORBIACEAE)

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CONTENTS

SUMMARY

The revision was undertaken because the latest monograph by Pax & Hoffmann, dating from 1912, did not provide a satisfactory key, and because since that time a very large amount of new material has been collected and several new species were described.

In the present revision 12 species have been recognized, among which 2 are new; 7 names have been reduced to synonymy.

One species (*E. eglandulosum* Pax & Hoffm.) is here for the first time excluded from the genus and from the *Euphorbiaceae* and was found to be conspecific with *Sterculia macrophylla* Vent. *(Sterculiaceae)*.

The variability of the characters used by Pax & Hoffmann for infrageneric and for specific delimitation appears to be far greater than formerly understood. This was already stressed by Corner (1939) in his review of the Malayan species. For example, the peltation of leaves has appeared to be constant in some species, but not in others. The same can be said about myrmecophily — ants inhabiting hollow twigs — which is constant in 2 species, but is facultative in 2 other ones. This mild form of 'parasitism' is encountered only from Celebes eastwards as far as the Solomons (doubtful in Fiji). The variability in number of cells of the ovary appears also to be more complicated than formerly accepted on the strength of observations in a limited number of specimens. The occurrence of stellate hairs, and of indumentum in general, has not emerged as important for taxonomy. Remarks on this are made under *E. diadenum*. The number of basal nerves and the occurrence and position of the glands is also liable to variation and is constant in a few species only.

Because of the variability of characters indicated above, the affinity of the species is reticulate and does not allow the distinction of clear infrageneric taxa.

A difficulty encountered is that either flowers or fruits of several species are not or inadequately known and that some species are known from one specimen only.

Though in 1867 Teysmann & Binnendijk mentioned the occurrence of polygamy in *E. moluccanum*, viz. a ♀ tree and a tree with ♂ and some bisexual flowers, their observation was never again recorded in literature. I have not been able to confirm their observation in the abundant material of this species at hand. However, I have found that two species, *E. banghamii* and *E. ronaldii* from Sumatra and the Malay Peninsula respectively, possess bisexual flowers. Both are known from one collection only and more material must show the constancy of this feature which is almost unique in the *Euphorbiaceae;* recently it has also been recorded for two species of *Aporosa* by Airy Shaw.

In collecting *Endospermum* one should always be aware of the necessity to preserve specimens with ♀ flowes and/or fruit, as sterile material or ♂ specimens are very difficult to identify. It is highly desirable that observations on variability and polygamy are made in the field or in botanical gardens.

HISTORICAL SURVEY

In 1861 Bentham (Fl. Hongk., p. 304) described a new genus of the *Euphorbiaceae*, *Endospermum*, based on material collected by Champion *(n. 468)* and Hance *(n. 1946)* in Hongkong. The specimens at his disposal were only in fruit. To the generic description the characters of ♂ flowers were added, taken from an *Endospermum* species from Borneo. This latter material is unknown to me. Bentham classified *Endospermum* in the tribe *Crotoneae*. In 1864 Müller Argoviensis (Flora 47, p. 469) described two new species, *E. borneense* and *E. malaccense*. Teysmann & Binnendijk (Nat. Tijd. N. I. 29, 1867, 238) founded a new monotypic euphorbiaceous genus, *Capellenia*, based on specimens from the Moluccas. In the same year Kurz (J. Bot. 5, p. 23) reduced *Capellenia* to *Endospermum*. Kurz was of the opinion that the main difference with the 3 already known species was in the peltate leaves of the Moluccan plant. Beccari (Malesia 2, 1884, 38) published an interesting paper on *Endospermum*, especially on the myrmecophilous nature of *E. formicarum* Becc. He agreed with Kurz on the reduction of *Capellenia*. The first Philippine species recognized was *E. peltatum* Merr. (Publ. Gov. Lab. Philip. 35, 1905, 35).

In 1912 the first revision of *Endospermum* was composed by Pax & Hoffmann (Pfl. R. Heft 52, p. 33—39). They recognized ten species, but the key to these is unsatisfactory as it is based on variable characters such as leaf shape, presence or absence of glands, nervation, hairiness, and peltate or non-peltate leaves.

Pax & Hoffmann put *Endospermum* in the tribus *Gelonieae* Pax & Hoffm., subtribus *Tetrorchidiinae* Pax. They divided the genus into the subgenera *Euendospermum* Pax and *Capellenia* (T. & B.) Pax. In 1914 (Pfl. R. Heft 63, p. 418) the first Pacific species, *E. macrophyllum* (M.A.) Pax & Hoffm. was recognized, based on *Macaranga macrophylla* M.A. (1866). In the same year Merrill (Philip. J. Sc. 9, Bot. p. 481) described a second Philippine species, *E. ovatum*.

In the second revision of *Endospermum* Pax & Hoffm. (in E. & P., Nat. Pfl. Fam. ed. 2, 19c, 1931, 184) still classified the genus in the tribus *Gelonieae*, but now referred it to a separate subtribus *Endosperminae;* both subgenera *Euendospermum* and *Capellenia* were maintained; 13 species were accepted.

In 1934 Merrill (Contr. Arn. Arb. 8, p. 89) described *E. banghamii* from N. Sumatra. He pointed out its close affinity with *E. chinense* Benth. var. *malayanum* Pax & Hoffm.

In 1939 Corner (Gard. Bull. Str. Settl. 10, p. 296—299) published a valuable critical review of the Malayan species, precursory to his Wayside Trees; in Malaya he accepted only one species.

In 1947 L. S. Smith (Proc. Roy. Soc. Queensl. 58, p. 52) described two species from New Guinea, *E. medullosum* and *E. myrmecophilum*.

In 1960 Airy Shaw (Kew Bull. 14, p. 395) reduced *Melanolepis ? diadena* Miq. from Sumatra to *Endospermum* as *E. diadenum* which appears to be the correct name for *E. malaccense* M.A.

The latest paper on *Endospermum* is from R. Schodde (Blumea 15, 1967, 397—402), describing a new species from New Guinea and adjacent areas, *E. labios*.

MORPHOLOGY

Anatomy. No detailed anatomical investigations have been made on *Endospermum*, though some attention was paid to it by several authors. Metcalfe & Chalk (Anat. Dicot. 2, 1950, 1207—1235, *passim*) put the genus in the *Gelonieae-Endosperminae*.

Myrmecophily. The symbiosis of *Endospermum* with ants is recorded from Celebes

and eastwards to the Solomon Is.; the hollow twigs of the Fijian *E. macrophyllum* can not with certainty be ascribed to a regular symbiosis with ants.

The symbiosis is mainly confined to two species, viz. *E. moluccanum* and *E. myrmecophilum*, while it may occur in *E. medullosum*. Like in other regularly myrmecophilous plants, single specimens may have been overlooked by the ants and we have occasionally found a specimen of *E. moluccanum* without hollow twigs. Also very young plants may not yet have acquired ants; Rant (Trop. Natuur 18, 1929, 187) found them already in stems of 1 cm diameter.

Cultivated specimens of otherwise obligately ant-inhabited species often lack ants and therefore keep solid twigs, especially if these specimens are grown from seed. Beccari already observed that the specific ant, *Camponotus quadriceps* F. Smith, does not occur west of Celebes. Besides, Rant (l.c.) observed that when ant-inhabited seedlings are transplanted the ants soon swarm out or the specific ants are easily chased away by other ants.

In the ant-inhabited specimens the branches are hollow and provided with pores. The cavities are used by the ants to live in. Beccari (Malesia 2, 1884, 45) already mentioned that the cavities and pores are bitten out by the ants themselves though he believed that the branches are hollow by nature. Docters van Leeuwen actually observed, however, that the pith of young stems was carried away by ants. F. J. F. van Hasselt (Trop. Natuur 18, 1929, 94) and Rant (ibid. p. 186—189) stated that the trees are hollow from the base of the stem up to the top. The cavities are either connected with each other or they are separated in internodal compartments. The advantage the ants have from the host plant is of course the provision of food (gland secretion) and housing. The advantage the host has from the ants is not so clear, but it seems certain that *Endospermum* has no disadvantage from the ants. From the excellent growth of trees without ants we can conclude that *Endospermum* does not need the ants, conforming to von Ihering's opinion that the trees need the ants as much as a dog its lice. Obligate symbiosis is apparently out of question. Therefore the phenomenon may better be considered as some kind of harmless parasitism.

Phyllotaxis. The leaves are either crowded in the apical part of stout branches which are fairly abruptly conically narrowed at the apex, or evenly distributed along slender branches which are gradually narrowed towards the apex; in *E. peltatum* this distinction is not valid. Though these characters may be helpful in distinguishing the species group at first sight, practice learns that it is not always easy to make use of them, at least not in herbarium specimens, therefore it seems safer not to incorporate these characters in the key.

Pith. In connection with the foregoing, it can be said that pith is always present in branches of the slender type, while the stout branches are usually hollow.

Leaves. *Leaf-shape:* The peltate or non-peltate condition of the leaves cannot be used satisfactorily for keying out the species. There is one species with exclusively peltate leaves, viz. *E. moluccanum*, occurring from Celebes eastwards. Other ones possess non-peltate leaves only, viz. *E. banghamii*, *E. chinense*, *E. diadenum*, *E. domatiphorum*, *E. ovatum*, and *E. ronaldii*, all, except the Papuan *E. domatiphorum*, occurring in West Malesia. The remaining ones have both peltate and non-peltate leaves, with a preference for the non-peltate condition. Species of the latter category are known from West Malesia and the Philippines and from New Guinea to the Fiji Is., but are not yet observed in continental Asia, Celebes, and the Moluccas.

Petiole. In dried material a striking feature is the constriction at both ends of the petioles in most species, while in some others the petioles are either at one end only or not at all constricted. A closer examination reveals that constriction at both ends occurs in *E.*

moluccanum, *E. myrmecophilum*, and *E. quadriloculare*, while *E. banghamii*, *E. domatiphorum*, and *E. ronaldii* show no constrictions. In the remaining species the constriction is restricted either to the base or to the apex. In *E. ovatum* both constricted and non-constricted petioles occur.

Nervation. Endospermum has either palmately or pinnately nerved leaves, the latter only in *E. quadriloculare* and *E. ronaldii*. The number of basal nerves in the palmate type varies from 3 to 10; *E. banghamii*, *E. domatiphorum*, and *E. ovatum* have exclusively 5-nerved leaves in the remaining species the number of nerves varies.

There is no essential difference in nervation between the so-called pinnate-nerved species and those which I have called palmate-nerved; also in the pinnate-nerved type there are two basal nerves making them triplinerved. It appears to be a matter of quantity; in the palmate-nerved type the basal nerves are strong and large, while in the pinnate-nerved type these are much more slender than the lateral nerves.

Glands. Glands are found on various places. They are common on the undersurface of the leaves; up to 10 glands may occur here, but occasionally they may be absent. Glands may also be found along the margin above. Most conspicuous are the large 'petiolar glands' beneath (in *E. macrophyllum* above). Their exact position varies from distinctly on the apex of the petiole to evidently on the base of the blade; even within one species this variability can be observed. Glands are always present in myrmecophilous plants. They may also be present in non-myrmecophilous specimens. The glands produce a sweet exudate which serves as food for the ants.

Hairs. The common type are the simple hairs. Stellate hairs may occur on the stem, petioles, leaves, and inflorescences. The indumentum is too variable to be useful for taxonomy. This variability may also depend on the age of the plant, as has been explained by Corner and is elucidated in this paper under *E. diadenum*.

Domatia. These are only known from *E. domatiphorum* (New Guinea), in which they usually occur as hair tufts in the axils and in the forks of the lateral nerves.

Floral organs. *Euphorbiaceae* have nearly unanimously been considered to possess exclusively unisexual flowers, with or without a rudiment of the other sex. *Endospermum* is commonly known to have unisexual flowers without rudimentary organs. Pax & Hoffmann, however, refer to a rudimentary ovary in ♂ flowers in some species, but I could not confirm this. On the other hand I observed a thickening of the apex of the androphore, terminated by some hairs, in *E. moluccanum* and *E. diadenum*. However, I doubt whether this represents a reduced ovary. Teysmann & Binnendijk stated the occurrence of bisexual flowers in one tree of *Capellenia moluccana* (= *E. moluccanum*). This observation was apparently overlooked by all subsequent authors. Though I had abundant material of this species, I could not find bisexual flowers in any specimen. However, during my revision I found two species *(E. banghamii* and *E. ronaldii)* with true bisexual flowers. Their pollen was quite normal, as confirmed by Mr. J. Muller. Of both species only one specimen is known. Recently Mr. Airy Shaw (in litt.) likewise mentioned the occurrence of bisexual flowers in *Euphorbiaceae*, viz. in two new species of *Aporosa* from the Solomon Is.

PALYNOLOGICAL REMARKS[1])

Two species of *Endospermum* were investigated for the purpose of checking the supposed bisexual nature of their flowers.

From *E. ronaldii (SF 18396, coll. Henderson)* two apparently normally developed

[1]) By J. Muller.

anthers were acetolyzed, which yielded fairly abundant pollen grains of which 72 % appeared normally developed and 28 % were smaller, crumpled, and possibly young or infertile.

From *E. banghamii* (*Bangham 739*) two small 'glandlike' anthers were prepared, which also yielded a fair quantity of pollen, 80 % of which was normally developed, while 20 % was smaller and crumpled and probably immature.

In both cases, therefore, normal functional anthers appear to be present.

It is further of interest to note that a specific difference in pollen morphology exists between the two species investigated.

While both clearly possess the *Klaineanthus* pollen type described for this genus by Punt (Wentia 7, 1962), the pollen of *E. ronaldii* is almost spherical (P/E 0.98) with clavae of uniform size, arranged in a *Croton*-pattern, whereas that of *E. banghamii* is prolate (P/E 1.48) with more variable shaped clavae of varying sizes and arranged in an indistinct Crotonoid pattern.

The *Klaineanthus* pollen type is also found in the genera *Klaineanthus*, *Cladogelonium*, *Glycydendron*, *Micrandra*, and *Adenocline*. The palynological similarity between these genera may indicate affinity.

INFRAGENERIC AND SPECIFIC DELIMITATION

The present revision was undertaken for several reasons. Firstly because identification with Pax & Hoffmann's works proved very difficult, as already stressed by Corner; secondly because several new species had been described, and thirdly because very large numbers of specimens had accumulated since their revision.

The division of *Endospermum* into two subgenera, viz. *Euendospermum* and *Capellenia*, as proposed by Pax & Hoffmann in 1912, was still decidedly accepted by L. S. Smith in 1947. Pax & Hoffmann distinguished the two subgenera as follows:

Leaves non-peltate. Ovary 2-celled . . . . . subg. **Euendospermum**
Leaves peltate or sometimes non-peltate. Ovary 4—6-celled. . . . . subg. **Capellenia**

L. S. Smith emended this division in the following way:

Leaves non-peltate or sometimes peltate. Ovary 1- or 2-celled. . . . . subg. **Euendospermum**
Leaves peltate, sometimes non-peltate. Ovary 4—6-celled . . . . . subg. **Capellenia**

During my study it has appeared, however, that the characters used by Pax & Hoffmann and by L. S. Smith are too variable to be used for a sharp distinction of infrageneric taxa. I have illustrated this in table 1 in which the variation of the characters which might be used for a subdivision is tabulated.

As I found no other combination of distinct characters that could be used for a division of the genus I prefer to abandon any attempt for a formal subdivision.

From table I it also appears that only few species are characterized by more than one reliable key character.

Specific distinction is indeed not in all cases satisfactory, and the variability of many characters has already been pointed out in the chapter on morphology.

The group *E. medullosum-myrmecophilum-domatiphorum* shows strong bonds and might in future turn out to represent only one compound species; I have described *E. domatiphorum* as a new species with some reluctance.

A practical difficulty is that several species are known from one or very few specimens only, and hence inadequately; for example flowers are not known from *E. ovatum* and

Species	Number of ovary cells 1	2	3	4	5	6	7	twigs hollow	twigs solid	both situations	nervation palmate	nervation pinnate	leaf-base peltate	leaf-base not peltate	both situations	inflorescence branched	inflorescence simple	domatia absent	domatia present
macrophyllum		—	—							•	•				•	•		•	
medullosum										•	•				•	•		•	
myrmecophilum	—							•			•				•	•		•	
moluccanum				—	—	—	—	•			•		•			•		•	
banghamii*									•		•			•		•		•	
ronaldi*		·		—					•			•		•		•		•	
diadenum		—	—						•		•			•			•	•	
chinense		—	—						•		•			•		•		•	
peltatum		—	—						•		•				•	•		•	
quadriloculare*				—					•			•			•	•		•	
ovatum*		—							•		•			•		•		•	
domatiphorum	—								•		•			•		•			•

Table I. Distribution of characters in the genus Endospermum. Species known from one specimen only have been provided with an asterisk.

E. quadriloculare, ♂ flowers not from *E. myrmecophilum*, ♀ flowers not from *E. peltatum* and *E. chinense*, and fruit not from *E. ronaldii*.

As a consequence of the selection of key characters, sterile material is difficult to identify; preferably ♀ flowers or fruits should be available.

AFFINITIES

When sterile *Endospermum* is sometimes confused with *Macaranga;* both may have more or less the same appearance. Fruiting specimens, however, may easily be distinguished. In Pax & Hoffmann's system (1931) *Endospermum* is put in the tribus *Gelonieae-Endosperminae*, while *Macaranga* is placed in the tribus *Acalypheae-Mercurialinae*. On anatomical grounds Metcalfe & Chalk also included *Endospermum* in the tribus *Gelonieae-Endosperminae*.

According to Airy Shaw (in litt.) the two genera can be distinguished as follows:

Endospermum: Male calyx open or scarcely imbricate, often truncate; stamens united in a column; stigma broad, discoid, sessile; fruit drupaceous.

Macaranga: Male calyx closed in bud, splitting valvately; stamens free or almost so; stigma long or short, sometimes plumose, never discoid; fruit a capsule.

USES

The soft timber is widely used as a second-rate material for house-building; also, but much less often, for other purposes: boats, crates, matches, and wooden shoes.

The bark has purgative properties, but otherwise the genus is hardly used in native medicine.

In the Philippines *E. peltatum* Merr. *('gubas')* was considered a wood which might be suitable for matches. Chinte reported on growth and development of pure stands planted (as seedlings) in old clearings in Dipterocarp forest at San Teodoro, Mindoro I., 1936—1941 (Philip. J. For. 6, 1951, 245—263, 8 fig., 2 pl.: 5 photogr.).

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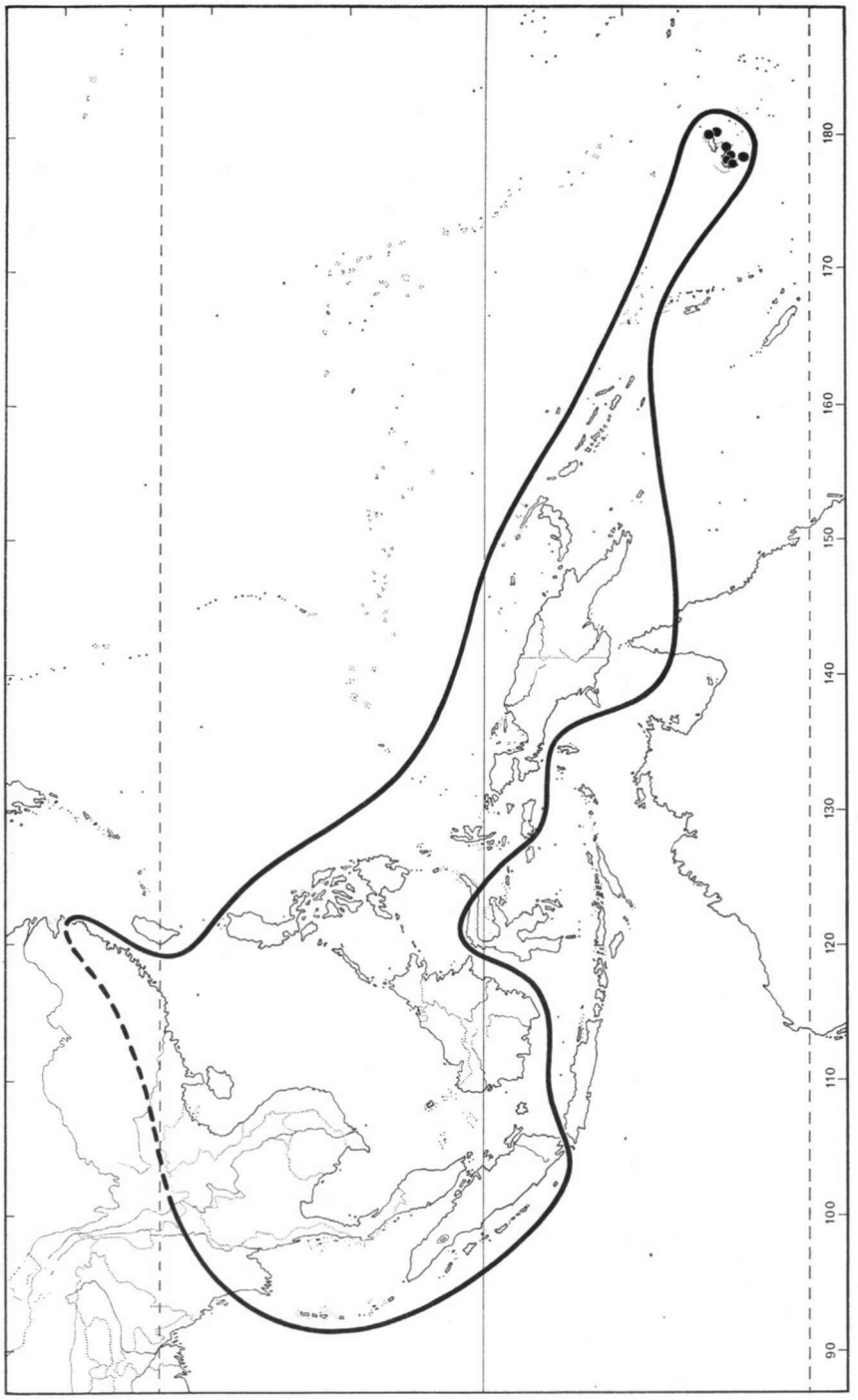
I express my sincere thanks to Prof. Dr. C. G. G. J. van Steenis who critically examined and polished the text of this revision.

A	Arnold Arboretum, Cambridge, Mass., U.S.A.
BISH	Bernice P. Bishop Museum, Honolulu, Hawaii, U.S.A.
BM	British Museum (Natural History), London, Great Britain.
BO	Herbarium Bogoriense, Bogor, Java, Indonesia.
BRI	Botanic Museum and Herbarium, Brisbane, Australia.
CANB	Commonwealth Scientific & Industrial Research Organization, Division of Plant Industry, Canberra, Australia.
CGE	Botany School, University of Cambridge, Great Britain.
FI	Herbarium Universitatis Florentinae, Florence, Italy.
K	Herbarium and Library, Royal Botanic Gardens, Kew, Great Britain.
L	Rijksherbarium, Leiden, Netherlands.
LAE	Botany Division, Lae, Papua, New Guinea.
P	Muséum National d'Histoire Naturelle, Paris, France.
SING	Herbarium of the Botanic Gardens Singapore, Singapore.
U	Botanisch Museum en Herbarium, Utrecht, Netherlands.
US	National Museum, Smithsonian Institution, Washington, D.C., U.S.A.

ENDOSPERMUM

Benth., Fl. Hongk. (1861) 304, *nom. cons.*; Boerl., Handl. 3 (1900) 196; Pax & K. Hoffm., Pfl. R. Heft 52 (1912) 33; Merr., En. Philip. 2 (1923) 457; Ridl., Fl. Mal. Pen. 3 (1925) 305; Gagnep., Fl. Gén. I.-C. 5 (1926) 452; Endert, Gesl. Tab. (1928) *passim* 39—47; Pax & K. Hoffm. in E. & P., Nat. Pfl. Fam. ed. 2, 19c (1931) 184; Corner, Gard. Bull. Str. Settl. 10 (1939) 296; Wayside Trees 1 (1940) 250—251; L. S. Smith, Proc. Roy. Soc. Queensl. 58 (1947) 52; Steen., Bull. Bot. Gard. Btzg III, 17 (1948) 457—458; Fl. Mal. Bull. 3 (1948) 74. — *Capellenia* T. & B., Nat. Tijd. N. I. 29 (1867) 238; Kurz, J. Bot. 5 (1867) 23.



Map 1. Range of the genus *Endospermum* (delineated; the broken line in SE. Asia giving the approximate boundary); *E. macrophyllum* (dotted in Fiji Is.).

Type species: *E. chinense* Benth., from Hongkong.

Trees 8—40(—50) m high, 15—80(—150) cm ∅, usually dioecious, very rarely flowers bisexual, unarmed, with watery or coloured (? milky) sap, sometimes myrmecophilous, occasionally buttressed. Indumentum usually of simple, sometimes partly or completely of stellate hairs. Branches terete, with pith or hollow. *Stipules* small, (narrowly) triangular, hairy. *Leaves* spirally arranged, petioled, peltate or non-peltate, herbaceous to coriaceous, usually palmately, rarely pinnately nerved; glands may occur at the base of the blade ('petiolar glands') and/or in the forks of the lateral nerves beneath, and/or along the margin above; domatia observed only in *E. domatiphorum;* margin entire, sometimes revolute; basal and lateral nerves stout, extending to near the margin, looped and joined; veins fine, transverse to the nerves; petiole usually constricted at one or both ends, terete, leaving large conspicuous scars. *Inflorescences* thyrsoid, usually branched (simple in *E. diadenum*), hairy. Bracts and bracteoles ovate to deltoid, concave, small, brownish, hairy. *Flowers* subsessile to distinctly pedicelled, unisexual, occasionally bisexual, apetalous, calyx gamophyllous, campanulate, 3—6-lobed, pubescent outside, glabrous inside. — ♂: *Stamens* 5—12, spirally arranged on an androphore; filaments free; anthers peltate, (3-or) 4-celled, cells elliptic, dehiscing by a longitudinal slit; rudimentary ovary absent. — ♀: *Ovary* ± globose, hairy, 1—7-celled, with 1 ovule per cell; stigma sessile, discoid, lobed; rudimentary androecium absent. — ☿: *Calyx* indistinctly lobed; *stamens* 5 or *c.* 10, either at the base of the ovary, or spirally arranged on a very short androgynophore; otherwise androecium and gynoecium as in ♂ and ♀ flowers resp. — *Fruit* ± drupaceous, indehiscent, 1—7-celled, stigma persistent, calyx and in bisexual flowers stamens persistent; exocarp thin to rather thick and fleshy; endocarp thin and woody, fibrous. *Seeds* ecarunculate, ellipsoid; testa hard, reticulately ribbed; endosperm whitish to orange, soft; embryo very small, flat; cotyledons 2, elliptic or ovate; radicle triangular, acute.

Distribution: 13 species in Assam, Burma, Thailand, Vietnam (Central Annam, Tonkin), Hainan, Hongkong, Swatou Is., mainland of Kwantung (?), Malesia (Sumatra, the Malay Peninsula, Borneo, Philippines, Celebes, Moluccas, and New Guinea), North Queensland, Solomon and Fiji Is. Map 1.

Ecology: Primary and secondary forest, often along streams and in water-logged or even swampy forests, from near sealevel up to 2000 m altitude. Fl. & fr. the whole year round.

KEY TO THE SPECIES

1. Apex of petiole with 3 or 4 glands above. Branches with pith, very occasionally (? incidentally) hollow. *Fiji Is.* . . . . . **1. E. macrophyllum**
1. Apex of petiole with 0—2 glands beneath or laterally.
   2. Branches hollow, housing ants, very occasionally (but in cultivation regularly) without ants and stems not hollow. Petiolar glands 2.
      3. Ovary and fruit 1-celled. *New Guinea, Solomon Is., N. Queensland.*
         4. Venation beneath conspicuous, prominent; petiolar glands shortly cylindrical or subglobose; lateral nerves 6—9 pairs . . . . . **2. E. medullosum**
         4. Venation beneath not conspicuous; petiolar glands flattened, elliptic, lateral nerves 4 or 5 pairs **3. E. myrmecophilum**
      3. Ovary and fruit 2—7-celled.
         5. Ovary and fruit 4—7-celled. Leaves always peltate. *Celebes to Solomon Is.* **4. E. moluccanum**
         5. Ovary and fruit 2- or 3-celled. Leaves rarely peltate. *Fiji Is.* . . **1. E. macrophyllum**
   2. Branches with pith, not housing ants. Petiolar glands 0—2.
      6. Ovary and fruit 1-celled. *New Guinea, N. Queensland, and Solomon Is.*
         7. Domatia present in the axils and in the forks of the lateral nerves **12. E. domatiphorum**

7. Domatia absent . . . . . **2. E. medullosum**
6. Ovary and fruit 2—4-celled. *SE. Asia and West Malesia, up to and incl. the Philippines.*
8. Flowers bisexual, pedicelled. *Sumatra and Malay Peninsula.*
9. Stamens 5. Leaves palmately 5-nerved, glandless.. . . . . **5. E. banghamii**
9. Stamens *c.* 10. Leaves pinnately nerved. Petiolar glands 0—2 . . . . **6. E. ronaldii**
8. Flowers unisexual. *SE. Asia, Sumatra, Malay Peninsula, Borneo, Philippines, Celebes.*
10. Inflorescence simple. *Sumatra, Malay Peninsula, Borneo* . . . . . **7. E. diadenum**
10. Inflorescence compound.
11. Petiolar glands globose, 2—3 mm ∅; similar glands often present in the ramifications of the lateral nerves. *Cont. SE. Asia* . . . . . **8. E. chinense**
11. Petiolar glands cylindrical.
12. Leaves 5—10 by 3—5.5 cm, palmately 5-nerved. *Philippines* . **11. E. ovatum**
12. Leaves 11—26 by 8—18 cm.
13. Fruiting stigma flattened, 2—2.5 mm wide. Leaves palmately 7—9-nerved. *Andaman Is., Peninsular Thailand, Borneo, Celebes, Philippines.* **9. E. peltatum**
13. Fruiting stigma conspicuously protruding, 3 mm wide. Leaves pinnately nerved. *Sumatra*.. . . . . **10. E. quadriloculare**[1])

1. Endospermum macrophyllum (M.A.) Pax & Hoffm., Pfl. R. Heft 63 (1914) 418; A. C. Smith, Bull. Bern. P. Bish. Mus. 141 (1936) 82. — *Macaranga macrophylla* M.A. in DC., Prod. 15, 2 (1866) 1001; Seem., Fl. Vit. (1867) 228. — *Tanarius macrophyllus* (M.A.) O.K., Rev. Gen. Pl. 2 (1891) 620. — *E. robbieanum* A. C. Smith, Bull. Bern. P. Bish. Mus. 141 (1936) 82, *syn. nov.*

Type specimen: *Seeman 396* (K), from Fiji Is.

Tree, 12—35 m high, 40—150 cm ∅. Branches gradually narrowed towards the apex, sometimes abruptly conically narrowed, 5—10(—17) mm ∅, glabrous, with pith or very occasionally hollow. *Leaves* usually non-peltate, but on non-flowering branches not rarely peltate; blade (broadly) ovate, coriaceous to herbaceous, cordate to rounded or subacute at the base, rounded to acute at the apex, glabrous above, hairy to glabrous beneath, 8—14 by 11—19 cm, palmately 5—10-nerved, lateral nerves 3—4 pairs, nerves slightly prominent and at the same time shallowly grooved above, or flat, distinctly prominent beneath, hairy, no glands along the margin above, a gland may be present in the forks of the side-nerves beneath; petiole often contracted at both ends, provided with 2—4 yellow-orange glands at the apex, glabrous, 6—23 cm by 2—4 mm. *Flowers* pedicelled, pedicels 1—1.5 mm. *Male inflorescence* paniculiform, up to 12 cm long, with side-axes up to 3 cm. Calyx 2—4 mm long, 2—3 mm wide; stamens *c.* 10; androphore 2—3 mm long; anthers 4-valved. *Female inflorescence* racemiform, up to 13 cm long, with short side-axes. Calyx very slightly 3- or 4-lobed, 3 mm long, 2.5 mm wide; ovary 3 by 2 mm, 2- or 3-celled, stigma 1—1,5 mm wide. *Infructescence* racemiform, up to 12 cm long, with side-axes *c.* 1.5 cm, thinly minutely stellate-hairy. *Fruits* 1—3 in the axils of the bracts, 2- or 3-lobed, 2- or 3-celled, with thin pericarp, 7 by 8 mm; calyx 4 mm wide; stigma 2 mm wide.

Distribution: Fiji Is. Map 1.

Ecology: Forests, 150—900 m. Occasionally I found hollow twigs but whether this is due to myrmecophily is not clear.

Uses: The wood is used for building and for making banana crates.

Vernacular names: Kauvula, kau vulavula, lekutu, vulavula.

Field notes: Buttresses may be present; bark creamy white; colourless sap abundant. Flowers brownish, with a faint but penetrating smell.

[1]) Flowers are unknown, but no traces of stamens were found under the fruit, hence it must have unisexual flowers.

Note. A. C. Smith distinguished a second species from the Fiji Is., *E. robbieanum.* The differences with *E. macrophyllum* were supposed by him to be the number of the cells in the ovary and fruit. Both shape and indumentum of the leaves vary to a considerable degree. Hairy and glabrous leaves are often found on the same branch. The number of ovary cells in *E. macrophyllum* and *E. robbieanum* is usually 3. Furthermore the general appearance of the two species is quite alike, so that I do not hesitate to merge them.

2. Endospermum medullosum L. S. Smith, Proc. Roy. Soc. Queensl. 58 (1947) 53, pl. 1.

Type specimen: *NGF 1738* (BRI), from New Guinea.

Tree, 20—35(—50) m high, 20—60(—80) cm ∅. Branches gradually narrowed towards the apex, 8—11 mm ∅, hairy, with pith, occasionally hollow. *Leaves* usually non-peltate, occasionally peltate; blade ovate to orbicular, cordate to rounded or broadly truncate at the base, acute to obtuse at the apex, thinly coriaceous, hairy to glabrous above, distinctly shortly tomentose beneath, but occasionally glabrous between the nerves, 11—23 by 9—17 cm, palmately 3—7-nerved; lateral nerves 6—9 pairs; 0—8 forks of the main nerves provided with a gland beneath; nerves grooved above, prominent beneath, stellate-hairy beneath; veins distinctly prominent beneath; margin provided with a number of small glands above; petiole not contracted at apex, occasionally so at the base, stellate-hairy, provided with 2 shortly cylindrical or subglobose brown-orange glands at the apex, 3—14 cm by 2—4 mm. *Flowers* sessile to short-pedicelled. *Male inflorescence* paniculiform, 7—20 cm long, with spike-like side-axes up to 4 cm long. Calyx indistinctly 4-lobed, 1.2—2 by 1—1.8 mm; stamens 5—7; androphore 1.7 by 0.5 mm; anthers 4-valved. *Female inflorescence* paniculiform, 7.5—13 cm long, with spike-like side-axes up to 4 cm, stellate-hairy. Calyx 1.1—4 by 0.9—2.5 mm, indistinctly 4-lobed; ovary 1-celled; stigma 1 mm wide. *Infructescence* paniculiform, with spike-like side-axes, stellate-hairy, 10—18 cm long; lowest side-axes up to 3 cm. *Fruits* stalked; stalk 1—2 mm long; body 7.5 by 6 mm, 1-celled; stigma 1.2 mm wide.

Distribution: New Guinea (incl. Salawati, Biak, and Japen), Bismarck Arch. (New Britain), Solomon Is., Australia: N. Queensland (Cape York Peninsula, Clump Point). Map 5.

Ecology: Primary forest, sometimes in secondary growth, once found on a riverbank, usually at low altitude up to 200 m, but also collected between 1200 and 2000 m. Myrmecophily has not been specifically recorded on field labels, but in a rather low percentage of specimens distinctly hollow twigs were observed.

Uses: The wood is used for building and for making canoes. Young leaves are sometimes eaten as a vegetable.

Vernacular names: New Guinea. Indonesian part. Vogelkop: *saimena, sajumena;* northern part: *jumkejuk, rikwa;* southern part: *jurasan;* Salawati: *adokko;* Biak: *mangguru, munabore;* Japen: *munabore.* Australian part: *aisasa, a'ugo, behbew, bige, bou, karubu, katuli, kirikendita, koindjal, koindza, mabung. sisibkoiru, taunpine, teppateh, yemo.* Bismarck Arch. New Britain: *nakau.* Solomon Is.: *a'asa, kadibi, kandiki, manogo.*

Note. Closely allied to *E. domatiphorum* and properly only distinguished as far as I can see by absence of domatia; like in many other species the nerve and vein axils on the lower leaf face often bear a prominent gland. See also the note under *E. myrmecophilum,* another closely allied species.

3. Endospermum myrmecophilum L. S. Smith, Proc. Roy. Soc. Queensl. 58 (1947) 56, pl. 2.

Type specimen: *NGF 1640* (BRI), from New Guinea.

Tree, 20—40 m high, 20—50(—100) cm ∅. Branches stout, abruptly conical at the apex, 10—18 mm ø, hollow, glabrous, provided with a few round pores; pores 2.5—3 mm ø. *Leaves* usually peltate; blade ovate, rounded to broadly truncate at the base, acute to rounded at the apex, firmly to thinly coriaceous, glabrous to minutely stellate-hairy on both surfaces, 8—18 by 10—22 cm; the posterior lobe about $\frac{1}{8}$—$\frac{1}{5}$ of the length of the anterior lobe; palmately 8- or 9-nerved (including the midrib); basal nerves flat above, prominent beneath; lateral nerves 4 or 5 on each side of the midrib, along the basal nerves 2 or 3; 0—5 forks of the lateral nerves provided with a gland beneath; veins inconspicuous; petiole somewhat contracted at both ends, glabrous to minutely stellate-hairy, 9—19 cm by 2—4 mm, provided with 2 flattened elliptic glands at the apex; glands 2—3 mm ø. *Male inflorescence* unknown. *Female inflorescence* paniculiform, 20 cm long, stellate-hairy, with side-axes up to *c.* 5 cm. Flowers pedicelled, 1—3 in the axils of the bracteoles; pedicel 2 mm long; calyx 4-lobed, 1.5 by 1.5 mm; ovary 1.5 by 1 mm, 1-celled; stigma 0.8—1 mm wide. *Infructescence* paniculiform, up to 16 cm long, stellate-hairy, with side-axes up to 5—6 cm long; pedicels 3—5 mm long. *Fruits* with a 1—2 mm long stalk; body 6 by 5.5 mm, 1-celled; calyx 2 mm wide; stigma 1.3 mm wide.

Distribution: East New Guinea. Map 3.

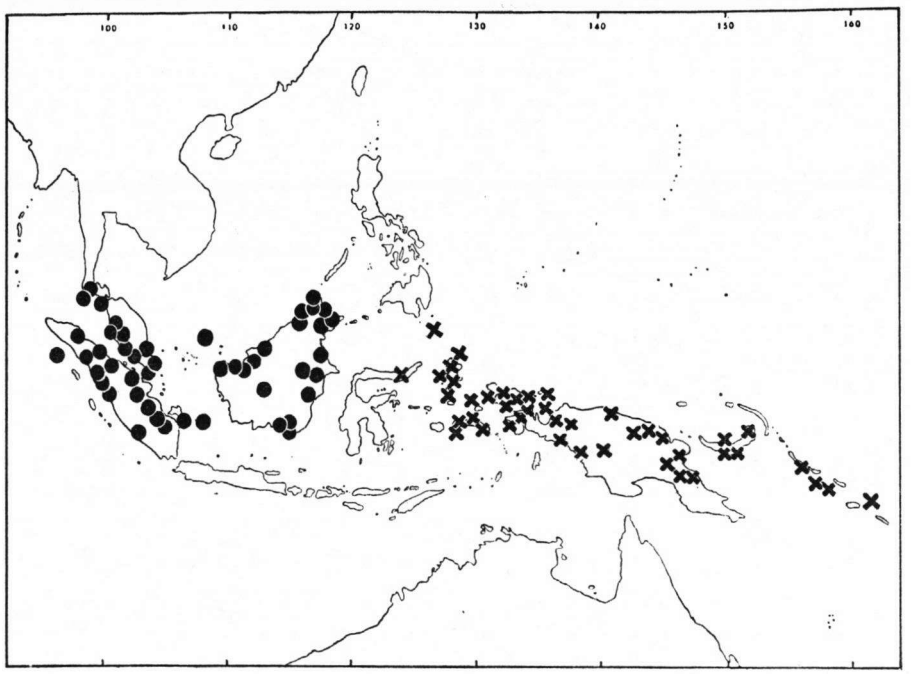
Ecology: Primary mixed forest and swamp forest, also near or along streams, from sealevel up to 500 m.

Vernacular names: Papua: *eladina, kerea;* Territory of New Guinea: *sisib koiru.*

Field notes: Bole 6—17 m, sometimes with small spur-roots; buttresses observed up to 1 m high; outer bark grey-brown to yellowish, the inner white to straw; sapwood yellowish white. Colourless or creamy exudation reported from stem, petiole, leaves, and fruit. Wood easily split and cut.

Note. E. myrmecophilum is undoubtedly closely allied to *E. medullosum*. Sometimes it is very difficult to distinguish the two species, as the hairiness varies, and peltate and non-peltate leaves occur in both species though *E. medullosum* has usually non-peltate leaves and *E. myrmecophilum* peltate ones. Both possess a 1-celled ovary and fruit.

4. Endospermum moluccanum (T. & B.) Kurz, J. Bot. 5 (1867) 23; Benth. & Hook. *f.*, Gen. Pl. 3 (1880) 322; Becc., Malesia 2 (1884) 38; Koord., Med. Lands Pl. Tuin 19 (1898) 584; De Clercq & Greshoff, Nieuw Plantk. Woordenb. Ned. Ind. (1909) 229; Pax & Hoffm., Pfl. R. Heft 52 (1912) 39; Bold., Cat. Herb. Pl. Hort. Bog. Cult. (1914) 94; Merr., Int. Rumph. (1917) 326; Heyne, Nutt. Pl. N. I. (1927) 956; Rant, Trop. Natuur 18 (1929) 186—188, 4 fig.; Nat. Tijd. N. I. 94 (1934) 113—116; Ann. Jard. Bot. Btzg 48 (1938) 123—128; Steen., Fl. Mal. I, 4 (1948) XXXV—XXXVI; Schodde, Blumea 15 (1967) 401. — *Hernandia sonora* ? (*non* Linné, 1753) Linné, Herb. Amb. (1754) 11; Amoen. Acad. 4 (1759) 122; Miq., Fl. Ind. Bat. 1, 1 (1858) 887. — *Capellenia moluccana* T. & B., Nat. Tijd. N. I. 29 (1867) 239. — *E. formicarum* Becc., Malesia 2 (1884) 44; Notizbl. Berl.-Dahl. 2 (1889) 129; K. Sch. & Hollr., Fl. Kais. Wilh. Land (1889) 80; Warb., Bot. Jahrb. 13 (1891) 348; K. Sch. & Laut., Fl. Schutzgeb. (1901) 406; Pax & Hoffm., Pfl. R. Heft 52 (1912) 36; Lane-Poole, For. Res. (1925) 105; Docters van Leeuwen, Treubia 10 (1929) 431—437; F. J. F. van Hasselt, Trop. Natuur 18 (1929) 93—95; L. S. Smith, Proc. Roy. Soc. Queensl. 58 (1947) 51; Schodde, Blumea 15 (1967) 401, *syn. nov.* — *E. labios* Schodde, Blumea 15 (1967) 401 (incl. ssp. *gracilipes* Schodde), *syn. nov.* — *Arbor regis* Rumph., Herb. Amb. 2 (1743) 257, pl. 85; Lamk., Encycl. Meth. (Bot.) 3 (1789) 123, *in syn. sub Hernandia sonora* L.; Meisn. in DC., Prod. 15, 1 (1864) 263, *in syn. sub Hernandia sonora* L.



Map 2. Range of *E. diadenum* (dots) and *E. moluccanum* (crosses).

Type specimen: *Teijsmann & Binnendijk s.n.* (BO) from the Moluccas.

Tree, 8—30 m high, 15—50 cm ∅. Branches abruptly conical at the apex, 10—15 mm ∅, striate, smooth, glabrous, provided with light brown lenticels, hollow or in cultivation with pith (by lack of excavating ants), with a few pores; pores 2 mm ∅. *Leaves* peltate; blade ovate, with broadly subtruncate base, rounded sides, and shortly acuminate apex, 13—26 by 11—23 cm, the posterior lobe about $\frac{1}{3}$—$\frac{1}{6}$ of the length of the anterior lobe; palmately 8—10-nerved (including the midrib); basal nerves flat to slightly impressed above, prominent beneath, glabrous above, hairy to glabrous beneath; side-nerves 3 or 4 on each side of the midrib, to the other nerves 2 or 3; petiole contracted at both ends, provided with 2 glands at the apex, glabrous to short-hairy, 12—23 cm by 2—5 mm. *Male inflorescence* racemiform, 7—25 cm long, with spiciform side-axes up to 4 cm. Calyx 3—5-lobed, 2—3 by 1.4—2.5 mm, light brown; stamens 9—12; androphore 2—3 by 0.5—1 mm, tip sometimes thickened, provided with some hairs; anthers 4-valved. *Female inflorescence* racemiform, 10 cm long, short-hairy. Flowers sessile, solitary; calyx 4-lobed, 2.5 mm long and wide; ovary 4—7-celled, 2.5—3 by 1.5—2 mm. *Infructescence* similar to the female inflorescence, with side-axes up to 6 cm. *Fruits* sessile to shortly pedicelled, 4—6(—7)-celled, globose, 7—16 by 7—20 mm; stigma 2—6 mm wide; pericarp thin- to rather thick-fleshy, wrinkled in sicco.

Distribution: Celebes, Moluccas, New Guinea, Bismarck Arch. (New Britain), Solomon Is. Map 2.

Ecology: Primary and secondary forest, often in very wet habitats, along streams and in swamp forest, on flat land, 0—1000 m.

Uses: The thin roots have been used as an antidote against the arrow-poison used by the

Macassars; the victim has to chew a piece, and partly swallow the sap and partly rub it on the arrow wound.

The long-fibrous wood is very light, being flexible and strong only when in a dried condition. Sometimes older trunks, which are light and rigid, are used for masts for vessels; young trunks are used for the floats of fishing nets. Leaves: young ones are boiled in water and consumed as a vegetable together with their decoction, producing a soft purgative effect; old leaves, however, are strongly laxative. If a man has become 'short-winded' as a result of having eaten food prepared by a menstruating woman, the skin of a mango wrapped in these leaves is applied to his throat and he recovers (*Blackwood 316*, New Britain).

Vernacular names: Moluccas. Talaud Is.: *aaròtò;* Ambon: *ai latu, ail latu, airatu, kaju* or *pohon radja, kaju* or *pohon semut* (*sĕmut* = ant), *pea pea;* Ceram & Ternate: *kaju radja;* Halmaheira: *hupu, ofo, owoto.* New Guinea. Indonesian part. Vogelkop: *aru, beprai, mani, maprai, njebbie, njeiglie, sajon, sejum, seraida, taneparoi, wakopak, wakpak, wapaap, wapaat;* Southern part: *urijk.* Australian part: *bondoa, kidikendi, koin, kumgum, mawr, me po'aro, munampun, pehpi, poteh, taingino.* Bismarck Arch. New Britain: *lalaul, lanlon, nanok malu, nauwawa, prim.* Solomon Is.: *a'asa, aiaofia, ai'aufia, aiautia, aiofia, kornu, u-kon-nu.*

Field notes: Bole 8—20 m; buttresses if present up to 1 m high, spreading to 1 m over the ground, up to 15 cm thick; bark smooth, grey-green to yellow-brown; inner bark soft or hard, yellow-brown to white; wood white to creamy yellow, soft or hard. Flowers with or without smell, cream to yellow. Sap milky or watery, whitish to yellowish.

Notes. In the ant-inhabited cavities in the branches and stem a dense growth of fungi living on the faeces of the ants is found. (Docters van Leeuwen, Treubia 10, 1929, 436). These fungi are not used by the ants as food. The timber is pale straw to pale yellow-brown, similar to that of *E. medullosum* and *E. myrmecophilum.* F. J. F. van Hasselt (Trop. Natuur 18, 1929, 934) stated that *Hydnophytum montanum* growing in these trees, still housed ants.

The specimens obtained from plants cultivated in the Botanical Garden at Bogor have pith in the branches, apparently because there are no specific ants available to hollow them out. The general appearance of the pithed branches is similar to that of the hollow ones. Very occasionally there seem to occur non-infected trees of which the branches are consequently not hollow (e.g. *BSIP 13980*).

Rant (Trop. Natuur 18, 1929, 187), who tried to transplant specimens from Ambon to Java, observed that already young specimens, with a stem diameter of 1 cm, were inhabited by ants. When specimens are transplanted, the specific ant, *Camponotus quadriceps,* easily leaves its host plant. Also, in transplanted specimens this ant is very shy, and is easily chased away by other ants.

In their description Teysmann & Binnendijk (l.c. p. 238) mentioned that they grew two trees in the Botanic Gardens at Bogor, transferred from Ambon. One tree produced ♀ flowers which dropped unfertilized. Later the second tree flowered, producing mainly ('grootendeels') ♂ flowers in which a rudimentary ovary was developed, the latter being in some flowers a true ovary growing into a fruit. Still later, this male or hermaphrodite tree and the first-mentioned ♀ tree flowered again, simultaneously, whereby the latter produced abundant seed. From this brief statement of their observations it must be concluded that *E. moluccanum* is normally dioecious but that in some flowers of the ♂ tree bisexual flowers may occur. Though I had abundant material of this species, I have found no bisexual flowers. If bisexual flowers are rare they may escape observation. Though not doubting Teysmann & Binnendijk's observation, their statement should be checked on living trees at Bogor or in the field.

5. Endospermum banghamii Merr., Contr. Arn. Arb. 8 (1934) 89.

Type specimen: *Bangham 739* (CGE), from Sumatra.

Tree, 33 m high. Branches slender, gradually narrowed towards the apex, 6—9 mm ⌀, striate, smooth, provided with a few hairs around the petiolar scars, otherwise glabrous, with some lenticels, with pith. *Leaves* non-peltate; blade ovate, truncate at the base, acute to acuminate at the apex, 11—15 by 7—11 cm, palmately 5-nerved; lateral nerves 3—5 pairs; nerves flat to slightly prominent above, distinctly prominent beneath; no glands in the forks of the side-nerves beneath; petiole not contracted at the ends, without glands at the apex, glabrous, striate, 5—6 cm by 1—2 mm, dark brown. *Inflorescence* racemiform, 11—14 cm long, with well developed side-axes up to 2.5 cm. Flowers pedicelled, bisexual, solitary; pedicel glabrous to slightly hairy, 4 mm long; calyx indistinctly 4-lobed, 2 by 3 mm; stamens 5, at the base of the ovary, persistent in the fruit; anthers 3-valved; ovary ellipsoid, minutely hairy, 3.2 by 2.5 mm, 3- or 4-celled; stigma 3- or 4-lobed, 2—2.5 mm wide. *Fruits* stalked, ellipsoid, 8 by 6 mm, 3- or 4-celled; stalk 0.5 cm long; stigma 1—2 mm wide; pericarp thin-fleshy.

Distribution: Only known from the type locality: N. Sumatra, Atjeh: Takengon. Map 5.

Ecology: Young secondary forest, 1100 m.

Field notes: Trunk 60 cm ⌀; bark whitish. Fruit green.

6. Endospermum ronaldii Schaeffer, *sp. nov.*

E. quadriloculare affinis, ab ea differt floribus hermaphroditis atque foliis minoribus (10—14 cm longa, 7—9 cm lata).

Type specimen: *SF 18396* (SING, isotypes in K, L), from the Malay Peninsula.

Branches tapering towards the apex, 7—9 mm ⌀, dark brown, smooth, glabrous, without lenticels, with pith, stellate-hairy towards the apex. *Leaves* non-peltate; blade ovate, green above, brownish beneath, coriaceous, pinnately nerved, glabrous above, stellate-hairy beneath, 10—14 by 7—9 cm, round to truncate at the base, acute at the apex; side-nerves 5 or 6 on each side of the midrib; all nerves slightly prominent above, distinctly so beneath; the margin provided with a few small glands above; petiole not contracted at the ends, with 1 or 2 cylindrical glands at the apex, or glandless, brown, minutely stellate-hairy, 4—8 cm by 1—1.5 mm. *Inflorescence* racemiform, *c.* 13 cm, the lowest side-axes up to 3 cm long. Flowers bisexual, solitary; pedicel 1.5 mm long; calyx 1.5 by 1.5 mm; stamens *c.* 10, spirally arranged on an androgynophore; anthers 3- or 4-valved; ovary 4-celled, 2—2.5 by 1 mm; stigma 4-lobed, 2 mm wide. *Fruits* unknown.

Distribution: Only known from the type locality: Malay Peninsula, Pahang Prov. (P. Tioman: Sedagong). Map 4.

Ecology: Altitude 300 m.

Vernacular name: Mĕlokan.

Field notes: Tall tree. Flowers green.

Note. Save for the bisexual flowers this species is very close to *E. quadriloculare.* Unfortunately, *E. ronaldii* is known from only one collection in flower and *E. quadriloculare* from three specimens in fruit. Vegetatively, these two differ in the following two features: *E. ronaldii* has leaves with a rounded base, underneath finely puberulous, *E. quadriloculare* has a broad-cuneate leaf-base glabrous underneath. Both these characters vary, however, in other species, for example in *E. diadenum.* My main argument for keeping *E. ronaldii* and *quadriloculare* separate is that in the latter under the fruits no traces of stamens could be found, as is the case in *E. banghamii.*

7. Endospermum diadenum (Miq.) Airy Shaw, Kew Bull. 14 (1960) 395. — *Melanolepis? diadena* Miq., Sum. (1860) 455. — *E. borneense* Benth., Flora 47 (1864) 469; M. A. in DC., Prod. 15, 2 (1866) 1132; Pax & Hoffm., Pfl. R. Heft 52 (1912) 35; Merr., Philip. J. Sc. 9 (1914) Bot. 481; Pax & Hoffm., Pfl. R. Heft 63 (1914) 418; Merr., En. Born. (1921) 346; Corner, Gard. Bull. Str. Settl. 10 (1939) 298. — *E. malaccense* Benth., Flora 47 (1864) 469; M.A. in DC., Prod. 15, 2 (1866) 1132; De Clercq & Greshoff, Nieuw Plantk. Woordenb. Ned. Ind. (1909) 229; Pax & Hoffm., Pfl. R. Heft 52 (1912) 34; Ridl., Fl. Mal. Pen. 3 (1925) 305—306; Corner, Gard. Bull. Str. Settl. 10 (1939) 296—299; Heyne, Nutt. Pl. N. I. ed. 3 (1950) 956; Airy Shaw, Kew Bull. 14 (1960) 395. — *Mallotus diadenus* (Miq.) M.A. in DC., Prod. 15, 2 (1866) 959. — *Rottlera diadena* (Miq.) Scheff. in Miq., Ann. Mus. Bot. Lugd. Bat. 4 (1869) 125. — *E. ovalifolium* Pax & Hoffm., Pfl. R. Heft 52 (1912) 34; Ridl., Fl. Mal. Pen. 3 (1925) 305—306; Corner, Gard. Bull. Str. Settl. 10 (1939) 297; Heyne, Nutt. Pl. N. I. ed. 3 (1950) 956. — *E. beccarianum* Pax & Hoffm., Pfl. R. Heft 52 (1912) 35; Merr., En. Born. (1921) 346; Corner, Gard. Bull. Str. Settl. 10 (1939) 298. — *E. chinense* Benth. var. *malayanum* Pax & Hoffm., Pfl. R. Heft 52 (1912) 36; Merr., Contr. Arn. Arb. 8 (1934) 89. — *E. malayanum* (Pax & Hoffm.) Chatterjee, Kew Bull. (1949) 546.

Type specimen: *Teysmann 3807 H.B.* (L), from Sumatra.

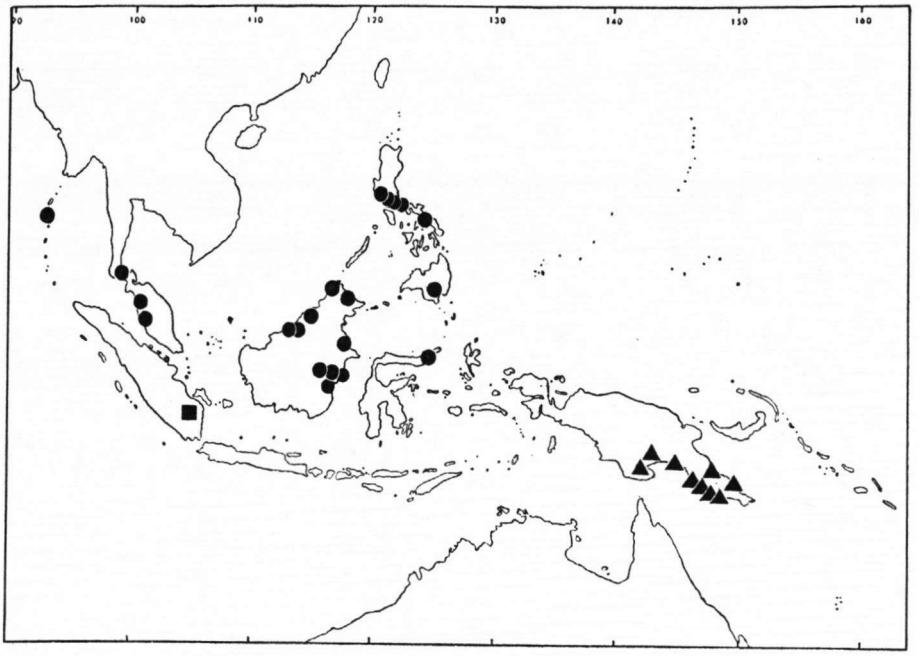
Tree, 15—35 m high, 30—65 cm ∅. Branches tapering towards the apex, 4—13 mm ∅, striate, hairy, without lenticels, with pith, smooth. *Leaves* non-peltate; blades obovate to broadly ovate or cordate, green, hairy to glabrous above, hairy beneath, cordate to rounded or truncate to acute at the base, rounded to obtuse or acute at the apex, palmately 3—9-nerved, 7—25 by 4—22 cm; side-nerves 3—5 on each side of the midrib; nerves somewhat prominent above, strongly prominent beneath; 0—10 ramifications of the side-nerves beneath provided with a gland; margin provided with numerous small glands above; petiole not contracted at apex, occasionally so at base, stout, yellowish, hairy, striate, provided with 2 or 1 small glands at the apex, or glandless, 5—25 cm by 2—4 mm. *Male inflorescence* simple or with (very) short side-axes, 7—17 cm long. Flowers sessile or minutely pedicelled, 1—3 in the axil of the bracts; calyx green, 4- or 5-lobed, 1—1.3 by 1—1.6 mm; stamens 9—11; androphore 1.7—2.5 mm long, sometimes with a few simple hairs at the ± thickened apex; anthers 4-valved. *Female inflorescence* simple 5—15 cm long, stellate-hairy; often 2 or 3 flowers in the axils of the bracts. Pedicel 1.5—5 mm; calyx 4- or 5-lobed, short-hairy outside; ovary broadly elliptic, green, 3 by 2 mm, 2- or 3-celled, stigma 1.5 mm wide. *Infructescence* simple or occasionally with 1—2 cm long side axes, stellate-hairy; sometimes 2 or 3 fruits in the axil of a bract. *Fruits* 4—8 mm long stalked, mostly 2- or 3-lobed, light brown, minutely hairy, 5—8 by 5—8 mm, 2- or 3-celled; calyx 1—5 mm wide; pericarp wrinkled, thin; stigma 1—2.5 mm wide.

Distribution: Peninsular Thailand, in Malesia: Sumatra (incl. Simalur, Riouw Arch., Banka & Billiton), Malay Peninsula, Borneo. Map 2.

Ecology: Primary and secondary forest, mostly in low undulating country, occasionally in places permanently submerged by fresh water, sometimes also found along streams, 0—400 m.

Uses: House building, clogs, planks; timber durable.

Vernacular names: Sumatra. West Coast: *kundui, labu, madang tapak kudu, modang kombiri;* Simalur Is.: *alifambang, a. bungo, a. uding;* East Coast: *simar antipa, sonduk;* Indragiri: *mara bulan, terbulan;* Palembang: *kaju labuh, ogan ulu;* Banka: *djelanding, njelanding;* Billiton: *libut.* Malay Peninsula: *bebaru bukit, kuyu sendok, membulan, poko susundo, sendok sendo(k), sindor sindor.* Sarawak & Brunei: *entabulan, sendok sendok.* Sabah: *dalam mata, katimahar, melokan.* Indonesian Borneo: *garung, lempaung, nangair, pajaug gunung, parupaek, pempiring.*



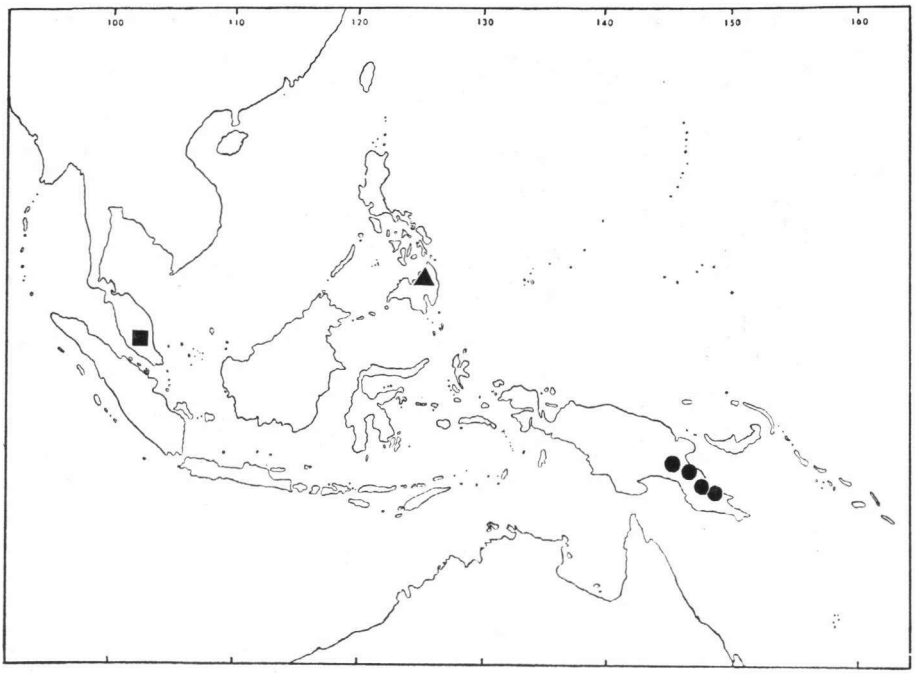
Map 3. Range of *E. peltatum* (dots), *E. quadriloculare* Pax & Hoffm. (square, in S. Sumatra), and *E. myrmecophilum* (triangles).

Notes. E. diadenum varies considerably in leaf characters, on which Corner (l.c. p. 296—297, under *E. malaccense*) made already some valuable critical remarks, based on observation of both dried and living material. The shape of the leaf varies from ovate-acuminate and deeply cordate to elliptic-obovate with acute base and apex. The leaves are never peltate. The indumentum shows all transitions from simple to stellately branched hairs, or may lack completely. In young trees simple hairs are prevailing. In the mature trees, however, stellate hairs are formed between the simple ones, the latter may disappear afterwards. In this way 3 kinds of indumentum are realized: leaves with simple hairs only, or with stellate hairs only, or with both simple and stellate hairs. In accordance with the shape of the leaves the number of basal nerves varies between 3 and 7. The number of the petiolar glands ranges from 0—2, moreover, a single gland may be present in each fork of the side-nerves near the margin beneath. Pax & Hoffmann based their key to the species upon these unreliable characters.

8. Endospermum chinense Benth., Fl. Hongk. (1861) 304; M. A. in DC., Prod. 15, 2 (1866) 1131; Pax & Hoffm., Pfl. R. Heft 52 (1912) 35; Dunn & Tutcher, Fl. Kwantung (1912) 240; Pax & Hoffm., Pfl. R. Heft 63 (1914) 418; Gagnep., Fl. Gén. I.-C. 5 (1926) 453; Cowan & Cowan, Trees of North Bengal (1929) 119; Merr., Contr. Arn. Arb. 8 (1934) 90; Corner, Gard. Bull. Str. Settl. 10 (1939) 298; Kanjilal & Das, Fl. Assam 4 (1940) 204; Airy Shaw, Kew Bull. 14 (1960) 395; Huntley & U Chit Ko Ko, List Trees Burma ed. 3 (1961) 236.

Lectotype specimen: *Hance 1946* (BM), from Hongkong.

Tree. Branches tapering towards the apex, 5—9 mm ∅, with pith. *Leaves* non-peltate;



Map 4. Range of *E. ronaldii* (square in Malaya), *E. ovatum* (triangle in Mindanao), and *E. domatiphorum* (dots).

blade rhomboid or elliptic to ovate, glabrous to thinly hairy, palmately 3-nerved, 8—15 by 5—13 cm; base truncate to acute, provided with 2 conspicuous globose yellow-brown glands, 2—3 mm ∅; apex obtuse to acute; side-nerves 3—5 on each side of the midrib; nerves flat to slightly prominent above, distinctly prominent beneath; 0—4 glands similar to the basal ones present in the ramifications of the side-nerves beneath; petiole hairy, 3—10 cm by 1—3 mm, slightly constricted at the base. *Male inflorescence* paniculiform, up to 21 cm long, with side-axes up to 4 cm. Calyx inconspicuously 4-lobed, yellow-brown, 2 mm wide. Stamens *c.* 10; androphore sparsely hairy, 3.5—4 by 0.6 mm; anthers 4-valved. *Female inflorescence* unknown. *Infructescence* racemiform, up to 18 cm long, with spiciform side-axes up to 2.5 cm long. *Fruits* 2—3(—4)-celled; stigma 1—2 mm ∅; pericarp thin.

Distribution: SE. Asia: Assam (Kanjilal & Das, l.c.), Burma, Thailand, North Vietnam (Annam, Tonkin), Hainan, Hongkong, Swatou Is. Map 5.

Ecology: Forests on dry sandy soil, at 250—700 m.

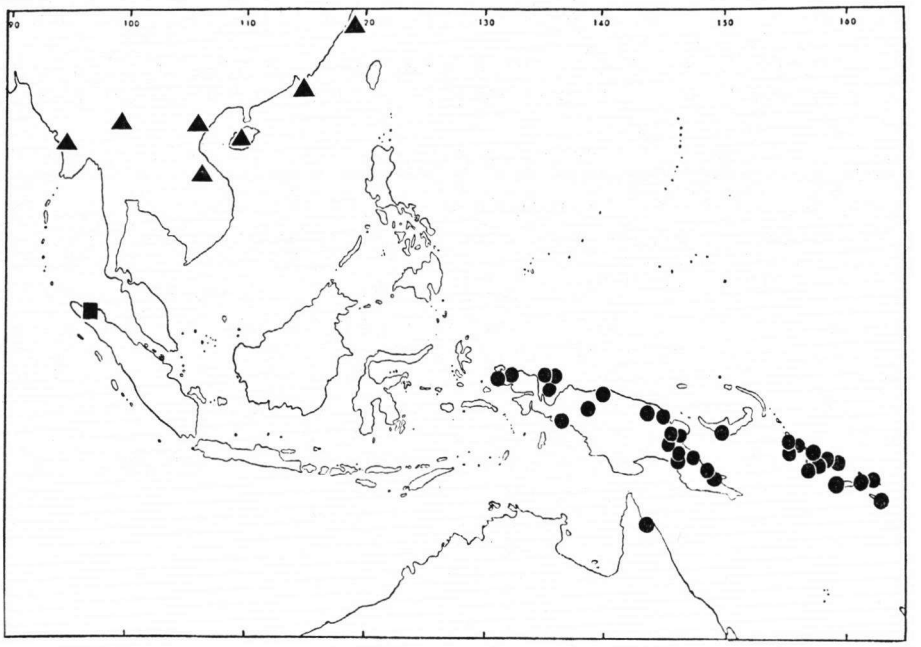
Uses: Hard light white timber.

Vernacular names: Assam: *bola, halud chaki, paklau-arong, thing-aiveng.* Burma: *okàlàput pun.* North Vietnam: *aloâng dôûg do, vang chung.*

9. Endospermum peltatum Merr., Publ. Gov. Lab. Philip. 35 (1905) 35; Pax & Hoffm., Pfl. R. Heft 52 (1912) 37; Chatterjee, Kew Bull. 4 (1950) 564.

Lectotype specimen: *Merrill 2603* (K), from the Philippines (Luzon).

Tree, 10—35(—45) m high, 30—60 cm ∅. Branches tapering towards the apex, 7—11 mm ∅, brown, without lenticels, with pith. *Leaves* peltate or not; blade elliptic or ovate-



Map 5. Ranges of *E. chinense* (triangles), *E. banghamii* (square), and *E. medullosum* (dots).

oblong, reddish brown above, yellow-green beneath, sparsely hairy above, densely hairy beneath, rounded to cordate at the base, rounded to acute at the apex, palmately 7—9-nerved, 11—25 by 9—18 cm, provided with glands along the margin above; nerves somewhat prominent above, distinctly prominent beneath; side-nerves 4—9 on each side of the midrib; 1—6 ramifications of the side-nerves provided with a gland beneath; petiole usually not contracted at apex, often strongly so at the base, brown, hairy, provided with 2 cylindrical glands at the insertion of the blade, 5—12 cm by 1.5—3 mm. *Male inflorescence* paniculiform, 13—35 cm, with the lowest side-axes up to 7 cm, densely hairy, slightly paler than the petiole. ♂ Flowers up to 3 in the axils of the bracts; pedicel *c.* 1.2 mm long; calyx obscurely 4- or 5-lobed, 0.8—1.3 by 1—1.8 mm, stamens *c.* 11; androphore glabrous. 1.5 by 0.4 mm; anthers 3-valved. *Female inflorescence* unknown. *Infructescence* paniculiform, 25 cm long, with side-axes up to 7 cm, hairy; pedicel 5 mm. *Fruits* 3—6 mm stalked, globose, brown, minutely hairy, 2- or 3-celled, 5—7 by 7—9 mm; calyx 4- or 5-toothed, 2—2.5 mm wide; stigma flattened, 2—2.5 wide.

Distribution: Andaman Is., Peninsular Thailand, in Malesia: Borneo, Philippines (Luzon, Samar, Mindanao), Celebes. Map 3.

Ecology: Forests on wet land, along rivers, also often on hillsides; from sealevel up to 200(—1000) m.

Uses: Wooden shoes, matches. Seeds edible.

Vernacular names: Sarawak & Brunei: *takaliu*. Sabah: *buah icras, kemiri, maram pangi*. Indonesian Borneo: *bungkul tekaja, kedjo luk long, peridja buaja*. Celebes, Manado: *mapoopo*. Philippines, Luzon & Mindanao: *gubas*.

Field notes: Bole 7—20 m. Bark smooth, grey-brown; inner bark yellow-brown, hard; wood soft, white to yellowish.

Note: In accordance with Dr. Whitmore I may remark that all peltate collections of *Endospermum* in the Malay Peninsula belong to *E. diademum* and not to *E. peltatum*.

10. Endospermum quadriloculare Pax & Hoffm., Pfl. R. Heft 52 (1912) 36; S. Moore, J. Bot. 63 (1926) Suppl. 104.

Type specimen: *Forbes 2751* (BM), from Sumatra.

Tree. Branches tapering towards the apex, 6—9 mm ∅, dark brown, minutely stellate-hairy towards the apex, with pith, provided with a few light brown lenticels. *Leaves* peltate or not; blade thinly coriaceous, the non-peltate ones ovate, acute to rounded at the base, acute to acuminate at the apex, the peltate ones elliptic, with an obtuse base and acute to acuminate apex, all pinnately nerved, 8—18 by 11—26 cm, glabrous above, minutely hairy beneath; side-nerves 5 or 6 on each side of the midrib; no glands in the nerve-forks; all nerves flat above, prominent beneath; the margin slightly revolute and provided with a few small glands above; petiole constricted at both ends, glabrous to minutely hairy, green to brown, 12.5 cm by 2.6 mm, provided with 2 large cylindrical glands at the apex; glands 2.5 by 1.5 mm. *Flowers* unknown. *Infructescence* racemiform, 10—20 cm long, without or with up to 1.5 mm long side-axes. *Fruits* on stalks 4—7 by 1.5 mm, globose, 11 by 9 mm, 4-celled, each cell not always provided with a well-developed seed; calyx orbicular, 6 mm wide; stigma 4-lobed, conspicuously protruding, 3 mm wide.

Distribution: South Sumatra (Tg. Ning), three collections. Map 3.

Ecology: In forests, 400 m.

Note. See for the affinity with *E. ronaldii* the note under that species.

11. Endospermum ovatum Merr., Philip. J. Sc. 9 (1914) Bot. 481.

Type specimen: *BS 15924 (E. Fenix)* (US), from the Philippines.

Tree. Branches tapering towards the apex, 6—7 mm ∅, glabrous, reddish brown, with pith. *Leaves* non-peltate; blades elliptic to ovate, light brown, glabrous, acute at the base and acute to rounded at the apex, 5—10 by 3—5.5 cm, palmately 5-nerved; 5 side-nerves on each side of the midrib; nerves flat above, prominent beneath; no glands in the ramifications of the side-nerves; petiole slightly contracted at the ends or not, somewhat hairy to glabrous, 2.5—4 cm by 1—1.5 mm, sometimes provided with 2 glands at the apex. *Male* and *female inflorescence* unknown. *Infructescence* paniculiform, hairy, 14 cm, with up to 4 cm long side-axes. *Fruits* disintegrated, 2-celled.

Distribution: Philippines (Mindanao). Only known from the type specimen. Map 4.

12. Endospermum domatiphorum J. Schaeffer, *sp. nov.*

Ex affinitate *E. medullosi* et *E. myrmecophili* ab fructus 1-loculares. Ab *E. myrmecophilo* et *E. medulloso* differt domatiis in nervorum axillis. Glandulae petiolares tantum, i.e. foliorum pagina inferior glandulis destituta. Ab *E. myrmecophilo* insuper differt foliis non-peltatis.

Type specimen: *Pullen 5922* (CANB), from New Guinea.

Tree, 25—30 m high, 18—25 cm ∅. Branches tapering towards the apex, 4—7 mm ∅, with pith, glabrous or hairy. *Leaves* non-peltate; blade orbicular to ovate, coriaceous, acute to rounded at the base, rounded at the apex, usually glabrous, occasionally stellate-hairy on both sides, green to brown above, green beneath, 7—20 by 5.5—18 cm, palmately 5-nerved; 3—7 side-nerves on each side of the midrib; the nerve-axils beneath

usually provided with domatia; nerves prominent beneath, flat above; petiolar glands present in the axils of the basal nerves, the margin provided with a number of small glands above; petiole not contracted at the ends, minutely stellate-hairy, 2.5—9 cm by 1.5—4 mm. *Male inflorescence* paniculiform or raceme-like, up to 11 cm long, with side-axes 2 cm long, brown, stellate-hairy. ♂ Flowers 1—3 in the axils of the bracts on 1 mm long pedicels. Calyx indistinctly 4-lobed, hairy outside, glabrous inside, 1 by 1.5 mm. Pedicel 1 mm; stamens 7—9; androphore 3—4 mm long; anthers 4-valved. *Female inflorescence* paniculiform, up to 8 cm long, brown, stellate-hairy, with side-axes *c.* 2 cm long. Flowers solitary, sessile or up to 1 mm long pedicelled. Calyx not or very indistinctly lobed, 2 mm long, 2 mm wide. Ovary 3 by 1.5 mm, 1-celled; stigma 1—1,5 mm wide. *Infructescence* paniculiform, up to 12 cm long, brown, stellate-hairy, with up to 4 cm long side-axes. *Fruits* sessile, globose, glabrous to very minutely hairy, brown, 6 by 5 mm, 1-celled; stigma light brown, 1.5 mm wide.

Distribution: New Guinea (Papua), six collections. Map 4.

Ecology: In forests, 700—2000 m.

Vernacular names: boroboro, mayak.

Field notes: Bole 18—20 m; outer bark smooth, grey-brown; inner bark yellow-orange. Twigs with red sap. Fruits green.

Note. Closely allied to *E. medullosum*, and properly only distinguished by the presence of domatia. Glands in the nerve and vein axils, as mostly found on the undersurface of the leaves in *E. medullosum*, are absent.

13. Endospermum sp. nov.

Thin-branched, branches solid. Leaves ovate to elliptic, not peltate, blunt, *c.* 6 by 9 cm; glands 2 on the petiole, inserted several mm from the leaf base; lateral nerves *c.* 4—5 pairs; small glands in marginal vein-axils.

WEST NEW GUINEA. Numfoor I. (Biak Dist., Geelvink Bay), in primary forest, 7 m alt., scattered, tree 25 m, 45 cm ∅ bh, vern. *aru*, sapwood yellow, bitter, *BW 1058* (A, L, LAE), sterile, Sept. 1954.

Mr. P. Baas, systematic anatomist at the Rijksherbarium, has been so kind to examine the anatomical characters of the presumed new species and compared these with those of *E. diadenum*, *E. domatiphorum*, and *Macarange cynae*, as to indumentum, stomata, midrib, vascular bundles in the petiole, cross-section of wood in twig, and petiolar glands. He found that there are a few minor differences between the presumed new species and the two other *Endospermums*, but that there is an overwhelming likeliness with these as compared with *Macaranga*, the alternative generic choice. He concluded that there is, from the anatomical point of view, no reason to exclude the presumed new species from *Endospermum*.

This species distinctly differs from all other ones by the very thin branches and the place of insertion of the petiolar glands.

SPECIES EXCLUDENDAE

Endospermum eglandulosum Pax & Hoffm., Pfl. R. Heft 63 (1914) 418.

Type specimen: *Beccari 1347* (BM, isotype), from Borneo.

According to Mr. F. Hildebrand (Rijksherbarium, Leiden) this belongs to **Sterculia macrophylla** Vent. *(Sterculiaceae).*

Endospermum perakense King *ex* Hook. *f.*, Fl. Br. Ind. 5 (1887) 458; Ridl., Fl. Mal. Pen. 3 (1925) 306; *King's Coll. 3273, 5267* (type), *Wray 2379*.

This was recognized to belong to *Macaranga* by Beccari (*in sched.* herb. Firenze), Corner (Gard. Bull. Str. Settl. 10, 1939, 299), and Airy Shaw (Kew Bull. 14, 1960, 396); by Corner referred to *aff. M. populifolia* (Wayside Trees 1, 1940, 269), and finally identified by Airy Shaw as **M. amissa** Shaw (Kew Bull. 21, 1968, 403).

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The number behind the names refers to the number of the species in the text. Synonyms are in *italics*, names of new species are in **bold type.** Names followed by 'Excl.' are mentioned under 'Species Excludendae'.