

A Revision of the Malesian Species of *Arthrophyllum* Bl. (Araliaceae)

by

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The genus *Arthrophyllum* forms a well-defined group of species within the Araliaceae. Its principal distinctive characters are the single-celled ovary and the arrangement of the umbels on specialized flowering branches. The vegetative shoots bear pinnate or bipinnate leaves in spiral phyllotaxis. Branches do not develop until flowering occurs, when a terminal tuft of lateral branches develops. These bear opposite leaves of reduced size and terminate in a whorl of secondary branches which may themselves bear umbellules or which may branch again before doing so (fig. 1). Vegetative growth is continued by one or more innovations, with spirally arranged leaves, arising below the crown of flowering branches.

The geographical range of the genus almost coincides with that of Flora Malesiana, but extends slightly further west to the Nicobar Islands and northwards into Laos and Thailand, and the range does not include the Lesser Sunda Islands. Apart from the treatment in Ridley's Flora of the Malay Peninsula, no revision of the species has appeared. The many taxa given specific names by early investigators (most of which are here regarded as synonyms) were never critically compared, so that knowledge of the genus has remained confused and fragmentary and botanists have tended to avoid it. Consequently it has been found necessary to describe several new species, while at the same time reducing several others to synonymy.

The present revision is regarded as only tentative. Herbarium material is abundant, but most specimens are fragmentary and therefore fail to illustrate the unusual branch-systems which characterize some species. Specific distinctions seem to be unusually difficult to define on the basis of herbarium specimens, so that knowledge of the group will remain superficial until a comprehensive field study can be undertaken throughout the range of the genus.

The genus comprises two species-complexes, and also the anomalous *A. proliferum*. One of these complexes includes seven shrubby species with simpler inflorescences (no more than three degrees of branching), namely, *A. maingayi*, *A. montanum*, and *A. alternifolium* (from the Malay Peninsula, with the first species also from Sumatra and Borneo); *A. papyraceum* (from Sumatra); *A. pulgarensis* and *A. cenabrei* (from the Philippines); and *A. kjellbergii* (from Celebes). The second complex consists of nine species of tree stature with larger inflorescences (having four degrees of branching). This complex occurs commonly throughout the range of the genus, and its subdivision into species presents considerable difficulty. To the east *A. macranthum* is abundant on the mainland of New Guinea, while on islands to the north a second species, *A. pacificum*, is recognized. In the Philippines and northern Moluccas this complex is represented by *A. ahernianum*, a species which also extends into the extreme north-east of Borneo. The complex is more difficult to classify further west and south, that is, in Celebes, Borneo, Java, Sumatra, and the Malay Peninsula. In the present

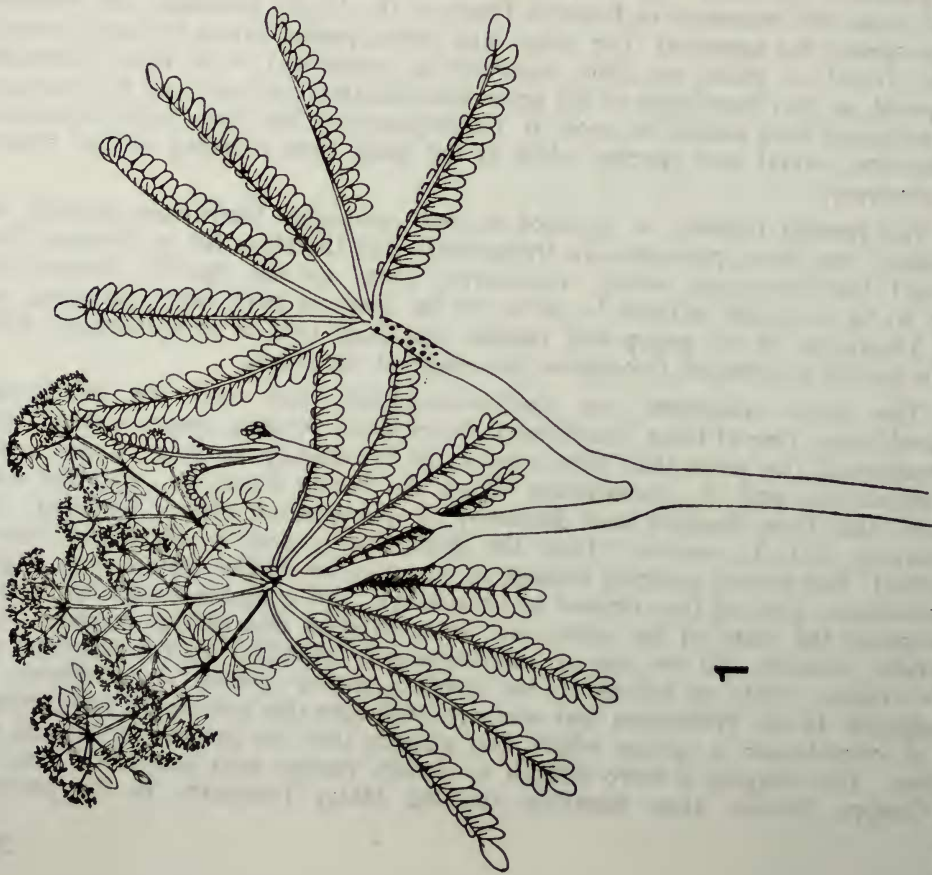


Fig. 1. *Arthrophyllum diversifolium*, diagrammatic sketch of habit showing vegetative and flowering branches ($\times 1/30$).

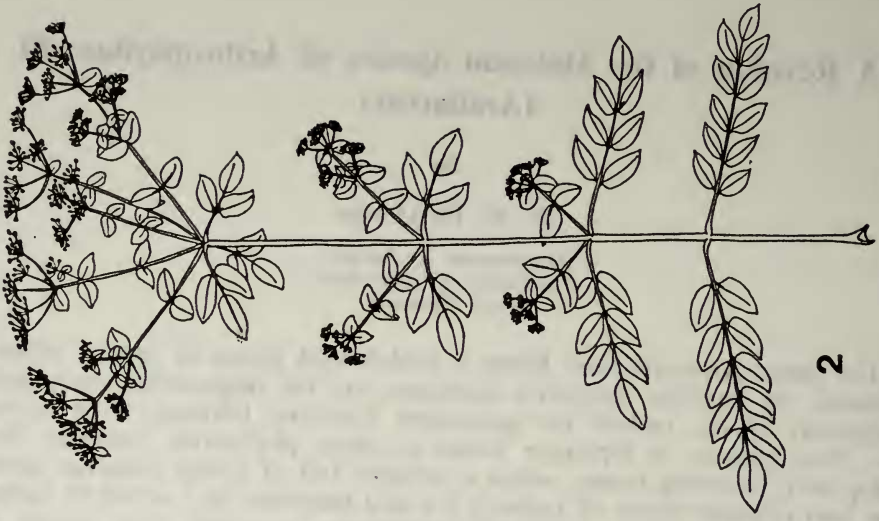


Fig. 2. *A. diversifolium*, schematic drawing of a single flowering shoot with four degrees of branching ($\times 1/10$).

revision, in addition to the widespread *A. diversifolium*, five entities from this area are given specific rank: three species endemic to Borneo (*A. crassum*, *A. collinum*, and *A. ashtoni*); one most distinctive species, *A. angustifolium*, which is rare in Borneo and the Malay Peninsula; and a species, *A. engganoense*, which is known only from the small island, Enggano, off the west coast of Sumatra. The remaining great mass of material is here treated as a single species, *A. diversifolium*. The variation and nomenclature of this widespread taxon is discussed separately under the section on that species.

ARTHROPHYLLUM

Arthrophyllum Bl. Bijdr. Fl. Ned. Ind. (1826) 878. *Mormorphis* Jack ex Wall. Cat. n. 4931 (1831).

Sparingly branched trees or shrubs, unarmed. The leaves on vegetative shoots spirally arranged, imparipinnate, those on flowering branches often opposite, smaller, or reduced to a single leaflet; stipular sheath small. Inflorescence consisting of compound umbels, either solitary and terminal or more commonly borne on a cluster of specialized leafy branches arising from the axils of the uppermost leaves; pedicels not articulated. Flowers hermaphrodite; calyx an undulate rim; petals 4-6, valvate in bud; stamens 4-6, anthers curved, basifixed; ovary turbinate, 1-celled; disk fleshy, rising in the centre to the \pm sessile capitate stigma. Fruit ovoid or spheroidal, often oblique; exocarp leathery; endocarp cartilaginous; seed solitary, pendulous; endosperm deeply transversely ruminant.

About 18 species (17 in Malesia) extending from the Nicobar Islands and in the larger islands or regions is as follows: Sumatra 4; Malay Peninsula 5; Java 1; Borneo 7; the Philippines 3; Celebes 2; Moluccas 2; New Guinea and Bismarck Archipelago 3. The genus *Eremopanax*, with several species in New Caledonia, may be congeneric.

KEY TO THE SPECIES ...

- 1. a. Inflorescence becoming paniculate by the successive development of branches below the umbellules (figs. 3, 4) 1. *A. proliferum*
- b. Inflorescence a compound umbel 2
- 2. a. Inflorescence with four orders of branching (fig. 2) 3
- b. Inflorescence with three (or fewer) degrees of branching (figs. 5, 6) 11
- 3. a. Leaflets lanceolate 4
- b. Leaflets broader 5
- 4. a. Leaflets c. 4-7 cm long (fig. 12) 2. *A. ashtoni*
- b. Leaflets much longer 3. *A. angustifolium*
- 5. a. Pedicels (at early anthesis) \pm 10 mm long 6
- b. Pedicels (at early anthesis) c. 5 mm long, or shorter 7
- 6. a. Peduncles of umbellules with bracts or bract-scars (fig. 13) 4. *A. ahernianum*
- b. Peduncles of umbellules (fig. 14) without bracts or scars 5. *A. engganoense*

7. a. Leaves associated with the umbels rotund (fig. 17) 6. *A. collinum*
 b. Leaves (or leaflets) associated with the umbels ovate or elliptic 8
8. a. Leaves associated with the umbels ovate, \pm fleshy, with the lower surface smooth (lateral veins obscure) (fig. 18) 7. *A. crassum*
 b. Leaves (or leaflets) associated with the umbels \pm elliptic, coraceous or chartaceous, veins visible 9
9. a. Young parts glabrous 8. *A. pacificum*
 b. Young parts with rufous tomentum 10
10. a. Umbels at anthesis with numerous filamentous pedicels (fig. 15) 9. *A. diversifolium*
 b. Umbels at anthesis with fewer stout pedicels (fig. 16) 10. *A. macranthum*
11. a. Leaflets membranaceous or chartaceous 12
 b. Leaflets coriaceous 14
12. a. Mid-leaflets about 16 cm long 11. *A. papyraceum*
 b. Mid-leaflets \pm 8 cm long or shorter 13
13. a. Leaflets usually 5–7 (fig. 7), primary inflorescence branches usually short (\pm 3–6 cm) and without articulations 12. *A. maingayi*
 b. Leaflets more numerous (fig. 10), primary inflorescence branches longer (10–20 cm) with one or more leafy nodes 13. *A. kjellbergii*
14. a. Leaflets c. 5 14. *A. cenabrei*
 b. Leaflets more numerous 15
15. a. Petals & stamens 6 15. *A. pulgarensense*
 b. Petals & stamens 4 or 5 16
16. a. Leaflets 6 cm long, or longer (fig. 8) 16. *A. montanum*
 b. Leaflets shorter (fig. 11) 17. *A. alternifolium*

1. ***Arthrophyllum proliferum*** Philipson, *sp. nov.*

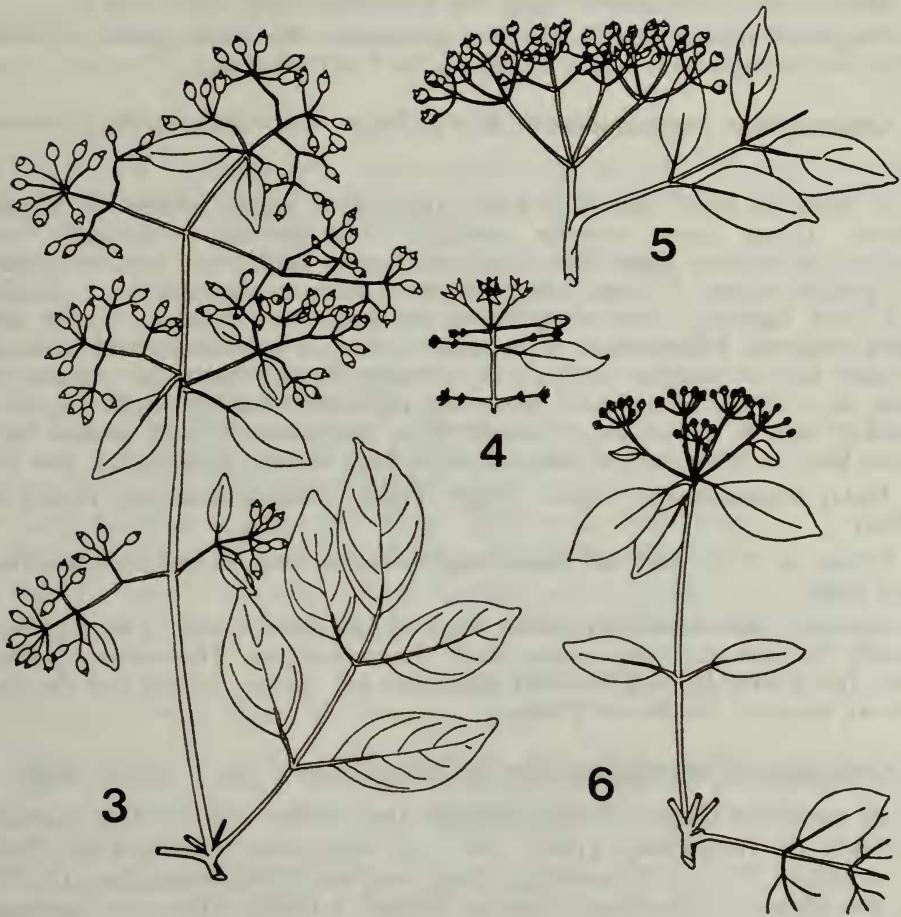
Arbor foliis imparipinnatis. Inflorescentiae ex suis propriis ramis natae, paniculatae factae ramis sub umbellulis iterum atque saepius ramificantibus.

Medium sized tree, glabrous. Leaves of the vegetative stems spirally arranged, imparipinnate, multijugate, 90 \times 24 cm, of the flowering branches smaller with fewer pinnae or usually simple; leaflets obovate-oblong, c. 16 \times 7 cm, chartaceous, margin entire, slightly revolute, base broadly cuneate to truncate, sometimes oblique, apex acute. Inflorescences terminating specialized plagiotropic shoots, bearing axillary flowering branches and ending in umbellules of a few flowers below which pairs of whorls of branches continue the growth of the inflorescence to produce an elongated panicle of umbellules.

Endemic to Papua New Guinea. Type: Territory of New Guinea, Morobe District, Mauwata Banda L.A., Bulolo, *Havel and Kairo NGF 17172* (Canberra).

In mid-mountain rain forest, reaching the canopy, on steep slopes, 300–1200 m.

The flower and fruit are typical of this well-defined genus, but the branching of the inflorescence is unlike that found in all other species.



Figs. 3-6. 3. *A. proliferum*; a portion of inflorescence in the fruiting state ($\times \frac{1}{2}$); 4, same, showing detail of ultimate branches of the inflorescence in the flowering stage ($\times 1$). 5. *A. maingayi*, terminal inflorescence ($\times \frac{1}{2}$). 6. *A. montanum*, a single flowering shoot ($\times \frac{1}{2}$).

2. *Arthrophyllum ashtoni* Philipson, *sp. nov.*

Abor gracilis tomento fusco. Folia imparipinnata, foliolis lanceolatis vel late-lanceolatis, 3-7.5 \times 1-2 cm. Inflorescentia ramis in praporium officium mutatis et in coronam terminalem dispositis, quarter ramificantibus.

A slender small tree, to 5 m high, young parts with brown scurfy tomentum. Leaves of the vegetative stems spirally arranged, imparipinnate, multijugate, to about 30 cm long; of the flower-bearing branches smaller with fewer pinnae, or simple; leaflets lanceolate to broadly-lanceolate; 3-7.5 \times 1-2 cm, thinly coriaceous, margin entire, revolute, base broadly cuneate, apex tapered to sub-caudate, veins channelled above, visible below. Inflorescence a terminal cluster of specialized leafy branches; the main rays variable in length in the same inflorescence, ending in a whorl of secondary rays subtended by simple leaves; the secondary rays 4-12 cm long, bearing simple leaves, usually in an opposite pair and terminating in compound umbels; umbellules with about 8-10 flowers pedicels 4-10 mm long, furfuraceous.

Endemic to Borneo. Type: Brunei: Pagon ridge, *Ashton Brun 2341* (Kew).

Moss forest on sandstone ridge, and Kerangas forest, 1000-1550 m.

The small narrow leaflets are very distinctive. No other species with small leaflets has inflorescences which branch to the fourth degree.

3. **Arthrophyllum angustifolium** Ridley in Journ. Fed. Mal. St. Mus. 10 (1920) 136.

A shrub or small tree, 5 m high, young parts rufous tomentose, becoming glabrous. Lower leaves spirally arranged, imparipinnate, multijugate, about 70-90 × 30-40 cm; upper leaves reduced mostly unifoliate, opposite, broader, with petioles about 2-4 cm long; leaflets coriaceous lanceolate, c. 15-22 × 1.5-2.5 cm, tapering to an acute or obtuse apex, base cuneate, margin entire, slightly revolute. Inflorescence a terminal cluster of specialized leafy branches; the main rays 30 cm (or more) long, bearing simple leaves in opposite pairs ending in a whorls of c. 10-12 secondary rays subtended by simple leaves; the secondary rays 8-12 cm long, terminating in an umbel of 5-12 tertiary rays c. 2-3 cm long, each bearing an umbellule of c. 8-12 flowers, pedicels c. 5 mm long.

Malay Peninsula and Borneo. Type: Perak, Gunong Keledang, *Ridley 9683* (SING).

Occurs in forest and old regenerated forest on peat swamp at low altitudes or on ridges.

The lanceolate leaflets are unlike those of any other species. The grey bark is minutely fissured and bears many small orange lenticels. The wood is soft and white. The Peninsular and Bornean specimens are similar, except that the flower buds are larger in the Brunei plant.

4. **Arthrophyllum ahernianum** Merr. in Philipp. Journ. Sci. 1 (1906) Suppl. 109.

— "*A. pinnatum* Clarke" F. -Vill. Novis. App. (1880) 103 — *Macropanax* sp. Vidal Rev. Pl. Vasc. Philip. (1886) 145. — *A. sablanense* Elmer in Leaflet, Philipp. Bot. 1 (1908) 331. — *A. borneense* Merr. in Univ. Calif. Pubs. Bot. 15 (1929) 231, non Baker. — *A. elmeri* Merr. in Webbia 7 (1950) 319. — *A. merrilliana* Furtado, in Gard. Bull. 19 (1962) 185.

Tree up to 15 m high, young parts with rufous tomentum. Leaves clustered at the ends of the branches, spirally arranged on the vegetative shoots, imparipinnate, multijugate, articulated at the insertion of the pinnae; up to 200 × 60 cm; of the flower-bearing branches smaller with fewer pinnae, or simple; leaflets ovate-oblong, occasionally oblong-lanceolate, up to 35 × 12 cm, membranaceous or chartaceous, margin entire, revolute, base cuneate to rounded, usually oblique, apex short acuminate. Inflorescence a whorl of specialized leafy branches forming a terminal crown; the main rays up to 150 cm long (or more), bearing pinnate leaves usually in 1-2 opposite pairs, ending in a whorl of secondary rays up to 30 cm long terminating in compound umbellules; umbellules with about 10-20 flowers; pedicels c. 10 mm long (at anthesis).

Extending from northern Borneo, throughout the Philippines to the northern Moluccas. Type: Lamao Forest Reserve, Luzon, *Meyer 2780*.

Primary and second-growth forest, from lowlands to 1000 m.

This species replaces the more westerly *A. diversifolium* which it closely resembles. It is characteristically larger in all its parts, particularly in the size of the individual flowers and the length of their pedicels. There are fewer flowers in an umbellule. The distinction between these two species is not always easy to make, especially when the material is fragmentary. A few specimens from the Philippines e.g. *Clemens 585*, *Merrill 1232* appear very similar to *A. diversifolium*, and it is possible that this species extends beyond Borneo. However, at present

these specimens are regarded as part of the range of variation of *A. ahernianum*. Similarly, at least one specimen from southern Borneo (*Buwalda 7973*) approaches *A. ahernianum* in appearance.

5. **Arthrophyllum engganoense** Philipson, *sp. nov.*

Arbor foliis imparipinnatis. Inflorescentia ramis in proprium officium mutatis et in coronam terminalem dispositis, quater ramificantibus; umbellulae pedicellis circa 5–10, c. 10–15 mm longis sub anthesi.

A tree to 21 m high, becoming glabrous. Lower leaves imparipinnate, multijugate, 60 cm long or more, petiole 24 cm long, 6 mm wide, petiolules 10–18 mm long; leaflets broadly elliptic to elliptic-oblong, c. 12–15 × 6–7 cm, base rounded with a short asymmetrical cuneate centre, apex shortly apiculate, margin entire often undulate chartaceous. Flowering branches c. 40 cm long; leaves opposite, simple or unifoliolate, ending in a whorl of simple leaves surrounding a compound umbel to 30 cm diam.; secondary rays about 8, c. 10–15 cm long, tertiary rays c. 8, slender c. 20–40 mm long, without bracts; pedicels c. 5–10 per umbellule, c. 10–15 mm at anthesis.

South Sumatra, Enggano Isd. Type: *Lütjeharms 4260* (Bogor).

Occurs in forest at low altitudes (up to about 100 m).

The two known collections of this species are very similar and contrast with the widespread *A. diversifolium* because of the few flowered umbelles with long, spreading pedicels.

6. **Arthrophyllum collinum** Philipson, *sp. nov.*

Arbor parva in prima aetate tomento rufo. Folia imparipinnate, foliolis oblongis, late ellipticis vel rotundis. Inflorescentia ramis in proprium officium mutatis et in coronam terminalem dispositis, quater ramificantibus; bracteis rotundis, coriaceis.

Sparingly branched shrub or small tree up to 12 m high, all young parts with dense rufous tomentum. Leaves of the vegetative stems spirally arranged, imparipinnate, multijugate, up to 60 (or more) × 32 cm; leaflets oblong, broadly elliptic or rotund, up to 16 × 7 cm, coriaceous, margin entire slightly revolute, base truncate to rounded, unequal, apex rounded, obtuse, or shortly and bluntly apiculate, mid-rib prominent, lateral veins usually clearly visible below, upper surface frequently rugose. Leaves of the flowering branches smaller with fewer pinnae or more frequently unifoliolate, leaflets more rotund and with longer petioles. Inflorescence a cluster of specialized leafy branches forming a terminal crown; the main rays up to 60 cm long, bearing one or more rarely two opposite pairs of usually unifoliolate rotund leaves.

Endemic to Borneo. Type: Sabah, Kinabalu, *Clemens 33195* (BM).

In forest and scrub from 600–2700 m, sometimes growing as an epiphyte in the crowns of trees.

The bark is grey and smooth, the wood pale and soft, and the cut stems exude a yellowish or orange latex. This species is characterized by the rotund coriaceous leaves on the flowering branches.

7. **Arthrophyllum crassum** Philipson, *sp. nov.*

Arbor parva in prima aetate tomento rufo. Folia imparipinnata, foliolis ellipticis oblongis vel lanceolatis. Inflorescentia ramis in proprium officium mutatis et in coronam terminalem dispositis, quater ramificantibus; bractea ovata plerumque acuta, rigidior alutaequa naturam habens, margine valde revoluta, nervis lateralibus obscurissimis.

Sparingly branched shrub or small tree up to 8 m high, all young parts with dense rufous tomentum. Leaves of the vegetative stems spirally arranged, imparipinnate, multijugate, up to 100 (or more) \times 50 cm, of the flowering branches smaller with fewer pinnae or more frequently unifoliolate; leaflets elliptic, oblong or lanceolate, up to 24 \times 7.5 cm, coriaceous, margin entire, strongly revolute, base cuneate to rounded, often oblique, apex narrowed to an acute often caudate apiculum, mid-rib prominent, lateral veins faint to obscure. Inflorescence a cluster of specialized leafy branches forming a terminal crown; the main rays up to 70 cm long, bearing an opposite pair (or rarely more pairs) of unifoliolate or (less frequently) pinnate leaves.

Endemic to Borneo. Type: Sarawak, Bako National Park, *Chai S18020* (Leiden).

Swampy peat forest and heath woodland, both primary and disturbed, from sea level to about 150 m. Some fragmentary collections (*Banying ak Nyudong S19404*; *Brunig S8720*; *Hewitt 770*) from higher altitudes (1000 m) further inland may belong to this species.

The leaves associated with the inflorescence are distinctively fleshy, have a strongly revolute margin and a smooth lower surface with indistinct lateral veins, and are ovate with rather acute apex. The leaflets of the pinnate leaves on the vegetative shoots are also rather leathery with indistinct lateral venation. The shrubs are occasionally epiphytic.

8. *Arthrophyllum pacificum* Philipson, *sp. nov.*

Arbor gracillis glabra, foliis imparipinnatis; foliolis plerumque ellipticis, c. 8–10 \times 4–5 cm, membranaceis Inflorescentia ramis in proprium officium mutatis et in coronam terminalem dispositis, quater ramificantibus.

A slender tree to 14 m high, glabrous. Leaves of the vegetative stems spirally arranged, pinnate, multijugate, about 60 \times 24 cm; of the flower-bearing branches smaller with fewer pinnae or simple; blade elliptic, oblong or ovate, about 8–10 \times 4–5 cm, rather membranaceous, margin entire, very slightly revolute, base abruptly cuneate, often oblique, apex obtuse, acute, or slightly apiculate. Inflorescence a whorl of specialized leafy branches forming a terminal crown to the vegetative shoots; the main rays 35 cm long bearing small pinnate leaves in opposite pairs.

Extending from the Moluccas to the Bismarck Archipelago. Type: Bismarck Archipelago, New Britain, Pomio subdistrict, *Isles et al NGF 34424* (Lae).

Primary forest on slopes of mountains, attaining Nothofagus mossy forest, from 800–2000 m. Reported as common in most localities.

All specimens from islands to the north of New Guinea are similar, in having more delicate foliage than *O. macranthum* from the mainland of New Guinea.

9. *Arthrophyllum diversifolium* Bl. Bijdr. Fl. Ned. Ind. (1826) 879. — *A. javanicum* Bl. l.c. — *A. ellipticum* Bl. l.c. — *Mormorphis sumatrana* Jack. ex Wall. Cat n. 4931 (1831). — *Arthrophyllum blumeianum* Zoll and Moritz, Syst. Verz. Pl. Zoll. (1845-6) 41. — *A. ovalifolium* Jungh. and de Vriese in Ned. Kruid. Arch. 1 (1846) 19. — *A. ovatifolium* Jungh. and de Vriese in Ann. Sci. Nat. 3, 6 (1846) 117. — *A. dilatatum* Miq. Fl. Ind. Bat. 1 (1856) 768. — *A. diversifolium* var. *lanceolata* Miq. Fl. Ind. Bat. Suppl. 1 (1860) 340. — *A. blumeianum* var. *oblongatum* Miq. in Ann. Mus. Bot. Lugd. -Bat. 1 (1863) 27; var. *ellipticum* Miq. l.c.; var. *ovalifolium* Miq. l.c. — *A. borneense* Baker in Kew Bull. (1896) 23. — *A. congestum* Ridley in Journ. Fed. Mal. St. Mus. 10 (1920) 137. — *A. havilandii* Ridley in Kew Bull. (1933) 494. *A. rufo-sepalum* Ridley l.c. (1946) 40. — *A. rubiginosum* Ridley l.c. 41.

A small tree up to 14 m high, young parts with rufous tomentum. Leaves clustered at the end of the branches, spirally arranged on the vegetative shoots, imparipinnate or bipinnate (rarely tripinnate), multijugate, 150 cm long and 45 cm wide (wider in bipinnate leaves); usually in opposite pairs on the inflorescence-bearing branches and smaller with fewer pinnae or unifoliolate; leaflets ovate-oblong or elliptic, up to 24×11 cm \pm coriaceous or membranaceous, margin entire, slightly revolute, base truncate, rounded, or cuneate, often oblique, apex shortly acuminate. Inflorescence a cluster of specialized leafy branches forming a terminal crown which abscises after fruiting; the main rays up to 150 cm long, bearing pinnate (or more rarely unifoliolate) leaves mostly in opposite pairs; the secondary rays up to c. 30 cm long, bearing mainly simple leaves in opposite pairs; tertiary rays (peduncles) about 5 cm long, articulate about the middle; pedicels \pm 20, c. 5–12 mm long.

From the Malay Peninsula and Sumatra to Java, Borneo and Celebes. Type: Java, Salak, *Blume* (Bogor).

From sea-level to 1600 m, in a wide variety of habitats, from dry sandy soil to swampy humus. Occurs in primary lowland and montane rain-forest and also in secondary forest, heath-forest and waste land.

The very widespread *A. diversifolium* is variable in many characters, and many comprise a number of geographic subspecies, but no basis for this is apparent at present. Most individuals have the lower leaves simply imparipinnate, whereas others have bipinnate, or rarely tripinnate, leaves. The flowers and inflorescences of these forms appear to be identical, though rapid changes in the umbellules after flowering produce a deceptively distinctive appearance in specimens at different stages of development. Field experience over the whole range of the species will be required to understand this interesting leaf-polymorphism. In treating all forms as one species I am partly influenced by the fact that most authors who have been familiar with the plants in Java (where both forms occur) have regarded the complex as a single species (the fact that some authors have recognized the variant from Salak as a distinct species does not affect the problem of leaf polymorphism).

Apart from the strikingly different leaf forms just discussed, certain local variants may eventually be shown to justify specific rank. A form growing on Salak (near Bogor) has often been regarded as distinct (see, for example, Hochreutiner in *Candollea* 2 (1925) 481, and Backer and Bakhuizen v.d. Brink, *Fl. Java* 2 (1965) 169). Indeed this form is the basis of the name *A. diversifolium*. I retain this name in preference to the other two names published simultaneously by Blume because it has been most consistently adopted since it was first used in this comprehensive sense by Clarke. On the evidence available I do not consider the Salak plants any more distinctive than many other local variants. It might be considered that *A. engganoense* is also no more than another such variant, but its facies is so marked that specific rank appears justified. It is possible that Ridley was correct in distinguishing *A. congestum*, but the material is not good and appears inadequate to confirm specific status. Five collections from Brunei and a neighbouring district of Sarawak are all very alike and sufficiently distinct from both *A. diversifolium* and *A. crassum* to suggest that they represent a further species: these are *Ashton* S7840, *Chew Wee-lek* 981; *Fuchs and Diederix* 21182; and *van Neil* 3895 and 4312. For the present these five gatherings are tentatively retained as a form of *A. diversifolium*. Similarly, the two collections described by Ridley as *A. rubiginosum* and *A. rufo-sepalum* are based on collections which are not altogether typical of *A. diversifolium*, but which come closest to that species. In the absence of more supporting material, it is advisable not to retain them as species. The first of these names (*A. rubiginosum*) has been widely used in

identifications of Bornean specimens, but the specimens concerned are either typical *A. diversifolium* or belong to the distinctive *A. crassum*. Specimens from Mt. Kinabalu described by Ridley as *A. havilandii* have bipinnate leaves, and appear to conform well with *A. diversifolium*. This form was again collected on Mt. Kinabalu by Clemens and is also known from Sarawak (e.g. *Morshidi* S24074).

10. ***Arthrophyllum macranthum*** Philipson, Bull. Brit. Mus. Nat. Hist. Bot. 1 (1951) 18.

Tree up to 25 m high, sparsely branched with leaves crowded at the ends of the branches, all young parts with dense rufous tomentum. Leaves of the vegetative stems spirally arranged, imparipinnate, multijugate, up to 100 × 30 cm; of the flower-bearing branches smaller with fewer pinnae, or simple; petioles; leaflets ovate to oblong, up to 16 × 8 cm, coriaceous, margin entire, revolute, base rounded, truncate, or cordate, very rarely cuneate, often oblique, apex obtuse or bluntly apiculate. Inflorescence a whorl of specialized leafy branches forming a terminal crown; the main rays up to 60 cm long, bearing pinnate leaves often in opposite pairs; the secondary rays about 10–20 cm long, bearing simple leaves, usually in opposite pairs, and terminating in umbellules or compound umbellules; umbellules with about 10–15 flowers; pedicels stout 3–5 mm long to 10 mm or more in fruit.

Endemic to New Guinea. Type: Morobe Distr. Boana, *Clemens* 8433 (A).

Usually a sub-canopy tree of rain forest ranging from the lower montane zone to mossy subalpine woodland and scrubland. Occasional in second growth. Usually above 1000 m (up to 2700 m) but occurs on the coastal scarps of the Astrolabe range.

Trees become very different in appearance when in flower or fruiting: the spiral pinnate foliage leaves are surmounted by tufts of branches which end in inflorescences and bear much smaller leaves. The foliage leaves are fleshy, leathery and glossy. The ripe fruit is purple and shining. The bark is grey, at first smooth with many leaf-scars and lenticels, but small longitudinal fissures develop. The cut branches exude a brown latex and a scent of celery. The soft wood is white or straw coloured.

11. ***Arthrophyllum papyraceum*** Philipson, *sp. nov.*

Frutex in prima aetate tomento rufo, mox glabrescens. Folia imparipinnata, foliolis circa 7; foliola tenuia, plana, c. 12–24 × 5–10 cm. Inflorescentia umbella terminalis composita radiis primariis paucis.

A shrub rufous tomentose on the young parts. Leaves alternate, imparipinnate; leaflets about 7, membranaceous elliptic c. 12–24 × 5–10 cm, base broadly cuneate, apex finely acuminate, margin entire, slightly revolute. Inflorescence a terminal compound umbel; primary rays few (2), 2–3 cm long 2 mm wide, without bracts (caducous), secondary rays few (3) c. 13–18 mm long, articulated about the middle, ending in an umbellule of c. 10–12 flowers; pedicels 2–3 mm long slightly furfuraceous.

Sumatra, Type: East Coast: Loendoet Concession, Koaloe, near Aek Sordang. *Bartlett* 6968 (Michigan).

Collected in primary rain forest.

Known from a single collection (with no duplicates) this species resembles *A. maingayi* in its simple inflorescence, and the few pinnae of its foliage leaves. However, the large size of the leaflets precludes its inclusion in that species.

12. **Arthrophyllum maingayi** Philipson, *nom. nov.* — “*A. pinnatum* (Lam.) Clarke” in Hook. f. *Fl. Brit. Ind.* 2 (1879) 734, excluding synonyms.

A low shrub or slender tree, rarely as high as 10 m, rufous tomentose on the very young parts, soon becoming glabrous. Leaves tufted at the end of the branches, spirally arranged, imparipinnate, usually with 5–7 leaflets (but up to 15), up to 30 × 18 cm; leaflets elliptic or elliptic-lanceolate, ± 8 × 3.5 cm, rather thin, base cuneate or rounded, apex apiculate or caudate, margin entire, slightly revolute, lateral veins faint and obscure. Inflorescence consisting of a number of primary branches radiating from the end of a leafy shoot; the primary branches, often rather few, usually 3–6 cm long and devoid of leaves except for a few terminal simple or 3-foliolate leaves around the compound umbels, occasionally the branches bear pairs of opposite leaves when they may be up to 30 cm long; secondary rays c. 2–3 cm long; pedicels 4–10 cm long.

Extending from Sumatra throughout the Malay Peninsula to Borneo. Type: *Maingay 679* (SING).

The name used by Clarke in *Flora of British India* has been in general use for this species. However, this name was based on *Panax pinnatum* Lam. This in turn was based on the Rumphius name “*Scutellaria secunda*”, which is quite a plant (*Polyscias pinnata*). Clarke therefore misapplied the name when using it for a Malay Peninsula *Arthrophyllum*, and a new name is necessary.

The three species *A. maingayi*, *A. montanum* and *A. alternifolium* are similar in having simpler inflorescences than *A. diversifolium*. *A. montanum* can be distinguished from *A. maingayi* by its more leathery leaves with more prominent nervation, and by the more woody and leafy flower-bearing primary branches of the inflorescence. *A. alternifolium* is distinguished from both these species by its small coriaceous leaflets with inconspicuous nervation. Most specimens can be readily distinguished, but a few can be assigned to a species only doubtfully, usually because the material is inadequate. This is usually due to the junction between the vegetative (spiral phyllotaxtic) shoots and the flower-bearing branches being omitted.

13. **Arthrophyllum kjelbergii** Philipson, *sp. nov.*

Arbor parva in prima aetate tomento rufo. Folia imparipinnata, foliolis ellipticis vel ovate-oblongis, ad 8 × 3.3 cm, chartaceis. Inflorescentia ramis in proprium officium mutatis et in coronam terminalem dispositis, ter ramificantibus.

A small tree, 10 m high, branches c. 1 cm diam., the young parts covered in rufous tomentum. Leaves clustered towards the ends of the branches, spirally arranged on the vegetative shoots, imparipinnate, multijugate, 25–30 × 16 cm; leaflets elliptic or ovate-oblong, up to 8 × 3.3 cm, chartaceous, margin entire minutely revolute, base rounded to cuneate often oblique, apex tapered to a blunt apiculum, or rounded and mucronate. Inflorescence a terminal cluster of c. 5–10 specialized branches; primary rays c. 15–20 cm long, 1.5–2.0 mm wide bearing near the middle an opposite pair of simple leaves or sometimes trifoliolate leaves, and 2–3 similar leaves below the terminal cluster of secondary rays; secondary rays c. 12, c. 2.5–3.5 cm long, terminating in an umbellule of about 12 flowers.

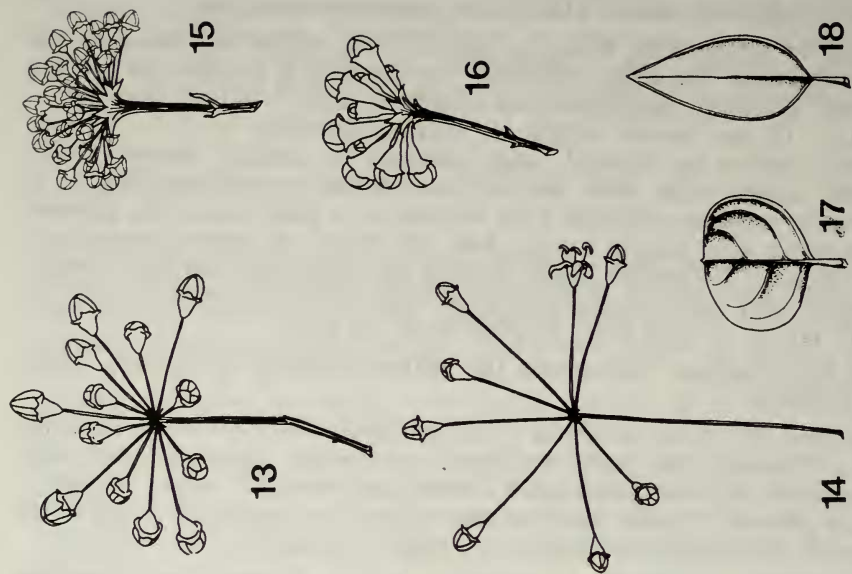
Endemic to Celebes. Type: South-east Celebes: near Kendari, Sangona, *Kjellberg 1145* (Bogor).

In primary rain forest 50–150 m.

The small leaves and relatively simple inflorescences are distinctive.

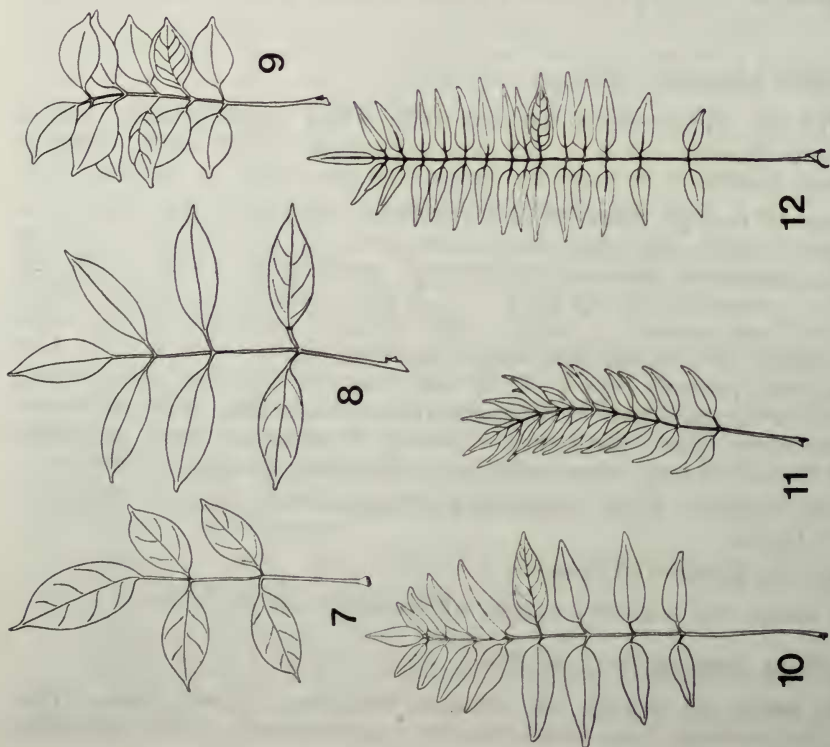
14. **Arthrophyllum cenabrei** Merr. in *Philip. Journ. Sci.* 20 (1922) 417.

A glabrous tree c. 10 m high, the ultimate branches c. 5 mm diam. Upper leaves pinnate, up to 10 cm long, leaflets mostly 5, sometimes 3, or the uppermost



Figs. 13-16. Umbellules (all $\times 1$). 13, *A. ahernianum*; 14, *A. engganoense*; 15, *A. diversifolium*; 16, *A. macranthum*.

Figs. 17-18. Bracts ($\times \frac{1}{2}$). 17, *A. collenium*, 18, *A. crassum*.



Figs. 7-12. Foliage leaves (all $\times 1/5$). 7, *A. maingayi*; 8, *A. montanum*; 9, *A. pulgarensis*; 10, *A. kjellbergii*; 11, *A. ashitoni*; 12, *A. alternifolium*.

reduced to simple leaflets, the rhachis and petiole c. 4 cm long, the leaflets mostly elliptic, 4.5–6 × 2.5–3.5 cm, chartaceous to subcoriaceous, very shortly and obtusely acuminate, base acute, brownish olivaceous and slightly shining when dry. Peduncels c. 4 cm long, umbellately arranged at the tops of the branchlets, usually however with solitary inflorescences in the axils of the uppermost leaves, thus forming a somewhat leafy inflorescence.

Endemic to the Philippines. Type: Cebu, *Cenabre and de la Cruz* FB28343 (n.v.).

On slopes at 600 m.

No specimen of this species has been located. The above description is taken from Merrill's original account. In placing this species in the key, it has been assumed that the inflorescence branching is relatively simple.

15. **Arthrophyllum pulgarens** Elmer in Leaflets Philipp. Bot. 7 (1915) 2551.

A small tree, branches c. 1 cm diam., young parts with red tomentum, becoming glabrous except on the ovaries. Leaves clustered towards the ends of the branches, spirally arranged on the vegetative branches, imparipinnate, about 6 pairs of leaflets, c. 22 × 8 cm; leaflets elliptic to rotund, c. 4 × 2.8, coriaceous, margin entire, revolute, rounded to broadly cuneate, apex rounded or abruptly tapered to a short obtuse apiculum. Inflorescence a terminal cluster of specialized branches; primary rays c. 6–10 cm long, 3–4 mm wide, bearing near the middle an opposite pair of simple rotund leaves, and with a whorl of similar leaves below the terminal cluster of secondary rays; secondary rays c. 6–8, 2–4 cm long terminating in an umbellule of about 8–12 flowers, bracts caducous.

Endemic to the Philippines. Type: Palawan, *Elmer 13193* (PNH).

Common in montane forests on Mt Pulgar.

The coriaceous small often rotund leaflets are characteristic.

16. **Arthrophyllum montanum** Ridley in Journ. Fed. Mal. St. Mus. 4 (1909) 24. — *A. nitidum* Ridley l.c. 7 (1916) 42. — *R. ovatum* Ridley l.c. 42.

Shrub or small tree to 6 m, unbranched or sparingly branched, rufous tomentose on the young parts, becoming glabrous. Leaves tufted at the ends of the branches, spirally arranged, imparipinnate, multijugate, about 30–55 × 12–22 cm; leaflets elliptic or oblong 6–10 × 2.5–4 cm, coriaceous or chartaceous, base cuneate, apex with a short blunt apiculum, margin entire, revolute, the few principal lateral veins usually rather prominent; the leaves associated with the umbels usually unifoliolate, broadly elliptic to rotund. Inflorescences on specialized leafy branches either in terminal clusters or axillary in the upper leaves; the branches 10–30 cm long, leaves mostly simple in opposite pairs, the branches ending in a whorl of simple leaves surrounding a compound umbel.

Malaya Peninsula. Type: Pahang, *Ridley 13687* (SING).

Primary forest ascending to montane zone, and in second growth, 250–1500 m.

Similar to *A. pinnatum* but distinguished by the more leathery leaves and by the leafy inflorescence branches which are usually absent in *A. pinnatum*.

17. **Arthrophyllum alternifolium** Ridley Fl. Mal. Pen (1922) 886. — *A. pinnatum* Clarke in Hook. f. Fl. Brit. Ind. 2 (1897) 734, pro parte; King in Journ. As. Soc. Bengal 67 (1898) 59, pro parte. — *A. alternifolium* Clarke l.c., in synon.

A slender sparingly branched shrub, to 2 m high, rufous tomentose on the young parts, becoming glabrous. Leaves tufted at the ends of the branches, spirally arranged, imparipinnate, multijugate, about 20–25 (30) × 9–12 (15) cm;

leaflets ovate, elliptic or lanceolate, 3.5–4 (6) × 0.9–2 (2.3) cm, coriaceous, base cuneate, apex acuminate to caudate, obtuse, margin entire, revolute, veins obscure; the leaves associated with the umbels (if any) reduced, with fewer leaflets or unifoliate, sometimes broadly ovate. Inflorescence usually a terminal compound umbel, occasionally a whorl of leafy branches (5–14 cm long) each ending in a compound umbel.

Malay Peninsula. Type: Malacca, *Griffith 2676* (SING).

In shady montane forest, with *Rhododendron* and *Dacrydium*, 3000 ft and above.

The small coriaceous, often apiculate, leaflets are characteristic. Although collected most frequently on Mt Ophir it occurs on other high ridges in the southern Peninsula.

INSUFFICIENTLY KNOWN SPECIES

A. reticulatum Bl. ex Miq. in Ann. Mus. Bot. Lugd. -Bot. 1 (1863) 27.

The original description was based on foliage leaves only. Their place of origin was uncertain. Since I have seen no specimen identified as this species, its identity cannot be decided.

A. serratifolium Miq. Fl. Ind. Bat. Suppl. (1860) 341.

The original description was based on foliage leaves only. I have seen no specimen identified as this species, but since all other members of the genus have entire margins to the leaflets, I doubt if this species would prove to be a true *Arthrophyllum*.

I wish to thank Dr E. Edgar of Botany Division, D.S.I.R., Christchurch for writing the Latin diagnoses.