

## DIOSCOREACEAE<sup>1</sup> (I. H. Burkill, Leatherhead, Surrey)

Rhizomes (rarely spiny) producing annual, mostly twining shoots, in Malaysia twining either to the right (fig. 4c) or the left (fig. 4a). Stems consisting of a main stem and sterile branches, both bearing leafless flowering axes. *Leaves* petiolate, generally cordate, simple and entire or palmately lobed, or palmately compound, except in the latter triplinerved; apex generally glandular, developed before the blade (forerunner tip); blade usually glandular on the lower side chiefly towards the base. *Flowers* hermaphrodite or dioecious, ♀ with staminodes, ♂ without even a rudimentary ovary, actinomorphic, 3-merous, mostly inconspicuous and greenish, ♂ often massed together and scented. *Tepals* in two whorls of 3. Stamens in 2 whorls of 3, the inner sometimes sterile; anthers usually introrse. Torus an urceolate, perianthoid chamber in *Stenomeris*, a saucer or cup in many *spp.* of *Dioscorea*, fleshy in *Dioscorea* § *Enantiophyllum*, in some *spp.* enlarged into a cone making the stamens appear to be connate. Style 1 with 3 bifid stigmas. *Ovary* 3-locular, inferior, sometimes separated from the perianth by a constriction, *Ovules* 2 in each cell or ∞ (in *Stenomeris*), anatropous. *Fruit* a capsule, but it breaks up rather than dehisces in *Trichopus*. Seeds winged or wingless (in *Trichopus*); endosperm horny, embryo in a marginal pocket.

Distr. *Ca* 9 genera and about 600 *spp.* (*Dioscorea* large, the other genera small or monotypic). Pantropic with considerable extensions into temperate regions. The *Stenomerideae* and *Trichopodeae* are restricted to the warm humid regions where *Nepenthes* grows and their geologic history must have been that of *Nepenthes*: they may be regarded as the survivors of the hermaphrodite ancestry of the *Dioscoreae*.

Ecol. The base of the stem is modified for storage of food and water in various ways by conversion into a thickened rhizome or a swollen vertical body of fixed position in the soil or most commonly into a short cormous body with tuberous outgrowths of annual duration. The storage organs are protected against herbivorous animals either by the overlying soil or by poisonous substances, or in a few species by a corky covering, or in a very few species by thorny roots.

The annual stems do not twine from their base, but commence to twine at a little distance above the soil, and do so consistently either to the right (fig. 4c) or to the left (fig. 4a). Departure from this rule has been observed in none but a single African species; and there are dwarf species among which is *Trichopus zeylanicus* (see p. 297) which do not attain sufficient height for twining. The direction of twining is an important taxonomic character.

The cauline axes are differentiated above ground in various degrees of completeness into (i) the main stem, (ii) branches arising from it, indued with fertility, not themselves carrying flowers, but carrying (iii) leafless axes which bear the flowers. Flowering commences as a rule well above the commencement of twining, and at the level where it begins, there is usually a diminution in the size of the leaf blades such as causes the leaves most useful taxonomically to be immediately below the horizon at which the flowers commence.

The cordation of the leaf characteristic of the family is completed in the last stages of its enlargement; and leaves that are hindered, say, by want of building material, from growing to their maximum, such leaves as occur towards the distal ends of stems, are less cordate than more favoured leaves. The leaves of seedlings at an age when the plants are few-leaved, are much larger at the base than leaves borne later in association with flowers (fig. 10).

The flowers are entomophilous. In the hermaphrodite flowers of the *Stenomerideae* and *Trichopodeae* there are elaborate arrangements to secure cross-fertilization which is inevitable in the dioecious *Dioscoreae*.

Sometimes 3 of the stamens, invariably the inner 3, are staminodal, and they are then as a rule modified, compelling visiting insects to move in such a way as to pick up pollen.

The flowers are inconspicuous except in the Madagascan genus *Avetra* (*Trichopodeae*), and of moderate

(1) This treatment of the *Dioscoreaceae*, more profuse than the general plan of this Flora, is justified by their economic importance, and above all by their difficulty. The specific delimitation accepted here is narrower than that adopted by some other authors; the present writer based his views on an exceptionally extensive and detailed knowledge of Malaysian *Dioscoreaceae* during many years of study of fresh materials. The separation of the sexes demands keys for each sex and such have been provided where the material made this possible; keys based entirely on vegetative characters proved to be ineffective.—Ed.

size but inconspicuous coloration in *Stenomeris*; or in *Dioscorea* they are green and small or very small; but they are often scented and the male flowers are massed together.

There is a greater abundance of male plants and a much greater abundance of flowers on male plants.<sup>1</sup>

The outer tepals usually are a little larger than the inner ones and cover them in the bud. Among the *Dioscoreaceae* of Malaysia, sterilization of stamens in the ♂ flowers is found in none but species of sect. *Lasiophyton*; sterilization occurs in two other Malaysian sections but not in species found in Malaysia.

The cells of the ovary enlarge so as to provide in advance space for the wings on the seeds which remain small until just before ripeness. The position of the ovules on the placenta, whether near the apex or the base or at the middle is bound up with the direction in which the wings grow. The act of pollination induces growth under the capsule and this growth is used through geotropism to determine the poise of the capsule.

Anat. There is a tendency throughout the family to have longitudinal ridges on the stems; sometimes they are inconspicuous, sometimes raised into ridges or wings, and they invariably overlie the vascular bundles that descend from the petiole; their number in each internode depends on the arrangement of the leaves.

Anatomical studies enabled QUEVA to state (Mém. Soc. Sc. Lille IV, 20, 1894, 42) that *Stenomeris* and *Trichopus* agree with *Dioscorea* in internal structure. Fig. 6 shows the shape of the epidermal hairs; they possess a taxonomic value and so also does the nature of the glandular fore-runner tip (see ORR, Notes R. Bot. Gard. Edinburgh 14 no 68, 1923, and 15 no 73, 1926).

Glands are of two kinds (i) spherical or lenticular superficial groups of cells, chiefly on the backs of the laminae but also on stems and petioles, and (ii) larger, often lobed, agglomerations of excretive cells with a pore to the surface. ORR found no case of the two occurring in association in any of the species which he was able to examine.

Notes. There is controversy about the rank of *Stenomerideae* and *Trichopodeae*: should they be raised to the rank of families, *Stenomeridaceae* and *Trichopodaceae*, as HUTCHINSON suggests (Fam. Fl. Pl. 1934, 141), or retained as tribes? The latter is preferable because the former obscures the epigenesis of the *Dioscoreae*. The botanists who first examined *Stenomeris* and *Trichopus* were puzzled by them. GAERTNER (1788) saw a resemblance of *Trichopus* to *Commelina*: LINDLEY (1832) referred it to *Aristolochiaceae*, seeing a similarity between it and *Asarum*; but KLOTZSCH (1859) suggested *Dioscoreaceae*.

PLANCHON (1852) put *Stenomeris* into the *Burmanniaceae* because the flower is similar in shape to the only *Thismia* then known. BECCARI brought it (1870) into the *Dioscoreaceae* and agreed with KLOTZSCH as to the position of *Trichopus*.

Today the genera are well established; but much information is needed before the interrelations of the sections of *Dioscorea* are understood. The sequence adopted here, namely *Stenomeris-Trichopus-Dioscorea* commencing with the section *Stenophora*, is employed as epigenetic: hermaphroditism is held to have preceded dioecism; unlimited seed production to have been the rule before limitation to six ovules in an ovary and enlargement of the base of the stem into a rhizome to have existed before the development of the compound tuber-bearing corm. In this sequence the units in which the forerunner tip is little developed find an early place and so also do those that do not have complex hairs. In the present treatment our monograph of *Dioscorea* (cf. Ann. R. Bot. Gard. Calc. 14, 1936 & 1938) is mostly followed.

#### KEY TO THE GENERA

1. Flowers hermaphrodite.
2. Fruit a capsule with numerous winged seeds. Torus developed into a perianthoid chamber, wherein the sexual organs are completely enclosed (*Stenomerideae*) . . . . . 1. *Stenomeris*
2. Fruit breaking up rather than dehiscing. Ovules 2 in each cell. Seeds wingless. Torus flat (*Trichopodeae*). . . . . 2. *Trichopus*
1. Sexes in separate plants. Fruit a capsule with winged seeds in each cell (*Dioscoreae*) 3. *Dioscorea*

#### 1. STENOMERIS

PLANCH. Mém. Sc. Nat. III, 19 (1852) 320; BECCARI, Nuovo Giorn. Bot. Ital. 2 (1870) 8; TAUBERT, Bot. Jahrb. 15, Beibl. 38 (1892) 1; R. KNUTH, Pfl. R. 87 (1924) 344.—*Halloschulzia* O. KUNTZE, Rev. Gen. Pl. 1 (1891) 705.—Fig. 1.

Underground a short rhizome. Stem tough, unarmed, twining to the left, with loosely paniculate flowering branches. *Leaves* entire, cordate at their largest, but distally gradually losing their auricles until the base of the lamina is obtuse or even acute, herbaceous, drying, as does the whole plant, a dark brownish purple. *Flowers* hermaphrodite; torus developed into a perianthoid urceolate chamber which en-

(1) A similar distribution of sexes has been found in other plants with corms, cf. Bull. Bot. Gard. Btzg III, 17 (1948) 449.

closes entirely the sexual organs and carries marginally the 6 tepals. *Stamens* 6, inserted just within the mouth of the chamber by rather stout, flattened, deflexed filaments which bring the anthers parallel to the chamberwall with their introrse anther-cells dehiscing towards the wall; beyond the anther-cells the connective is prolonged as a slender process which reaching the apex of the columnar style may adhere there and seems usually to do so, but the manner is not yet known.<sup>1</sup> Style rising into the perianthoid chamber from the base, columnar, ending in three bifid stigmas. *Ovary* widening upwards to make the floor of the chamber, 3-locular with numerous ovules. *Fruit* a triangular capsule, dehiscent along its whole length at the angles. Seeds developing a wing forwards and outwards, the body of the seed flat, triangular, and widened from its insertion to its wing.

Distr. *Malaysia*, almost entirely N of the equator. Species 2, intimately allied.

Ecol. Everwet, humid, lowland forests.

Note. TAUBERT's sections *Hematanthera* and *Mystranthera* appear untenable, cf. discussion under *S. dioscoreifolia*.

#### KEY TO THE SPECIES

1. Panicle long and directed downwards, the flowers on it more or less facing earthwards. Tepals 6–15 mm long, slender above the base . . . . . 1. *S. dioscoreifolia*
1. Panicle relative small, usually exceeded by the axillant leaf. Tepals to 5 mm long, maintaining an even breadth from the base upwards almost to a rounded or obtuse apex . . . . . 2. *S. borneensis*

1. *S. dioscoreifolia* PLANCH. Mém. Sc. Nat. III, 19 (1852) 320; WALP. Ann. 6 (1861) 211; BECCARI, l.c.; SCHEFF. Nat. Tijd. Ned. Ind. 34 (1874) 70; VIDAL, Phan. Cum. Philip. (1885) 153; Rev. Pl. Vasc. Filip. (1886) 276; ROLFE, J. Bot. 23 (1885) 216; MERR. Philip. J. Sc. 2 Bot. (1907) 268; En. Philip. Fl. Pl. 1 (1922) 219; R. KNUTH, Pfl. R. 87 (1924) 344.—*S. cumingiana* BECCARI, Nuovo Giorn. Bot. Ital. 2 (1870) 8; MERR. l.c.; R. KNUTH, l.c.—'Rajania?' NAVES in NAVES & F.-VILLAR, Nov. App. (1880) 260.—*S. wallisii* TAUBERT, Bot. Jahrb. 15, Beibl. 38 (1892) 1; R. KNUTH, l.c.—Fig. 1b–k.

Underground parts unknown. Plant glabrous, though perhaps with a minute scurfiness about the inflorescences. Stem smooth. *Leaves* that are below the horizon of flowering large, even to 21 by 19 cm, exactly cordate save for their acumination, and when of this size 13-nerved from the base; petiole about half as long as the blade with the lower pulvinus occasionally much elongated (as in fig. 1); (though such a pulvinus is not prehensile it aids climbing by preventing slipping from supports). Fertile branches sometimes of great length, arching out from the axil and then pendent, sometimes bearing a few small assimilating leaves. *Flowers* cymosely arranged, mostly facing earthwards; pedicels as long as, or longer than the flowers, thin or even capillary. Many flowers are open at the same time, and anthesis is deliberate. *Tepals* during anthesis gradually recurving; tube 3–7 mm deep, persisting in a disorganized state to fruit-ripening; lobes 6–15 mm long, if more than 10 mm long and associated with a tube 4 mm long (or longer: *var. megalanthera* BURK. n. var.), tube slightly contracted at the mouth; lobes growing a little during anthesis, narrowed rapidly at the base by ceasing growth from above downwards. *Stamens* as de-

scribed above. *Ovary* with 9 ridges, 1–2 mm long. *Capsule* at ripeness to 35 cm long or longer, with perhaps 100 seeds, pendent but not always straight, dehiscing along its whole length. Seeds to 7–9 mm long widening evenly from the attachment to 2–3 mm in width and with 6–7 broken lines on each face, included the wings to 2½ cm long, the wings to 1 cm in width, so placed in the capsule that one seed scarcely overlaps another.

Distr. *Malaysia*: Philippines (fig. 3c).

Ecol. *S. dioscoreifolia* occurs only in the most evenly humid parts of the Philippines, which parts are towards the eastern ocean; it grows near streams at low elevations. The progress of anthesis is indicated here by the three drawings fig. 1d–f. Because in anthesis the tepals progressively move away from their early upright position TAUBERT's use of their position to define his *S. wallisii* cannot be justified, nor BECCARI's in defining *S. cumingiana*.

The blades are poised, as is general in the family, with the acumination pointing downwards. *Fl.* May & June, Dec. & Jan.

Notes. It is desirable to justify the reduction of *S. cumingiana*. BECCARI had but two specimens when he assigned the one to *S. dioscoreifolia* and the other to *S. cumingiana*, consequently the variability of the flower was hidden from him: one of the two was an isotype of *S. dioscoreifolia*, the other a unique no 1739 which the writer has seen but owing to the paucity of the material he is obliged to accept the internal structure of its flower from BECCARI without verification. BECCARI enumerated four differentiating characters: he stated that (i) the prolongations of the connective which unite with the style in *S. dioscoreifolia*, fail to do so in *S. cumingiana*; (ii) the leaves are 7–9-

(1) BECCARI suggested, that there is a nectary at the apex.

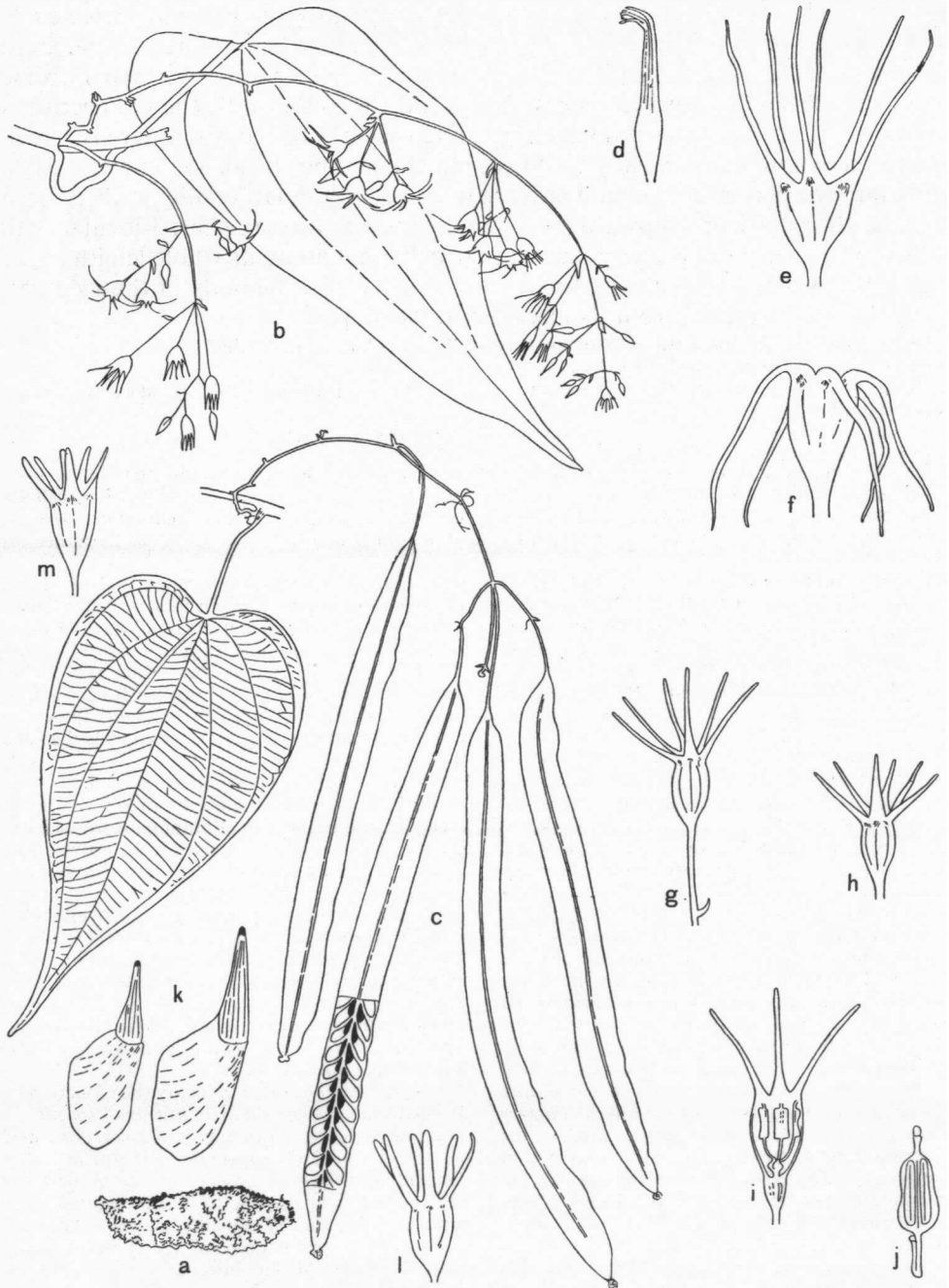


Fig. 1. *Stenomeris*.—*a*. Rhizome,  $\times 2/5$ .—*St. dioscoreifolia* PLANCH.: *b*. inflorescence of *var. megalanthera* BURK.,  $\times 4/5$ , *c*. infructescence with part of valve removed to expose seeds,  $\times 2/5$ , *d-f*. three stages in the anthesis of *var. megalanthera* BURK.,  $\times 2$ , *g-h*. flowers as of the type,  $\times 2$ , *i*. vertical section through flower showing downwardly bent stamens and their prolongations which reach the style,  $\times 2$ , *j*. a stamen from the face turned downwards the chamber wall,  $\times 2$ , *k*. seeds,  $\times 2$ .—*St. borneensis* OLIV.: *l*. flower from type specimen showing its blunt tepals,  $\times 2$ , *m*. flower from isotype of *St. mindanaensis* KNUTH,  $\times 2$ .



nerved and gradually acuminate in the first but 13-nerved and abruptly acuminate in the second; (iii) the throat which is 'constricted and strengthened by a somewhat outstanding ring' in the first is 'scarcely constricted' in the second, and (iv) the perianth lobes which are erect and then recurved in the first, are 'erect to spreading and bent inwards at the apex' in the second.

Material now available shows that characters ii, iii, and iv make an unbroken series throughout, then, as to the first character, seeing that the adhesion is a secondary phenomenon in the development of the flower, failure to achieve adhesion would seem to be merely an accident. On reducing *S. cumingiana* TAUBERT's sections of the genus, *Nematanthera* and *Mystranthera* fall. CUMING preserved two inflorescences, one only 4 cm long, the other 10 cm, apparently belonging to a plant of weak growth.

2. *S. borneensis* OLIV. in HOOK. Ic. Pl. 4 (1894) t. 2328; RIDL. Mat. Fl. Mal. Pen. 2 (1907) 85; RIDL. & WINKLER, Bot. Jahrb. 44 (1910) 529; MERR. En. Born. (1921) 119; RIDL. Fl. Mal. Pen. 4 (1924) 313;

R. KNUTH, Pfl. R. 87 (1924) 328.—*S. mindanaensis* R. KNUTH, l.c.—Fig. 1 l-m.

Underground a short horizontal rhizome with an uneven surface, scars of a few more or less amplexicaul scale-leaves and white flesh. Plant glabrous except for a minute scurf on the inflorescences. Stems climbing to 5 m, faintly ridged at the base where they are 2-3 mm in diam.: ridges 3 from each leaf-base. A few scale-leaves are produced before the first assimilating leaves. Lower leaves to 25 by 18 cm, the largest 11-nerved, in appearance exactly as those of *S. dioscoreifolia*. Panicles smaller than in that species but otherwise similar. Flowers with shorter and broader perianth lobes; the lobes usually to 4 mm in length, rounded at the apex in specimens from Borneo, bluntly pointed in specimens from Mindanao (var. *mindanaensis* R. KNUTH); the rest of the flower as in *S. dioscoreifolia*, capsule perhaps shorter.

Distr. *Malaysia*: Sumatra (East Coast), Mal. Peninsula, Borneo, Philippines (Mindanao). Fig. 3b.

Ecol. Preferably on wet soil. Fl. Sumatra: April-May, Sarawak: March & Oct., Mindanao: Oct.

## 2. TRICHOPUS

GAERTN. Fruct. (1788) 44, t. 14; BECCARI, Nuovo Giorn. Bot. Ital. 2 (1870) 13; BENTH. in B. & H. Gen. Pl. 3 (1883) 745; PAX in E. & P. 2, 5 (1888) 136; ULINE, Bot. Jahrb. 25 (1898) 155; TRIMEN, Handb. Fl. Ceylon 4 (1898) 279; R. KNUTH, Pfl. R. 87 (1924) 347; in E. & P. ed. 2, 15a (1930) 461.—*Trichopodium* LINDL. Bot. Reg. (1832) sub t. 1543; ENDL. Gen. Pl. 1 (1837) no 2165.—*Steyrea* RAFINESQUE, Fl. Tell. 4 (1836) 100.—*Podianthus* SCHNIZLEIN, Bot. Zeit. 1 (1843) 739.—Fig. 2.

Glabrous, preserving through life the habit of the first-year seedling of *Dioscorea*, which lies in the arrest of the second leaf of a stem to the advantage of the first. In the surface soil a rather dry, 1-4 cm long rhizome with occasional branching, ascending slightly at the apex and dying behind, losing its scale-like leaves before death, coated with chaffy very acute scale-leaves up to 5 mm long. Stems 5-7 (-20), erect or ascending, to 12 cm below the solitary leaf, with c. 7 low ridges. Fertile branch with distichous scale-leaves similar to those on the rhizome but shorter, with flower buds in their axils, the whole looking like a spikelet of *Bromus*. Flowers extruded from between the protecting scale-leaves one at a time until 1 or 2 are pollinated whereupon those following are arrested. Leaf (in Malaysia) always cordate-sagittate, 10 by 4 cm, primary nerves 5-7, 3 reaching the blunt apex, the outer being in the margin. Blade shortly acuminate below the apex; margin undulate; petiole usurping the line of the stem by pushing the fertile branch to one side, vertical (in Malaysia). Pedicels to 7 cm long, nodding, dull purple with a greenish colour towards the base. Tepals (in Malaysia) to 1 cm long. Stamens 6, anthers raised on short zigzag filaments widening into broad connectives with the anthers edge to edge and making a roof over a chamber into which pollinating insects should enter; beyond the anthers the filament is prolonged into a process which projects forwards between the stigmas. Style stout. Fruit 3-winged, wings thick instead of flat as in *Dioscorea*, to 13 by 6 mm, somewhat trapezoid by reason of the way in which they narrow towards the apex and the base of the fruit, broadest



Fig. 2. *Trichopus zeylanicus* GAERTN. ssp. *travancoricus* (BEDD.) BURK. a. fruiting plant,  $\times 2/3$ , b. rhizome branching (near arrow),  $\times 2/3$ , c. two inflorescences,  $\times 7$ , d. flower showing its poise,  $\times 2$ , e. outer tepal,  $\times 2$ , f. stamen seen from outer side,  $\times 20$ , g. section through flower indicating how the prolonged connective passes between the stigmatic arms, h. two sides of a seed, showing the difference in sculpture,  $\times 3$ .

above mid-length. *Seeds* upwards of 6 freed by the fruit walls breaking irregularly, wingless, flat, more so on one side than on the other, and differently invaginated.

*Distr.* Monotypic, Ceylon and Southern India, in *Malaysia*: Malay Peninsula. The area is remarkably similar to that of the dilleniaceous genus *Acrotrema*.

1. *T. zeylanicus* GAERTN. *Fruct.* 1 (1788) 44, t. 14; THWAITES, *En. Pl. Zeyl.* (1861) 291; BECCARI *l.c.*; BEDDOME, *l.c. Pl. Ind. Or.* (1874) t. 290, but not quite accurate; HOOK. *f. Bot. Mag.* (1894) t. 7350; RIDL. *Mat. Fl. Mal. Pen.* 2 (1907) 79.—*Trichopodium cordatum*, *T. intermedium* & *T. angustifolium* LINDL. *Bot. Reg.* (1832) sub t. 1543.—*Podianthus arifolius* SCHNIZLEIN, *Bot. Zeit.* 1 (1843) 739.—*Trichopodium zeylanicum* THWAITES, *l.c.*—*Trichopodium travancoricum* BEDDOME, *l.c.*—*Trichopus malayanus* RIDL. *Fl. Mal. Pen.* 4 (1924) 312, with a slightly inaccurate figure.—Fig. 2.

Characters as of the genus.

*Distr.* Ceylon, S. India, and *Malaysia*: Malay Peninsula (Kelantan, where the rivers Lebir and Galas unite, and Pahang, at a place near the Pahang River, about 300 km further south). Fig. 3a.

*Ecol.* In Ceylon it grows in lowland sandy forest near streams and in the Malay Peninsula in lowlying forest. In these places it is liable to be flooded; but that similar conditions rule where it grows (at about 1000 m alt.) in S. India is not known.

In Ceylon and the Malay Peninsula the dispersal of the seeds is undoubtedly by sudden floods which break the fruit from its slender peduncle and carry it away. The upright position of the leaf blades as seen in Malaya is doubtless a reaching out for light from above, for when the plant was grown in a glass house at Kew, their poise was less upright (see *Bot. Mag.* t. 7350); moreover, herbarium specimens from Ceylon show that the poise may differ. It is not known if the flower is scented.

*Notes.* The Malayan plant agrees exactly with that of Travancore (*Trichopodium travancoricum*

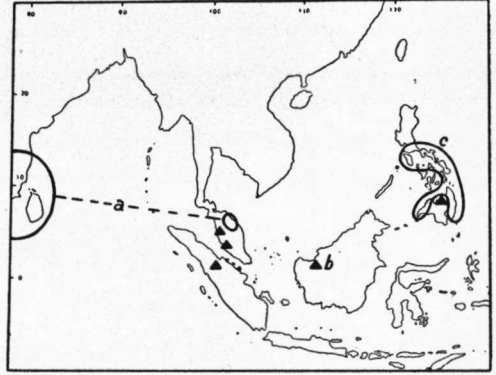


Fig. 3. Geographical distribution of a. *Trichopus*, b. (▲) *Stenomeris borneensis* OLIV., c. *Stenomeris dioscoreifolia* PLANCH.

BEDD.). The Ceylon plant undoubtedly differs by deltoid or even linear-lanceolate, erect leaves and tepals 3 mm long, but THWAITES held the Travancore plant to be conspecific with the Ceylon plant and would therefore have regarded the Malaysian as conspecific also. If consent be given to that view, this distinguishing name is required for the Indian-Malaysian plant: *Trichopus zeylanicus* ssp. *travancoricum* (BEDD.) BURK. *stat. nov.*

The subspecies is then to be defined on the size of the flowers. It may be commented that the Ceylon plant possesses a variability which is absent from the Indo-Malaysian subspecies.

### 3. DIOSCOREA

LINNÉ, *Sp. Fl.* (1753) 1032; KUNTH, *En. Pl.* 5 (1850) 325; R. A. SALISBURY, *Gen. Pl. Fragm. ed.* GRAY (1866) 12; BENTH. in B. & H. *Gen. Pl.* 3 (1883) 742; PAX in E. & P. 2, 5 (1887) 133; ULINE in E. & P. *Nachtrag zu II-IV* (1897) 80; R. KNUTH, *Pfl. R.* 87 (1924) & in E. & P. ed. 2, 15a (1930) 438; PRAIN & BURK. *Ann. R. Bot. Gard. Calc.* 14 (1936 & 1938).—*Helmia* KUNTH, *l.c.*—*Polynome*, *Hamatris*, *Strophis* and *Elephantodon* R. A. SALISBURY, *l.c.*—*Peripetasma* RIDL. *J. Bot.* 58 (1922) 147.—Fig. 4-13.

Underground in a few *spp.* a rhizome, in more *spp.* a firm, often woody corm which gives off well defined parenchymatous tubers and replaces them annually; as a rule these tubers are buried at the ends of long stalks, but in some species they are without stalks and may be regarded as not more than lobes of the corm; in 2 (perhaps 4-5) species of Malaysia spiny roots are produced. Stems in all the Malaysian species twining, some very tall; often woody at the base and armed, always tough; the direction of twining—to the right (fig. 4c) or to the left (fig. 4a)—is characteristic of whole sections. Axillary buds often more than one in an axil and

then in vertical column with the youngest lowest. *Leaves* more frequently alternate than opposite; when both conditions are associated, they are alternate on thin axes becoming opposite as the plant strengthens, simple or palmately compound (§

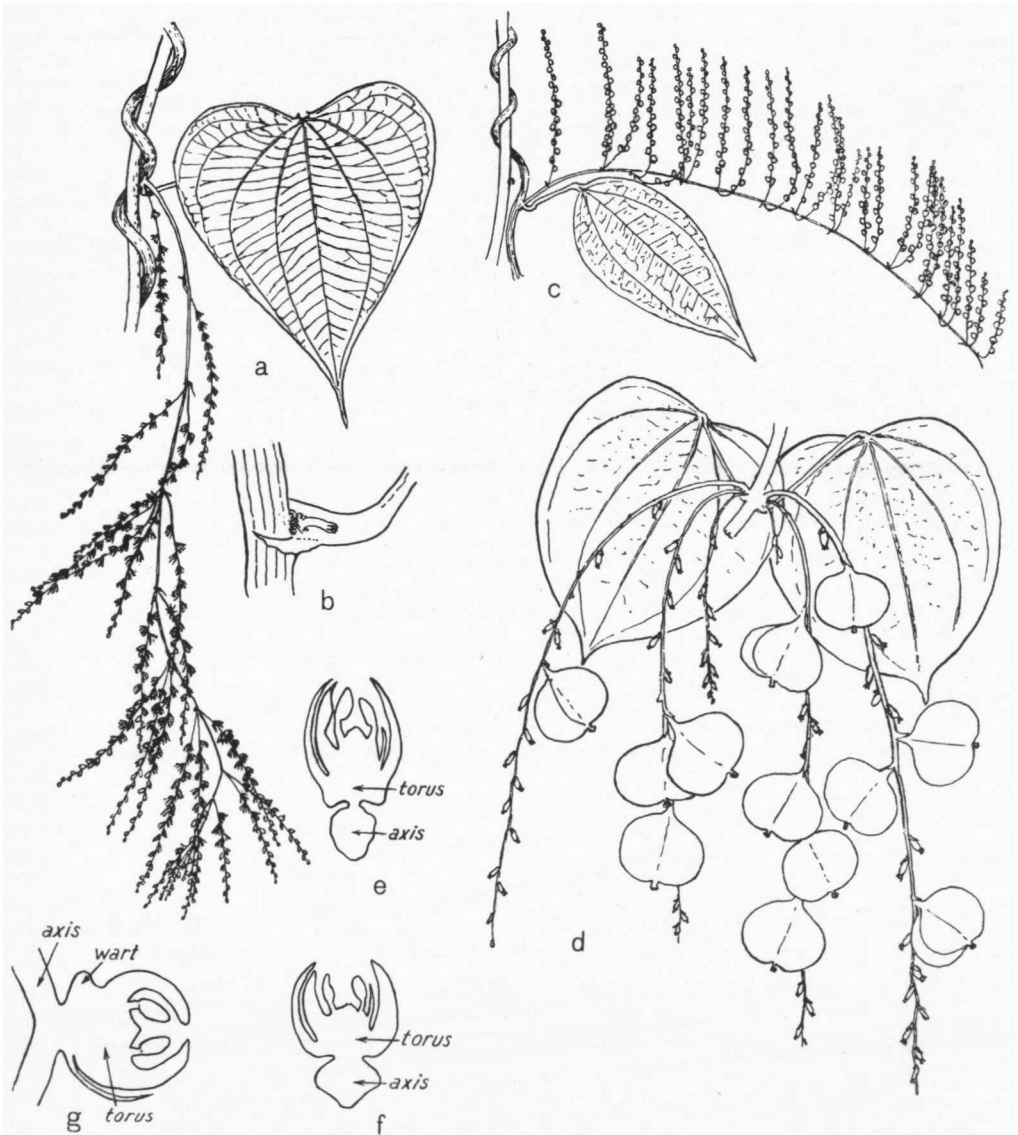


Fig. 4. *a. Dioscorea bulbifera* L. showing a stem which twines to the left, a leaf with its characteristic ladder-like secondary venation, and a male inflorescence,  $\times \frac{1}{2}$ , *b.* the large petiolar auricle of *D. bulbifera* L., *c. D. laurifolia* WALL. ex HOOK. showing a stem which twines to the right, the interruption of the secondary nerves as they cross from midrib to primary nerve, and the male inflorescence which in this species has strongly developed negative geotropism in the axis of the spikes,  $\times \frac{1}{2}$ , *d. D. pyrifolia* KUNTH, a group of ♀ inflorescences showing how they are decurved and showing also, as is common, that fertilization may be intermittent, flowers at one horizon obtaining effective pollination and at another dying infertile doubtless as a consequence of unsuitable weather when they were ripe,  $\times \frac{1}{2}$ , *e.* vertical section through a flower of *D. sexrimata* BURK. showing the enlarged torus, *f.* similar section through a flower of *D. luzonensis* SCHAUER, *g.* section through a flower of *D. filiformis* BL. showing wart at base of flower.

*Lasiophyton*), poised so that the forerunner tip is towards the ground; in compound leaves the nerves in the leaflets are pinnate; in simple leaves the primary nerves are palmate. Petiole with a pulvinus at each end, which adjusts the poise of the blade. *Male flowers* frequently in small cymes racemously arranged along the fertile axes; at the distal end of the axis the cymes reduced to single flowers so that this part is a raceme or, in some sections, a well defined spike. Flowers always small and green, but in *D. bulbifera* tinted at times with rose and the green so diluted that the flower is at times loosely called white, often scented (as benzoin), in more than half of the *spp.* of Malaysia opening but little in anthesis. *Stamens* 6, all fertile or the inner 3 as staminodes (§ *Lasiophyton*). *Female flowers* in spikes or spike-like racemes; pollination stimulates growth under the ovary so that a short pedicel is made which adjusts the position of the capsule (fig. 5); the ♀ flowers rather more widely opened than the male and produced in much smaller numbers, their perianth lobes are as a rule more fleshy. *Staminodes* very small. *Style* columnar, stigmas deflexed about its column in all Malaysian species. *Capsules* dehiscent from the apex downwards along the wing-margin and sometimes freeing the margin which, then, looks like a fine wire (fig. 5 k, 5 o). *Seeds* always much flattened, winged from the margin, sometimes from the whole margin, sometimes towards the apex of the cell and sometimes towards the base.

*Distr.* Species about 600, distributed through the tropics and the warm temperate zones of the world, very largely montane, some ascending to considerable heights; none naturally common to the Old and

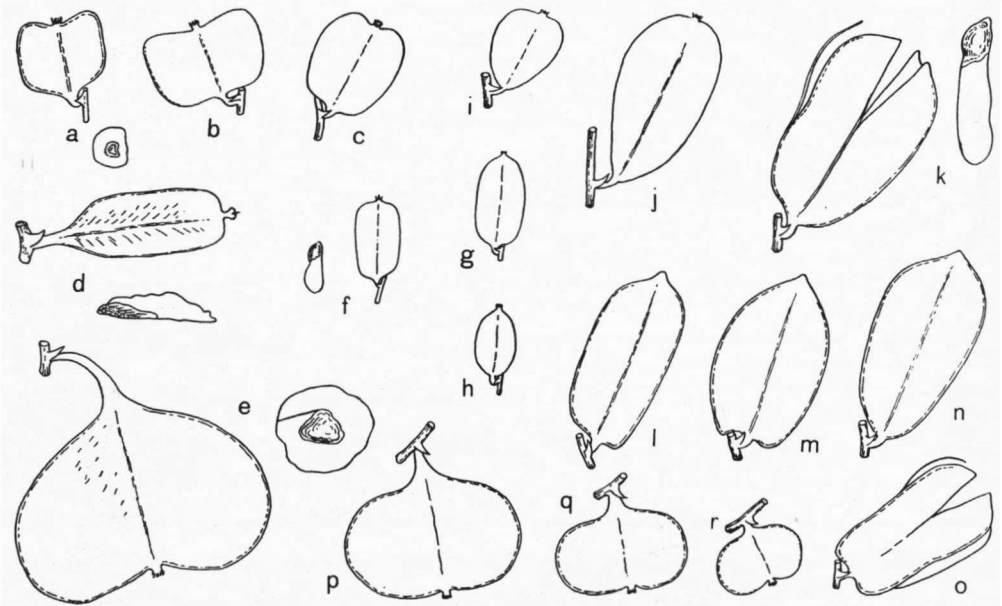


Fig. 5. *Dioscorea* capsules of various species, all  $\times 1/2$ , showing the angle at which they stand when mature. a-b. Capsules and seed of § *Stenophora*: a. *D. prazeri* PR. & B., b. *D. membranacea* PIERRE ex CRAIB. c. Capsule of § *Combilium*: c. *D. esculenta* (LOUR.) BURK.. d. Capsule of § *Paramecocarpa* and its winged seed: d. *D. flabellifolia* PR. & B.. e. Capsule of § *Stenocorea* and its winged seed: e. *D. sumatrana* PR. & B.. f. Capsule of § *Opsophyton* and its winged seed: f. *D. bulbifera* L.. g-o. Capsules of § *Lasiophyton* and its winged seed: g. *D. pentaphylla* L., h. *D. tamarisciflora* PR. & B., i. *D. elmeri* PR. & B., j. *D. cumingii* PR. var. *ramosii* BURK., k-n. *D. hispida* DENNST., o. *D. scortechinii* PR. & B.. p-r. Capsules of § *Enantiophyllum*: p. *D. orbiculata* HOOK. f., q. *D. divaricata* BLANCO, r. *D. pubera* BL.

the New Worlds and only one common, without the aid of man, to the continents of Africa and Asia. Many are plentiful where they occur.

Section *Stenophora* has its centre in China whence it extends in the one direction to the Balkans and in the other direction appears in the United States and Canada. The 2 species marking its frontier towards India, enter Malaysia from the north and 2 other little known species, endemics of Malaysia, are attached here to the section.

The sections *Stenocorea* and *Paramecocarpa* are shared by the Indo-Chinese Peninsula and Malaysia.

*Combilium* holds but one species, apparently an entrant into Malaysia from Indo-China, but it may be native of New Guinea as well as Indo-China.

*Opsophyton*, *Lasiophyton* and *Enantiophyllum* are common to Asia and Africa and spread throughout the tropics of both continents. Of sections that penetrate Australia, *Enantiophyllum* extends furthest and then *Opsophyton*; *Lasiophyton* stops at the Torres Straits.

Ecol. It is not known what insects pollinate the flowers, but it is evident that insects do adequate service even when no small distance separates male and female plants from each other. Fig. 4d suggests, that stormy weather may interrupt the activity of whatever the agent may be. The sterilized inner 3 stamens in *Lasiophyton* make baffles in the path of visiting insects: they block the mouth of the flower and cause a visiting insect to touch the pollen-producing anthers. All the Malaysian species of other sections have 6 fertile stamens; though reduction to 3 is met with in two of them, it occurs outside Malaysia.

Uses. The food-value of the yams is great, but some are naturally so poisonous that preparation extended over even as much as seven days is required to make from them a meal that can be eaten. One of the most poisonous is *D. hispida* (see p. 318) which is the chief famine-food of much of the tropical East. *D. esculenta* (see p. 307) and *D. alata* (see p. 330) produce yams that are eaten after a short boiling. *D. alata* is a cultigen of specific rank, and *D. esculenta* var. *fasciculata* a cultigen of varietal rank. Many wild yams from the forests are eaten after prolonged boiling and others after an all-night boiling along with wood-ashes to mitigate their acidity. Among poisonous species an abundance of saponin causes *D. piscatorum* to be used for stupifying fish in rivers, and *D. prazeri* for killing lice in the hair. Many hold tannin enough to make them unsavoury, yet not prevent the needy from eating them. Good or bad, the food-value of every yam lies in the amount of starch that it furnishes; but since the important starchy

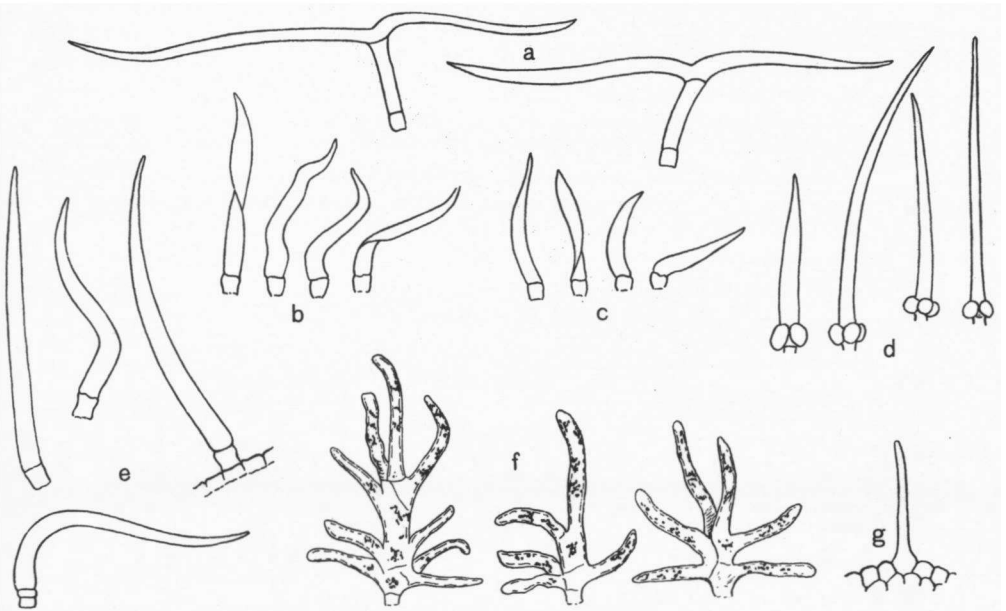


Fig. 6. *Dioscorea* hairs from various species, all drawn to the same scale. a. *D. esculenta* (LOUR.) BURK.: T-shaped hairs with two supporting cells the upper of which varies greatly in length, b. *D. blumei* PR. & B. and c. *D. pentaphylla* L.: 2-celled hairs similar to those of *D. hispida* DENNST. (fig. e) but the cell-walls are thin and the cavity collapses, usually with torsion, d. *D. pyrifolia* KUNTH: stiletto-hairs in which the supporting cell is surrounded by 4 small round cells, e. *D. hispida* DENNST.: rigid hairs consisting of a straight or curved long cell with strong walls raised on an equidimensional cell (or sometimes in its section on 2 such cells), f. *D. orbiculata* Hook. f.: dendroid hairs, g. *D. caucasica* LIPSKY: one-celled type of hair present in it and other species of § *Stenophora*.

tubers of American origin, Sweet potato, Irish potato and Manioc, were brought into the homes of the yams, all have lost ground to them.

Vern. The uses mentioned above are naturally connected with quite a number of vernaculars; these in turn may give hints on the wanderings of palatable cultigens. As far as they are reliable and important they have been enumerated or discussed under the individual species.

Notes. The genus *Dioscorea* is so closely knit, that to divide it on a higher level than sections is unreasonable; KUNTH's use of *Helmia* as a genus was a convention now out of date, and SALISBURY's divisions the result of inadequate knowledge of *Dioscoreaceae*. Not until 1897 when ULINE proposed divisions based on all the characters, was there any taxonomy likely to persist; and that is not yet stable. It is unfortunate that the underground parts which collectors neglect, furnish a first line character. Second in importance comes the direction of the twining; thirdly the manner in which the seeds are winged and their colour, the shape and the poise of the capsules; fourthly the shape that the torus of the flower takes; fifthly the completeness or incompleteness of segregation of flowers from parts wholly given to photosynthesis; and after that such anatomical features as the hairs exhibit and the glands, etc. Fig. 5 and 6 are inserted to aid the student in regard to characters derived from the capsules and hairs respectively: the capsules are given at the angle at which they stand when mature, which is reflexed in most cases; if directed forward as on the lower line, they then hold seeds winged all round the margin.

The limits of the sections above are not identical with the limits suggested by ULINE and by R. KNUTH. § *Stenophora* ULINE (1897), as recognized here, contains what ULINE put into it and § *Macropoda*, including also KNUTH's (1924) § *Orientali-Asiaticae* and § *Japonicae*. § *Stenocorea* (1914), § *Combilium* (1914) and § *Paramecocarpa* (1924) were created by PRAIN and the author at the dates given: species of the first and last, and perhaps of the second, were unknown to ULINE. § *Opsophyton* ULINE (1897) was greatly and mistakenly enlarged by KNUTH, and is returned to what it was to ULINE. § *Lasiophyton*, § *Botrysicyos* and § *Triumphorstemon* which were created by ULINE (1897) and retained by KNUTH (1924), are united here, but a note regarding the union of § *Triumphorstemon* with § *Lasiophyton* will be found on p. 314 forward where the combined section is discussed. ULINE's § *Stenophyllidium* is inseparable from § *Enantiophyllum*: it contains two Australian species, one of which approaches the Torres Straits so nearly that it should be sought in New Guinea.

KEY TO THE SECTIONS (♂ plants)

- 1. Stems twining to the left (fig. 4a). Flowers usually pedicelled.
  - 2. Leaves simple.
    - 3. Tepals on a broadened torus.
      - 4. Torus saucer- or cup-shaped.
        - 5. Inflorescence with flowers in cymose groups towards the base e.g. a second flower on the pedicel of the first. *Spp.* 1-4 . . . . . Sect. 1. *Stenophora*, p. 303
        - 5. Inflorescence a spike or a raceme with solitary flowers. . . . . Sect. 2. *Stenocorea*, p. 305
        - 6. Hairs absent. *Spp.* 5-8 . . . . . Sect. 3. *Combilium*, p. 307
        - 6. Hairs abundant, T-shaped (fig. 6). *Sp.* 9 . . . . . Sect. 4. *Paramecocarpa*, p. 309
      - 4. Torus infundibular. *Spp.* 10-12 . . . . . Sect. 5. *Opsophyton*, p. 311
    - 3. Tepals free, on the end of the pedicel. *Sp.* 13 . . . . . Sect. 6. *Lasiophyton*, p. 313
  - 2. Leaves compound. *Spp.* 14-21 . . . . . Sect. 7. *Enantiophyllum*, p. 320
- 1. Stems twining to the right (fig. 4c). Flowers invariably sessile. *Spp.* 22-59.

KEY TO THE SECTIONS (♀ plants)

- 1. Stems twining to the left (fig. 4a).
  - 2. Leaves simple.
    - 3. Capsule as broad or almost as broad as long (fig. 5a-c). Seeds usually winged evenly all round.
      - 4. Hairs, if present, not T-shaped.
        - 5. Capsules reflexed against the axes of decurved infructescences, their walls as a rule rather thin. *Spp.* 1-4 . . . . . Sect. 1. *Stenophora*, p. 303
        - 5. Capsules facing earthwards on decurved or more or less horizontal infructescences. *Spp.* 5-8. . . . . Sect. 2. *Stenocorea*, p. 305
      - 4. Hairs plentiful, T-shaped (fig. 6). Capsule reflexed. *Sp.* 9 . . . . . Sect. 3. *Combilium*, p. 307
    - 3. Capsules decidedly longer than broad.
      - 6. Capsules parallel-sided and horizontal (fig. 5d). *Spp.* 10-12 . . . . . Sect. 4. *Paramecocarpa*, p. 309
      - 6. Capsules long-elliptic, reflexed on a pendulous infructescence (fig. 5f). *Sp.* 13. . . . . Sect. 5. *Opsophyton*, p. 311
  - 2. Leaves compound. *Spp.* 14-21 . . . . . Sect. 6. *Lasiophyton*, p. 313
- 1. Stems twining to the right (fig. 4c). *Spp.* 22-59 . . . . . Sect. 7. *Enantiophyllum*, p. 320

1. Section *Stenophora*

ULINE in E. & P. Nachtr. (1897) 84; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1936) 19.—Sect. *Eustenophora* (in a subgenus *Stenophora*) R. KNUTH, Pfl. R. 87



(1924) 313.—*Sect. Orientali-Asiaticae* R. KNUTH, *l.c.* 252.—*Sect. Japonicae* R. KNUTH, *l.c.* 254.—Fig. 5a–b, 6g, 7.

Underground a rhizome, often short; but there are species in which by report it may be 2 m long. Plant glabrous (in Malaysia), stems twining to the left. Bulbils only produced (rarely) in *D. prazeri*. Leaves alternate, simple but not always entire, invariably with large auricles at the base of the lamina making it cordate in varying degree. ♂ Flowers in cymes disposed racemously on leafless flowering axes; cymes 2–4-flowered reduced to 1 distally. ♀ Flowers on decurved or pendent leafless axes, almost spicate; after fertilization the pedicel reflexes the capsule so that it faces upwards. Seeds at maturity of the capsule which dehisces from the upper end downwards winged all round, but not evenly.

Distr. Predominantly temperate, reaching the Amur River northwards; absent from the Pacific. Two well-known *spp.* occur widely along its southern frontier towards the Indian Peninsula and Malaysia, two others are inadequately known.

Note. Glands have not been found in the forerunner tips of the leaves. About one quarter of the *spp.* carry epidermal hairs, either of a single elongated cell (fig. 6g) or of a filament of cells, 2–3 in number; but the hairy species do not reach Malaysia. There are *spp.* with 3 of the stamens in the male flowers sterilized, but again these do not reach Malaysia.

#### KEY TO THE SPECIES

1. Male flowers sessile or almost so.
2. Male flowers for the most part solitary; perianth raised by a short tube. Capsule wings  $2\frac{1}{2}$  times as long as wide. Leaves entire, cordate . . . . . 1. *D. prazeri*
2. Male flowers in small cymes; perianth raised by a well developed tube. Capsule wings nearly twice as long as wide. Leaves trifid . . . . . 2. *D. membranacea*
1. Male flowers with conspicuous pedicels, almost without a tube. Capsules unknown 3. *D. palawana*
- Obs.* Male flowers and underground parts unknown. Capsule-wings nearly as wide as long. 4. *D. ridleyi*

1. *D. prazeri* PRAIN & BURK. J. As. Soc. Beng. 73 (1904) Suppl. 2; R. KNUTH, Pfl. R. 87 (1924) 175; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1936) 29, pl. 5.—*D. deltoidea* var. *sikkimensis* PRAIN, Beng. Pl. (1903) 1066.—*D. sikkimensis* PRAIN & BURK. J. As. Soc. Beng. *l.c.*—*D. clarkei* PRAIN & BURK. J. As. Soc. Beng. new ser. 10 (1914) 12.—Fig. 5a.

Rhizome branching freely, short and stout, gray-brown or nearly black; flesh white and very poisonous. Stem smooth, ridges very indistinct, climbing to 4 m. Leaves cordate or long-cordate, usually to 12 (–20) cm in either dimension, 7–11-nerved; secondary nerves differing a little from the network; both surfaces shining; petiole half as long as the lamina. Male flowering branches 1–3 together, from upper leaf-axils or sometimes collected on branches with reduced leaves, cymes 1–3 mm apart; the axis between the cymes apt to be flexuous; narrow wings descend from the bracts; bracts broadly ovate and abruptly long acuminate. Perianth-cup less than 1 mm deep. Tepals  $1\frac{1}{2}$  mm long, ovate and almost rounded above. Anthers turned outwards, much shorter than their filaments. Female flowering axes solitary, directed downwards, with about 20 flowers and to 30 cm long. Tepals shorter and thicker than those of the male flower, only just united at the base. Capsules, though rarely more than 8 mature, near enough to each other to imbricate, becoming a satiny chestnut brown; wings broadly semi-obcordate or subrhomboidal, rarely semicircular, the base of the capsule obtuse as it passes into the short curved stipe and

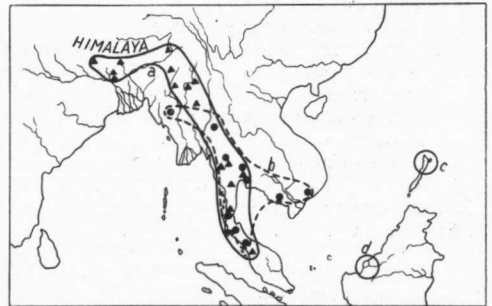


Fig. 7. Distribution of the species of § *Stenophora* which enter or are endemic in Malaysia: a. (▲) *D. prazeri* PR. & B., b. (●) *D. membranacea* PIERRE ex PR. & B., c. *D. palawana* PR. & B., d. *D. ridleyi* PR. & B.

the apex cordate with shoulders (fig. 5a). Seeds ovate-oblong, to 12 by 8 mm, reddish at maturity but the wing pale.

Distr. From the eastern Himalaya and the mountains between Assam and Burma where it is abundant, southwards through the Shan Hills to the Isthmus of Kra, in Malaysia: forward to the northern edge of the Malay Peninsula (Perlis). Fig. 7a.

Ecol. At its southern limits it grows on limestone. It ascends the mountains of NW. India from near sea-level to 1600 m. It approaches in the Hima-



laya *D. deltoidea* WALL. but does not mingle with it. It is noteworthy that *D. deltoidea* which produces shorter blades, has longer petioles than *D. prazeri*; also that it requires less humidity.

Econ. The rhizome of both is used for soap in India, particularly for washing the hair as the saponin in it kills lice.

2. *D. membranacea* PIERRE ex [CRAIB, Kew Bull. (1912) 407, name only] PRAIN & BURK. J. As. Soc. Beng. new ser. 10 (1914) 13; R. KNUTH, Pfl. R. 87 (1924) 315; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1936) 59, pl. 7.—Fig. 5b.

Rhizome wide-running, perhaps even to 2 m, 1/2–1 cm diameter, dark brown, with white flesh. Stem slightly ridged, unarmed, with stipule-like processes at the base of the petioles on the better developed axes. *Leaves* deeply trifid above a cordate base, shortly acuminate, 9-nerved, two primary nerves reaching the forerunner tip along with the midrib and the second pair reaching the tips of the lateral lobes; petiole 1/2–2/3 the length of the blade. *Male flowers* in small subsessile cymes with up to 4 flowers, spaced along a leafless conspicuously angled axis; bracts ovate-acuminate, very thin in texture, 1 1/2 mm long; pedicels exceedingly short. Tube of the flower campanulate or urceolate, 1 mm long, its thin walls strengthened by the vascular bundles which descend in it from the insertion of the filaments; tepals 1 mm long, long-ovate, obtuse, 1-nerved. Stamens all alike, the filaments inserted just below the tepals, incurved, 0.3 mm long; anthers introrse, small. *Female flowers* on downwardly directed spike-like racemes; axis angled, to 20 cm long or even longer; pedicels 1 mm; bracts ovate-acute, very thin, 1 1/2 mm. Tube of the flower absent. Outer tepals obovate, obtuse, just exceeding 1 mm, inner ones lanceolate, a little shorter than the outer. Style short. *Capsules* 1–2 cm apart and scarcely imbricate, wings a little broader than semicircular and sometimes widest above the middle, retuse at the apex, nearly truncate at the base.

Distr. From Siam westwards to N. Burma and eastwards into Cambodia; southwards passing beyond the Isthmus of Kra into *Malaysia* to the Siamese Circle of Puket. Fig. 7b.

Ecol. Like *D. prazeri* it grows on limestone at its southern limit.

3. *D. palawana* PRAIN & BURK. Kew Bull. (1925) 59; Ann. R. Bot. Gard. Calc. 14 (1936) 52, pl. 22.

Rhizome imperfectly known, but slender, branching, brown in colour with white flesh. Stem smooth. *Leaves* cordate-sagittate with rather elongated auricles that are distally rounded, 9 cm long by 8 cm across the auricles and 4 cm above them; primary nerves 5, the two outer forking and curving in the auricles; upper surface shining; lower dull; petiole about as long as the blade. *Male flowers* in small cymes disposed on solitary, probably horizontal, rather stiff axes which sometimes carry small branches at the base; the cymes up to 2 cm apart; axis angled, to 30 cm long; pedicels to 1 cm long. Tube of the flower extremely short; tepals ovate, spreading in anthesis so much as to make the flower almost patelliform. Outer tepals a little broader than the inner ones, to 1 1/2 mm in length. Stamens 6, on very short filaments which raise the anthers so that they touch at the centre of the flower. *Female plant* unknown.

DISTR. *Malaysia*: Philippines (N. Palawan). Fig. 7c.

Note. It is feared that the only specimen which was obtained, was lost in the destruction of the Bureau of Science, Manila, in 1945.

4. *D. ridleyi* PRAIN & BURK. J. As. Soc. Beng. new ser. 10 (1914) 12; R. KNUTH, Pfl. R. 87 (1924) 191; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1936) 69, pl. 33.

Lower parts unknown. Stem terete, unarmed at least in the upper parts. *Leaves* subcordately ovate to narrowly ovate, acuminate, the largest seen 11 by 6 cm, but larger are to be expected and these will be more cordate, 7-nerved; petiole rather short, approximately 1/3 the length of the blade. *Male plant* unknown. *Female flowers* on decurved branches to 30 cm long. Tepals ovate. Capsules spaced so that they scarcely imbricate; wings broader than semicircular and widest in the upper third, to 22 by 22 mm; the capsule truncate above and drawn out into the stipe below. Seeds with a pale brown wing.

Distr. *Malaysia*: Borneo (Sarawak). Fig. 7d.

Note. The underground parts are needed to confirm the conclusion, arrived at from the shape and poise of the capsule, that it belongs to the section *Stenophora*.

## 2. Section *Stenocorea*

PRAIN & BURK. J. As. Soc. Beng. new ser. 10 (1914) 40; R. KNUTH, Pfl. R. 87 (1924) 310; *em.* PRAIN & BURK. Kew Bull. (1931) 88; Ann. R. Bot. Gard. Calc. 14 (1936) 70.—*Peripetasma* RIDL. J. Bot. 58 (1920) 147.—Fig. 5e.

Underground one or more descending tubers. Plants glabrous, stems twining to the left, apparently unarmed. Bulbils unknown. *Leaves*, it seems, always alternate, typically cordate, but not invariably (*cf.* *D. stenomeriflora*). *Male flowers* pedicellate, one at a time along leafless branches which are decurved in all the species except *D. stenomeriflora*; the pedicel carries a bracteole above mid-length and is reflexed in all the species except *D. stenomeriflora* so that the flower faces upwards.

Stamens 6. *Female flowers* distinctly pedicellate, on decurved spike-like racemes similar to those of the male except that the pedicels do not become reflexed.

Distr. Siam, Cambodia to 15° N, in *Malaysia*: E. Sumatra, Celebes, Central Java; apparently never abundant.

KEY TO THE SPECIES

1. Male flowering axes spreading and their flowers directed forward. Leaves very much longer than broad. . . . . 5. *D. stenomeriflora*
1. Male flowering axes decurved and flowers reflexed. Leaves cordate.
  2. Leaves twice as long as broad.
    3. Pedicels of male flowers to 1½ mm long. (Capsules to c. 25 mm long) . . . . . 6. *D. daunaea*
    3. Pedicels of male flowers to 4–5 mm long. (Capsules unknown) . . . . . 7. *D. keduensis*
  2. Leaves nearly as broad as long. (Capsules of great size, their fertile part even to 40 mm along the placenta; the stipe much elongated) . . . . . 8. *D. sumatrana*

5. *D. stenomeriflora* PRAIN & BURK. J. As. Beng. new ser. 10 (1914) 40; R. KNUTH, Pfl. R. 87 (1924) 310; RIDL. Fl. Mal. Pen. 4 (1924) 319; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1936) 72, pl. 30–31.—*Peripetasma polyanthum* RIDL. J. Bot. 58 (1920) 147; Fl. Mal. Pen. 1 (1922) 103; *ibid.* 5 (1925) 340.

Lower parts unknown. Stem vigorous, recorded as climbing to 25 m, ridged. *Leaves* herbaceous, long-elliptic, 16 by 5 cm, base obtuse or rounded; at lower horizons large sagittate leaves up to 28 by 16 cm occur, but it is questionable if a sagittate outline always occurs; primary nerves 3–5, and the outer of them give a branch to the auricle in the large leaves; secondary nerves very distinct from the network, widely spaced, crossing the space between one primary nerve and another without interruption; upper surface shining; petiole short, ¼ to ½ the length of the blade, narrowly winged, these wings pass into the outer primary nerves at the back of the blade as in *D. bulbifera* and certain other species. *Male flowering axes* on short leafless branches, to 35 cm in length, stretching outwards from the upper leaf-axils and bearing possibly more than 100 flowers. Flowers produced singly; from the midrib of the bract of each a pronounced ridge descends the axis; bracts lanceolate, keeled, to 2 mm long; pedicels to 2 mm long, directed obliquely forward. Torus expanded into a wide cup. Outer tepals lanceolate, obtuse, just over 1 mm long, 3-nerved; inner ones similar, but a little less acute. Stamens 6, inserted at the base of the flower; filaments short, stout at the base, incurved, not long enough to lift the anthers out of the cup. *Female flowering axes* solitary or 2–3 together, decurved from the axils of distal leaves or sometimes on short leafless branches; axis conspicuously angled. Bracts lanceolate-ovate, to 1½ mm long. Tube of flower 1 mm deep. Outer tepals narrowly ovate, to 3 mm long, subacute, inner ones a little shorter. Capsules not yet known.

Distr. *Malaysia*: Malay Peninsula (Perak to Singapore), Sumatra (East Coast).

Ecol. Fl. Febr.–April, Oct. (Perak), fr. 2 months later, both flowerings occurring at times when the mountains have heavy rains.

Note. This has been described by error as a new genus, *Peripetasma*, in the *Menispermaceae*.

6. *D. daunaea* PRAIN & BURK. J. As. Soc. Beng. new ser. 4 (1908) 450; *ibid.* 10 (1914) 12; R. KNUTH, Pfl. R. 87 (1924) 191; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1936) 73, pl. 32 & 32/2.

Tubers apparently more than one a year, descending deeply into the soil from the corm. *Leaves* lanceolate-ovate-sagittate, shortly acuminate, to 16 by 6 cm (acumen 8 mm long), 5–7-nerved; secondary nerves rather distinct as they traverse the network; upper surface bright; lower paler; petioles to 4 cm. *Male flowering axes* solitary or 2 together, or sometimes on short leafless branches, or branching themselves, *i.e.* they tend to be paniculate; axis straight, angled; bracts lanceolate-acuminate. Pedicels to 1 mm long. Buds globose. Torus making a cup 1½ mm deep. Outer tepals ovate, acute, inner ones blunter and a little broader. Stamens 6, 3 upright and 3 inclined towards each other. *Female flowering axes* solitary, either from the axils of the leaves or from axils of bracts replacing the leaves on short branches which grow to 30 cm long; axes winged. Bracts ovate-acuminate, 3 mm long. Pedicel in anthesis 3–4 mm. *Capsule* (rather before complete maturity) with wings 25 by 12 mm, semicircular except that the widest part is rather above mid-length and that they are slightly drawn out at the base; apex truncate.

Distr. Mountains of the Tenasserim-Siam border and those SE of Bangkok, and southwards in *Malaysia* to the southern parts of Peninsular Siam.

Ecol. Fl. Jan.–March at which time there is little rain.

7. *D. keduensis* PRAIN & BURK. *ex* BACKER, Handb. Fl. Java 3 (1924) 114; Ann. R. Bot. Gard. Calc. 14 (1936) 74, pl. 90 in part 2 (1938).

Lower parts unknown. Stem faintly ridged. *Leaves* long-cordate or cordate-linguiform, acuminate, to 14 by 5 cm, 5-nerved; petiole about ½ as long as the lamina. *Male flowering axes* solitary or 2 together from a leaf-axil, to 18 cm long. Flowers solitary, to 30 in number or more on each axis; axis angled. Bracts lanceolate-acuminate, to 2 mm long. Pedicels 4–5 mm long. Buds pear-shaped. Flowers wide open in anthesis; tube very short. Outer tepals narrowly ovate, obtuse, 2 mm long,

inner ones a trifle longer and blunter. Stamens inserted at the base of the perianth lobes. *Female plant* unknown.

Distr. *Malaysia*: Central Java, SW. Celebes.

8. *D. sumatrana* PRAIN & BURK. Kew Bull. (1931) 90; Ann. R. Bot. Gard. Calc. 14 (1936) 75, pl. 32/3.—Fig. 5e.

Lower parts unknown. Stems apparently terete. *Leaves* cordate but not exactly so, because the auricles tend to be drawn out rather than rounded, to 9 cm across, 5–7-nerved; secondary nerves not conspicuous in the network; petiole c.  $\frac{1}{2}$  as long as the blade. *Male flowering axes* solitary or 2–3 together, directed downwards from the axils of upper leaves or not infrequently on short special leafless branches: axis rigid, up to 15 cm, many-

flowered; bracts lanceolate, reflexed along with the pedicel, acute. Pedicels to 1 mm. Tube of flower in anthesis  $\frac{1}{2}$  mm deep. Tepals long-ovate, acute,  $1\frac{1}{2}$ –2 mm long. Stamens inserted below the tepals with their filaments inclined towards the centre of the flower, 3 of them shortest. *Female flowering axes* solitary, directed stiffly downwards from the axil, with numerous flowers which face forward and remain facing forward while the pedicel, at first 3–4 mm long, grows into a curved stipe 2–3 cm long. Tepals lanceolate-acute, 2 mm long. Capsule remarkably large (fig. 5e), facing earthwards; wings 4 by  $3\frac{1}{2}$ –4 cm; apex retuse; base drawn out into the stipe. Seeds winged to a width of 3 cm.

Distr. *Malaysia*: Sumatra (East Coast).

Note. The size of the capsule is not approached in any other *Dioscorea*.

### 3. Section Combilium

PRAIN & BURK. J. As. Soc. Beng. new ser. 10 (1914) 19; R. KNUTH, Pfl. R. 87 (1924) 186, in small part only; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1936) 79.—Fig. 5c.

Tubers 4 to many, thrust downwards from a corm lying close to the surface of the soil, esculent, and protected in the wild plant by a formidable *cheval-de-Frise* of thorny roots, wherein the longest thorns are those directed upwards; but races of cultivation are largely without thorns. Plant abundantly hairy with T-shaped hairs (fig. 6a). Extra-floral nectaries are of the deep kind (see p. 294). Bulbils absent. *Leaves* alternate, entire and cordate or broadly cordate. *Male flowers* almost always one at a time distributed along rather stiff axes which ascend from distal leaf-axils; if there be more than one flower the arrangement is cymose. Torus expanded into a saucer-shaped tube. *Female flowers* on decurved spikelike racemes; capsules reflexed.

Distr. Monotypic, native in SE. Asia and *Malaysia*, widely dispersed by cultivation.

9. *D. esculenta* (LOUR.) BURK. Gard. Bull. S. S. 1 (1917) 396, 3 pl.; *ibid.* 2 (1919) 159, 1 pl.; MERR. En. Philip. Fl. Pl. 1 (1922) 216; R. KNUTH, Pfl. R. 87 (1924) 189; BURK. Dict. (1935) 818; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1936) 80, pl. 35–37.—*Combilium* RUMPH. Herb. Amb. 5 (1747) 357, t. 126.—*D. sativa* LINNÉ, Sp. Pl. (1753) 1033 in small part, and in confusion by most later taxonomists; DENNST. Schlüss. Hort. Malab. (1818) 34; BLANCO, *op. cit.* (1845) 551; NAVES in BLANCO Fl. Filip. ed. 3 (1880) 209.—*D. aculeata* L. (not of Sp. Pl. 1753) Herb. Amb. (1754) 23; Syst. Nat. ed. 13 (1791) 582; Miq. Fl. Ind. Bat. 3 (1859) 575; QUEVA, Mém. Soc. Sc. Lille IV, 20 (1894) 373; WESTER, Philip. Agr. Rev. 9 (1916) 194, with plates; BACKER, Handb. Fl. Java 3 (1924) 112; RIDL. Fl. Mal. Pen. 4 (1924) 315; HEYNE, Nutt. Pl. N.I. (1927) 455; OCHSE, Veg. D.E.I. (1931) 22.—*Oncus esculentus* LOUR. Fl. Coch. (1790) 194.—*D. fasciculata* ROXB. Fl. Ind. 3 (1832) 801.—*D. papillaris* BLANCO, Fl. Filip. (1837) 801, ed. 2 (1845) 552.—*D. tugui* BLANCO, *op. cit.* (1837) 800.—*D. tiliifolia* KUNTH, En. Pl. 5 (1850) 401; Miq. *op. cit.* 3 (1859) 576; CERON, Cat. Pl. Fl. For. (1892) 171; KOORD. Exk. Fl. Java 1 (1911) 311; R. KNUTH, Pfl. R. 87 (1924) 188.—*D. spinosa* ROXB. ex HOOK. f. Fl. Br.

Ind. 6 (1892) 291 as regards the male plant.—*D. papuana* WARB. Bot. Jahrb. 13 (1891) 273; in KRIEGER, Neu Guinea (1899) 65; K. SCH. & LAUT. Fl. D. Schutzgeb. Süds. (1901) 223.—Fig. 5c, 6a.

Tubers as described above, protected by thorny roots in the wild plant and by man's vigilance in cultivation; skin of the tubers bright brown or gray-brown, thin so that the tuber is easily bruised, often rough with indurated bases of rootlets; flesh white, sometimes with a trace of bitterness at the surface, but on the whole sweet and esculent. When the tubers are many, they tend to be shortly cylindrical with both ends rounded; when they are few and relatively larger as in various cultivated races, they may be lobed; sometimes they are large and may weigh over 3 kg. *Plant* pubescent with T-shaped hairs, the shank of which varies in length and when short brings the tomentum close down on the epidermis; the cross piece is of a single cell; exposed surfaces are glabrescent. *Stems* 1 or rarely more, terete, prickly at the base and diminishly so upwards: basal internodes carry prickles, medial at the nodes only, one at each side of the petiole and distal none. *Leaves* when very large to 15 by 17 cm, but most of them do not exceed 10 by 10 cm, acuminate acute at the apex, the forerunner tip a

small mucro, 9–13-nerved; secondary nerves fairly regular but not conspicuously ladder-like; petiole 1–1½ times as long as the blade, sometimes with small prickles in its pubescence. *Male flowering axes* almost invariably solitary, carrying flowers one at a time or very rarely 2–4 in a small cyme, the flowers to 70 or more; axis slightly angled. Bracts ovate-acuminate, to 2½ mm long. Pedicels to 1¼ mm, but usually nearly absent. Torus a shallow cup. Outer tepals broadly lanceolate, acute, 1¾ mm, inner ones a trifle shorter. Stamens all alike inserted just below the perianth lobes, the vascular bundle strengthening the cup, forming a ridge; filament 1 mm long, curved so as to cause the anthers to dehisce upwards. *Female flowering axes* solitary from upper leaf axils, to 40 cm, decurved, slightly angled. Bracts ovate, acuminate, 2 mm long. Pedicels in anthesis very short. Torus scarcely developed into a tube under the perianth lobes. Outer tepals lanceolate-ovate, obtuse, 1½ mm long, inner ones more acute. *Capsules* (only one seen and it not quite ripe) reflexed, 27 by 12 mm, subtetrate at the apex and nearly truncate at the base. Seeds winged all round.

Distr. Native in Siam and Indo-China, but very local; also growing wild, but without certainty of being indigenous, in the Sontal Hills of N. India, on Mt Popa in central Burma, in the Shan Hills, and perhaps in New Guinea. By A.D. 1498, when the Portuguese found their way into the Indian Ocean, it had obtained a dispersal in cultivation from Madagascar to Tahiti; and it appears to have had centres of relatively intensive cultivation in two parts of northern India, in Burma and Siam and in and around either end of New Guinea. As a servant of man it does not equal *D. alata*; but it can be raised where the humid season is short for *D. alata* and a return taken at 6 months, which is before the tubers become firm and fibrous. After A.D. 1500 it was carried round the Cape to the shores of the Atlantic in company with *D. alata* but not in rivalry. Those parts of Malaysia without a dry monsoon are rather too humid for its thrift.

Out of the wild population in the remote time when he became conscious of primitive agriculture man has acquired by selection forms with larger tubers, getting fewer at the same time, and lobed tubers, and his operations reduced the armature of thorny roots. It is convenient to distinguish the two intergrading varieties<sup>1</sup> upon which ROXBURGH based two species as:

*var. spinosa* (ROXB.) PRAIN & BURK. (1914).—*D. spinosa* ROXB. *l.c.*, non BURM.—Plants well provided with thorny roots.

*var. fasciculata* (ROXB.) PRAIN & BURK. (1914).—*D. fasciculata* ROXB. *l.c.*—Plants ill-provided with thorny roots.

There are some cultigens in *var. spinosa* and

(1) It is not possible to assign LOUREIRO's type to one of these varieties as LOUREIRO's specimen is insufficient and his account of the underground parts is too poor.

with them all the truly wild plants; *var. fasciculata* consists entirely of cultivated plants.

Plants in the field-crops of India never flower, and certain races never do so in Malaysia. In what measure this may be a climatic response or alternatively a consequence of the gathering of the crop is unknown. On the other hand some of the races cultivated in Malaysia never flower freely, or if they flower do so in the male sex only; everywhere it is extremely rare for any form of the female plant to flower; and fruiting does not follow.

A good idea of the range in shape of the tubers is found in the two cited papers from the Gard. Bull. Str. Settleme.

RUMPHIUS writing between 1653 and 1692, stated of Malaysia, that *D. esculenta* was cultivated in the greatest degree from Celebes through Buton, to the Moluccas, Ambon and Banda; and was to be found in Java, Bali and Bima, but not in great quantity though particularly near Jakarta to which centre immigrants from among the eastern folk had taken it.

Vern. Malay and Sundanese names sustain the view that W. Malaysia has obtained both *var. fasciculata* and *var. spinosa* from E. Malaysia. Both languages hold names distinguishing the two varieties, while linking it to *D. alata*; in Malay the names *ubi tēropong* (pipe *D. alata*) and *ubi torak* (trident yam), and in Sundanese *huwi taropong* and *huwi landak* (porcupine *D. alata*) are used.

The first of each pair is *var. fasciculata*; the second, as the qualifying words show, is *var. spinosa*. There is also a name in Javanese, *uwi mayong* (cat-fish *D. alata*), which provides another indication of the cultivation in Java of *var. spinosa*. RUMPHIUS excludes *D. esculenta* from the genus *ubi*, giving its proper name as *kombili*. He does not state that any of the races in Ambon were altogether without thorns, but he states that the fewer the thorns the better the race; and his kind with numerous tubers, which was grown in garden fences where it never flowered, was certainly *var. fasciculata*. Among the others was *var. spinosa*. The noun *kombili* becomes *kēmbili*, *gēmbili*, *gēmbilim*, *gēmbilēm*, *gēmbolo*, *gēmbulu*, *kēmili* and *bili* in western Malaysia, and is applied also to *Coleus tuberosus*. BLUME seems to have been aware of the confusion when he called the *Coleus* 'kummuli java' (Bijdr. 1826, 838). It is a strange confusion; for appearance and taste are very distinct.

Through the area which RUMPHIUS indicates as that of intense cultivation, *D. esculenta* is known today by a noun of considerable variability and completely specific. It is *siawu*, *siawu*, *siapu*, *sayawu*, *sayabu*, *sayahu*, *sayafu*, *sayahul*, *siaho*, *sahu*, *siyau*, *hiyahu*, *isahu* and *isayahu*. An outflow of the noun from the area is to be expected, and perhaps is seen in the use of *sahu* in N. Borneo; and in *uwi sayawu* of N. Celebes. The relationship of *siawu* to *sudo* or *wisudo* employed in eastern Java and Bali is not evident; *wi* here equals *uwi*. Where Buginese and Makassarese are spoken this plant is known as *opa* or *oppa*; and an apparent outflow of it is the name *ubi opang* recorded from Java. In the same languages of Celebes the yam is liable to be

classified under *lame*, as *lame chengka*, but may be simply *chengka* or *chingka*. The outflow of names of the *siawu* group towards the north is blocked by equally firmly established names of more than one group. Thus in the Bisayan languages of the central Philippines *bodot*, *borot*, *bolot*, *bolod* is established in a way that makes another name unnecessary, until the speaker seeks to indicate races, and in the languages of W. Luzon, *tugul*, *tuqul*, *tugi*, *dogue*, *toquing*, *tungo* and *tongo* does the same up to a certain point. In Ilocano, Sambali and Tagalog *boga* and *buga* are used, to denote a race. The names recorded from New Guinea seem to have racial values; for instance *diba*, *nemu* and *taitukava* in the Hanuabada language of the E. end of the island have racial values. Lastly it would seem useful to list some dissimilar names that they may not miss attention by those interested in the languages; they are as unlike each other as the names of wider use given above; given alphabetic-

ally they are:—*aneg* (Ibanag of Luzon); *bangan* (Sambali of Luzon); *biau* or *bihaun* (Bali); *dukai* (Ivatan of the islands N of Luzon); *invod* (Palawan); *kaburan* (Madura); *kamiging* (Bikol of S. Luzon); *karat* (Pangasinan of W. Luzon); *katilin* (Ceram); *luttu* (Ibanag of Luzon); *nale* (S. New Guinea). BRANDERHORST in recording the last name connects it with a verb meaning to eat.

It is not at present useful to enumerate the many double names under *ubi*, *huwi*, etc. that are racial; it may suffice to suggest that there are several races spread from Burma to the eastern parts of Malaysia, varying in name but not in nature; and to add they do not vary in nature because reproduction is entirely by clones so that the characters are constant; and the main direction of the prehistoric spreading of this useful plant has been out of the continent of Asia through the Philippines, thence to diffuse towards the S and SE, and ultimately towards the SW.

#### 4. Section *Paramecocarpa*

PRAIN & BURK. Gard. Bull. Str. Settl. 3 (1924) 123 *in nota*; Ann. R. Bot. Gard. Calc. 14 (1936) 93.—*Sect. Combilium* R. KNUTH, Pfl. R. 87 (1924) 186, in part.—*Sect. Celebenses* R. KNUTH in FEDDE, Rep. 36 (1934) 128.—Fig. 5d, 8.

Tubers descending into the soil, apparently not to a considerable depth, protected against herbivores in some *spp.* and probably in all by a poisonous saponin in addition to thorny roots on the surface of the tubers. Corm little developed for new tubers appear in the axils of scale leaves against the soil, as if misplaced bulbils. Hairs, when present, of the stiletto shape as in *D. pyrifolia* of § *Enantiophyllum* (fig. 6d). Extrafloral nectaries of the deep kind exist, at least in *D. piscatorum*. Bulbils not recorded. *Leaves* entire, cordate, alternate, chartaceous. *Male flowers* one at a time along spreading flowering axes. Torus expanded into an infundibular tube from the rim of which the tepals become reflexed during anthesis. *Female flowering axes* decurved, carrying numerous pedicellate flowers which face forward; but after fertilization the pedicel lifts the capsule to a horizontal position (fig. 5d). *Style* stout. *Capsules* horizontal when ripe or very slightly ascending, elongated, their sides parallel. Seeds with a triangular body and winged from it on the outer side and forward (in the Tonkin species also from the base).

*Distr.* *Ca 5 spp.*, from the S. border of China southwards to *Malaysia* as far as the equator and to Palau Islands. Fig. 8.

*Notes.* The section approaches *Stenomeris* in: (i) a great demand for humidity, (ii) the elongation of the capsules, with (iii) forwardly directed wings on elongated seeds, and (iv) reflexed perianth lobes. When KNUTH described *D. kjellbergii* he suggested a new section *Celebenses*; but beyond all doubt this species is a typical member of the section *Paramecocarpa*.

#### KEY TO THE SPECIES

1. Stem (as far as known) sparingly prickly. Leaves about as broad as long. Hairs on the inflorescence and rather sparingly on the backs of the leaves.
  2. Leaves about 13 by 13 cm. Tepals 1½ mm long . . . . . 10. *D. flabellifolia*
  2. Leaves about 10 by 8 cm. Tepals ½ mm long . . . . . 11. *D. kjellbergii*
1. Stem with long crests of confluent prickles on the lower internodes. Leaves distinctly longer than broad and half as large again as those of *D. flabellifolia*, glabrous. (Inflorescences unknown.)
  12. *D. piscatorum*

10. *Dioscorea flabellifolia* PRAIN & BURK. in EL-MER, Leaf. Philip. Bot. 5 (1913) 1593; J. As. Soc. Beng. new ser. 10 (1914) 12; MERR. En. Philip. Fl.

Pl. 1 (1922) 217; R. KNUTH, Pfl. R. 87 (1924) 188; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1936) 94, pl. 38–39.—*D. ledermannii* R. KNUTH, Pfl. R.

87 (1924) 188; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1936) 209; *ibid.* (1938) 425.—*D. bullata* PRAIN & BURK. Kew Bull. (1925) 60; Ann. R. Bot. Gard. Calc. 14 (1936) 96, pl. 40.—Fig. 5d.

Tuber unknown. Plant to some extent hairy, but glabrescent. Stem to 14 mm in diam. at the base

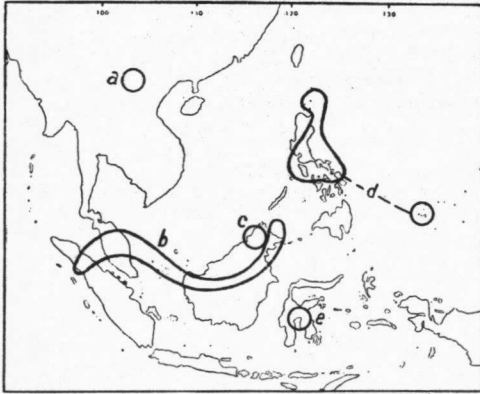


Fig. 8. Distribution of the spp. of § *Paramecocarpa* in SE. Asia: a. *D. petelotii* PR. & B., b. *D. piscatorum* PR. & B., c-d. *D. flabellifolia* PR. & B., e. *D. kjellbergii* R. KNUTH. Note a similarity to the distribution of *Stenomeris* (fig. 3, p. 299).

and there abundantly prickly, above with scattered small prickles. *Leaves* almost exactly cordate, with the margin very evenly rounded, shortly acuminate, to 16 by 20 cm, but as a rule not larger than 13 by 13 cm, 9-nerved; primary and secondary nerves distinct above and somewhat impressed, prominent below, the secondary almost ladder-like; surfaces of the lamina equally bright on the two sides; petiole puberulous or pubescent, shorter than the lamina by  $\frac{3}{4}$  to  $\frac{1}{3}$ . *Male flowering axes* 1-4 together from the axils of upper leaves, more or less ascending and sometimes erect, to 45 cm, carrying upwards of 70 pale green flowers which are for the most part solitary though there may be sometimes a second flower cymosely on the pedicel of the first; axis conspicuously ridged. Bracts lanceolate, acute, puberulous, 3 mm long; bracteoles placed rather above the middle of the pedicel. Torus a funnel-shaped perianthoid tube  $\frac{1}{2}$  mm. Tepals lanceolate, ridged on the inner face just within their margins and down the middle line,  $1\frac{1}{2}$  mm long. Stamens inserted just below the tepals, raising their anthers well out from the tube; filaments  $\frac{1}{2}$  mm long. *Female flowering axes* to 80 cm, sometimes branched, axis strongly ridged. Tepals recurved as in the male, but less sharply,  $1\frac{1}{2}$  mm long. Stigmas big, extruding from the flower. Pedicel 6-8 mm long in anthesis. Ovary more or less pubescent. *Capsules* horizontal from the downwardly directed axis or perhaps slightly ascending by being reflexed through rather more than 90°; wings to 35 by 9 mm, the obtuse apex raises the withered remains of the flower by 1-2 mm; stipe to 1 cm. Seeds inserted on the lower

half of the placenta, their outer margin narrowly winged, wing widening upwards and extended from the apex of the seed towards the apex of the cell, to 35 mm long wing included.

Distr. Micronesia (Palau), in *Malaysia*: Philippines (Luzon, Mindoro), Br. N. Borneo. Fig. 8c-d.

Ecol. Chiefly in the eastern more humid parts of Luzon.

Vern. *Paynut* (Tagalog).

Note. The Palau specimen described as *D. ledermannii* KNUTH is tentatively referred here, the capsule being slightly different from the Philippine plant.

11. *Dioscorea kjellbergii* R. KNUTH in FEDDE, Rep. 36 (1934) 128.

Lower parts unknown. Inflorescence thinly hairy and a few hairs on the leaves. Stem terete in its distal parts, to 5 mm in diam., unarmed, firm in texture, glabrous except in the leaf-axils. *Leaves* at the horizon of flowering to 11 by 9 cm (assuredly larger at a lower horizon), very shortly acuminate, 7-nerved with firm margins; the secondary nerves ladder-like; petiole to 5 cm. *Male flowering axes* solitary from upper leaf-axils or on very short leafless branches, 10-20 cm, carrying 20-30 flowers which are directed slightly forward; axis angled. Bracts ovate, acute,  $\frac{1}{2}$  mm long. Pedicel 1-2 mm, with scattered hairs, with a bracteole in its lower part. Funnel-shaped perianthoid torus-tube nearly 1 mm deep; tepals long-deltoid  $\frac{1}{2}$  mm long. Stamens inserted just below the perianth lobes; anthers conspicuously exserted, opening upwards. *Capsules* (teste R. KNUTH) on axes to 60 cm long, in a slightly immature state 40 by  $12\frac{1}{2}$ - $17\frac{1}{2}$  mm.

Distr. *Malaysia*: Central Celebes (Malili). Fig. 8e.

Ecol. Rainforest at sea-level, fl. August and with not quite mature fr.

12. *Dioscorea piscatorum* PRAIN & BURK. Gard. Bull. Str. Settlement. 3 (1924) 123; R. KNUTH, Pfl. R. 87 (1924) 356; RIDL. Fl. Mal. Pen. 4 (1924) 319; BURK. Dict. (1935) 822; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1936) 98, pl. 41.—*D. borneensis* R. KNUTH, *op. cit.* 188.—*D. sp.* PRAIN & BURK. J. As. Soc. Beng. 73 (1904) 186; RIDL. Mat. Fl. Mal. Pen. 2 (1907) 84; Agric. Bull. Str. & F.M.S. 7 (1908) 444; PRAIN & BURK. J. As. Soc. Beng. new ser. 10 (1914) 13.

Tubers more than one, clavate, arising in axils where the base of the stem touches the soil surface, unarmed or with short roots which may be indurated into thorns, some of which (teste KEITH) come above the soil; skin liver-coloured; flesh the red colour of diluted blood, intensely poisonous. Plant glabrous. Stems to 8 mm in diam. near the ground where there are 4-5 lines of confluent flat prickles; these give place upwards to scattered prickles and then more or less cease. *Leaves* except in their greater size and complete glabrousness as those of *D. flabellifolia*, attaining 18 by 14 cm, 9-nerved; petiole shorter by  $\frac{1}{4}$  than the blade, with scattered small prickles on the back and the sides.

Flowers unknown, acc. to KNUTH those of his '*D. borneensis*' are formed on male inflorescences reaching a length of 70 cm.

Distr. *Malaysia*: N. Sumatra, Malay Peninsula (Perak and Pahang, P. Tiunan), and Borneo. Fig. 8b.

Ecol. The saponin in the tubers stupifies fish and the tubers are used as an alternative to *Derris*. Attention was drawn to this in 1908 by a Malay who exhibited the plant at an Agri-Horticultural Exhibition in Kuala Lumpur. BURKILL & HOLTUM proved the effect (see BURK. Dict. 822); GATER tried the tubers as an insecticide and found them effective, but less so than *Derris*. Being a substitute

for *Derris* it shares the name *tuba*, and is known as *tuba ubi* (*tuba yam*) in the Malay Peninsula, *tuba gunjo* (wild *tuba*) among the Battaks of Tapanuli and *tuba podedh gantung* among the Dayaks of the Sanggau valley of Borneo. It is recorded that rasped tubers are put into the runnels of rice fields in Tapanuli 'to kill injurious worms'. Beyond all doubt the tubers are inedible to such animals as wild pig and are preserved from molestation by their poisonousness as well as by their thorny roots. Ignorance of the flowers is probably due to flowering not occurring until the climber has topped the forest.

### 5. Section Opsophyton

ULINE in E. & P. Nachtr. (1897) 84; R. KNUTH, Pfl. R. 87 (1924) 88 *pro subsect. Euopsophyton*; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1936) 109.—Fig. 4a-b, 5f.

Tuber annually replaced, solitary, produced close under the surface of the soil, swelling downwards from a rather thick attachment; in Asia and the East that attachment does not possess any length, but in Africa it makes a definite stalk; flesh poisonous in varying degree, the least poisonous being cultigens derived from *D. bulbifera*. Hairs as a rule absent, when present finger-like and of one cell. Extrafloral nectaries of the superficial kind. *Leaves* cordate, alternate. *Male flowers* in spikes or spike-like racemes which may be collected together into large inflorescences; torus without enlargement, tepals long and narrow. *Female flowers* on decurved axes and after pollination the ovary is reflexed. *Capsules* twice as long as broad or relatively longer. Seeds winged towards the base of the cell.

Distr. *Ca* 5-6 spp. native in the Old World, only one sp. in *Malaysia*.

13. *Dioscorea bulbifera* LINNÉ, Sp. Pl. (1753) 1033; BL. En. Pl. Jav. 1 (1827) 23; MIQ. Fl. Ind. Bat. Suppl. (1860) 270; J. Bot. Néerl. 1 (1861) 90; WARBURG, Bot. Jahrb. 13 (1891) 273; CERON, Comis. Fl. Forest. (1892) 171; PRAIN, Beng. Pl. (1903) 1066; KOORD. Exk. Fl. Java 1 (1911) 309, Atlas (1923) fig. 501; KOORD.-SCHUM. Syst. Verz. 9 (1912) gen. 1252; MERR. Interpr. Herb. Amb. (1917) 146; En. Philip. Fl. Pl. 1 (1922) 215; HEYNE, Nutt. Pl. Ned. Ind. (1922) 496; R. KNUTH, Pfl. R. 87 (1924) 88, *excl. syn. eburina & eburnea*; BACKER, Handb. Fl. Jav. 3 (1924) 113; RIDL. Fl. Mal. Pen. 4 (1924) 315; OCHSE, Veget. D.E.I. (1931) 248; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1936) 111, pl. 49-51; *ibid.* (1938) 420.—*D. sativa* (non LINNÉ, Sp. Pl.) THUNB. Fl. Jap. (1784) 151; BENTH. Fl. Hongkong (1861) 368; Fl. Austr. 6 (1873) 460; K. SCH. & HOLLR. Fl. K.-Wilhelmsl. (1889) 14; HOOK. f. Fl. Br. Ind. 5 (1892) 295; WARBURG, Pfl.-Kl. N. Guin. (1899) 65; RIDL. Mat. Fl. Mal. Pen. 2 (1907) 84; LAUT. Bot. Jahrb. 41 (1908) 224.—*D. crispata*, *D. heterophylla*, and *D. pulchella* ROXB. Fl. Ind. 3 (1832) 801.—*Helmia bulbifera* KUNTH, En. Pl. 5 (1850) 435; QUEVA, Mém. Soc. Sc. Lille IV, 20 (1894) 178, 374.—Fig. 4a-b, 5f.

Tuber (as produced in the East) globose to pyriform, rarely somewhat lobed, usually covered densely with harsh short roots, nauseous in the wild plant and in quantity poisonous; but with

tubers fit to eat in various cultigens selected by man, weighing up to 1 kg. In certain cultigens the tuber is suppressed in favour of rather large bulbils. In the wild plant bulbils numerous; a seedling only a few months old can be made to produce one by a checking of its growth; bulbils usually in the leaf-axils but at times displacing ♂ flowers at the base of flowering axes; small bulbils are as a rule warted; when large they may be smooth; in Africa curiously angled bulbils are produced. Flesh usually pale yellow, perhaps tinted with violet, and it oxydizes when cut to orange; very mucilaginous. *Leaves* usually broadly cordate, but sometimes long-cordate [*var. heterophylla* (ROXB.) PRAIN & BURK. (1936)], up to 20 by 20 cm and even to 32 by 32 on unusual plants, 5-nerved, secondary nerves very conspicuously ladder-like; upper surface shining and slightly bullate between the secondary nerves, lower duller, with the nerves prominent; petiole from half as long to as long as the blade, sometimes marginally winged with wings that ascend to the backs of the outer primary nerves; these wings descend on the stem having between them a wing from the centre of the base of the petiole. Sub-foliaceous auricles (fig. 4b) may occur at the base of the petiole and partly embrace the stem; they are larger than in any other sp., but they are commonly altogether absent. *Male flowering axes* pendulous, 1-4 from the axil of a bract or rarely

of a leaf; those arising from axils of bracts may make large pendulous inflorescences (fig. 4a) even to 100 cm; axis carrying the flowers to 14 cm, though usually about 4 cm; when large with perhaps 100 flowers which open from the lowest upwards in a succession that is often by no means as obvious in the genus; flowers facing forwards which, the axis being pendulous, means towards the earth, pleasantly scented, sometimes tinted with a rose coloured pigment and generally with the green so diluted that collectors have called them white. Torus very small, tepals and stamens crowded together. Outer tepals linear-lanceolate, 1 $\frac{1}{4}$ –4 mm long, but nothing like the large flowers of the Himalayan *var. simba* PRAIN & BURK. (1914) have been met with in Malaysia; inner ones not so acute. Stamens half as long or a little longer, anthers as long as the filaments. *Female flowering axes* directed downwards but not rigid, solitary or 2 or more together from a leaf-axil, carrying about 40 flowers which appear sessile but after pollination show that they have enough pedicel to direct the ovary upwards. Bracts long-acuminate. Outer tepals rather broader than those of the male and greener, rarely more than 1 $\frac{1}{2}$  mm long, inner ones a trifle shorter and blunter than in the male. *Capsules* bright chestnut and usually formed in large numbers, imbricating; wings rounded at both ends (fig. 5f) sometimes rather broader towards the apex than below, 20–22 by 8–9 mm. Seeds as a rule not quite as broad as their wing, but nearly so.

*Distr.* From the Atlantic coast of Africa to the furthest islands of the Pacific, the most prolific and the widest spread of all the *Dioscoreas*. The dry countries from the Sahara to the Punjab interrupt its distribution; and on the African side of this break the plants are liable to carry small hairs which they do not carry in Asia; and they have angular bulbils whereas those of Asia have rounded bulbils; moreover there is the difference noted above in the shape of the tuber. The African plants are conveniently called collectively *var. anthropophagorum* (CHEV.) PRAIN & BURK.

*Taxon.* It is convenient to distinguish some varieties (*cf.* J. As. Soc. Beng. new. ser. 10, 1914, 26 and Ann. R. Bot. Gard. Calc. 14, 1936, 117).

#### KEY TO THE VARIETIES

1. Tubers and bulbils acrid and nauseous; wild plants.
2. Leaves shortly cordate . . . *var. bulbifera*
2. Leaves elongated, long-cordate.  
*var. heterophylla*
1. Tubers and bulbils selected by man not to be acrid and nauseous, less or little so.
3. Bulbils dark gray-brown, abundantly warted.  
*var. suavior*
3. Bulbils large, smooth, glivous . . . *var. sativa*

*Var. bulbifera* is that met with in Malaysia wherever the plant grows. *Var. heterophylla* is fairly plentiful in Penang in association with the type and has been obtained sparingly to the south as far as Malacca. Its stems are rough at the base. ROXBURGH attributed *var. heterophylla* also to the

Moluccas, but no specimens have been seen derived thence. The known dispersal of the cultigens is given below.

If a growing stem of one of the cultigens with large bulbils be examined, starch is found, often in quantity, within the parenchyma, showing that what man has done is to select races, not with the amelioration of increased starch and food production, but with a loss of ability to transport the elaborated food to the base of the plant. And the plant, therefore, must die each year. Consequently maintenance of its situation is dependent on the bulbils with broken tenancy. Man obtained large bulbils in Asia and Africa, but as said above growing to unlike shapes. The cultigens of the two continents have been distributed widely without intermingling, unless it be in remote Tahiti to which *var. anthropophagorum*, after having been taken to America along with negro slaves was carried to Tahiti by Spaniards after Tahiti had received cultivated *D. bulbifera* from out of Asia. Asia, more progressive than Africa, has gone much further than Africa in abandoning a line that had ceased to reward the cultivator adequately; but there is left a wide dispersal of the Asiatic cultigens to show how they gave at one time an adequate reward. In contrast Africa still cultivates *D. bulbifera* considerably and would seem still to be endeavouring ennoblement.

*Ecol.* From a rather extensive study of *D. bulbifera* in India a climatic limit has been determined towards the dry NW where its existence ceases (PRAIN & BURK. Ann. R. Gard. Calc. 14, 1938, 433–4). This limit is where the rainfall of the wetter six months diminishes to less than 700 mm, an amount seemingly just adequate, though 1000 mm serve better. This observation in India leads to an expectation that there is little land in Malaysia insufficiently humid to provide a home. *D. bulbifera* crosses Torres Straits into Australia and passes down the east coast in the coastal margin to 21° S; but here, though the summer rains of Brisbane exceed 700 mm, it does not reach that city. Towards the W. coast of Australia it does not overpass Port Darwin. It ascends the Himalaya to 1800 m and is recorded in Yunnan at 2700 m, heights which cause the records of it on the mountains of Malaysia to be unsatisfying; there are specimens in herbaria from 1000 m in Sumatra, Borneo and Java; it probably exceeds this. Mountains however, are not where it is most abundant; this is always near sea-level and it seems to find a home readily in small islands. It was found in Verlaten Island and Sebesi near Krakatoa when the returning vegetation was investigated (DOCTERS VAN LEEUWEN, Krakatoa, 1936, 435). It gets some dispersal by floating bulbils. The high forest chokes it out; disturbed wooded land is suitable; and in coastal woodland which is always exposed to storm damage (as well as to interference by man; storms and man working together produce conditions favourable to it, and so aid in creating a greater abundance of it near the sea than in little inhabited country. The widest distribution of any *Dioscorea* with the greatest amount of reproduction by bulbils points to bulbils as of great value in its thrift. It



may be added here that a seedling, checked at the age of a few weeks, is able to produce a bulbil before its stem perishes down to the ground, and so to carry on as two plants, one from the bulbil and the other from the tuber, the former making trial of a new spot. By its bulbils a female plant, occupying a new site can multiply while awaiting the establishment of a male within pollinating distance. Adult *D. bulbifera* is very floriferous and commonly produces an abundance of seed. The pollinating agents, presumably insects, have not been detected; the flowers are pleasantly scented. Male and female flowers resemble each other, more closely than the flower of the two sexes in many species of *Dioscorea*. The maximum of its flowering in Malaysia north of the equator is in September, and south in May.

Econ. The tubers of wild plants become increasingly unpalatable as the time of new growth approaches. They are bitter and acrid and the backward tribes who fall back on them slice and cook them with lime and wood ashes; the product is rather like starch paste with acidity introduced. 'Vile in taste', wrote RUMPHIUS, adding humourously, 'but suited to the Amboinese stomach'. The bulbils of the varieties *suavior* PRAIN & BURK. (1914) and *sativa* PRAIN (1903) are much pleasanter and the best even pleasant to eat. Until recently the latter existed on the edge of Singapore from former cultivation and the names *ubi china* (Chinese yam) and *ubi kastela* (Portuguese yam, literally yam of Castile) lingered but without providing proof that the Chinese or Portuguese had brought it either from China or elsewhere. The same variety, cultivated near Jakarta, passed as *huwi singapura* (Singapore yam), as if Singapore had supplied it. It has been found elsewhere in the Malay Peninsula to which it is certainly exotic. *Var. suavior* has been recognized in specimens from Java, Madura, Buru, and Halmaheira. Both varieties have been met with among collections from the SE of New Guinea

and from the islands to the eastward. It is interesting that *var. sativa*, as it grows in Singapore, produces fertile female flowers at the base of male axes.

It may be well to remark that PRAIN did not use the name '*sativa*' for his variety in reference to any previous application of that adjective to this species. The earlier applications of the adjective in the form of *Dioscorea sativa* from LINNAEUS to BENTHAM were extremely confused (PRAIN & BURK. in Kew Bull. 1919, 339). BENTHAM in 1861 accepted it as for *D. bulbifera* and for a time many botanists followed him; this was an error for there is no doubt regarding the earlier use of the name *D. bulbifera*. THUNBERG's *D. sativa* was *D. bulbifera* as cultivated in Japan: the type of *D. bulbifera var. sativa* PRAIN is a plant brought to India from the Pacific and cultivated in Jail gardens under the name *Otaheite potato*. The writer has eaten its bulbils and found them pleasant, as cooked.

Vern. The names *ubi atas* (top-side yam) in Malay and *huwi buwah* (fruit yam) in Sundanese, can only be applied to cultivated varieties; and their use is evidence of former resort to these varieties in western Malaysia. In the islands of SE. Malaysia where the importance of *D. esculenta* is declared by consistent naming (see under that species) *D. bulbifera* has names as *abobo*, *abubu*, *ahuhu* and *ohuhu*; but it must be added not without a little confusion with *D. pentaphylla* and *D. hispida*. *Abau*, used for *D. bulbifera* in Solor appears to be of the same group of names; and attention may be directed to similarities in the Javanese names *jebubug* and *kambulu*. There is another name, *boti* and *botil*, used in Roti and Timor to cover it and *D. hispida* (q.v.). *Singal* is an isolated name reported from Timor. In the Bisayan languages of the central Philippines there would seem to be two groups of names, (i) *baong*, *bohayan*, *bayangkan* and *banayan*, and (ii) *pulugan*, *pologan* and *pugang*. In Luzon it is *aribukbuk* (Ilocano) and *ubi-ubihan* or *utong-utongan* (Tagalog).

#### 6. Section Lasiophyton

ULINE in E. & P. Nachtr. (1897) 84; *emend.* PRAIN & BURK. J. As. Soc. Beng. new ser. 10 (1914) 7, to incl. *sect. Trieuphorostemon* and *sect. Botryosicyos* ULINE, *l.c.*; R. KNUTH, Pfl. R. 87 (1924) after ULINE, 131, 137, 150; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1936) 135.—Fig. 5g-o, 6b-c, e.

Tubers renewed annually from a corm that is superficial in the soil, stalked or not, or in *D. hispida* as lobes on the corm, harmless or poisonous, sometimes very poisonous. Plants as a rule pubescent with characteristic hairs (fig. 6b-c, e). In the Malaysian species the lower equidimensional cell of the hair is single; elsewhere it may be doubled. Sometimes both cells are coloured red, sometimes only the lower. Extrafloral nectaries superficial. Stems twining to the left, in most species prickly at the base. *Leaves* alternate palmately compound, usually with 3 or 5 leaflets, sometimes simple. The forerunner tip is not well-developed and in most species receives but a single nerve. *Male flowers* one at a time along the flowering axes; pedicellate (except in *D. hispida*), the pedicel growing out of the stem carries up the bract with the flower. The flower-carrying axes are assembled into large leafless inflorescences.

*Female flowers* on downwardly directed axes and after pollination reflexed. *Capsules* rather longer than twice their breadth. Seeds winged towards the base of the cell.

Distr. Over 20 *spp.* from the Atlantic to Tahiti.

Anat. ORR (Notes Bot. Gard. Edinb. 15, 1926, 138) describes a lignified coat about the extrafloral nectaries of *D. hispida* such as he detected in none of the other species of *Dioscorea* that he examined.

ULINE subdivided too much when he made three sections out of the material which constitutes this section; his section *Botryosicyos* cannot be upheld; but it must be admitted that the separation of § *Triephorostemon* from § *Lasiophyton* can be argued on the differences in the male flowers and the tubers. If *Triephorostemon* be kept, then 21. *D. hispida* is the only member of § *Lasiophyton* in Malaysia; the rest are in Africa.

KEY TO THE SPECIES (♂ plants)

1. Stems as they dry discolouring, indicative of their herbaceous nature. Flowers pedicelled. Fertile stamens 3.
  2. Plants scarcely coarse. Leaflets produced at the horizon of flowering rarely exceeding 10 cm in length.
    3. Pubescence soft but not silky, rusty-red and abundant. Leaf blade herbaceous. Middle leaflet 3–5 times as long as broad . . . . . 16. *D. pentaphylla*
    3. Pubescence silky and very abundant everywhere . . . . . 15. *D. pierrei*
    3. Pubescence short on the inflorescences and scant on the leaves. Middle leaflet 2–2½ times as long as broad.
      4. Flowers 2 mm in diam. Leaf blade coriaceous. Pubescence rusty-red. . . . . 20. *D. scortechinii*
      4. Flowers 1 mm diam. Leaf blade subcoriaceous. Pubescence white on the perianth, but rusty-red on the bracts. . . . . 14. *D. tamarisciflora*
  2. Plants coarse. Leaflets up to 18 cm long.
    5. Leaf blade coriaceous . . . . . 17. *D. elmeri*
    5. Leaf blade herbaceous.
      6. Leaf blade and smaller axes firmer than in the next and spikes less densely set together. . . . . 18. *D. cumingii*
      6. Leaf blade and smaller axes less firm and the latter more densely set . . . . . 19. *D. blumei*
1. Stems as they dry preserving a bright straw colour, firm. Flowers sessile. Fertile stamens 6.
  21. *D. hispida*

KEY TO THE SPECIES (♀ plants)

1. Stems as they dry discolouring, indicative of their herbaceous nature.
  2. Plants scarcely coarse. Capsules 2–2½ cm long, completely reflexed at maturity.
    3. Apex of capsule obtuse.
      4. Pubescence short, not very abundant . . . . . 14. *D. tamarisciflora*
      4. Pubescence long and silky, abundant . . . . . 15. *D. pierrei*
    3. Apex of capsule rounded. Plant hirsutely pubescent . . . . . 16. *D. pentaphylla*
  2. Plants coarse. Capsules not less than 2½ cm long, and up to 4½ cm, usually more or less horizontal.
    5. Leaves coriaceous. Capsules rounded above . . . . . 17. *D. elmeri*
    5. Leaves coriaceous or nearly so. Capsules truncate above . . . . . 20. *D. scortechinii*
    5. Leaves herbaceous. Capsules truncate above. (diagnostic characters fail in regard to ♀ plants of the following species) . . . . . 18. *D. cumingii*
    19. *D. blumei*
1. Stems as they dry preserving a bright straw colour, firm. Capsules large and woody 21. *D. hispida*

14. *Dioscorea tamarisciflora* PRAIN & BURK. J. As. Beng. new ser. 10 (1914) 22; R. KNUTH, Pfl. R. 87 (1924) 144; RIDL. Fl. Mal. Pen. 4 (1924) 314; PRAIN & BURK. Gard. Bull. Str. Settlement. 4 (1927) 86 with a plate; Ann. R. Bot. Gard. Calc. 14 (1936) 153, pl. 60.—*D. pentaphylla* var. RIDL. Mat. Fl. Mal. Pen. 2 (1907) 81.—Fig. 5h.

Tubers one or two or three, descending from a corm at the surface of the soil, cylindrical, to 30 cm long with a hard black cortex studded with short indurated root-bases. Stem to 6 mm in diam. at the base and with a few prickles, with red or dirty white thin pubescence. *Leaves* ternate; petiole equal in length to the middle leaflet; middle leaflet narrowly elliptic, long acuminate, penninerved, to 6 by 2½ cm; base acute; lateral leaflets slightly inequilateral, with one primary nerve in addition to the midrib on each side of it; upper surface of the leaflets with a few hairs, the nerves scarcely

raised, lower with red-brown hairs; petiolules 2–3 mm. Simple leaves may be produced distally and are of small size. *Male flowering axes* usually gathered together on leafless branches which attain 20 cm; axis to 4½ cm, with upwards of 45 flowers closely set except that there are a few bare mm at the base. Pedicel ½–1 mm. Bracts ovate, acuminate, hirsute with white and deep red hairs. Torus not flattened. Outer tepals broadly ovate, very obtuse, less than 1 mm long, pubescent outside. Inner tepals spatulate and thick, glabrous. Stamens ½ mm long, filaments as long as the anthers; staminodes overtopping the anthers. *Female inflorescences* as those of *D. pentaphylla* (see p. 315). Capsules differing in the apex being obtuse; wings 22 by 7 mm (see fig. 5h).

Distr. From Peninsular Siam to *Malaysia*: Malay Peninsula (as far as Johore), rare and local.

15. *Dioscorea pierrei* PRAIN & BURK. J. As. Soc. Beng. new ser. 10 (1914) 22; R. KNUTH, Pfl. R. 87 (1924) 144; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1936) 154, pl. 69.

Tuber stalked and clavate, as much as 130 cm long by 8 cm in diam.; flesh edible. Stem with scattered prickles, abundantly softly pubescent. *Leaves* 3–5-foliolate; petiole shorter than the middle leaflet by  $\frac{1}{4}$ , with red-brown hair; middle leaflet elliptic to ovate, moderately acuminate; base acute, penninerved, to 15 cm long; outer leaflets inequilaterally ovate and smaller than the middle leaflet by  $\frac{1}{4}$ ; upper surface of the leaflets with scattered red-brown rather stiff hairs, lower densely pubescent; petiolules to 5 mm long. *Male flowering axes* on leafless branches which attain 30 cm; axes 1–2 together to 30 mm long, their flowers set touching. Bracts ovate, rather acute, densely pubescent on the back; pedicels  $\frac{1}{2}$  mm. Outer tepals exactly ovate above a broad base, 1 mm long, pubescent outside. Inner tepals narrowly obovate, glabrous, shorter than the outer ones and thick. Stamens as in *D. tamarisciflora*, staminodes overtopping them. *Female flowering axes* decurved, 1–2 together, densely pubescent. Bracts lanceolate to 1 mm long. Outer tepals linear-lanceolate, acute, rather less than 1 mm long pubescent outside, inner ones a little shorter. Pedicels less than 1 mm long, reflexed after pollination. *Capsules* just imbricating, retaining their pubescence to ripeness by which time it is bleached white, truncate at the apex, rounded at the base, wings 22 by 7 mm.

Distr. Annam, Cambodia and thence down Peninsular Siam beyond the Isthmus of Kra to the border of *Malaysia*, at Pang-nga in the Circle of Puket.

16. *Dioscorea pentaphylla* LINNÉ, Sp. Pl. (1753) 1032; ROXB. Fl. Ind. 3 (1832) 806; BLANCO, Fl. Filip. (1837) 802; HASSK. Hort. Bog. (1844) 33; MOR. Syst. Verz. (1846) 92; ZOLL. Syst. Verz. (1854) 68; MIQ. Fl. Ind. Bat. 3 (1859) 574; WARBURG, Bot. Jahrb. 13 (1891) 273; HOOK. f. Fl. Brit. Ind. 6 (1892) 289; QUEVA, Mém. Soc. Sci. Lille IV, 20 (1894) 197, 373; MERR. Rev. Sp. Blanc. (1905) 86; RIDL. Mat. Fl. Mal. Pen. 2 (1907) 80; KOORD. Exk. Fl. Java 1 (1911) 308, Atlas (1923) 259; KOORD.-SCHUM. Syst. Verz. 9 (1912), *genus* 1252; MERR. Fl. Manila (1912) 152; PRAIN & BURK. J. As. Soc. Beng. new ser. 10 (1914) 23; MERR. Interpr. Rumph. Herb. Amb. (1917) 147; BURK. Gard. Bull. S. S. 2 (1918) 92 with a plate; W. H. BROWN, Bull. 22 Philip. Bur. For. 2 (1921) 258; MERR. En. Philip. Fl. Pl. 1 (1922) 218; HEYNE, Nutt. Pl. Ned. Ind. (1922) 501; R. KNUTH, Pfl. R. 87 (1924) 145 *excl. var. lunata* ROTH; BACKER, Handb. Fl. Jav. 3 (1924) 111 in chief part; RIDL. Fl. Mal. Pen. 4 (1924) 314; OCHSE. Veget. D.E.I. (1931) 255; BURK. Dict. (1935) 822; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1936) 160, pl. 66 & 67 & (1938) 422.—*D. triphylla* LINNÉ, Sp. Pl. (1753) 1032; BL. En. Pl. Jav. 1 (1827) 20; MIQ. *op. cit.* 573 in part.—*D. kleiniiana* KUNTH, En. 5 (1850) 394; MIQ. *op. cit.* 573.—*Hamatrix triphylla* R. A. SALISBURY, Gen. Pl. Fragm. (1866) 12.—Fig. 5g, 6c.

Tuber in some varieties elongated and burying deeply, in others not so and then globose or pyriform, in some cultigens palmately lobed, never stalked, generally coated if short by bristly roots, or if long with such roots on the upper part; flesh white or lemon yellow, sometimes with purple flecks in it, nauseous in the wild plants, though not particularly so if deep burying. *Stem* single, to 7 mm in diam. at the base, climbing to 10 m, and usually abundantly prickly over the lowest internodes, pubescent, but then glabrescent. Bulbils plentiful, globose or shortly ellipsoid, rarely cylindrical, skin brown, flesh yellow. *Leaves* 3–5-foliolate; petiole shorter than the middle leaflet by about  $\frac{1}{4}$ , pubescence deep rusty red or dirty white; middle leaflet broadly oblanceolate or obovate, apex shortly acuminate, not glandular, base obtuse or rounded, to 15 by  $4\frac{1}{2}$  cm; outer leaflets inequilateral with one additional primary nerve outside the midrib; leaflets relatively broader when 3 than when 5, pubescent on both surfaces, but soon glabrescent above. Petiolules at most 5 mm. *Male flowering axes* for the most part gathered on leafless branches of considerable size, only rarely axillary; axis to 3 cm long, carrying upwards of 50 flowers placed close together or in contact. Buds appearing to be globose because the bract and bracteole so wrap them as to hide their flat base. Pedicels  $\frac{1}{2}$ –1 mm; bract and bracteole near the apex. Bracts usually broader than long. Outer tepals broadly lanceolate, subsacute, pubescent or glabrous at the back, to  $1(-1\frac{1}{2})$  mm long; inner ones rather broader and blunter, glabrous. Stamens inserted at the base of the tepals, the 3 fertile stamens shorter than the staminodes; anthers twice as long as the filament. *Female flowering axes* directed downwards, 1–3 together from a leaf-axil, up to 25 cm long, pubescent, the hairs variable in the intensity of their redness. Tepals as in the male plant. Flower inverted after pollination. *Capsule* blackening somewhat as it ripens, with rounded shoulders about the apex though just retuse at the flower, base usually rounded; wings to 20 by 6 mm, retaining some pubescence until of full size.

Distr. From Upper India through *Malaysia* to the remoter islands of the Pacific (probably carried by man); in Thursday Island but not in Australia. North along the Himalaya (to 1900 m), and across S. China through Yunnan and Kwang-tung to c. 22° N.

Ecol. The climatic requirements of *D. pentaphylla* are almost those of *D. bulbifera*. It is, moreover, like *D. bulbifera* in the quantity of the bulbils that it produces and the freedom with which it seeds; but it has not furnished man as *D. bulbifera* has, with cultigens altered in bulbils, but it has yielded cultigens with the shape of the tuber altered. *Fl. N.* of the equator Sept.–Oct., S. of the equator April–May.

Taxon. Within its wide range it has a number of varieties, some of them cultigens. The tubers of certain of them are figured in the 'Gardens Bulletin Straits Settlements' and the 'Philippine Agriculturist and Forester'; references to these figures are entered into the following key, cited resp. as *G.B.* and *P.A.*

## KEY TO THE VARIETIES

1. Tubers elongated to more, generally to much more, than twice their diameter (*G.B.* 2, 92); *P.A.* 3, 207). Red pubescence rather abundant, the leaflets rather narrow. . . *var. malaica*
1. Tubers not elongated to more than twice their diameter and frequently considerably lobed.
2. Tubers not flattened, rooty all over their surface.
3. Large vigorous plant, leaflets to 20 cm long, red pubescent. Flowers large. Distal leaves not uncommonly simple (*G.B.* 3, 258).  
*var. papuana*
3. Smaller plant. Leaflets commonly to 10 cm long. Flowers smaller (*G.B.* 3, 258).  
*var. javanica*
2. Tubers flattened (by fasciation), smooth-skinned. Leaflets rather narrow, rather silvery pubescent.
4. Leaflets to 20 cm long. Flowers relatively large. Tubers (*G.B.* 3, 258; *P.A.* 3, 207) generally larger than in the following.  
*var. palmata*
4. Leaflets to 14 cm long. Flowers smaller than in the above. Tuber (*G.B.* 3, 258) smaller.  
*var. sacerdotalis*

Econ. It has been said that the jungle tribes of the Malay Peninsula seek it more than any other *Dioscorea* (SKEAT & BLAGDEN, Pagan Races 1, 1906, 109); but this seems doubtful as the supplies are small. The high forest shuts it out, and perpetual humidity is unfavourable. To lesser humidity is apparently due a greater abundance N of Penang and in the country behind Malacca. In both parts it is planted in garden fences whence tubers may be dug if required. The variety used is *var. malaica* PRAIN & BURK. (*J. As. Soc. Beng.* new ser. 1, 1914, 23): rather long tubers, the middle leaflet is c. 4 times as long as broad. The Sakai call it *jabet* or *chabet*. Plants of N. Borneo may equally be referred to *var. malaica*.

In a similar way *D. pentaphylla* is planted in garden hedges in other parts of Malaysia, in several varieties. OCHSE (*l.c.*) has given an account of those in Java, describing the tubers of the most usual form as small, cylindrical and unbranched, calling it *huwi sawut* (fibrous yam). With it are more ennobled plants as *huwi jahe* (ginger yam, so named from the shape), which is *var. javanica* BURK. (*Gard. Bull. Str. Settl.* 3, 1924, 258).

*Huwi sawut* can bear no botanical name at present because the Sundanese and the Javanese do not apply the vernacular name strictly. It occurs in bamboo thickets, on forest margins and in similar places, as well as in garden hedges; in the hedges it has encouragement without cultivation and now and then is dug for food, eaten roast or boiled by itself or in mixed vegetables as a flavouring.

Superior to *huwi jahe* and considerably superior to the average *huwi sawut* is *var. sacerdotalis* BURK. (*l.c.*). It has high sounding names as *huwi mantri* (priest's yam), *huwi putri* (princess' yam) and *huwi dewatu* (sacred yam); it has been suggested that they came to denote it because it was a food allowed on Hindu fast days. The foliage of these

Javanese economic varieties is smaller than that of *var. malaica* and the male flowers are small in a degree which makes recognition easy, not of the exact variety for that depends on the tuber, but that one of the group is under the eye.

*Var. sacerdotalis* is recorded from the Res. of Madiun, Pasuruan and Besuki in E. Java and the Kangean Isl. between 1 and c. 1000 m. Its leaflets are broader, in proportion to their length, than those of the wider spread *var. javanica* BURK. (*l.c.*) and not uncommonly there are simple leaves towards the stem-ends. The type was cultivated by K. HEYNE at Bogor, but he did not record whence he obtained it.

*Var. javanica* occurs in Celebes as well as in Java, and would seem to occur through the Lesser Sunda Islands. RUMPHIUS's account of *D. pentaphylla* is interesting (*Herb. Amb.* 5, 359): he wrote in particular of its uses in Sumbawa, where three kinds occurred. The first he called the white kind; it produced large white-fleshed tubers of which the extremities could be eaten although of vile flavour; the second he called the red kind and it had hard red flesh; it produced smaller tubers and they were better to eat; the third, called the black kind, turned black in cooking and blackened the water in which it was boiled. These cannot as yet be assigned to varietal names.

The Ambonese, RUMPHIUS recorded, would transplant tubers from the forest to their gardens but not much and they would eat the produce of their gardens but not the plant direct from the forest unless driven by famine. The two tubers figured by him (pl. 177), the one lobed, the other clavate, represent respectively the cultivated and the wild plant.

The above references do not dispose entirely of the forms of the species in SE. Malaysia, for FORSTEN collected in Bima (Sumbawa Island) a very graceful plant which has not been seen from elsewhere.

In the Philippines there are at least two varieties: one may be referred to *var. malaica* BURK., the other has been named *var. palmata* BURK. (*l.c.*); it is a cultigen close to *var. sacerdotalis*, but larger in tuber. A plant appearing to be *var. palmata* has been collected in Timor.

In New Guinea there is a very robust *var. papuana* BURK. (*l.c.*) with a remarkably prickly stem up to 12 mm in diam. and so large as to have paired scale-leaves at the base. Can it be *D. globifera* R. KNUTH which otherwise remains unplaced?

Vern. A few names which suggest transference within Malaysia from one place to another doubtless originates with the adoption of a cultivated race. A name recorded by RUMPHIUS for Ternate is *ubi pariaman* suggesting transference from Priaman in NW. Sumatra. Another place-name *ubi magindano* meaning yam of Menado, is in use in N. Celebes. Various descriptive names under *ubi* and *huwi* have been mentioned under Economy. It is very interesting to record that the name *jabet* used by the Central Sakai of the Malay Peninsula has been obtained by BACKER in central Java and in this connection to point out the similarity of *jabet*

to *rabet* used in Madura. Immediately E of Java the name changes, and is *samoan*, *samowan*, *samwan* and *susuan*. Again to the E, in the Moluccas, it is *iwel*, *aywel*, *iae* or *ahet*; and it is *lae*, *lahi* or *lua*, and besides there are not fewer than ten other names, the currency of which are not well enough vouched for as yet.

17. *Dioscorea elmeri* PRAIN & BURK. in ELMER, Leaf. Philip. Bot. 5 (1913) 1594; J. As. Beng. new ser. 10 (1914) 24; MERR. En. Philip. Fl. Pl. 1 (1922) 216; R. KNUTH, Pfl. R. 87 (1924) 147; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1936) 180, pl. 70.—Fig. 51.

Underground parts unknown. Stem thicker than that of *D. pentaphylla* and of greater growth. Leaves harsh, 3–5-foliolate; petiole shorter than the middle leaflet by about 1/4; middle leaflet ovate or elliptic-ovate, very shortly acuminate, to 13 by 7 cm, base obtuse; outer leaflets very inequilateral, with one primary nerve outside the midrib; upper surface glabrous at maturity, lower with abundant rusty red hairs on the larger nerves. Male plant uncertain. Female flowering axes solitary or 2 together from the axils of upper leaves, decurved, to 20 cm long and then bearing c. 40 capsules, densely red-brown pubescent. Bracts broadly ovate, to 2 mm. Pedicel after pollination turning the fruit upwards. Outer tepals lanceolate-ovate, acute, densely covered outside by red-brown hair, inner ones similar, but less pubescent. Capsules chestnut-coloured, rounded at both ends, but variable in the evenness of rounding at the base, appearing to be a little uncertain in the way of dehiscence; wings 25 by 10 mm.

Distr. *Malaysia*: Philippines (Luzon, S of Manila).

Ecol. Everwet forests to 800 m.

18. *Dioscorea cumingii* PRAIN & BURK. J. As. Soc. Beng. new ser. 4 (1908) 449; *ibid.* 10 (1914) 25; MERR. En. Philip. Fl. Pl. 1 (1922) 216; R. KNUTH, Pfl. R. 87 (1924) 148; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1936) 182, pl. 73.—*D. inaequifolia* ELMER *ex* PRAIN & BURK. in ELMER, Leaf. Philip. Bot. 5 (1913) 1595; J. As. Soc. Beng. new ser. 10 (1914) 24; R. KNUTH, *op. cit.* 146; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1936) 181, pl. 71.—*D. polyphylla* R. KNUTH, Pfl. R. 87 (1924) 148; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1936) 184, pl. 74.—*D. echinata* R. KNUTH, Pfl. R. 87 (1924) 148.—Fig. 53.

Underground parts unknown. Stem to 10 mm in diam. at the base and decidedly prickly. Leaves 5–9(–10)-foliolate; petiole ± as long as middle leaflet; middle leaflet lanceolate to ovate-elliptic or elliptic, acuminate in varying degree, acute at the base, to 18 cm long; outer leaflet inequilateral, the less so the more numerous the leaflets, even to being almost equilateral, acuminate in varying degree; leaflets herbaceous, glabrescent above, pubescent below though tending to lose the hairs which are of a red colour passing to a dirty white; petiolules to 10 mm. Male flowering axes collected into large leafless branches to 70 cm long, usually

2 together, sometimes more, one considerably larger than the others; flowering axes to 3 cm, generally with red-brown hairs, flowers their own diameter apart; pedicels 1/2 mm; bracts 1 mm long wrapping over the buds incompletely. Outer tepals ovate, acute, glabrescent, 1 mm long, inner ones smaller. Spathulate, obtuse and curved inwards slightly. Stamens inserted at the base of the tepals, filaments as long as the anthers, the 3 staminodes overtopping the anthers. Female flowering axes solitary or paired, downwardly directed from the axils of upper leaves; axis angled, pubescent, with upwards of 30 flowers. Bracts lanceolate-ovate, acuminate, 2–3 mm long. Pedicels turning the ovaries so as to be horizontal or slightly ascending. Capsule darkening somewhat as it ripens, truncate above or very obtuse, truncate or even retuse at the base, sides rather straight, wings to 36 by 12 mm.

Distr. *Malaysia*: throughout the Philippines.

Taxon. Variable and divisible into the following varieties:

#### KEY TO THE VARIETIES

1. Capsule to 30 mm long.
2. Leaflets to 7, more or less ovate.
3. Pubescence moderately abundant, rusty red.
  - var. *inaequifolia*
  3. Pubescence dense, of matted white or whitish hairs . . . . . var. *cumingii*
  2. Leaflets to 9 (–11), linear-lanceolate or lanceolate . . . . . var. *polyphylla*
  1. Capsule to 40 mm long . . . . . var. *ramosii*

The first and the third of these are respectively *D. inaequifolia* ELMER and *D. polyphylla* R. KNUTH, here reduced to varieties, the last, var. *ramosii* BURK. has not been described hitherto unless it is synonymous with *D. heptaphylla* SASAKI (Trans. Nat. Hist. Soc. Formosa 21, 1931, 47; for a comment on SASAKI's description see Ann. R. Bot. Gard. Calc. 14, 1938, 423), which was obtained in the island of Botel Tobago, or Koto sho, which is 80 km E of the southern point of Formosa. Var. *ramosii* has been obtained in both sexes on the slopes of Mt Iraya in the island of Batan (RAMOS 79927, 79946) and on Camiguin Volcano in the island of this name (EDAÑO 79173). These islands are between Luzon and Formosa.

Var. *polyphylla* (R. KNUTH) BURK., which by reason of its many leaflets appears more distinct from the other components of *D. cumingii* than it really is, occurs from the N. parts of Luzon to the latitude of Manila, whence southwards var. *inaequifolia* (ELM.) BURK. replaces it. Near the boundary between these two the type of var. *cumingii* was obtained, at an unspecified locality in the Province of Batangas (CUMING 1469).

Ecol. The usual habitat of *D. cumingii* is about the skirts of mountains where the rainfall is considerable.

Econ. ELMER recorded that parts of the tuber, obviously the lower parts, are eaten as food in the Province of Benguet, Luzon. He gave to it the Igorot name *kasi*. *Pari* is said to be its name in the Bagobo language of Mindanao. Townsfolk who do not need to eat tubers of *D. pentaphylla* and its

immediate allies do not distinguish it from *D. pentaphylla* and call both by the factitious name *limalima* (the fives) from the usual five leaflets.

19. *Dioscorea blumei* PRAIN & BURK. J. As. Soc. Beng. new ser. 10 (1914) 25; R. KNUTH, Pfl. R. 87 (1924) 149; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1936) 185, pl. 75.—*D. pentaphylla* (non L.) BLUME, En. Pl. Jav. (1827) 20; BACKER, Handb. Fl. Jav. 3 (1924) 111 in small part.—Fig. 6b.

Underground parts and lower parts of the stem unknown; distal parts glabrous (doubtless glabrescent), sparingly prickly, faintly ridged. Bulbils none seen. Leaflets 5, thinly herbaceous; petiole c. 7 cm, sparingly clad with rather stiff hairs; middle leaflet elliptic, obtuse or almost rounded at the base, abruptly acuminate, to 12 by 5 cm; outer leaflets only slightly inequilateral; upper surface of the blades glabrous; lower retaining to maturity a small amount of rusty red hair; nerves prominent; petiolules to 10 mm. Male inflorescences up to 50 cm long, the primary axis branched and the branching twice or thrice repeated, shortly pubescent, ultimately glabrescent. Bracts carried almost at the top of the pedicel which is 1 mm long, broadly triangularly ovate, ± acuminate, rusty red haired. Flower-bearing axes to 2 cm long so densely placed that they touch one another. Outer tepals ovate, obtuse, bordered and beset down the middle line by red-brown hairs 1½ mm long, inner ones elliptic, shorter than the outer ones, obtuse. Stamens overtopped by the staminodes. Female plant unknown.

Distr. *Malaysia*: W. Java (Mt Salak, S of Bogor); collected by REINWARDT, and not collected since. Also in N. Sumatra?

Notes. LINNÉ had made two spp.: *D. pentaphylla* and *D. triphylla* on closely similar material, and BLUME identified the more vigorous part of his material with the first, and the less vigorous plants with the latter.

A ♂ plant similar to REINWARDT's has been obtained in N. Sumatra (at Sibolangit, LÖRZING 4816, 4817), well-collected except the tuber; base of stem 12 mm diam., paired scale-leaves at the base, leaves 3–7-foliolate, middle leaflet 28 by 10 cm. It is likely that the base of REINWARDT's specimen was as large. If it be, as is probable, that the Javan and Sumatran specimens belong to the same species, there is a reasonable possibility that in both places a polyploid condition has been thrown by local *D. pentaphylla*. If so, is *D. cumingii* an established polyploid?

HAINES (Fl. Bihar & Orissa 1925, 1123) has suggested that the Indian *D. kalkapershadii* PRAIN & BURK., a larger plant than *D. pentaphylla*, is a polyploid. It is desirable that the chromosome numbers should be taken of any giant specimens resembling *D. pentaphylla*.

20. *Dioscorea scortechinii* PRAIN & BURK. J. As. Soc. Beng. new ser. 4 (1908) 455; *ibid.* 10 (1914) 25; R. KNUTH, Pfl. R. 87 (1924) 149 in part; RIDL. Fl. Mal. Pen. 4 (1924) 314 in part; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1936) 186, pl. 76, *ibid.*

(1938) 424.—*D. pentaphylla* (non L.) RIDL. & CURTIS, J. Str. Br. R. As. Soc. 38 (1902) 66 in part.—Fig. 5o.

Tuber pyriform to clavate; flesh firm. Stem abundantly prickly at the base, to 6 mm in diameter, from pubescent to glabrescent. Leaves 3–5-foliolate, herbaceous; petiole about as long as the middle leaflet, glabrous; middle leaflet elliptic, acuminate, acute at the base, to 8 by 4 cm, outer leaflets inequilateral with one primary nerve outside the midrib; blades below with short red-brown hair, nerves prominent; petiolules to 5 mm. Male flowering axes aggregated into long leafless inflorescences, 1–4 together; flowers to 25 on the flower-bearing axes 5 cm long, touching each other, pubescent with red-brown hair. Bracts narrowly ovate, acuminate, covering but not enwrapping the flower, densely pubescent, 1½ mm long. Pedicels carrying the bract close under the flower. Outer tepals ovate, acute, 1 mm long; filament as long as the anther; staminodes subspathulate, overtopping the stamens. Female flowering axes solitary from the axils of upper leaves, with c. 35 flowers buried in red-brown hair but later glabrescent. Bracts lanceolate, acute, densely pubescent, 1½ mm long. Fertilized ovary in a horizontal position. Outer tepals broadly ovate, acute, 1½ mm long, densely pubescent outside, inner ones similar except thinner margins. Capsules blacken as they ripen, slightly retuse at either end, margins parallel; stipe 2 mm; wings 40–50 by 11–12 mm.

Distr. Tonkin (a variety), *Malaysia*: Simalur Island, N. Sumatra, Malay Peninsula (from Perak southwards).

21. *Dioscorea hispida* DENNSTEDT, Schlüss. Hort. Malab. (1818) 15; MERR. Interpret. Rumph. Herb. Amb. (1917) 148; Sp. Blanc. (1918) 103; En. Philip. Fl. Pl. 1 (1922) 217; HEYNE, Nutt. Pl. N.J. (1922) 498; BACKER, Handb. Fl. Jav. 3 (1924) 110; PRAIN & BURK. Kew Bull. (1927) 237; OCHSE, Veget. D.E.I. (1931) 250; BURK. Dict. (1935) 818; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1936) 188, pl. 77 & 78.—*D. triphylla* (non LINNÉ, Sp. Pl.) LINNÉ, in STICKMANN, Herb. Amb. (1754) 23; AMOEN. Ac. 4 (1754) 131; JACQ. Ic. Pl. Rar. 3 (1790) 627; GMEL. in LINNÉ, Syst. Nat. ed. 13, 1 (1791) 481; BLANCO, Fl. Filip. (1837) 799; PRAIN & BURK. in ELMER, Leaf. Philip. Bot. 5 (1913) 1595; J. As. Soc. Beng. new ser. 10 (1914) 25; WESTER, Philip. Agr. Rev. 9 (1915) 173; RIDL. Fl. Mal. Pen. 4 (1924) 314; R. KNUTH, Pfl. R. 87. (1924) 131; ORR, Not. R. Bot. Gard. Edinb. 15 (1926) 136.—*D. hirsuta* DENNST. *op. cit.* 33; BLUME, En. Pl. Java 1 (1827) 21; MOR. Syst. Verz. (1846) 92; MIQ. Fl. Ind. Bat. 3 (1859) 575; WARB. Bot. Jahrb. 13 (1891) 273; GRESHOFF, Med. s-Lands Plantentuin 10 (1893) 151; KOORD. *ibid.* 19 (1898) 312; GRESHOFF, Med. Dep. Landb. 3 Suppl. (1913) 28.—*D. mollissima* BLUME, En. Pl. Java 1 (1827) 21; MIQ. *op. cit.* 574.—*D. daemong* ROXB. Fl. Ind. 3 (1832) 805; HOOK. f. Fl. Br. Ind. 6 (1892) 289; RIDL. & CURT. J. Str. Br. R. As. Soc. 38 (1902) 66; RIDL. Mat. Fl. Mal. Pen. 2 (1907) 80; WATT, Comm. Prod. Ind. (1908) 494; KOORD. Exk. Fl.

Java 1 (1911) 308.—*Helmia hirsuta* KUNTH, En. Pl. 5 (1850) 438; QUEVA, Mém. Soc. Sc. Lille IV, 20 (1894) 193, 381.—Fig. 5k-n, 6e.

Tuber in a general way globose, but lobed, occasionally slightly elongated, up to 35 kg or even more, straw-coloured to light grey outside, produced at the surface of the soil and intensely poisonous, flesh white to lemon yellow. Stem to 9 mm in diam. or more, usually prickly, green to straw-coloured, at first pubescent, then glabrescent. Bulbils never seen. *Leaves* 3-foliolate; petiole as a rule rather longer than the middle leaflet, to 25 cm long, frequently with small prickles on the larger nerves at the back; middle leaflet elliptic or elliptic-oblong, rarely obovate, still more rarely tri-partite, acuminate, acute at the base, to 30 by 28 cm; lateral leaflets inequilateral, the outer half 3-nerved; blade herbaceous in the Indian *var. daemona* (ROXB.) PRAIN & BURK. (1934), more or less chartaceous in the varieties of Malaysia particularly in *var. reticulata* (HOOK. f.) PRAIN & BURK. (1927) upper surface thinly silky when young, then glabrous, with all the nerves conspicuous; lower surface retaining its hairs to some extent; petiolules to 10 mm. *Male flowering axes* gathered into large leafless inflorescences twice or thrice compounded, sometimes 50 cm long; axes bearing the flowers usually solitary, with upwards of 40 flowers which are closely packed in *var. daemona*, but spaced in the other varieties, clothed in tawny or white hairs [*var. mollissima* (PRAIN & BURK.) PRAIN & BURK. (1927)]. Bracts just overtopping the flowers, subsaccate and acuminate, pubescent at the back. Outer tepals orbicular, very thin at the margin, pubescent on the back at the middle,  $\frac{3}{4}$  mm diam., inner ones a little longer and firmer, incurved. Stamens all fertile,  $\frac{1}{2}$  mm long, anther as long as the filament. *Female flowering axes* solitary from upper leaf axils, downwardly directed, when capsules are mature pendulous by their weight. Flowers spaced. Bracts triangularly lanceolate, pubescent, 2-2½ mm long. Fertilized ovaries and capsules facing more or less upwards. Outer tepals ovate-lanceolate, pubescent, inner ones a trifle smaller. Capsules becoming glabrous, honey-coloured, imbricating, apex obtuse in various degrees, base variable and at times one wing may be more truncate than another (fig. 6e); sometimes the wings are retuse at the base about the stipe; wings broadest above the middle, to 40-50 (-60) by 10-12 mm, their margin sometimes freed in dehiscence and looking like a fine wire. Seeds winged to the base of the cell.

Distr. W. India through *Malaysia* to W. New Guinea, also in New Ireland. As it is cultivated to some extent, the occurrence in New Ireland and N. Guinea may be due to man.

#### KEY TO THE VARIETIES

1. Male flowering spikes dense, flowering terminal part not more than twice as long as thick; foliage more herbaceous than chartaceous.  
*var. daemona*
1. Male flowering spikes considerably longer and the flowers barely touching each other.

2. Vigorous plants with capsules truncate or even retuse at the apex.

3. Hairs honey-coloured . . . *var. hispida*

3. Hairs white denser as a rule *var. mollissima*

2. Less vigorous plants with much smaller almost acute capsules . . . *var. scaphoides*

*Var. hispida* is universal in Malaysia. *Var. mollissima* is reported to occur in various localities from Burma to Java, and always in country where *var. reticulata* occurs. *Var. scaphoides* PRAIN & BURK. (1927) occurs in Siam and southwards down Peninsular Siam to the Circle of Puket. *Var. daemona* has been reported from various localities within Malaysia but all these need verification, because the determination has depended on imperfect herbarium material. The undisputed distribution of *var. daemona* is from the Bombay coast to the western edge of Burma. LINNÉ confused *D. hispida* with *D. pentaphylla* under the name *D. triphylla*; and when JACQUIN figured it calling it *D. triphylla* his very excellent figure went far towards fixing that name. But DENNSTEDT put forward two names for it in 1818 and one of them *D. hirsuta*—it stood second in order of pages—BLUME took for it and led a school which employed it. ROXBURGH had already issued *D. daemona*. Botanists in India became divided, some following BLUME and some ROXBURGH. MERRILL in 1917 showed that by rule DENNSTEDT's first name, *D. hispida*, is the correct one. Writers on African plants confused the African *D. dumetorum* PAX; and the circumstance has this of interest in it that, whereas *D. hispida* is the chief famine food of tropical Asia, *D. dumetorum* takes the same position in a large part of tropical Africa (see CORKILL, Ann. Trop. Med. 42, 1948, 278).

Econ. *D. hispida* owes its importance in famine to the comparative ease with which its surface-growing tubers can be gathered, and to their size which goes far towards relieving a situation of distress. After harvesting follow days of preparation during which the poisonous alkaloid, *dioscorine*, must be washed out of the tissues by water. The process entails a killing of the tissues in which slicing, pounding, rasping and boiling may be used in various ways; then must follow days of soaking in water, sea water or water with salt in it being best. The final product is a starchy meal which can be made into palatable preparations and moreover will keep if dried and kept dry. The alkaloid is present in the foliage as well as in the tuber. A piece of the raw tuber of the size of an apple kills a man. A proverb of the Island of Roti runs—'he who eats *botti* (the local name for the tuber) must die'. Pounded tubers are used in India for poisoning bait for tigers. All mammals are susceptible and beyond all doubt the plant is very well protected in the forests. In many countries it is customary to prepare the meal, though in most of them to use it only when there is scarcity; but Hindu priestly law permitted the eating on fast days (*cf.* under *D. pentaphylla*). It would seem that *D. hispida* is planted in Java more than elsewhere; but it has not been demonstrated that a race less poisonous than

the wild plant is employed. Malays who made palm sugar from *Arenga* formerly encouraged it because they employed pounded tubers as a paste to keep sterile the wounds of their tapping. This accounts

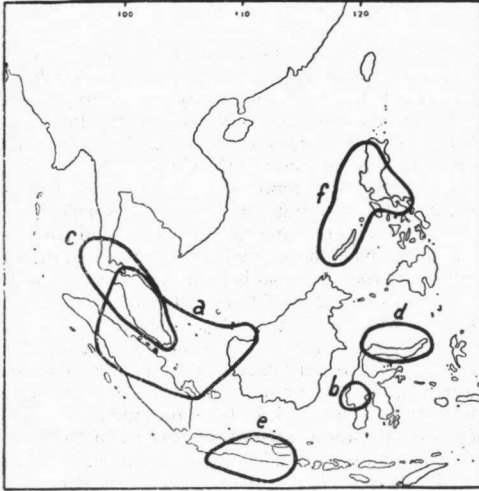


Fig. 9. Distribution of the species of § *Enantiophyllum* which have negative geotropism in the male flowering axes: a. *D. laurifolia* WALL. ex HOOK., *D. bancana* PR. & B., and *D. havilandii* PR. & B. taken together, b. *D. vanvuureonii* PR. & B., c. *D. prainiana* KNUTH, d. *D. warburgiana* ULINE ex KOORD., e. *D. vilis* KUNTH, f. *D. luzonensis* SCHAUER and *D. peperoides* PR. & B. taken together.

for an unusual abundance about villages near Malacca; and for a like abundance which exists no longer but was observed by RIDLEY in Singapore Island (see J. Str. Br. R. As. Soc. 33, 1900, 167).

Vern. There is a Mon-Khmer word *khoei* for yam, converted everywhere in Burma to *kywe* and restricted by the Burmese to *D. hispida* which appears on the tongues of the Northern Sakai and Ple-Temiar of the mountains between Perak, Kelantan and Pahang in the form *kuai*. It is not used by those who live in the lowlands whose noun for *D. hispida* is the unlike word *gadong*. *Gadong*—*gadung* in Java—is wide-spread; it is used in Sumatra, the Malay Peninsula, Borneo, and by the Bugis of Celebes, through Java and down the Lesser Sunda Islands at least to Sumbawa where it loses its terminal *ng* and becomes *gadu*. It is known to the Northern Sakai, along with *kuai*, and recorded from them as *gadog*. It invariably indicates *D. hispida*, but the Battaks of Sumatra extend it, with qualifications, to other *Dioscoreas*. It is a well defined name, as befits a plant of considerable importance. In the northern parts of the Philippines *D. hispida* is widely named by a noun commencing with *k*: *karut*, *karot*, *kadut* and *kayos*, passing to *orot*, *orkot* and *gayos*. Among the Tagalog of Luzon, curiously the Spanish word *nyami* has been taken into use for it in the form *nami*. One would doubt the origin were it not that another Spanish word, *sarsaparilla*, has been adopted in the Sambali language (see below under § *Enantiophyllum*). In Bali and on the opposite coasts of Celebes *D. hispida* is named *sikapa*, *siapa*, *sikapang* or *sikapu*. In Bali *yangga* and *diangga* are also used. In Roti and Timor, *boti* and *botil* are used, but cover also *D. bulbifera*. There is another name in Timor, *kasimun*.

About the Alfura Sea the following names are known: *butule*, *hayule*, *hayuru* or *hayuro*. *Ondo* or *ondot* occur in Ceram and Amboyna. *Lede* is reported from Bima in Sumbawa; *lei* from the Serwatti Islands (near Timor), and from the Kei Islands; and lastly *mamo* in the Bikol language of Mindanao and *bagai* in the Mangyane language of Central Mindoro.

### 7. Section *Enantiophyllum*

ULINE in E. & P. Nachtr. (1897) 87; PRAIN & BURK. J. As. Soc. Beng. new ser. 10 (1914) 8; R. KNUTH, Pfl. R. 87 (1924) 257; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1938) 211.—Fig. 4c–f, 5p–r, 6d–f, 9–14.

Tubers 1 or sometimes 2 or more, usually deeply descending into the soil, annually replaced, never poisonous though sometimes unpleasant to eat, chiefly from tannins and saponins. Stem twining to the right, usually armed, particularly at the base. Hairs usually absent, if present as stiletto hairs (fig. 6) or dendroid hairs. Extra-floral nectaries of the deep kind. *Leaves* entire, opposed or alternate; on thin axes alternate, on axes thicker at origin opposite; petiole not auriculate at the base. *Male flowers* in spikes axillary or more generally cauliflorous. Flower fleshy, particularly the torus (fig. 4e–g), the latter not enlarging into a cup, in some *spp.* of Celebes growing upwards; tepals incurved through anthesis so that the flower scarcely expands; outer tepals ovate,  $\frac{3}{4}$ –2 mm, inner ones narrower at the base and  $\pm$  shorter and blunter. Filaments as long as the introrse anthers. Bract repressed against the axis and curving round the bud, not so in ♀ fls; bracteole inserted within



one margin of it. *Female flowering axes* decurved, 1 to 3 together from a leaf axil; flowers and capsules facing forward; wings of the capsules as broad as or broader than long; stipe growing proportionately with the ripening capsule. Seeds winged all round with a smoky brown, membranous wing conform to the loculus, of 2–3 cm diam.

Distr. The *Enantiophylla* make a compact group of species often difficult to discriminate, spread through the tropics of the old World from the Atlantic to the Pacific.

Ecol. Most of them protect their tubers by deep burial in the soil. One species which does not bury deeply has much tannin in its tubers and a few others have thorny roots; but none of these are Malaysian. Some hold saponins. Man uses the tubers of almost every one for food when circumstances make the labour of digging them up worth while. He created *D. alata* as a cultigen taking advantage particularly of such variations as it produced towards shallow burying, perpetuating the variations in clones. In Malaysian *Enantiophylla* largeness of lamina and presence of hairs are associated characters; the species possessing hairs are placed at the end of the taxonomic sequence adopted here. None of the hairy species pass into Malaysia eastwards of Borneo and Java, and hairiness is absent except that *D. merrillii*, a local species of the Philippines, has a few hairs (fig. 13d).

The commonest species of the section in W. Malaysia is the hairy *D. pyrifolia*, in contrast the commonest species to the eastward, is the glabrous *D. nummularia*.

The distribution in Malaysia of species with narrow leaves is illustrated in fig. 11. The intensive negative geotropism of the male flowering axes (fig. 4c) has been used to bring the species that have it together at the commencement of the sequence. This character is not met with outside Malaysia except slightly in western Africa. *D. laurifolia* and several others have strongly benzoin-scented flowers. This species is used again (fig. 10) to illustrate the dissimilarity of seedling and mature leaves. Female plants possess fewer useful taxonomic characters than male plants. The capsules vary in size as shown in fig. 5 (lowest line, where p is the largest of Malaysia and r the least).

Vern. Every villager in Malaysia distinguishes by name *D. alata* from all the wild species of *Enantiophyllum* as definitely as he distinguishes *D. esculenta*, *D. hispida*, *D. bulbifera* and *D. pentaphylla*, but he does not distinguish consistently the wild *Enantiophylla* one from another, nor from the genus *Smilax*. Often for instance, those who speak Sundanese will give the name as *chanar* or *banar* (that is *Smilax*), adding a qualifying word. Curiously the resemblance to *Smilax*, which is genuine, has introduced into the Sambali language of Luzon the Spanish word *sarsaparilla*, by application to *D. nummularia*, in the form *sapsapariliya*. Malays classify the wild *Enantiophylla* as *akar* (climber) with a qualifying word such as *keminiyan* (benzoin)—e.g. *akar keminiyan* or climber with benzoin-scented flowers. Javanese substitute *aroi* for *akar*. *Kemhang*, recorded as a Semang name is a distortion of *keminiyan*. It is not unusual to cut the tough stems to serve as cordage, whence the Malay word *tali* (cord) may take the place of *akar*. It is recorded as used in the Malay Peninsula, Ambon, and eastern New Guinea. RUMPHIUS used it for *D. nummularia* as *tali cupang* which he translates penny cord, cord strung with coins or mussel shells (the leaves); RUMPHIUS's further names, *daun keping-keping* and *daun pitis-pitis*, may be translated coin-leaved. RUMPHIUS goes on to explain that there is an acrid juice in the stem which irritates the skin and gives rise to the name *daun bisol* (boil leaf). The tubers hold the same juice; but it does not prevent the wild pigs from eating them.

Names for the wild *Enantiophylla* in the Philippines are of more than one series; it is not obvious why this is so. The series are (i) *dulian*, *durian*, *duwiyen*, *duyan*; (ii) *kiroi*, *kiru*, *kwiroi*, *kwiru*, *kwireot*, *kirini*, and (iii) *ubag*, *kobag*. These are used in the several languages of eastern Luzon from the northern end down to Manila for *D. luzonensis*, *D. divaricata*, *D. nummularia*, etc. In Javanese the following names belong to the wild *Enantiophylla* of that island: *weru*, *werung*, *kerung*, *werungan*, *wirung*, *gadungan*. *Waru* used in Ambon seems to be of the group.

#### KEY TO THE SPECIES<sup>1</sup>

1. Male flowering spikes negatively geotropic (fig. 4c).
2. Male flowers carried on leafless branches. Blades of contemporaneous leaves not cordate at the base.
3. Blade very coriaceous.
  4. Blade ovate to broadly elliptic, rounded under the acumen . . . . . 22. *D. havilandii*
  4. Blade ovate and narrowed into the acumen . . . . . 23. *D. bancana*
3. Blade coriaceous, ovate and narrowed into the acumen, 10 by 5 cm . . . . . 24. *D. laurifolia*
3. Blade herbaceous, to 15 by 7 cm . . . . . 25. *D. prainiana*

(1) It is impossible to construct a key for the determination of female plants of the section *Enantiophyllum*; they do not exhibit adequate characters.

NAVES introduced the names of several species of the *Enantiophylla* into his *Novissima Appendix* (1880) which are most unlikely to occur in the Philippines, and as his material was destroyed in 1899 in the burning of the Guadeloupe convent at Manila, all that can be done towards elucidation is to enumerate them among the '*excludendae*'.

2. Male flowers in fascicles in leaf-axils. Blade in some *spp.* rounded at the base, in others auricled.
5. Blade coriaceous.
6. Blade to 17 by 10 cm. Male spikes to 20 cm long . . . . . 26. *D. warburgiana*
6. Blade to 4 by 2 cm. Male spikes to 5 cm long . . . . . 27. *D. vanvuureni*
5. Blade herbaceous.
7. Blade lanceolate or long-lanceolate . . . . . 28. *D. vilis*
7. Blade cordate.
8. Male flowers relatively small, the sepals 1 mm long. Auricles of leaves generally rounded.
29. *D. peperoides*
8. Male flowers twice as large. Auricles of leaves angled. . . . . 30. *D. luzonensis*
1. Male flowering spikes positively geotropic, carried in fascicles in leaf-axils or towards the ends of weakening stems in the axils of bracts that replace the leaves . . . . . 31. *D. tenuifolia*
1. Male flowering spikes but little influenced by geotropism.
9. Torus in the male flower growing upwards centrally, causing the petals and stamens to appear connate or adnate (fig. 4e).
10. Male flowering spikes in large axillary fascicles . . . . . 32. *D. sarasinii*
10. Male flowering spikes 1 or 2 together along compound flowering branches . . . . . 33. *D. sexrimata*
9. Torus in the male flower not growing upwards centrally.
11. Spikes distributed among the foliage leaves, arising direct in their axils.
12. Blade ovate. Fascicles of spikes small . . . . . 34. *D. oryzetorum*
12. Blade lanceolate or linear-lanceolate. Fascicles of 1-3 spikes.
13. Male flower bud warted at the base inwards in the axil (fig. 4g). Blade very thin.
35. *D. gracilipes*
13. Male flower bud not warted.
14. Blade very thin . . . . . 34. *D. oryzetorum var. angustifolia*
14. Blade harsh to coriaceous.
15. Buds of male flowers globose . . . . . 36. *D. elegans*
15. Buds of male flowers elongated . . . . . 37. *D. moultonii*
11. Spikes produced on leafless branches.
16. Leafless branches small; spikes of unequal sizes. Leaves very coriaceous. Stems very woody.
38. *D. lamprocaula*
16. Leafless branches shorter in general than the axillant leaves, the spikes not showing irregularity in length, but diminishing as the leaf diminishes with its distance from the base of the branch.
17. Blade at least 4 times as long as broad.
18. Leafbase just cordately auricled; lower side dull. Capsules relatively small . . . . . 39. *D. calcicola*
18. Leafbase rounded; lower side bright. Capsules relatively large . . . . . 40. *D. grata*
17. Blade broadly ovate, acumen long . . . . . 41. *D. opaca*
17. Blade cordate large, abruptly acuminate . . . . . 42. *D. wallichii*
16. Leafless branches well developed, as a rule much longer than the axillant leaves. Spikes maintaining a uniform length (but unknown in *D. madiunensis*).
19. Hairs absent.
20. Leafbase obtuse or rounded on mature plants (youth forms possess auricles).
21. Capsule of large size, wings reaching 27 by 30 mm . . . . . 43. *D. madiunensis*
21. Capsule smaller, wings to 22 by 25 mm.
22. Blade very thin, drying a deep purple-brown . . . . . 44. *D. sitamiana*
22. Blade thinly coriaceous, usually rounded at the base, not turning brown.
23. Blade exactly ovate . . . . . 45. *D. nieuwenhuisii*
23. Blade large and long, to 20 by 5 cm . . . . . 46. *D. kingii*
23. Blade small and elongated, to 10 by 2½ cm . . . . . 47. *D. salicifolia*
20. Leafbase auriculate.
24. Axis of male spike zigzag.
25. Stem cylindric. Auricles at the base of the lamina usually with the inner margin bayed about the petiole . . . . . 48. *D. filiformis*
25. Stem quadrangular with a wing on each angle. Auricles not bayed towards the petiole.
49. *D. alata*
24. Axis of male spikes not zigzag. Stem if not cylindrical, yet almost so.
26. Leafbase with rounded auricles.
27. Leaf and capsules drying a red-brown. Blade in general a little shorter than that of the species which follow . . . . . 50. *D. nummularia*
27. Leaf and capsules inclined to be glaucous green when dry. Blade in general rather longer than in the last . . . . . 51. *D. glabra*
26. Leafbase with divaricate auricles and the margin between the auricle and the apex rather straight . . . . . 52. *D. divaricata*
26. Leafbase subtruncate, and blade somewhat hastate in consequence . . . . . 53. *D. loheri*
19. Hairs present on at least some part of the plant, particularly on petiole and inflorescences.

- 28. Blade ovate-elliptic.
- 29. Blade thinly coriaceous. Hairs only on the flowering branches . . . . . 54. *D. merrillii*
- 29. Blade herbaceous. Pubescence on the petioles, backs of leaves in their lower parts, and inflorescences.
- 30. Capsule wings not much wider than semicircular, to 18 by 22 mm. . . . . 55. *D. pyriformis*
- 30. Capsule wings broader than semicircular, to 21 by 22 mm . . . . . 56. *D. platycarpa*
- 28. Blade cordate. Pubescence more extensive and in *D. orbiculata* dendroid as well as stiletto hairs.
- 31. Leaf margin hyaline. Male flowers nearly or quite in contact one with another, not pubescent outside . . . . . 57. *D. puber*
- 31. Leafmargin not hyaline; male buds pubescent outside.
- 32. Male flower buds not in contact, the spikes long. Upper surface of the leaf glabrous. . . . . 58. *D. orbiculata*
- 32. Male flower buds usually close packed, spikes short. Leaf hairy on both sides 59. *D. polyclades*

22. *Dioscorea havilandii* PRAIN & BURK. J. As. Soc. Beng. new ser. 10 (1914) 40, excluding the Banka specimen; R. KNUTH, Pfl. R. 87 (1924) 281; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1938) 220, pl. 86.

Tuber unknown. Stem glabrous, wiry, probably unarmed throughout. Bulbils none seen. *Leaves* alternate, decidedly coriaceous, elliptic or the larger so broad as to be almost circular, sometimes ovate [var. *ovalifolia* PRAIN & BURK. (1938)], abruptly acuminate (acumen to 10 mm), base just cordiform, to 11 by 9 cm, 5-nerved, the outermost nerves submarginal and the intermediate much nearer to the margin than to the midrib; upper surface somewhat shining, the larger nerves just prominent after the leaf has been dried; petiole  $\frac{1}{3}$  the length of the lamina. *Male flowering axes* gathered into large leafless branches up to 70 cm long, the axes directed strictly upwards and flowerless through 2-5 mm at the base, then fertile with about 40 flowers, angled. Buds globose, up to 1 mm long. *Female flowering axes* to 35 cm and probably at times longer. *Capsules* broader than in the species immediately following; wings to 20 by 22 mm, apex retuse, base subtruncate.

Distr. *Malaysia*: Borneo (Sarawak and Kutai) and Billiton. Fig. 9a.

Ecol. Mountain ridges, near Kuching apparently common.

Vern. *Akar kawat* (Kuching).

23. *Dioscorea bancana* PRAIN & BURK. Kew Bull. 1925, 62; Ann. R. Bot. Gard. Calc. 14 (1938) 221, pl. 87.—*D. havilandii* PRAIN & BURK. J. As. Soc. Beng. new ser. 10 (1914) 40, as regards the Banka specimen.

Underground parts unknown. Stem as that of *D. havilandii*. Bulbils none seen. *Leaves* alternate, decidedly coriaceous, ovate or ovate-elliptic, to 15 by 6 cm, acuminate, base rounded, nerves 5 with courses as in *D. havilandii*; petiole to 3 cm long. *Male flowering axes* in large leafless inflorescences, perhaps not quite so strongly negatively geotropic as those of *D. havilandii* for they curve upwards less abruptly than do those of *D. havilandii*. *Female flowering axes* 1-3 together markedly angled. *Capsule* unknown.

Distr. *Malaysia*: Banka. Fig. 9a.

Note. A study of the plant in life is desirable in order to decide if it really differs from *D. laurifolia*.

24. *Dioscorea laurifolia* WALL. [Cat. lith. (1828) no 5111] ex HOOK. f. Fl. Br. Ind. 6 (1892) 293; RIDL. & CURTIS, J. Str. Br. R. As. Soc. 33 (1902) 66; RIDL. Mat. Fl. Mal. Pen. Monoc. 2 (1907) 83; PRAIN & BURK. J. As. Soc. Beng. new ser. 10 (1914) 39; KNUTH, Pfl. R. 87 (1924) 289; RIDL. Fl. Mal. Pen. 4 (1924) 319; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1938) 222, pl. 88.—*D. oppositifolia* (non L.) CURTIS, J. Str. Br. R. As. Soc. 25 (1894) 149.—Fig. 4c, 10.

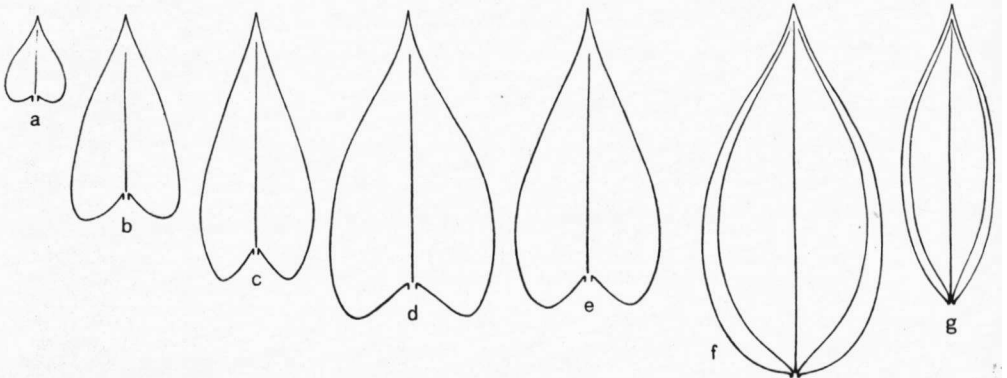


Fig. 10. Leaf-shape in *Dioscorea laurifolia* WALL. ex HOOK. f.: a. the first assimilating leaf of the seedling, b-c. the first and second leaves of the first developed stem, d-e. the first and second leaves of the second developed stem, which stem is not arrested as is the first at the second leaf, f. a leaf from the vegetative part of an adult plant, g. a leaf from a flowering part. All drawn  $\times \frac{1}{3}$ ; the proportions work out approximately as 1 : 4 : 5 : 9 : 7 : 12 : 6.

Tubers 1 or perhaps 2, descending into the soil but not very deeply, flesh red to pink, fibrous in the upper parts. Stem wiry, unarmed, faintly ridged, rooting at times from lower nodes that happen to lie on sufficiently moist soil. *Leaves* alternate, coriaceous, lanceolate-ovate, to 16 by 5 cm on the mature plant, not much less on plants that are not quite mature but of a different shape being auricled at the base (fig. 10), 5-nerved, the outer nerve submarginal, the intermediate nerve as near to the margin as to the midrib; upper surface dull with the larger nerves slightly prominent, lower surface shining, smooth but with the larger nerves raised; petiole rather short, between  $\frac{1}{3}$  and  $\frac{1}{4}$  of the length of the lamina. *Male flowering axes* usually on leafless branches or branch-ends, but occasionally spikes are found in the axils of assimilating leaves, to 7 cm long, angled, with 40–60 flowers spaced their own diameter apart. Buds slightly longer than globose. *Female flowering axes* 1–2 together to 10 cm long or a little more. *Capsules* relatively large, wings to 27 by 24 mm, apex of capsule retuse, base obtuse.

Distr. *Malaysia*: Malay Peninsula, W. side (not yet in Kelantan, Pahang, and Trengganu). Fig. 9a.

Ecol. Plentiful in the mountains, particularly the Main Chain, 0–1200 m. *Fl.* irregularly, flowers strongly benzoin-scented.

25. *Dioscorea prainiana* R. KNUTH, Pfl. R. 87 (1924) 286, *pro specim. Mal.*; BURK. Dict. (1935) 824; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1938) 225, pl. 89.—*D. deflexa* (non GRIS.) HOOK. f. Fl. Br. Ind. 6 (1892) 293; RIDL. Mat. Fl. Mal. Pen. 2 (1907) 83.—*D. glabra* (non ROXB.) RIDL. *op. cit.* as regards his 8059.—*D. oppositifolia* (non L.) BACKER, Handb. Fl. Jav. 3 (1924) 115, *in syn.*—*D. maliliensis* R. KNUTH in FEDDE, Rep. 36 (1934) 127.

Tuber thrust deep into the soil, subglobose, to 30 by 15 cm, on the end of a stalk perhaps 30 cm long, flesh yellow. Stem climbing to 16 m, unarmed, to 5 mm in diam. at the base. Plant glabrous. Bulbils not seen. *Leaves* alternate on the thinner stems and opposed on the thicker, elliptic or ovate-elliptic, to 15 by 7 cm, acuminate, base rounded, 5–7-nerved, the outermost nerves when there are 7 very weak and submarginal, 5-nerves more usual; secondary nerves only a little more distinct than the network which is only just visible on the upper surface; lower surface with prominent primary nerves; petiole to 6 cm or  $\frac{1}{3}$  to  $\frac{1}{4}$  the length of the blade. *Male flowering axes* gathered into decurved inflorescences which may be 60 cm long; the axes themselves to 8 cm with upwards of 60 flowers set their own diameter apart. Buds ovoid and not exceeding  $1\frac{1}{2}$  mm in length. *Female flowering axes* to 50 cm long, markedly angled. *Capsules* relatively large; wings 25 by 30 mm, apex retuse to almost truncate, base almost truncate.

Distr. *Malaysia*: NE. Sumatra (Berastagi and Sibolangit), Malay Peninsula (Perak, S to Singapore and apparently also in Pahang and Trengganu, but the material brought as yet from these

two States is sterile), Central Celebes (a ♂ plant, KJELLBERG 2009, from Malili). Fig. 9c.

Ecol. Ascending in the Malay Peninsula to 350 m, but in Sumatra to 500 m and yet higher.

Note. Attention is drawn to the manner in which the primary nerves may diverge at the base of the lamina—a gradual diverging which implies an unusual ratio between the rates here of longitudinal and latitudinal growth.

*D. kingii* should be compared, as the same happens in it. RIDLEY (Fl. Mal. Pen. 5, 1925, 340) holding this species and his *D. nenupolia* to be one, claims the latter name for it.

26. *Dioscorea warburgiana* ULINE *ex* KOORD. Minahassa 19 (1898) 313, *nomen*; PRAIN & BURK. J. As. Soc. Beng. new ser. 4 (1908) 456; *ibid.* 10 (1914) 40; MERR. En. Philip. Fl. Pl. 1 (1922) 219; R. KNUTH, Pfl. R. 87 (1924) 291; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1938) 227, pl. 93.

Underground parts unknown. Plant glabrous. Stem unarmed in the upper parts, probably throughout, smooth. Bulbils none seen. *Leaves* at the horizon of flowering opposite, almost coriaceous, elliptic-ovate, to 17 by 10 cm, shortly acuminate, 7-nerved, the outermost nerves weak and submarginal; upper surface with the nerves distinct, the secondary tending to break up in the network; petiole short, to 5 cm or  $\frac{1}{3}$  to  $\frac{1}{4}$  the length of the lamina. *Male flowering axes*, as far as seen, in fascicles in the leaf-axils, unusually long, to 20 cm, bearing about 80 flowers spaced at rather more than their own diameters apart, conspicuously angled. Buds globose, to  $1\frac{1}{2}$  mm long. *Female flowers* unknown. *Capsules* broad, wings 22 by 22 mm, on a stipe 6–7 mm long.

Distr. *Malaysia*: Celebes (N. peninsula). Fig. 9d.

Ecol. *Fl.* irregularly; flowers benzoin-scented.

27. *Dioscorea vanvuurenii* PRAIN & BURK. Kew Bull. (1925) 63 & Ann. R. Bot. Gard. Calc. 14 (1938) 224, pl. 91.

Underground parts unknown. Plant glabrous. Stem in the upper parts unarmed, scarcely ridged. Bulbils none seen. *Leaves* at the horizon of flowering opposed, coriaceous, ovate, to 3 by 2 cm, shortly acuminate, 5-nerved; petiole about  $\frac{1}{3}$  the length of the lamina. *Male flowering axes* in small fascicles on leafless branch-ends and also in the axils of leaves on the stem, to 5 cm in length, erect in response to gravity, with about 60 flowers. Buds globose. *Female plant* unknown.

Distr. *Malaysia*: Central and SE. Celebes (Kendari at 300 m, KJELLBERG 671). Fig. 9b.

28. *Dioscorea vilis* KUNTH, En. Pl. 5 (1850) 400; ZOLL. Syst. Verz. (1854) 68; MIQ. Fl. Ind. Bat. 3 (1859) 576; PRAIN & BURK. J. As. Soc. Beng. new ser. 10 (1914) 41; R. KNUTH, Pfl. R. 87 (1924) 290, *quoad specim.* ZOLL.—*D. filiformis* (non BL.) KOORD. Exk. Fl. Java 1 (1911) 309; *ibid.* 4 (1923) fig. 500 (indifferent); PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1938) 228 with part of pl. 90, excluding the reference to BLUME's plant, the upper right hand figure of pl. 90 and pl. 94.—*D. oppositi-*

*folia* (non L.) BACKER, Handb. Fl. Java 3 (1924) 115, in small part.

Tuber apparently burying itself deep, edible, slender, attaining 25 cm and more. Plant glabrous. Stem 3–4 mm in diameter at the base and with a few small prickles there, unarmed above, terete or

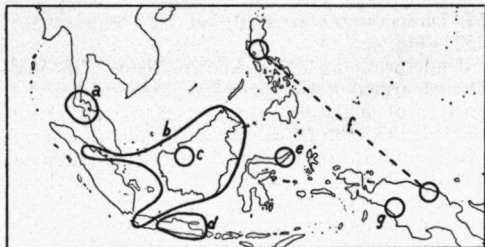


Fig. 11. Distribution of the Malaysian species of § *Enantiophyllum* with narrow leaves, a. *D. calcicola* PR. & B., b. *D. salicifolia* BL., c. *D. moultonii* PR. & B., d. *D. vilis* KUNTH, e. *D. sp. indet.* (KOORDERS 16731), f. *D. grata* PR. & B., g. *D. elegans* RIDL. ex PR. & B.

very obscurely ridged, climbing to 16 m (KOORDERS). Bulbils none seen. *Leaves* alternate, herbaceous, broadly lanceolate to narrowly ovate, 10 by 4 cm, acuminate, 7-nerved; upper surface with the larger nerves prominent; petiole to 4 cm or to  $\frac{1}{4}$  or  $\frac{1}{3}$  of the lamina. *Male flowering axes* all in fascicles in leaf-axils, 1–3 together, assuming an upright position in response to gravity, to 7 cm long with about 50 flowers; axis strongly ridged and minutely scabrid. Buds globose except that the base is flattened. *Female flowers* unknown. *Capsules* rather large, apex retuse, base almost retuse about the stipe; wings more or less evenly rounded, 18–20 by 20 mm; stipe 7–8 mm long.

Distr. *Malaysia*: Java (from Mt Gedeh eastward). Fig. 9e, 11d.

Ecol. In the mountains, 650–2400 m, apparently rare, also in *Casuarina* forest.

Notes. The nomenclature has been confused from not recognizing BLUME's plant of *D. filiformis*; a careful examination of BLUME's authentic, which are unfortunately only with very young bud, leads to the conclusion that they represent poor specimens of what has later been called *D. myriantha* (see p. 329).

29. *Dioscorea peperoides* PRAIN & BURK. in ELMER, Leaf. Philip. Bot. 5 (1913) 1597; J. As. Soc. Beng. new ser. 10 (1914) 28; R. KNUTH, Pfl. R. 87 (1924) 269; PRAIN & BURK. in LECOMTE Fl. Gén. I.C. 6 (1934) 736; Ann. R. Bot. Gard. Calc. 14 (1938) 230, pl. 95.—*D. luzonensis* (non SCHAUER) MERR. & MERRITT, Philip. J. Sci. 5 (1910) Bot. 339.

Underground parts unknown, but assumed as those of *D. luzonensis*. Plant glabrous. Stems, at least in the upper parts, unarmed, with very faint ridges. Bulbils none seen. *Leaves* on the larger stems opposed, but on the plant more often alternate than opposed, broadly cordate with evenly

rounded auricles or angular auricles [*var. sagittifolia* PRAIN & BURK. (1914)] to 12 by 12 cm, 7–9-nerved, acuminate; petiole about as long as the lamina. *Male flowering axes* 1–4 together in fascicles in leaf-axils, more or less erect, up to 6 cm long with about 60 flowers spaced so as to be in contact one with another; axis angled. Buds rather more elongated than globose, to  $1\frac{1}{2}$  mm long. *Female flowering axes* 1–2 together slightly angled. *Capsule* slightly retuse at the apex, more or less rounded at the base; wings 17 by 10 mm, nearly semicircular; stipe to 3 mm long.

Distr. Tonkin (a variety) and *Malaysia*: Philippines. Fig. 9f.

Ecol. Chiefly in the mountains of Luzon, ascending to 1300 m, where pine forests commence, growing there in thickets, but also found at sea-level in Golo Island off Mindoro and on limestone cliffs in the Pabellones Islands off Palawan.

Notes. *D. peperoides* is very closely allied to *D. luzonensis* but has much smaller flowers and slightly different leaves. It has not been found that the two grow together. There is no indication that it is distinguished in the field from *D. luzonensis* and is probably used as food equally.

30. *Dioscorea luzonensis* SCHAUER, Nov. Act. Nat. Cur. 19, Suppl. 1 (1843) 444; MIQ. Fl. Ind. Bat. 3 (1859) 571; NAVES, Fl. Filip. Novis. App. (1880) 258; VIDAL, Phan. Cuming. Philip. (1885) 153; Rev. Pl. Vasc. Filip. (1886) 176; CERON, Cat. Pl. Comis. Fl. For. (1892) 171; PRAIN & BURK. in ELMER, Leaf. Philip. Bot. 5 (1913) 1597; J. As. Soc. Beng. new ser. 10 (1914) 28; WESTER, Philip. Agr. Rev. 9 (1916) 175; W. H. BROWN, Bull. 22 Philip. Bur. For. 2 (1921) 258; MERR. En. Philip. Fl. Pl. 1 (1922) 21; R. KNUTH, Pfl. R. 87 (1924) 270; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1938) 232, pl. 96–97.—Fig. 4f.

Tuber one a year, subclavate, descending down to a depth of 1 m; flesh white or pinkish white, esculent. Plant glabrous. Stem unarmed, faintly ridged. Bulbils none seen. *Leaves* on the larger stems opposed, but more often alternate than opposed, cordate with the auricles somewhat hastately extended, shortly acuminate, 15 by 12 cm, 5–7-nerved; petiole about as long as the lamina. *Male flowering axes* 2–4 together in fascicles in the axils of upper leaves, to 7 cm long with about 60 flowers spaced their own diameter apart. Buds nearly globose, to 2 mm long. *Female flowering axes* solitary, to 22 cm long, carrying up to 35 flowers, angled. *Capsules* truncate at the apex, very obtuse at the base, wings to 22 by 15 mm, ashy green when nearly dry, stipe to 5 mm long.

Distr. *Malaysia*: Philippines (Luzon, Palawan). Fig. 9f.

Ecol. Chiefly at low elevations, not collected in the parts of Luzon where the climate has no break in humidity, but plentiful in the provinces near Manila where there are two dry breaks in the year. *Fl.* Sept. or possibly earlier. The size of the male flowers is noteworthy.

Vern. In Luzon it shares its names with *D. peperoides*; and in a less measure with other mem-

bers of the genus. In Tagalog it is *kobag* or *ubag*; *pakwit*, *korini* and *mayatbhang*. The number and diversity is curious. In Ilocano it is *kamangeg* and in confusion with *D. bulbifera* is *aribukbuk* or *aribubu*.

Uses. The tubers are often used as food, chiefly because it is abundant where it grows and search is quickly rewarded. To dig it out is laborious but to many worth while.

31. *Dioscorea tenuifolia* RIDL. J. Str. Br. R. As. Soc. 41 (1904) 34; R. KNUTH, Pfl. R. 87 (1924) 289; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1938) 414, pl. 146.—*D. zollingeriana* (non KUNTH) MIQ. Fl. Ind. Bat. Suppl. (1860) 611; RIDL. Mat. Fl. Mal. Pen. 2 (1907) 82; Fl. Mal. Pen. 4 (1924) 317, in part.—*D. oppositifolia* (non L.) BACKER, Handb. Fl. Jav. 3 (1924) 115, in part.

Tubers several each year, sphaeroidal, at the ends of rather long descending stalks; flesh esculent. Plant glabrous. Stems sparingly armed at the base, ascending to 16 m. Bulbils none seen. Leaves mostly opposed, but also alternate, herbaceous, elliptic or elliptic-ovate, rather shortly acuminate, base rounded to obtuse, 15 by 7 cm, rarely larger even to 16 by 11½ cm, 7-nerved; lower surface sometimes bronzed; petiole to 7 cm. Male flowering axes 1 or 2 together from upper leaf-axils and also on weak stem-ends from the axils of bracts that displace leaves, directed downwards apparently in a geotropic response, up to 80 mm long with perhaps 40 flowers spaced 2–3 times their own diameter apart, slender, angled. Buds globose except for a flattened base, to 1 mm long. Female flowering axes solitary, attaining 50 cm, with about 40 flowers; axis markedly angled. Capsules large, apex retuse, base almost truncate; wings 30 × 35 mm; stipe to 6 mm in length.

Distr. *Malaysia*: Sumatra (East Coast & Palembang), Banka, and Malay Peninsula (Singapore Island).

Note. The leaves, when large, suggest those of *D. orbiculata*, but are glabrous.

32. *Dioscorea sarasinii* ULINE ex R. KNUTH. Pfl. R. 87 (1924) 291, excl. fig. 56; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1938) 266, pl. 109.

Underground parts unknown. Plant glabrous. Stem in the upper parts unarmed, faintly ridged. Bulbils none seen. Leaves alternate, but often two so close as to appear opposed, elliptic or elliptic-ovate, abruptly acuminate, rounded at the base, chartaceous, to 12 × 5½ cm, 7-nerved; upper surface quite smooth; petiole to 2 cm or about ¾ the length of the lamina. Male flowering axes in dense fascicles in the axils of leaves, up to 10 cm long with perhaps 60 flowers spaced 2–3 times their diameter apart; axis slender, angled, slightly flexuous. Bracts deltoid-acuminate, 1 mm long. Buds ovoid from a narrow base, to 1¼ mm long. Tepals said to be greenish white. Stamens in two series, obviously by elevation of the torus as described in *D. sexrimata*; the torus raises those before the inner tepals higher than those before the outer tepals. Female flowering axes attaining 60 cm in

length with upwards of 100 flowers; axis slightly angled. Capsules unknown.

Distr. *Malaysia*: Celebes (N. peninsula).

Note. There is a resemblance to *D. vanvuureinii* but an absence of negative geotropism in the male flowering axes.

33. *Dioscorea sexrimata* BURK. Kew Bull. (1950) 259.—Fig. 4e.

Underground parts unknown. Plant glabrous. Stem unarmed in its upper parts, 2 mm thick at the horizon of flowering, wiry and in its appearance like the stem of *D. laurifolia*. Bulbils not seen. Leaves opposed on the thicker parts and alternate distally, lanceolate or broadly lanceolate, base rounded or very obtuse, apex acuminate, to 13 by 3 cm; margin strengthened, 5-nerved; petiole equaling only ¼ the length of the lamina, or even less. Male inflorescences one at a time from the axils of upper leaves, some of them exceeding the leaves in length; others shorter; the flower-bearing axes carried on these, 1 or 2 together, are laxly disposed after the manner of the inflorescence of *D. lamprocaula*; anthesis proceeds up the axes whereas in many species of *Dioscorea* anthesis is nearly simultaneous along its whole length. Half grown buds are globose, later the base widens and forms a saddle half embracing the axis. Filament as long as the anther. The torus lifts the organs of the flower: the inner tepals a little, the stamens before the outer tepals rather more, and those before the inner tepals more still; superficially the stamens appear connate, but the impression is false; the lower part of the mid-line of the petals, and the backs of the filaments have their attachment to the torus continued upwards and there arise from this six narrow slits as a complication in the flower-structure. Female flowers unknown. Capsule (known only from detached valves) just retuse at the apex, the wings 22 by 18 mm; stipe 6–7 mm.

Distr. *Malaysia*: Celebes (SE. Peninsula).

Ecol. In rain forest and among shrubs, ± 300 m alt., fl. in September. If it be right that water held by the fleshiness of the male flowers of *Enantiophylla* preserves them fresh during anthesis for a longer time than would be possible without it, then this upward growth of the torus is an adaptation of interest and it appears as an advance that has originated in Celebes.

34. *Dioscorea oryzetorum* PRAIN & BURK. Kew Bull. (1927) 242; Ann. R. Bot. Gard. Calc. 14 (1938) 363, pl. 133.

Tubers several as globose endings on long stalks differing from those of *D. glabra* in these stalks which are sometimes branched; flesh white. Plant glabrous. Stems unarmed, smooth. Leaves opposite, varying much its shape, elliptic-cordate to ovate-lanceolate or even linear-lanceolate with a rounded base [*var. angustifolia* PRAIN & BURK. (1927)], acuminate, 10 by 2–6 cm, 5–7-nerved, upper surface with the network obscure; petioles of the broader leaves about ¾ the length of the lamina, but petioles of the narrower leaves short to very short. Male flowering axes usually on leafless

branches, but if not then 1-3 together in leaf-axils, the leafless branches to 12 cm in length; flowering axes very thin, to 4 cm in length with flowers to the number of 50. Buds ellipsoid, directed slightly forward, to 1 mm long. Outer tepals 1 mm long. Inner tepals a little shorter, oblanceolate or subspathulate. Stamens with very short filaments. *Female flowering axes* solitary, to 20 cm long, angled, rather slender. *Capsules* relatively small, subglaucous in a degree similar to that of *D. glabra*; apex very slightly retuse; base nearly truncate; wings to 14 by 11 mm; stipe 4-5 mm long.

Distr. Siam from 16° N southwards beyond the Isthmus of Kra to *Malaysia* in the Siamese Circle of Sri Tamarat at Kao Chem Tung Song about 8° N, in deciduous forest and scrub or among bamboos.

Note. This species possesses variability in its leaf blades as a specific character, demonstrated in the ratio of the breadth to length. Broad-leaved specimens approach *D. glabra*.

35. *Dioscorea gracilipes* PRAIN & BURK. Kew Bull. (1925) 63; *ibid.* (1927) 244; Ann. R. Bot. Gard. Calc. 14 (1938) 365, pl. 133.

Underground parts unknown. Plant glabrous. Stem unarmed above and perhaps throughout, wiry. Bulbils none seen. *Leaves* herbaceous, opposite, broadly lanceolate, tapering to the apex so that they are scarcely acuminate, base rounded, 8 by 2 cm, 5-nerved; petiole to 3 cm or  $\frac{1}{3}$  the length of the blade. *Male flowering axes* solitary or sometimes in small fascicles in the upper leaf-axils, to 6 cm long with perhaps 30 flowers spaced about twice their own diameter apart; axis not quite straight, capillary, with ridges descending from the bracts. Buds with a rather broad base and a minute wart over the axis on the upper side, at maturity 1 mm long. *Female flowering axes* wiry, few-flowered. *Capsules* apparently not more than 5 on an infructescence, slightly retuse at the apex, nearly truncate at the base; wings 14-16 by 11 mm; stipe about 4 mm long.

Distr. Peninsular Siam, between the Isthmus of Kra and the border of *British Malaya* in the Circles of Puket, near Pangnga, and of Surat at Kachanadit.

Ecol. It is a limestone plant and a dwarf.

36. *Dioscorea elegans* RIDL. *ex* PRAIN & BURK. Kew Bull. (1925) 65; Ann. R. Bot. Gard. Calc. 14 (1938) 264, pl. 116.—*D. papuana* (non WARB.) RIDL. Trans. Linn. Soc. Lond. Bot. 9 (1916) 227; R. KNUTH, Pfl. R. 87 (1924) 323.

Underground parts unknown. Plant glabrous. Stem in the upper parts unarmed, terete. Bulbils none seen. *Leaves* (at least in the distal parts of the stem) alternate, lanceolate or lanceolate-ovate, acuminate, rounded or just cordiform at the base, 9 by 2 cm, 5-nerved or obscurely 7-nerved; upper surface shining and smooth; petiole short, not exceeding  $\frac{3}{4}$  the length of the lamina. *Male flowering axes* 2-3 together in the axils of the upper leaves, to 7 cm long with 30-40 flowers spaced about their own diameter apart. Buds ovoid, 1 mm

long. *Female flowering axes* solitary, rather slender, to 30 cm long, conspicuously ridged, with capsules so spaced as scarcely to imbricate. *Capsules* subtruncate above, more or less rounded below; wings 20 by 15 mm; stipe 3 mm long.

Distr. *Malaysia*: SW. New Guinea (Utakwa river), 150 to 930 m. Fig. 11g.

37. *Dioscorea moultonii* PRAIN & BURK. Kew Bull. (1925) 62; Ann. R. Bot. Gard. Calc. 14 (1938) 265, pl. 108.

Underground parts unknown. Plant glabrous. Stem unarmed in the upper parts, wiry, terete. Bulbils none seen. *Leaves* alternate, coriaceous, broadly lanceolate, narrowed rather gradually into the acumination, base rounded, 8 by 2 cm, 5-nerved; reticulation rather prominent below; petiole short, only  $\frac{1}{2}$  cm long. *Male flowering axes* 1-3 in small fascicles in the axils of upper leaves or in the axils of bracts towards stem-ends, 5-10 cm long with over 60 flowers spaced more than their diameter apart; axis angled conspicuously. Buds elongated and directed obliquely forward, rather more than 1 mm long. *Female plant* unknown.

Distr. *Malaysia*: Borneo (Sarawak). Fig. 11c.

Note. There is in the Herbarium at Bogor a sterile specimen from Billiton collected by VORDERMAN with similar leaves, and in the Leyden Herbarium capsules obtained by the same collector in the same island. They have the shape of capsules of *D. pyrifolia*, and it is likely that *D. moultonii* has such. These specimens do not prove that *D. moultonii* occurs in Billiton, but suggest that it should be looked for.

38. *Dioscorea lamprocaula* PRAIN & BURK. Kew Bull. (1932) 245; Ann. R. Bot. Gard. Calc. 14 (1938) 343, pl. 126.

Underground parts unknown. Plant glabrous. Stem very prickly at the base, the prickles 3-4 mm long, very tough to more or less woody, to 7 mm in diameter. Bulbils produced which when large are branched. *Leaves* alternate, coriaceous, from narrowly ovate to nearly orbicular, to 17 by 13 cm, 5-7-nerved; nerves somewhat prominent on the lower surface; petiole to 6 cm or half the length of the lamina. *Male flowering axes* collected together along leafless branches which may themselves branch again; the axes varying much in length, the flowers on them spaced at about twice their diameter apart. Buds not flattened at the base and directed obliquely forward, to rather more than 1 mm in length. *Female plant* unknown.

Distr. *Malaysia*: N. Sumatra, Malay Peninsula (Perak, Pahang, Johore), Java (Preanger).

Ecol. The Johore locality was swampy forest on the coast; but the other localities are on hills and mountain slopes.

39. *Dioscorea calcicola* PRAIN & BURK. Kew Bull. (1925) 64; Ann. R. Bot. Gard. Calc. 14 (1938) 366, pl. 130; RIDL. Fl. Mal. Pen. 5 (1925) 341.

Underground parts unknown. Plant glabrous. Stem wiry, terete, possibly entirely unarmed. Bulbils not seen. *Leaves* firm, narrow, broadest at

the horizon of the insertion of the petiole which, as they are rounded or only just cordiform at the base, means that they taper almost from the base to pass very gradually into the little defined acumen, 12 by 1½ cm; upper surface smooth and shining; petiole to 2–2½ cm long. *Male flowering axes* 1–2 together on very short leafless branches from the upper leaf-axils, branches attaining no more than the mid-length of the axillant leaf; axis very red when dry, to 4 cm in length, with about 50 flowers spaced their own diameter apart. Buds slightly elongated, 1 mm long. *Female flowering axes* though short, rather stout and rigid, solitary, with up to 10 flowers, ridged. *Capsules* bunched close to the axil, only 1–3 to an infructescence, apex retuse; base almost truncate; wings 12–14 by 9–10 mm; stipe 1–2 mm long.

Distr. Peninsular Siam (Circle of Puket), in *Malaysia*: to the N of the Malay Peninsula (Langkawi Islands, Kedah Peak, G. Baling). Fig. 11a.

Ecol. A limestone plant.

40. *Dioscorea grata* PRAIN & BURK. J. As. Soc. Beng. new ser. 10 (1914) 35; MERR. En. Philip. Fl. Pl. 1 (1922) 217; R. KNUTH, Pfl. R. 87 (1924) 293; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1938) 376, pl. 134.

Underground parts unknown. Plant glabrous. Stem possibly armed at the base, thin. Bulbils none seen. *Leaves* alternate, rather firm, linear-lanceolate above a very slightly cordiform base, tapering evenly to the apex, 8 by 0.8 cm, 5-nerved; petiole only 1½ cm long, slender. *Male flowering axes* solitary or a small number along weak leafless branches which scarcely exceed the length of the axillant leaves; axis slightly angled, to 2½ cm in length, with about 20 flowers spaced their own diameter apart. Buds subglobose over a broad base, less than 1 mm long. *Female flowering axis* short, giving rise to few capsules. *Capsules* with the apex truncate, base obtuse, wings 20 by 15 mm; stipe 3 mm long.

Distr. *Malaysia*: Philippines (Luzon: Rizal prov.), NW. New Guinea (Nabire: KANEHIRA & HATUSIMA 12301). Fig. 11f.

Ecol. In New Guinea in *Agathis*-forest at 300 m.

Note. A first impression was that *D. grata* is a depauperate state of *D. loheri*; but this has not been demonstrated; and the detection of the plant in New Guinea goes against it. The New Guinea plant is an exact match of that of the Philippines.

41. *Dioscorea opaca* R. KNUTH, Pfl. R. 87 (1924) 283; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1938) 342, pl. 126.—*D. carrii* and possibly also *D. morobensis* R. KNUTH in FEDDE, Rep. 52 (1937) 164.

Underground parts unknown, but the tuber is said to be eaten. Plant glabrous. Stem with minute prickles near its base, ridged, to 4 mm in diam. Bulbils not seen. *Leaves* coriaceous, opposite or subopposite, broadly ovate, rounded at the base, with a long acumen, to 14 by 9 cm, 5-nerved; lower surface with even the smaller nerves some-

what prominent; petioles to 8 cm. *Male flowering axes* on small leafless rather lax branches and on leafless branch-ends, 1–3 together, to 5 cm long, with ca 30 flowers spaced rather more than their own diameters apart, slender, straight, ridged. Buds somewhat elongated, to 2 mm long. *Female plant* unknown.

Distr. *Malaysia*: New Guinea.

Ecol. Mountains, 850–1750 m.

42. *Dioscorea wallichii* HOOK. f. Fl. Br. Ind. 6 (1892) 295; R. KNUTH, Pfl. R. 87 (1924) 274; PRAIN & BURK. in Fl. Gén. I.C. 6 (1934) 741; Ann. R. Bot. Gard. Calc. 14 (1938) 281, pl. 115.—*D. aculeata* LINNÉ, Sp. Pl. (1753) 1033 *quoad* ref. RHEEDE, but excluding the bulbils added to his figure.

Tuber descending deeply into the soil, 1 m or more long; flesh white, edible. Plant glabrous. Stem armed at the base, smooth, to 4 mm in diameter. Bulbils not produced. *Leaves* alternate, herbaceous, broadly cordate, shortly acuminate, to 25 by 25 cm, 7-nerved; lower surface somewhat glaucous; petiole about as long as the lamina, its lower pulvinus as a rule tinged with a purplish red. *Male flowering axes* on leafless axillary branches not exceeding 10 cm which have a characteristic pyramidal shape; axes that bear the flowers to 5 cm long carrying 20–30 flowers spaced rather more than their own diameter apart. Buds globose, 1 mm in diameter. *Female flowering axes* 1–2 together, to 50 cm long. *Capsules* usually not more than 5 on an infructescence; apex rounded or truncate; base obtuse or rounded; wings 18 by 15–18 mm; stipe about 4 mm long.

Distr. India (Bombay coast to the Bengal plains, the lower Himalaya and hills of the Assam-Burma frontier), S to beyond the Isthmus of Kra in *Malaysia* in the Circle of Surat at Chumpawn.

43. *Dioscorea madiunensis* PRAIN & BURK. Kew Bull. (1925) 63; Ann. R. Bot. Gard. Calc. 14 (1938) 229, pl. 92.—*D. gedensis* PRAIN & BURK. Kew Bull. (1925) 64; Ann. R. Bot. Gard. Calc. 14 (1938) 374, pl. 92.

Underground parts unknown. Plant glabrous. Stem possibly armed at the base, very inconspicuously ridged. Bulbils none seen. *Leaves* opposed or alternate, ovate or lanceolate-ovate with a slightly cordiform base, acuminate, 8–10 by 4 cm, 5-nerved; petiole to 3 cm or more or less ¼ the length of the lamina. *Male plant* unknown. *Female flowering axes* 1–2 from upper leaf-axils, to 15 cm long. *Capsules* large, apex and base retuse; wings to 28 by 25 mm, stipe to 6 mm long.

Distr. *Malaysia*: Java (Mt Gedeh, Ponorogo), hills and mountains.

Note. The capsules of this species are the largest among Malaysian *Enantiophylla*.

44. *Dioscorea sitamiana* PRAIN & BURK. Kew Bull. (1925) 64; Ann. R. Bot. Gard. Calc. 14 (1938) 372, pl. 134.

Underground parts unknown. Plant glabrous. Stem unarmed in the upper parts. Bulbils none seen. *Leaves* opposed, herbaceous, oblong-ovate,



shortly and abruptly acuminate, drying a dark brown colour; base rounded or very obtuse, to 6 by 2½ cm on the parts collected (but larger leaves certainly occur below the horizon of flowering), 5-nerved; petiole short, only about 1½ cm long. *Male flowering axes* 1-3 together on leafless branches of moderate length or on leafless branch-ends, 4-5 cm long, angled, with 20-30 flowers spaced their own diameter apart. Buds globose, except that the base is flat, 1 mm long. *Female plant* unknown.

Distr. *Malaysia*: Borneo (Sarawak, Kinabalu).

45. *Dioscorea nieuwenhuisii* PRAIN & BURK. Kew Bull. (1925) 65; Ann. R. Bot. Gard. Calc. 14 (1938) 373, pl. 91.

Underground parts unknown. Plant glabrous. Stem unarmed in the upper parts, very indistinctly ridged. Bulbils none seen. *Leaves* opposed, rather firm, exactly ovate, acute or acuminate, the base neatly rounded, 8 by 3½ cm, 7-nerved; petiole to 5 cm. *Male flowering axes* aggregated rather densely on leafless branches or branch ends which attain 20 cm in length; axis angled, to 2 cm long; flowers spaced about their own diameter apart. Buds subglobose, 1 mm long. *Female plant* unknown.

Distr. *Malaysia*: East Central Borneo.

46. *Dioscorea kingii* R. KNUTH, Pfl. R. 87 (1924) 289; RIDL. Fl. Mal. Pen. 5 (1925) 341; PRAIN & BURK. Kew Bull. (1925) 66; Ann. R. Bot. Gard. Calc. 14 (1938) 381, pl. 129.—*D. nurii* & *D. harrissii* R. KNUTH, *op. cit.* 352.—*D. porteri* PRAIN & BURK. *ex* R. KNUTH, *op. cit.* 353; RIDL. Fl. Mal. Pen. 4 (1924) 318.

Tubers several in one year, thrust deep into the soil on long stalks; flesh soft and more or less esculent. Plant glabrous, of vigorous growth. Stems very prickly at the base and markedly furrowed, attaining 6 mm in diam., becoming unarmed upwards, climbing to 20 m and perhaps more. Bulbils none seen. *Leaves* opposed, firm, broadly lanceolate to elliptic-ovate, rounded at the base or just cordiform at the horizon of flowering (leaves in youth forms are sagittate), to 15 by 4½-5½ cm, sometimes larger even to 20 by 4½ cm, 5-7-nerved, the primary nerves with the peculiarity of the first pair not leaving the midrib at the base of the lamina, but curving away a few mm above; lower surface often suffused with a reddish purple colour (*var. purpureovenia* PRAIN & BURK. *ex* RIDL.); petiole about 4 cm long. *Male flowering axes* 1-4 together, assembled on large leafless branches that are produced high among forest trees and difficult to obtain; axes rather wiry, to 3 cm long and carrying about 30 flowers spaced about their own diameter apart. Buds subglobose, 1½ mm long, sometimes with a small wart over the axis on the base. *Female flowering axes* solitary. *Capsules* slightly retuse at the apex, nearly truncate at the base; wings 20 by 22 mm; stipe to 6 mm long.

Distr. *Malaysia*: Malay Peninsula.

Ecol. In high forest; it seems to grow for many years without flowering.

47. *Dioscorea salicifolia* BL. En. Pl. Jav. 1 (1827) 23; KUNTH, En. Pl. 5 (1850) 390; MIQ. Fl. Ind. Bat. 3 (1859) 573; KOORD. Exk. Fl. Java 1 (1911) 309 *quoad cit.* BLUME & 4 (1923) 270 only the figures on the right; R. KNUTH, Pfl. R. 87 (1924) 290; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1938) 374, pl. 91.—*D. gracillima* (non MIQ.) RIDL. & WINKLER, Bot. Jahrb. 44 (1910) 528.—*D. glabra var. salicifolia* PRAIN & BURK. J. As. Soc. Beng. new ser. 10 (1914) 37; MERR. En. Born. (1921) 118.—*D. oppositifolia* (non L.) BACKER, Handb. Fl. Jav. 3 (1924) 115, in small part.—*D. sarawakensis* R. KNUTH *op. cit.* 291.

Underground parts unknown. Plant glabrous. Stem unarmed in its upper parts, faintly ridged. Bulbils none seen. *Leaves* opposed or alternate, firmly herbaceous, lanceolate or sometimes with the base just cordiform, shortly acuminate, up to 10 by 2½ cm, 5-nerved; petiole short, usually only 2 cm. *Male flowering axes* aggregated on leafless branches of considerable length, but not uncommonly some in fascicles in the leaf-axils; axes 1½-2 cm long, the longer of these are found at the base of the large branches and the shorter near the end so that the inflorescence tapers a little. Buds globose above their flat base, to 1 mm long. *Female plant* not yet known.

Distr. *Malaysia*: Sumatra, W. Java, Borneo. Fig. 11b.

Ecol. Mostly in the hills and montane, but also in the lowland.

Note. The specimens from E. Java (KOORDERS 23608) and from NE. Celebes (KOORDERS 16731), referred to *D. salicifolia*, do not belong to this species.

48. *Dioscorea filiformis* BLUME, En. Pl. Java 1 (1827) 22; KUNTH, En. Pl. 5 (1850) 400; MIQ. Fl. Ind. Bat. 3 (1859) 576; MERR. En. Philip. Fl. Pl. 1 (1922) 217.—*D. myriantha* KUNTH, *op. cit.* 382; CERON, Cat. Pl. Comis. Fl. For. (1892) 171; KOORD.-SCHUM. Syst. Verz. 9 (1912) *genus* 1252; PRAIN & BURK. J. As. Soc. Beng. new ser. 10 (1914) 38 *excl. ref. D. salicifolia* ULINE; KOORD. Exk. Fl. Java 4 (1923) fig. 505, indifferent; R. KNUTH, Pfl. R. 87 (1924) 271; RIDL. Fl. Mal. Pen. 1 (1924) 317; PRAIN & BURK. Kew Bull. (1927) 239; Ann. R. Bot. Gard. Calc. 14 (1938) 293, pl. 120, *excl. syn. D. salicifolia, D. koordersii* R. KNUTH & *D. sp.—D. gibbiflora* HOOK. f. Fl. Br. Ind. 6 (1892) 294; CURTIS, J. Str. Br. R. As. Soc. 25 (1894) 149; RIDL. Mat. Fl. Mal. Pen. 2 (1907) 92; R. KNUTH, *op. cit.* 266; RIDL. Fl. Mal. Pen. 4 (1924) 317; PRAIN & BURK. Gard. Bull. Str. Settl. 5 (1930) 51; Ann. R. Bot. Gard. Calc. 14 (1938) 291, pl. 120.—Fig. 4g.

Tuber descending deeply into the soil. 50 cm and more long, increasing in diameter somewhat downwards until 2 cm through near the apex; flesh white or nearly so, esculent. Plant glabrous. Stem unarmed, often with a purple flush, with very faint ridges. Bulbils produced. *Leaves* opposed on the larger stems, but more often alternate, herbaceous, between cordate and hastate, the basal sinus cut into a bay on either side of the petiole (this character is very well marked in the type of *D.*

*myriantha*, but not so well marked in the type of *D. filiformis*; the laminae in the first measure to 10 by 7 cm and those in the second to 10 by 5½ cm), acuminate, 5-7-nerved, the first pair of primary nerves nearer to the margin than to the midrib; upper surface dull; lower often tinted with purple;

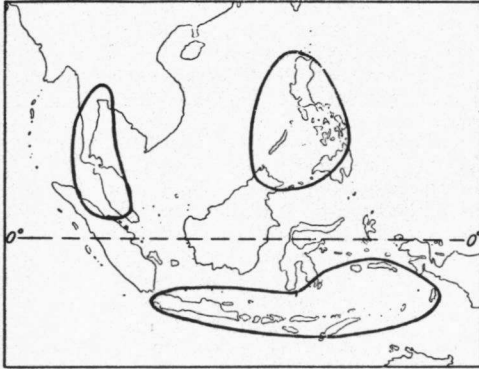


Fig. 12. Distribution of *D. filiformis* BL.

petiole rather shorter than the lamina. *Male flowering axes* either on special leafless branches with relatively long internodes between one group of axes and the next, or less commonly in fascicles in leaf-axils, 10-15 mm long, zigzag with a flower on each angle, narrowly ridged beneath each bract. Buds globose over a flat base and with a minute wart on the upper side against the axis, 1 mm long. *Female flowering axes* solitary, to 20 cm long, rather slender and a little flexed at the flowers, but not zigzag as are the male flowers. *Capsules* rather large; apex retuse; base almost truncate; wings to 24 by 22 mm, somewhat shining when dry; stipe 3 mm long.

*Distr.* Siam and throughout the N. and S. parts of *Malaysia*, but not yet known from the most equatorial, and not yet found in New Guinea. Fig. 12.

*Ecol.* A lowland plant apparently indifferent to chalk, but demanding drainage.

*Vern.* *Aroi huwi churuk* (or snout yam climber), *S. dudung*, *J. kiroi* or *kiru* (Tagalog) are recorded, but convey little information as they are not exclusive.

49. *Dioscorea alata* LINNÉ, Sp. Pl. (1753) 1033; N. L. BURMAN, Fl. Ind. (1768) 214; THUNB. Fl. Jav. (1825) 6; BLUME, En. Pl. Jav. 1 (1827) 22; BLANCO, Fl. Filip. (1837) 799; MIQ. Fl. Ind. Bat. 3 (1859) 572; Suppl. (1860) 60, 270; WATT, Dict. 3 (1890) 126; WARBURG, Bot. Jahrb. 13 (1891) 274; HOOK. f. Fl. Br. Ind. 6 (1892) 296; RIDL. & CURTIS, J. Str. Br. R. As. Soc. 30 (1897) 279; KOORD. Minahassa (1898) 312; MERR. Rev. Sp. BLANCO Fl. Filip. (1905) 86; RIDL. Mat. Fl. Mal. Pen. 2 (1907) 84; KOORD. Exk. Fl. Jav. 1 (1911) 308; PRAIN & BURK. J. As. Soc. Beng. new ser. 10 (1914) 39; BURK. Gard. Bull. Str. Settl. 1 (1917) 371, 3 pl.; MERR. Interpr. Rumph. Herb. Amb. (1917) 146; En.

Philip. Fl. Pl. 1 (1922) 215; HEYNE, Nutt. Pl. Ned. Ind. (1927) 456; BURK. Gard. Bull. Str. Settl. 3 (1923) 4, 2 pl.; R. KNUTH, Pfl. R. 87 (1924) 265; BACKER, Handb. Fl. Jav. 3 (1924) 114; OCHSE, Veget. Dutch E. I. (1931) 229; BURK. Dict. (1935) 814; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1938) 302, pl. 123-125.—*D. eburina* LOUR. Fl. Coch. (1790) 625.—*D. eburnea* WILLD. in LOUR. Fl. Coch. ed. 2, 3 (1793) 767.—*D. atropurpurea* ROXB. Hort. Beng. (1814) 72, *nomen*.—*D. globosa*, *D. purpurea*, *D. rubella* ROXB. Fl. Ind. 3 (1832) 797-800.—*D. vulgaris* MIQ. *op. cit.* 572.—*D. sativa* (non L.) MUNRO, Hort. Agr. (1844) 30.—*D. javanica* QUEVA, Mém. Soc. Sc. Lille IV, 20 (1894) 372, pl. 18/5.

Tuber polymorphous, (i) cylindrical or clavate and deeply descending into the soil even to 1½ m, (ii) globose and stout and short (*D. globosa* ROXB.), (iii) pyriform, (iv) lobed in various way, (v) fingered, (vi) fingered and fasciated (*D. vulgaris* MIQ.), (vii) losing its positive geotropism with a subsequent change of direction in the soil (*D. spiculata* BL. only as to ref. to RUMPH); skin brown to black; flesh white or ivory coloured or purple, either superficially or throughout (for the complete range of shapes see Ann. R. Bot. Gard-14, pl. 125), never poisonous. Plant glabrous. Stem unarmed though rarely rough or warted close to the soil, climbing to 10 m, quadrangular and as a rule conspicuously 4-winged above the very base at which the leaves are not decussate. Bulbils abundant, more so in some races than in others. *Leaves* generally a few alternate at the very base, thereafter opposed, herbaceous, subsagittately or subhastately ovate, rarely subhastately deltoid, shortly acuminate, usually to 22 by 15 cm, the upper surface bright green, 5-nerved; petiole about as long as the lamina, sometimes marginally frilled, sometimes with the pulvini suffused with purple. *Male flowering axes* 1-2 together, aggregated on leafless branches which only rarely exceed 30 cm in length, with upwards of 20 flowers spaced about their own diameter apart. Buds somewhat flattened at the base, otherwise nearly globose 1 mm long, at times the axis a little zigzag with the buds on the angles. *Female flowering axes* 1 from an axil, decurved but rigid, to 60 cm long with about 20 flowers, angled or at the base narrowly winged. *Capsules* at the apex slightly retuse, at the base obtuse; wings 17-20 by 15 mm; stipe 3-4 mm long.

*Distr.* Cultivated throughout *Malaysia* and indeed throughout the moister tropics. It originated in continental Asia, but seems to have been ennobled not a little in *Malaysia* (see BURKILL, Adv. Sc. 7, 1950, 443). It thrives on a rainfall of 1500 mm annually with a resting period of about 2 months. It gives its harvest at the same time as the rice; and in parts of the East where the amount of rice raised is not quite adequate, *D. alata* is one of the first of supplementary resources, but since the introduction of American sources of starchy food *D. alata* has lost considerably in importance. Because it keeps well and the crop is ready when the period of calms begins sailors carried it on voyages and man early took it both out into the

Pacific and to such parts on the western side of the Indian Ocean as are not too dry for its thrift. Europeans after A.D. 1500 carried it round the Cape to both sides of the Atlantic. It is invariably grown from clones, and varietal names are therefore inappropriate.

Vern. The tuber is called *ubi*, *ovi*, *owe*, *ohi*, *hubi*, *huwi*, *ohi*, through western Malaysia, eastwards *iwi*, *wiwi*, *wili*, almost to the exclusion of other nouns. But in Celebes *lame* meaning that which is planted, holds a place. It is *lulu* in Banda; *heri* or *heli* in Ambon; *gusuo* in Halmaheira, *kinampai* among the Bisayan languages of the Philippines. Right through Polynesia the name used is derived from *ubi*.

50. *Dioscorea nummularia* LAMK, Encycl. Méth. 3 (1789) 231; WILLD. Sp. Pl. 4 (1806) 792; BLUME, En. Pl. Jav. 1 (1827) 21, *quoad specim.*; MIQ. Fl. Ind. Bat. 3 (1859) 572 in small part; PRAIN & BURK. in ELMER, Leaflet. Philip. Bot. 5 (1913) 1599; J. As. Soc. Beng. new ser. 10 (1914) 35; MERR. Interpr. Rumph. Herb. Amb. (1917) 148; En. Philip. Fl. Pl. 1 (1922) 217; HEYNE, Nutt. Pl. Ned. Ind. 1 (1922) 500; R. KNUTH, Pfl. R. 87 (1924) 282; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1938) 367, pl. 132.—*D. villosa* L. (non 1753) in STICKMAN, Herb. Amb. (1754) 142.—*D. glabra* (non ROXB.) KOORDEERS, Minahassa (1898) 312.—*D. seemannii* PRAIN & BURK. J. As. Soc. Beng. new ser. 10 (1914) 34; R. KNUTH, *op. cit.* 272.—*D. koordersii* PRAIN & BURK. ex KOORD.-SCHUM. Syst. Verz. 3 (1914) 20, non R. KNUTH, *op. cit.* 291.—*D. angulata*, *D. glaucoidea*, *D. lufensis*, *D. palauensis* & *D. raymundii* R. KNUTH, *op. cit.* 191, 272, 283, 284.—*D. palapoensis* R. KNUTH in FEDDE, Repert. 36 (1937) 69.

Tubers descending deep into the soil, increasing in diameter downwards slowly by a long undefined stalk, to 1 m long and 6 cm in diam.; flesh white, esculent. Plant glabrous. Stem armed, sometimes abundantly at the base, rather wiry, with very obscure ridges. Bulbils none seen. *Leaves* opposed on the larger stems and alternate elsewhere, but more abundantly opposed than alternate, firmly herbaceous, from exactly cordate to broadly elliptic, with a rounded base, apex rather abruptly acuminate, to 11 by 9 cm, 5-7-nerved; petiole to 7 cm. *Male flowering axes* 1-4 together, aggregated on downwardly directed leafless branches to 4 cm long, with about 50 flowers spaced their own diameter apart, angled. Buds almost globose above a flattened base, to 1¼ mm long. *Female flowering axes* 1-2 together, to 15 cm long; axis angled. *Capsules* with the apex retuse, the base obtuse; wings 20 by 22 mm; stipe to 5 mm.

Distr. Pacific as far as Tahiti (whither perhaps man took it) to *East Malaysia*: (westward the N. corner of Borneo and Celebes in great abundance, not yet recorded from the Lesser Sunda Islands).

Ecol. & Vern. The esculent tuber of this most common species of *Dioscorea* in E. Malaysia lies too deep, yields too little and that unpleasant in carrying saponin to give the plant any prominence as a source of food. The tough stems serve for a handy bit of cordage when needed in the forest,

whence the word *tali* or cord in its name (see under *Enantiophyllum* above). Some additional recorded names are *uwi* in *tuwa* in N. Celebes, *ubing basol* in Tagalog (Luzon) which recalls RUMPHIUS's *ubi bisol*, *banan* in Bagobe (Mindanao), *tatopo* in Halmaheira, *singgo* in the Kem language of western New Guinea and *boku* of Port Moresby (New Guinea). It shares *pakit* in Tagalog with its allies.

Notes. A slight difference of the NE. Celebes specimens from the type (from Ambon) led to the distinction of *D. koordersii* PRAIN & BURK. ex KOORD.-SCHUM. which name does not cover *D. koordersii sensu* R. KNUTH, the latter being a state of *D. filiformis* BL.

RUMPHIUS's figure of the fruiting plant is good; the second figure, that of the plant in bud, is only useful in regard to the stem, as there is in the foliage that which suggests RUMPHIUS's figure of *Stemona* (fig. 129). It is as if the artist had not gone direct to life, but to a wrong model to obtain his way of representing the leaves.

51. *Dioscorea glabra* ROXB. Fl. Ind. 3 (1832) 803; HOOK. f. Fl. Br. Ind. 6 (1892) 294; RIDL. Mat. Fl. Mal. Pen. 2 (1907) 83; PRAIN & BURK. J. As. Soc. Beng. new ser. 10 (1914) 37 *excl. var. salicifolia*; R. KNUTH, Pfl. R. 87 (1924) 277 *excl. the same and ARSIN's specimens*; RIDL. Fl. Mal. Pen. 4 (1924) 318 in part; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1938) 354, pl. 131.—*D. nummularia* (non LAMK) ROXB. *op. cit.*—*D. laurifolia* (non WALL.) CURTIS, J. Str. Br. R. As. Soc. 25 (1894) 149.—*D. oppositifolia* (non L.) BACKER, Handb. Fl. Java (1924) 115, in part.—*D. siamensis* R. KNUTH, *op. cit.* 281.

Tuber single or sometimes more than 1, descending deep into the soil on a long stalk gradually increasing in diameter, cylindrical, to 50 cm long, 4 cm diam.; flesh white, esculent. Plant glabrous. Stem abundantly armed at the base, climbing to 8 m, tough, very faintly ridged. Bulbils not produced. *Leaves* herbaceous, opposed or alternate, long-cordate, the base varying between cordiform, hastate and rounded, to 14 by 16 cm, but usually not larger than 10 by 10 cm, 5-7-nerved; petiole usually 4-5 cm. *Male flowering axes* 1-4 together aggregated on leafless branches which attain at times 70 cm in length, only very rarely fasciated in leaf-axils; axis to 4 cm in length with about 25 flowers set at less than their diameter apart. Buds globose over their broad base, 1 mm long. *Female flowering axes* solitary or 2 together, to 40 cm long with upwards of 50 flowers; axis angled. *Capsules* slightly retuse at the apex, very obtuse at the base; wings 15-18 by 14-20 mm; stipe to 4 mm long.

Distr. India (particularly in Bengal) and Burma to the centre of the *Malay Peninsula*. In general a common species wherever it occurs.

Ecol. The tubers are eaten if it is worth while to dig for them. Rarely is the plant encouraged by those who use it for food. It has little importance in the Malay Peninsula though used by the pagan races. It is of considerable importance to the Andamanese.

To distinguish it from *D. nummularia* is often

difficult in herbaria. Dried leaves of the latter are redder and those of *D. glabra* browner; and the blade in *D. glabra* is as a rule somewhat longer than that of *D. nummularia*.

52. *Dioscorea divaricata* BLANCO, Fl. Filip. (1837) 797; KUNTH, En. Pl. 5 (1850) 391; WESTER, Philip. Agr. Rev. 9 (1916) 178; MERR. Sp. Blanco (1918) 101; W. H. BROWN, Bull. 22 Bur. For. Philip. 2 (1921) 257; MERR. En. Philip. Fl. Pl. 1 (1922) 216; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1938) 378, pl. 135.—*D. soror* PRAIN & BURK. in ELMER, Leaf. Philip. Bot. 5 (1913) 1598; J. As. Soc. Beng. new ser. 10 (1914) 34; MERR. En. Philip. Fl. Pl. 1 (1922) 219; R. KNUTH, Pfl. R. 87 (1924) 274.—*D. foxworthyi* PRAIN & BURK. J. As. Soc. Beng. new ser. 10 (1914) 84; Ann. R. Bot. Gard. Calc. 14 (1938) 380, pl. 136.—*D. oxyphylla* R. KNUTH, *op. cit.* 269.—Fig. 5q.

Tuber 1 or more, thrust deep into the soil on a long stalk, stalk and tuber together to 1 m in length; flesh edible. Plant glabrous. Stem armed at the base, rather wiry, slightly ridged. Bulbils none seen. *Leaves* opposed, herbaceous, cordately sagittate or subsagittate or ovate-hastate, the auricles not evenly rounded but drawn out as barbs, acuminate, to 16 by 8 cm, 7-nerved; petiole to 7 cm. *Male flowering axes* 1–2 together, aggregated on leafless branches or branch-ends which attain 60 cm in length, carrying upwards of 30 flowers spaced their own diameter apart, slender, angled. Buds globose, above a broad base, 1 mm long. *Female flowering axes* solitary, to 18 cm in length, angled. *Capsules* with the apex slightly retuse, the base obtuse; wings to 21 by 22 mm; stipe to 4 mm.

Distr. *Malaysia*: Philippines (Luzon, Panay, and Cebu).

Note. *D. divaricata* may be described as *D. nummularia* with the outer margins of the laminae straightened. As the leaves of the *Dioscoreas* are variable the propriety of maintaining it as a species has been questioned, but botanists who have been familiar with it in life have maintained it. The vernacular names reflect the difficulty of isolating it. Tagalog names recorded for it are: *kiroi*, *kiroe*, *kireot*, *buloi*, *paket*, *pakwit*, *kobag* and *ubag*; Ilocano, Pangasinan and Sambali: *dulian*, *durian*, *duyan*, *duwuyan*; Biscayan: *baliacag*. They are shared by the species whose tubers are used alternatively.

53. *Dioscorea loheri* PRAIN & BURK. J. As. Soc. Beng. new ser. 10 (1914) 33; MERR. Sp. Blanco (1918) 101; En. Philip. Fl. Pl. 1 (1922) 217; R. KNUTH, Pfl. R. 87 (1924) 270; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1938) 377, pl. 135.—*D. oppositifolia* (non L.) BACKER, Handb. Fl. Java 3 (1924) 115 *in syn.*

Tuber less elongated than that of *D. divaricata* but in general similar. Plant glabrous. Stem armed at the base, firm, very indistinctly ridged. Bulbils none seen. *Leaves* opposed as a rule, mostly ovate with the base if not rounded somewhat truncate, but the larger leaves are hastate, acuminate, as a rule about 9 by 2 cm, but at times to 20 by 9 cm, 7-nerved; petiole to 4 cm. *Male flowering axes* 1–3

together, aggregated on rather long leafless branches which attain 20 cm in length, or at times in axillary fascicles; axis angled, to 6 cm long with about 40 flowers spaced their own diameter apart. Buds globose above a broad base, 1 mm long. *Female flowering axes* to 14 cm long or longer, angled. *Capsules* apparently exactly as those of *D. divaricata*.

Distr. *Malaysia*: Philippines (Luzon, in the provinces near Manila).

54. *Dioscorea merrillii* PRAIN & BURK. in ELMER, Leaf. Philip. Bot. 5 (1913) 1598; J. As. Soc. Beng. new ser. 10 (1914) 35; MERR. En. Philip. Fl. Pl. 1 (1922) 218; R. KNUTH, Pfl. R. 87 (1924) 271; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1938) 381, pl. 136.

Underground parts unknown. Stem presumably armed at the base, wiry, faintly ridged. Bulbils none seen. *Leaves* opposed, rather coriaceous, long-ovate, sometimes just cordiform at the base, otherwise rounded, shortly acuminate, to 12 by 5 cm; petiole to 5 cm. *Male flowering axes* 1–2 together, aggregated on leafless branches which as far as known are more lax and shorter than those of *D. nummularia* and *D. divaricata*; parts of the branch carry hairs thinly scattered which do not extend onto the axes that carry the flowers; hairs of the stiletto type; axes of the spikes to 4 cm long with flowers spaced about their own diameter apart. Buds nearly globose above their broad base, 1 mm long. *Female plant* unknown.

Distr. *Malaysia*: Philippines (Mindoro, Mindanao), in the hills. Fig. 13d.

Note. As fig. 13 suggests, *D. merrillii* occurs as if marking the front of an advance of hairiness from western Malaysia towards the East.

55. *Dioscorea pyriformis* KUNTH, En. Pl. 5 (1850) 384; MIQ. Fl. Ind. Bat. 3 (1859) 571; HOOK. f. Fl.

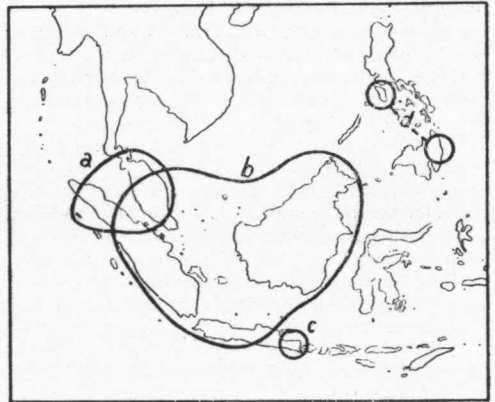


Fig. 13. Distribution of the pubescent species of § *Enantiophyllum* in Malaysia apart from *D. pubera* (fig. 14): a. *D. orbiculata* HOOK. f., b. *D. pyriformis* KUNTH and *D. polyclades* HOOK. f. taken together, c. *D. platycarpa* PR. & B., d. *D. merrillii* PR. & B.

Br. Ind. 6 (1892) 292; RIDL. & CURTIS, J. Str. Br. R. As. Soc. 33 (1902) 66; RIDL. Mat. Fl. Mal. Pen. 2 (1907) 82; KOORD. Exk. Fl. Java 1 (1911) 310 (as *pirifolia*); KOORD.-SCHUM. Syst. Verz. Lief. 9 (1912) genus 1252; RIDL. ex GIBBS, J. Linn. Soc. Lond. Bot. 42 (1914) 165; KOORD. *op. cit.* 4 (1923) 266; R. KNUTH, Pfl. R. 87 (1924) 278; RIDL. Fl. Mal. Pen. 4 (1924) 316; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1938) 384, pl. 137, 138.—*D. nummularia* (non LAMK) BLUME, En. Pl. Jav. 1 (1827) 21; O. KUNTZE, Rev. Gen. Pl. 1 (1891) 704–5, *vars glabrescens* and *puberula*.—*D. zollingeriana* KUNTH, En. Pl. 5 (1850) 384; MIQ. *op. cit.* 571, not in Suppl.—*D. diepenhorstii* MIQ. Fl. Ind. Bat. Suppl. (1860) 611; KOORD. Exk. Fl. Java 4 (1923) 271.—*D. cornifolia* (non KUNTH) RIDL. Mat. Fl. Mal. Pen. 2 (1907) 81.—*D. preangeriana* ULINE ex PRAIN & BURK. J. As. Soc. Beng. new ser. 10 (1914) 33 in *syn.*—*D. oppositifolia* (non L.) BACKER, Handb. Fl. Jav. 3 (1924) 115, in chief part; Onkr. Suiker. (1931) 191 with fig. 203.—*D. sandakanensis* R. KNUTH in FEDDE, Rep. 36 (1934) 127.—Fig. 4d, 6d.

Tubers more than 1 each year, thrust deep into the soil even to 2½ m, by long stalks from which they are not sharply differentiated; flesh white; the corm whence the tubers arise is intensely woody. Stems abundantly armed at the base, climbing to 10 m, glabrescent, ca 5 mm in diam. Bulbils absent. *Leaves* opposed except a few at the very base of the stem, rather firm, ovate-elliptic from a cordiform base, acuminate, the acumen with large glands in it, to 11 by 8 cm; youth leaves hastate; lower surface drying often an intense rust-red, pubescent in various degrees, sometimes only at the petiolar end of the blade; petiole to 4½ cm long. *Male flowering axes* 1–4 together, aggregated on leafless branches or branch-ends; axes to 5 cm long, with perhaps 50 flowers spaced their own diameter apart or a little less, pubescent or puberulous, often curved and upwards showing a slight inconstant negative geotropism. Buds globose above their flat base, 1 mm long. *Female flowering axes* (1)–2(3) together, to 24 cm long, pubescent, angled. *Capsules* glabrous at maturity, apex slightly retuse; base subtruncate; wings 18–20 by 22 mm; stipe to 7 mm.

*Distr. Malaysia:* Sumatra, Mal. Peninsula, Borneo, and W. Java (E. to Cheribon). Fig. 13b.

*Ecol.* Ascending to 700 m and possibly higher, confined to an ever-wet climate and often close to running water, so favoured by a wet soil as on roadside borders in Malacca to increase where the road dips into a hollow. It cannot thrive in the tall forest; it will hold a place in the sun provided that the soil is shaded.

The large glands on the leaf-tips have been described by ORR (Not. R. Bot. Gard. Edinb. 73, 1926, 139).

*Fl.* Mal. Pen., Borneo: Dec.–Jan.; N. Sumatra: Jan.–Dec., April–June; Java: May–June.

*Econ.* The tubers escape human use and the vernacular names are such as *akar kemenyan* or benzoin climber which recall the scent of the flowers.

## KEY TO THE VARIETIES

1. Stems, when the plant is mature, abundantly prickly in their lowest 10 cm.
2. Lower surface of the leaf with a grey tint.
3. Blade carries hairs on the back near the petiole, but the upper part is without them.

*var. diepenhorstii*

3. Lamina carries hairs generally, on the lower surface *var. pyrifolia*
2. Lower surface of the leaf coated with tawny hairs *var. borneensis*
2. Lower surface of the leaf dries a bright rust red. *var. ferruginea*

1. Stem without prickles, even at maturity.

*var. subinermis*

*Var. subinermis* PRAIN & BURK. (1938) occurs in the central parts of the Malay Peninsula.

*Var. borneensis* PRAIN & BURK. *l.c.* seems to be common in NE. Borneo.

*Var. diepenhorstii* (MIQ.) PRAIN & BURKILL (1914) is frequent in Java and S. Sumatra.

*Var. pyrifolia* and *var. ferruginea* PRAIN & BURK. (1914) are met with throughout the area that the species occupies. O. KUNTZE published (*op. cit.*) two other varietal names: on a visit to Palabuhan Ratu, on the south coast of western Java he met with *D. pyrifolia* in *var. pyrifolia* and *var. diepenhorstii*, and when he came to name them he called them *D. nummularia var. puberula* and *var. glabrescens*.

56. *Dioscorea platycarpa* PRAIN & BURK. Kew Bull. 1925, 65; Ann. R. Bot. Gard. Calc. 14 (1938) 410, pl. 92.

Lower parts unknown. Stem climbing to 16 m, distally unarmed, but probably armed at the base. Bulbils none seen. *Leaves* opposed, exactly ovate, shortly mucronate, to 8 by 5 cm at the horizon of flowering, 5-nerved; upper surface apparently pubescent when young, but not so when fully grown; lower surface with rather short tawny or reddish hairs in abundance; the secondary nerves broken considerably in the network; petiole to 2 cm. *Male plant* unknown. *Female flowering axes* as far as known, rather short and slender; their flowers not seen. *Capsules* with the apex just retuse, the base truncate; wings 21 by 22 mm, conspicuously broad; stipe to 4 mm.

*Distr. Malaysia:* Java (Besuki), once found. Fig. 13c.

57. *Dioscorea puber* BLUME, En. Pl. Jav. 1 (1827) 21; KUNTH, En. Pl. 5 (1850) 390; KOORD. Exk. Fl. Java 1 (1911) 310; R. KNUTH, Pfl. R. 87 (1924) 282, in part; PRAIN & BURK. Ann. R. Bot. Gard. Calc. 14 (1938) 402, pl. 138 & 143.—*D. anguina* ROXB. Fl. Ind. 3 (1832) 803 *excl. ref.* RUMPH.; KOORD. Exk. Fl. Java 1 (1911) 310; KOORD.-SCHUM. Syst. Verz. Lief. 9 (1912) genus 1252; PRAIN & BURK. J. As. Soc. Beng. new ser. 10 (1914) 32; KOORD. Exk. Fl. Java 4 (1923) 265.—*D. cornifolia* KUNTH, En. Pl. 5 (1850) 385; MIQ. Fl. Ind. Bat. 3 (1859) 571.—*D. oppositifolia* (non L.) BACKER, Handb. Fl. Java 3 (1924) 115, in small part.—Fig. 5r.

Tubers 1 or 2 each year, driven deep, even to 2 m, into the soil by long stalks, tubers to 8 cm in diam.; skin tawny orange; flesh lemon yellow, fibrous in the upper part of the stalk but edible. Stem warted but not armed at the base, pubescent, to 8 mm in diam. Bulbils large. *Leaves* more often

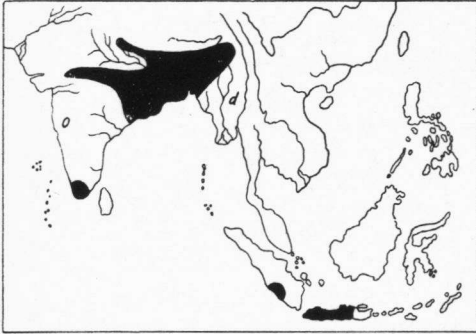


Fig. 14. Distribution of *D. puber* BL. showing the considerable area in India which seems to be its natural home and outlying posts in Travancore, S. Sumatra, and Java. In SE. Asia *o* on the map indicates where the pubescent *D. oppositifolia* L. grows and *d* where the equally pubescent *D. decipiens* HOOK. f. grows.

alternate than opposed, from exactly cordate to ovate-cordate, acuminate, typical leaves to 12 by 9–11 cm, but sometimes as large as 24 by 20 cm; lower surface permanently pubescent, upper surface glabrescent; petiole as long as the blade, usually livid in colour at the pulvini. *Male flowering axes* 1–2 together (usually 2), aggregated on leafless branches which attain 18 cm in length and are densely pubescent; axes to 2 cm long with flowers to the very base, these in number to 30 or more, so little spaced that they touch one another. Buds globose above a flat base, to 1 mm long. *Female flowering axes* 1–3 together in axils of leaves or sometimes on very short axillary branches; axis densely pubescent, up to 15 cm long, with up to 40 flowers. *Capsules* retaining to ripeness in sheltered angles some of their pubescence; apex retuse; base almost truncate; wings 15 by 18 mm; stipe 3–4 mm.

*Distr.* SE. Asia and *Malaysia*: Sumatra (West Coast, once collected), Java (E to Madiun), not in the Moluccas. Fig. 14.

*Ecol.* It has the largest leaves of any of the *Enantiophylla*, the leaf surface attaining almost 200 cm<sup>2</sup>. *Fl.* Java: April–June, India: Aug.–Dec. Ripe fruit has not yet been obtained in Java.

*Econ.* The needy eat the tubers in India, but they make a poor food and it is difficult to think that man can have transported it intentionally.

58. *Dioscorea orbiculata* HOOK. f. *Fl. Br. Ind.* 6 (1892) 292; CURTIS, *J. Str. Br. R. As. Soc.* 25 (1894) 149; RIDL. *Mat. Fl. Mal. Pen.* 2 (1907) 82; PRAIN & BURK. *J. As. Soc. Beng. new ser.* 10 (1914) 31;

R. KNUTH, *Pfl. R.* 87 (1924) 281; RIDL. *Fl. Mal. Pen.* 4 (1924) 317; BURK. *Dict.* (1935) 822; PRAIN & BURK. *Ann. R. Bot. Gard. Calc.* 14 (1938) 411, *excl. specim. Born.*, pl. 145.—*D. glabra* (non ROXB.) RIDL. & CURTIS, *J. Str. Br. R. As. Soc.* 38 (1902) 66, in part.—*D. oppositifolia* (non L.) BACKER, *Handb. Fl. Jav.* 3 (1924) 115, in part.—Fig. 5p, 6f.

Tubers several each year on long spreading stalks that may reach 2 m in length; flesh white, edible, delicate. Stem rather sparingly armed at the base, climbing to 10 m, slightly ridged, with rusty red pubescence when young. Bulbils none seen. *Leaves* usually opposed, rather firm, orbicular below the acumen or orbicular-ovate or orbicular-cordate, with a well developed acumen (to 2 cm long), pubescent when young but glabrescent to 18 by 14 cm, 7-nerved; the larger hairs dendroid (fig. 6); petiole to 10 cm, pubescent. *Male flowering axes* 1–6 together, usually aggregated on leafless branches which may be 70 cm long; rarely a few of the axes in fascicles in leaf-axils; axis to 6 cm long with upwards of 50 flowers spaced along it at more than their own diameter apart, coated with brown dendroid hairs. Buds globose above a broad base, 1 mm long. *Female flowering axes* solitary, up to 15 cm long and with upwards of 30 flowers; axis with a coating of brown hairs. *Capsules* large, becoming glabrous before reaching full size; apex truncate; base rounded-truncate; wings to 30 by 26 mm; stipe 8–9 mm.

*Distr. Malaysia*: Sumatra (Asahan), Malay Peninsula (from Puket to Johore). Fig. 13a.

*Ecol.* By no means uncommon in Perak, *fl.* Oct.–Nov., but also in the less rainy months May–June.

*Econ. & Vern.* The Pagan tribes of the Malay Peninsula eat the tubers; the northern Sakai call them *takob* and *wauh*; but the second vernacular covers more species than *D. orbiculata*; it may have been derived from the Mon-Khmer noun *khaoi*. *Takob* is a name well enough known for Malays to use it as *akar takob* (takob climber). Further names collected from pagan tribes are *kud*, *kedak* and *kakap*.

59. *Dioscorea polyclades* HOOK. f. *Fl. Br. Ind.* 6 (1892) 294; RIDL. *Mat. Fl. Mal. Pen.* 2 (1907) 81; PRAIN & BURK. *J. As. Soc. Beng. new ser.* 10 (1914) 32; KOORD. *Exk. Fl. Java* 4 (1923) 269 as *polycloides*; R. KNUTH, *Pfl. R.* 87 (1924) 275; RIDL. *Fl. Mal. Pen.* 4 (1924) 315; PRAIN & BURK. *Ann. R. Bot. Gard. Calc.* 14 (1938) 407, pl. 144.—*D. nummularia* (non LAMK) MOR. *Syst. Verz.* (1846) 92; KUNTH, *En. Pl.* 5 (1850) 386 *excl. ref.*; ZOLL. *Syst. Verz.* (1854) 68; MIQ. *Fl. Ind. Bat.* 3 (1859) 572 in large part; O. KUNTZE, *Rev. Gen. Pl.* 1 (1891) 704, *pro ref. var. velutina*.—*D. puber* (a) (non BLUME) KOORD.-SCHUM. *Syst. Verz. Lief.* 9 (1912) *genus* 1252; R. KNUTH, *op. cit.* 282, in part.—*D. oppositifolia* (non L.) BACKER, *Handb. Fl. Jav.* 3 (1924) 115, in part.

Tubers very like those of *D. pyriformis*, flesh edible. Stems abundantly armed with rather small prickles in the lower parts but unarmed above, climbing to 30 m, densely pubescent, faintly ridged

under the pubescence. Bulbils none seen. *Leaves* opposed, herbaceous, elliptic-cordate or exactly cordate, or more rarely oblong (*var. velutina* O. K.), acuminate, usually to 12 by 12, but occasionally attaining 25 by 22 cm, 7-nerved, retaining a thin pubescence on the upper surface and more pubescence on the lower; petiole at times prickly, up to 4(-6) cm. *Male flowering axes* 1-4 together, aggregated on leafless branches which rise in the axils of upper leaves and attain 30 cm in length; axes conspicuously longer if at the base of one of these large inflorescences than towards the end, with a characteristic short sterile part at the base below the flowers as a stalk 2-5 mm long, their total length to 2-2½ cm. Flowers about 20 or more, usually touching each other though not in *var. oblongifolia*; pubescent axis angled under the pubescence. Buds more or less globose above a flattened base, 1 mm long. *Female flowering axes* to 20 cm long, covered with tawny hairs; bracts dense-

ly pubescent ovate, acute, 2 mm long. *Capsules* becoming glabrous as they grow to full size; apex retuse; base truncate; wings to 25 by 20 mm; stipe to 5 mm.

*Distr.* *Malaysia*: Sumatra (incl. Sebesi Island in Sunda Straits), Malay Peninsula, and Java. Fig. 13b.

*Ecol.* Ascending to 700 m.

*Note.* *Var. oblongifolia* ULINE *ex* KNUTH is typified by ZOLLINGER 283 from Java. O. KUNTZE's collections nos 5297 and 5279 typifying *D. nummularia var. velutina* O. K. sufficiently agree with *var. oblongifolia*, and it seems convenient to redefine this variety thus:

*var. velutina* (O. K.) BURK. *comb. nov.*—*D. pyrifolia var. oblongifolia* ULINE *ex* KNUTH, Pfl. R. 87 (1924) 275.

Leaves narrower than in the type. Male spikes longer and sometimes with the flowers spaced their own diameter apart.

#### Excluded and doubtful species

*Dioscorea aculeata* NAVES in NAVES and F. VILLAR, *Novis. App. Fl. Filip.* (1880) 260, from the island of Panay is probably *D. aculeata* L. (1754, not of 1753) and therefore would be *D. esculenta* BURK.

*Dioscorea batatas* NAVES, *op. cit.* 258, from Manila, would not be *D. batatas* DECNE (which is *D. opposita* THUNB.) and may represent *D. divaricata* BLANCO.

*Dioscorea bolonjonica* BLANCO, *Fl. Filip.* (1837) 800, ed. 2 (1845) 551, ed. 3, 3 (1879) 208 = *Pueraria phaseoloides* BENTH. (*Legum.*).

*Dioscorea eburnea* NAVES, *op. cit.* 260, from Antique, Philippines, as based on RUMPHIUS's *Herb. Amb.* is probably a clone of *D. alata* L.

*Dioscorea glabra* NAVES, *op. cit.* 258, from Bosoboso in Rizal Province, Luzon, as a misinterpretation of VIDAL's no 3932 would be *D. peperoides* PRAIN & BURK.

*Dioscorea globifera* R. KNUTH, Pfl. R. 87 (1924) 149 may represent *D. pentaphylla* L. *var. papuana* PRAIN & BURK. described above, p. 316.

*Dioscorea japonica* NAVES, *op. cit.* 259, certainly not *D. japonica* THUNB., is indeterminate.

*Dioscorea mindanaensis* R. KNUTH, Pfl. R. 87 (1924) 271; PRAIN & BURK. *Ann. R. Bot. Gard.*

*Calc.* 14 (1936) 70. The name is virtually a *nomen nudum*, the scrap to which it was given being inadequate even for the establishment of the section. But it is interesting to know that a *Dioscorea* occurs on the E. slopes of Mt Apo in Mindanao (S. Philippines) at the considerable height of 2000 m.

*Dioscorea oppositifolia* NAVES, *op. cit.* 258, from S. Mateo, near Manila and from the islands of Panay, Cebu and Negros, cannot have been *D. oppositifolia* L. and is indeterminate.

*Dioscorea repanda* BLUME, *En. Pl. Jav.* 1 (1827) 22 is an indeterminate immature condition of one of the species of section *Enantiophyllum*.

*Dioscorea spiculata* BLUME, *En. Pl. Jav.* 1 (1827) 22 *excl. obs. foliis oppositis, caule alato et syn. Rumph.*; MIQ. *Fl. Ind. Bat.* 3 (1859) 573 = according to HALLIER, *Med. Rijksherb. Leiden* 1 (1910) 40 = *Tinospora crispa* Miers = *Tinospora coriacea* (BL.) BEUMÉE *ex* HEYNE (*Menispermaceae*).

*Dioscorea verticillata* LAMK, *Dict. Encycl.* 3, 3 (1789) 231 = *Rubia cordifolia* L. (*Rub.*); *cf.* DAVEAU, *Bull. Soc. Bot. Fr.* 75 (1928) 254-256. This was based on a Javan specimen collected by COMMERSON.