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The Genus *Argostemma* (Rubiaceae-Argostemmatae) in Borneo

Author(s): Birgitta Bremer

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THE GENUS *ARGOSTEMMA*
(RUBIACEAE—
ARGOSTEMMATEAE)
IN BORNEO¹

Birgitta Bremer²

ABSTRACT

Argostemma is a large paleotropical genus of the tribe Argostemmatae. From Borneo 28 species are recognized. All are herbs growing in rainforests. Six species, *A. apiculatum*, *A. burtii*, *A. geesinkii*, *A. gaharuense*, *A. brookei*, and *A. calcicolum*, are new. There is one new name, *A. chaii*. *Argostemma* is the larger genus of the tribe; the other genus is *Neurocalyx*. The sister group to the Argostemmatae is the mainly Central American tribe Hamelieae. These two tribes form a monophyletic group within the subfamily Rubioideae. About two-thirds of the *Argostemma* species are endemic to Borneo. The species belong to at least three different monophyletic groups, each having its sister group outside Borneo. Nomenclature, descriptions, illustrations, maps, and a key for all species are provided.

Argostemma Wall. in Roxb. is a large, complex genus with about 220 described species. The revision of the genus will be published in parts dealing with different geographical areas. About 51 taxa have been described from Borneo. There is no treatment covering the whole island. In this study I have recognized 28 species, of which six are new. Most of the 28 species are endemic to Borneo, although six of them were described from specimens collected outside of Borneo. The remaining 22 are typified on Borneo specimens.

Only synonyms typified by specimens from Borneo are listed under the species.

During the 1950s, the late Dr. Bakhuizen van den Brink, Jr. studied the genus for the Flora Malesiana project. He annotated many herbarium labels about typifications. I have studied his lectotypifications, and in most cases I do agree with him, and have accepted the lectotypifications which are published in this paper.

No infraspecific taxa are recognized in this study. Most species are stenomorphic, and a few species are polymorphous. Among the latter, *A. elatostemma* occurs as two differing populations on Borneo, but since its whole variation outside Borneo

is not yet known, they are not recognized as separate taxa. The substantial variation in *A. borragineum* is not correlated with geographical distribution and does not reveal distinct evolutionary lines. *Argostemma hameliifolium* and *A. moultonii* form a complex without discrete infraspecific units. The distinction between the two species is more or less preliminary. *Argostemma densifolium* is dimorphic, but as the variation seems small, I have treated the two morphs as one taxon.

MATERIALS AND METHODS

All cited specimens including types have been studied, unless otherwise stated. I have seen material from the following herbaria: A, AAU, B, BM, BO, BR, E, G, GH, HBG, K, KLU, L, MO, NY, P, S, SAR, SING, U, UC, and US.

I have studied *Argostemma parvifolium*, *A. elatostemma*, *A. ophirensense*, *A. rupestre*, *A. hameliifolium*, *A. moultonii*, *A. gracile*, *A. havilandii*, *A. calcicolum*, *A. psychotrioides*, and *A. bryophilum* in the field. Material of most of these species was fixed in the field and later embedded and sectioned for anatomical studies of leaves, an-

¹ I am grateful to Mr. Paul Chai and his staff at the Forest Department at Kuching for assistance during my fieldwork, to the late Dr. Bakhuizen van den Brink, Jr. for much information about the genus, to Dr. John Dwyer for checking my Latin diagnoses, as well as to Mrs. Gunilla Hägglund, Miss Kerstin Kustås, and Miss Mari Källersjö for technical assistance. I am also indebted to the directors and curators of the herbaria listed in the Materials & Methods and to the reviewers for many useful comments. I thank Dr. Peter Raven, Director of the Missouri Botanical Garden, where I finished this study. Financial support from the Swedish Institute, the Royal Academy of Sciences, Stockholm, the Swedish Natural Science Research Council, and the University of Stockholm is gratefully acknowledged.

² Department of Botany, University of Stockholm, S-106 91 Stockholm, Sweden.

thers, and ovaries. For endothecial structure, whole anthers of all species were mounted in Hoyer's solution for study.

The species are arranged roughly in phylogenetic order. Species 1–12 (the *A. parvifolium* group) belong to one evolutionary group, species 13–26 (the *A. psychotrioides* group) to a second group, species 28 (*A. neurocalyx*) to a third group, and species 27 (*A. bryophilum*) assumes an uncertain position within the genus.

The drawings are my own. In the figures (4–31), all details of plants indicated by the same letter (B–I) are drawn at the same magnification and illustrate the same plant part. Hence, if a particular part is not illustrated, the corresponding letter is not used in the figure. The branch, indicated by letter A, is drawn twice as large in Figures 7–15, 17, 19–22, 30, and 31 as in Figures 4–6, 16, 18, and 23–29.

SYSTEMATIC POSITION AND INTERRELATIONSHIPS WITHIN *ARGOSTEMMA*

Argostemma is the largest genus of the Argostemmataceae (Verdcourt, 1958; B. Bremer, 1987; Argostemmatideae fide Darwin, 1975, sphalm., pers. comm.). The other genus of the tribe is *Neurocalyx* (B. Bremer, 1979), a small genus endemic to Sri Lanka and southern India. The sister group to the Argostemmataceae is the mainly Central American tribe Hamelieae (B. Bremer, 1987). These two tribes form a monophyletic group within the subfamily Rubioideae.

In Borneo there are 28 species of *Argostemma*. About two-thirds of these are endemic. The Bornean species belong to at least three different monophyletic groups, each having its sister group outside Borneo.

The *A. parvifolium* group is represented by species 1–12, characterized by “radial” endothecium (see morphological notes), anisophyllous leaves, rotate corollas, a narrowly ovoidal anther cone, thin and smooth apical appendages, and a glabrous style with a hardly widened to slightly capitate stigma. Three species from this group (*A. parvifolium*, *A. elatostemma*, and *A. ophirensis*) also occur in the Malay Peninsula and on other Sunda Islands.

The *A. psychotrioides* group, species 13–26, is characterized by a sturdy connective, umbelliform inflorescences, in most species a corolla cleft to less than half its length, and usually a style much longer than the stamens. Most species also have a “polarized” endothecium (one species cannot be

classified as “radial” or “polarized”), and most species have an endothecium with distinct cell margins (see morphological notes). *Argostemma hameliifolium*, *A. moultonii*, *A. psychotrioides*, and *A. borragineum* also occur on other Sunda Islands but not in the Malay Peninsula.

The remaining species, *A. bryophilum* (27) and *A. neurocalyx* (28), are more isolated. *Argostemma neurocalyx* belongs to a totally different group within *Argostemma*. It is characterized by an apical leaf rosette and free stamens, of which the anthers open by pores instead of slits. The group to which it belongs has a very wide distribution from West Africa to the Philippines. The systematic position of *A. bryophilum* is not yet clear. It does not fit in any of the groups mentioned above and is part of a complex of taxa common in the Philippines and New Guinea.

MORPHOLOGICAL NOTES

Raphides. Raphides are found in most parts of the plants and can be seen easily in corollas or in young glabrous stems.

Colleters. On living material the colleters can be seen easily, but on old dry specimens they are hardly visible. They are of the standard rubiaceous type (Lersten, 1975), with elongated axial cells surrounded by a palisade epidermal layer. The colleters are found singly or a few together between the calyx lobes. At each node they surround the stem in a ring and occur on the adaxial side of the petiole and at stipule bases. In species with few colleters in each ring, the colleters are generally round in outline, whereas in species with a dense ring of several hundred colleters they are narrow, often reduced, and almost without a palisade epidermis (Lersten, 1974). The stipules often end in apical colleters. In *Argostemma chaili*, with fringed stipules, each of the processes making up the fringe ends in a distinct colleter.

Hairs. In Borneo, only *A. apiculatum* is glabrous. The other species are more or less entirely or partially pubescent. There are no substantial differences between hairs on vegetative organs and those on flowers. Normal hairs are monoseriate and completely septate, with thin to very thick walls, and they generally do not collapse when dry. They may occur all over the leaf surfaces or only on (or rarely only between) the veins. If there is indumentum on the inside of the corolla or on the style, the hairs are shorter, mostly one- or few-celled and thinner (Verdcourt, 1958). Another hair type occurs on, e.g., *A. rupestre* (Fig. 13I) and *A. gee-*

sinkii (Fig. 14I). On the upper leaf surfaces of these species there are three or five rows of stiff, pluricellular hairs. One row occurs along the midrib and the others along the margins, making them appear more or less serrulate.

Leaf anatomy. I have studied in detail cross sections of field-fixed material of *A. bryophilum*, *A. elatostemma*, *A. havilandii*, *A. moultonii*, *A. ophirensis*, *A. psychotrioides*, and *A. rupestre*. Cross sections of young leaves of the species are generally very similar. With the exception of *A. bryophilum*, cross sections of these species can be described as follows: upper epidermis of one layer of large, rectangular cells with rather thin walls and lacking plastids; palisade chlorenchyma of one or a few layers of small carrot-shaped cells filled with plastids; spongy parenchyma of a few to many layers of small to medium-sized cells almost without plastids; lower epidermis of one layer of large, rounded cells with thin walls and without plastids; stomata quite exposed. This type of leaf also occurs in *Neurocalyx* (B. Bremer, unpubl.). *Argostemma bryophilum*, aberrant in many other ways, differs from the others in leaf cross section. Its epidermal layers are thinner with smaller cells, and the chlorenchyma consists of large rounded cells with few plastids.

Species whose lower leaf surface appears white (e.g., *A. rupestre* and *A. gracile*) have more intercellular spaces in the spongy parenchyma than other species.

Endothecium. The endothecium of *Argostemma* (Fig. 1) was studied with light microscope on whole mounts of anthers. The endothecium varies between groups of *Argostemma* species. In *A. bryophilum* and *A. neurocalyx*, in many ways aberrant species, only narrow longitudinal bands of cells close to the stomium have wall thickenings, while in all other species from Borneo, wall thickenings occur in all cells of the endothecial layer. In the following, the terms endothecium, endothecial layer, and endothecial type will only be used for those cells with wall thickenings.

The endothecial cells are generally elongated longitudinally or horizontally compared with the line of dehiscence and with the anther-length axis, or rarely they are isodiametric. In *Argostemma* the wall thickenings are U-shaped ribs arranged transversely in relation to the longest axis of the cell and with their openings toward the epidermal layer. The ribs end in knobs.

Dormer (1962), Nordenstam (1978), Noel (1983), and French (1985) have shown the systematic significance of endothecial structures. This

study shows that different endothecium types occur in *Argostemma* and that these types are restricted to different systematic units within the genus. Dormer (1962) and Noel (1983) presented systems for classification of endothecial structures. Dormer (1962) classified endothecial cells in the Compositae as "polarized" or "radial." In a polarized endothecium the thickenings are concentrated mainly at the upper and lower ends of the cells, and when ribs occur they are parallel to the line of dehiscence. In a radial endothecium the cells are ribbed all around; on elongated cells the bars are arranged transversely, parallel to the line of dehiscence. I have found Dormer's system somewhat difficult to use with Rubiaceae because the endothecial cells are different, often elongated horizontally, i.e., transversely to the anther-length axis. In Compositae (Nordenstam, 1978; Dormer, 1962; K. Bremer, pers. comm.), when the cells are elongated, the elongation is parallel to the anther-length axis.

Noel (1983) presented a more general system which embraces over 500 taxa from different families. He distinguished several endothecial characters, such as size and shape of the cells, organization of the thickenings, whether a basal plate and/or ribs occur, and the shape and number of these. In general, the endothecial cells of *Argostemma* can be characterized following Noel's scheme (1983: 837): cells medium-sized, 27–60 μm on the longest side, isodiametric, rectangular or fusiform; wall thickenings localized; base plate absent; ribs U-shaped; 5–ca. 15 ribs per cell (in several species the cell margins become indistinct, and it is difficult to see where the cell ends); spacing from close to wide; branching absent; tips knobbed.

There are four types of endothecial cells in *Argostemma*. The first two are "polarized." In the first type, in *A. bryophilum*, *A. hameliifolium* (Fig. 1A), *A. moultonii*, and *A. neurocalyx*, the cell margins become indistinct, and the endothecial layer can be described as consisting of long, horizontal, rather narrow bands with many close distinct transverse ribs and knobs. This type also occurs in the sister genus *Neurocalyx*. I have examined the endothecia of *Hamelia patens*, *Hoffmannia vesiculifera*, and *Xerococcus congestus*, belonging to Hameliaceae, the sister tribe to Argostemmateae (B. Bremer, 1987), and they are of the same type.

In the second type (e.g., *A. nerve*, *A. gracile*, *A. havilandii*, and *A. psychotrioides* (Fig. 1B)), the cells are horizontally elongated and fusiform but with distinct cell margins. The ribs are not as close together, and the knobs are larger than in the first type.

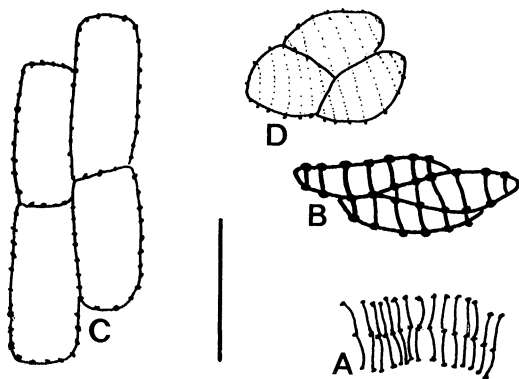


FIGURE 1. Endothelial cell thickenings. Scale bar = 50 μm —A. *Argostemma hameliifolium*.—B. *A. psychotrioides*.—C. *A. parvifolium*.—D. *A. borragineum*.

The third type could be classified as “radial.” This type occurs in many species, e.g., *A. ophiense*, *A. parvifolium* (Fig. 1C), and *A. rupestre*. The cells are generally rectangular, with the longitudinal axis parallel to the dehiscence line. The cells are larger than in the “polarized” group. The transverse ribs are indistinct to hardly visible, and the knobs are smaller and look like a string of pearls surrounding the cell margins.

The fourth group consists solely of *A. borragineum* (Fig. 1D), whose endothecium is unique at least among the Borneo species of *Argostemma*. The cells are generally isodiametric and large. The ribs are indistinct, generally arranged parallel to the dehiscence line, and the knobs are indistinct. Since the ribs are not transversely arranged in relation to the anther-length axis, this type cannot be described as “radial,” and since the knobs surround the cells on all margins, it cannot be described as “polarized.”

Fruit. After anthesis the pedicels and peduncles become erect. These parts and the fruit, crowned with the calyx lobes, become fleshy and succulent. The fruit opens by an apical operculum. Such fleshy capsules are not uncommon in the tropics (Ehrendorfer, 1983: 829). Bakhuizen f. (1975) said about fruits of Rubiaceae:

I am convinced that true capsules are not found in Rubiaceae. The rubiaceae “capsules” distinctly possess a (very) thin, often leathery endocarp. For that reason I propose to distinguish two main types of fruits in Rubiaceae: pyreniferous and non-pyreniferous. The pyreniferous fruits may be subdivided into pachypericarpous (having a thick, fleshy pericarp, known as “drupe”) and leptopericarpous (having a (very) thin, dry, often leathery pericarp, so-called “capsule”). Non-pyreniferous fruits are conventionally termed “berry.”

The fruit of *Argostemma* does not fit into this

system. Although Bakhuizen f. was an expert on this genus, he had never seen it in the field (pers. comm.), and on dry material he had probably misinterpreted the fruit type.

When the fruit is open the fibrous endocarp separates from the remaining pericarp and splits into threads, which are visible in the opening. The septum, with the attached placentas, is also fibrous and will split. Among the resulting threads the numerous seeds will be exposed. Perhaps the threads prevent sudden dispersal. It is not uncommon to find specimens with many seeds germinated within the capsules. This kind of “vivipary” or germination in situ is described earlier from *Ophiorrhiza tomentosa* (Tan & Rao, 1981).

Placentation. Placentation is axile with the placentas (Fig. 2) attached at the top of the septum. The placentas are stalked, pendulous, fleshy, and in front view broadly ovoidal to kidney-shaped.

Seeds. *Argostemma* has numerous, small (ca. 0.5 mm), angular to ovoidal seeds (Fig. 3). The testa seems to be unique to this genus. The surface is mostly reticulate with a mamilla or a ring in each cell.

DISTRIBUTION

The maps (1–28) of *Argostemma* show that most localities are from northwestern Borneo. This is not because *Argostemma* is more common there, but indicates that this part, Sarawak, is botanically most well known. The same pattern can be seen in *Memecylon* (K. Bremer, 1983) and other genera. The few localities in Kalimantan result from comparatively few botanical expeditions, and large areas of former rainforest have been deforested.

Taxonomically, *Argostemma* in Borneo belongs to at least three different species groups which are more or less sympatric, and many species within the same group are sympatric. The distributions of different species of *Argostemma* are influenced by altitude, a fact that is hardly evident on the maps. *Argostemma elatostemma*, *A. densifolium*, *A. gaharuense*, *A. chaili*, *A. havilandii*, *A. calcicolum*, *A. trichosanthes*, *A. psychotrioides*, and *A. variegatum* grow only at low altitude; and *A. anisophyllum*, *A. dulitense*, *A. apiculatum*, *A. burttii*, *A. geesinkii*, *A. gracile*, *A. brachyantherum*, and *A. brookei* grow only at altitudes over 1,000 m. Some species occur at both low and high altitudes: *A. parvifolium*, *A. subfalcifolium*, *A. ophiense*, *A. rupestre*, *A. hameliifolium*, *A. moultonii*, and *A. borragineum*.

Most of the lowland species and those growing

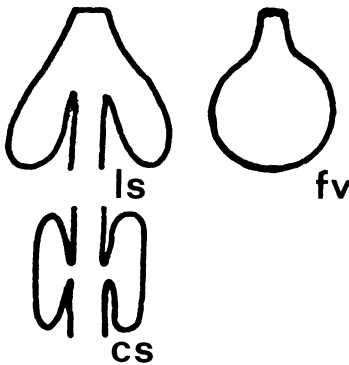


FIGURE 2. Placenta in ripe fruit (diagrammatic). ls, longitudinal section; fv, front view; cs, cross section.

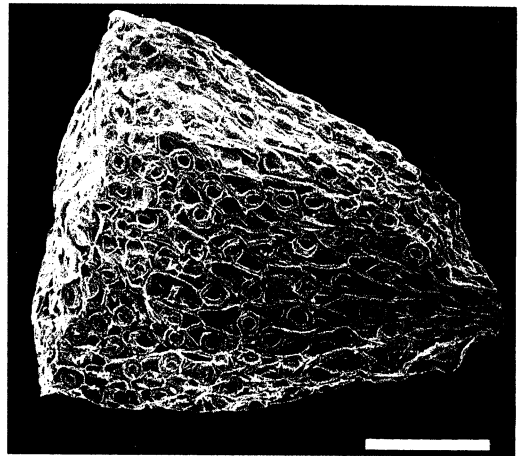


FIGURE 3. Seed of *A. borragineum* in SEM surface view. From Bremer 1668 (S). Scale bar = 100 μ m.

from low to high altitude are widespread, and many of them are sympatric. Of the eight species known only from a single locality each, four are from high altitude, the altitudes of three are unknown, and only one is from low altitude (ca. 700 m).

TAXONOMIC TREATMENT

Argostemma Wall. in Roxb., *Flora Indica* 2: 324, 1824. *Pomangium* Reinwardt, *Syll. Pl. Rat.* 2: 10. 1825. *Argostemmella* Ridley, *J. Bot.* 65: 41. 1927. TYPE: *Argostemma sarmentosum* Wall. (Pfeiffer, *Nomenclator Botanicus*, 1873).

Erect, suberect, or creeping herbs, isophyllous or anisophyllous, glabrous to densely pubescent, often succulent. Stem usually unbranched or slightly branched, often succulent; internodes very short to 85 mm long. Leaves opposite or verticillate, when anisophyllous unequal, scattered along the stems, or decussate, or distichous, or rosulate on a short stem, or apically rosulate on a well-developed stem, herbaceous, or coriaceous, or membranaceous; stipules interpetiolar, persistent or deciduous, small to large, usually entire, rarely slightly cleft or fringed, with colleters near the base on the adaxial side or rarely at the apex, if fringed then with a colleter at each point; midrib distinct, the primary veins distinct or obscure, the veinlets generally not visible. Anisophyllous leaves with the small (nanophyllous) leaf persistent or deciduous, similar in shape to the stipules or to the larger leaf, often cordiform, with or without a short petiole. Inflorescences terminal, subterminal or rarely axillary, solitary or a few together, 1–160-flowered, cymose, corymbiform to umbelliform, glabrous or pubescent; peduncles up to 10 cm long or rarely absent; bracts often persistent and small; pedicels

in fruiting stage succulent. Flowers (4–)5(–6)-merous, actinomorphic or rarely zygomorphic, perfect. Calyx with a very short tube; lobes shorter or rarely as long as the corolla lobes, erect or spreading to reflexed, in fruiting stage succulent, glabrous or pubescent. Corolla with valvate aestivation, white, sometimes with green nectar guides at the base, rotate, or subcampanulate but with recurved lobes, or campanulate, 3–12 mm long, with the tube more than $\frac{2}{3}$ as long as the lobes, externally glabrous or pubescent, internally glabrous or pubescent with the pubescence often only on the lobes; lobes erect-spreading to recurved or reflexed. Stamens 4 or 5(6), equal in number to the corolla lobes, inserted near the base of the corolla, introrse, coherent into an anther cone or free; if coherent then fused along the whole anther or partially so; thecae with two sacs (loculi); anthers bright yellow to cream-colored, erect or slightly upcurved; filaments free, short or long, mostly equal, erect or rarely curved, smooth, glabrous; sacs opening by vertical slits, rarely with pores; apical appendages ca. $\frac{1}{2}$ as long as the anther or absent, thin to coriaceous, smooth to papillose; connectives distinct to indistinct from the thecae, smooth to papillose. Ovary 2-celled; style filiform, glabrous to pubescent, shortly to long-exserted, with a capitate, clavate, or scarcely widened stigma, shallowly to rarely distinctly bifid. Fruit a succulent capsule with a fibrous endocarp, opening by an apical operculum, smooth or rarely with emergences, furrows, or ribs (at least on dry specimens), glabrous to densely pubescent. Seeds brown, numerous, minute, angular or ovoid, the testa generally reticulate with a central mamilla or ring in each cavity.

KEY TO THE SPECIES OF *ARGOSTEMMA* IN BORNEO

- 1a. Leaves more or less condensed into an apical rosette. Stamens free at least after anthesis 2
 2a. Leaves membranaceous. Corolla campanulate, not deeply cleft. Stamens opening by apical pores 28. *A. neurocalyx*
- 2b. Leaves herbaceous to coriaceous. Corolla rotate, cleft to near the base. Stamens opening by longitudinal slits 17. *A. chailii*
- 1b. Leaves scattered along the stem, not condensed into an apical rosette. Stamens connate or free 3
 3a. Leaves anisophyllous 4
 (See also the insufficiently known 16. *A. flavescens* not included in the key.)
- 4a. Corolla cleft to near the base, starlike; lobes spreading, erect-spreading, or rarely reflexed, never recurved. Stamens as high as the style with stigma only slightly exerted 5
 5a. Flowers slightly zygomorphic. Calyx lobes almost as long as the corolla lobes. Filaments unequal, curved 1. *A. parvifolium*
- 5b. Flowers actinomorphic. Calyx lobes much shorter than the corolla lobes. Filaments equal, straight 6
 6a. Plant creeping. The larger of the anisophyllous leaf pair basally very unequal-sided. Peduncles and the outside of the corolla pubescent. Anther cone black when pressed and dried 2. *A. elatostemma*
- 6b. Plant erect or creeping. The larger of the anisophyllous leaf pair unequal- or equal-sided. Peduncles and the outside of the corolla generally glabrous. Anther cone not black when pressed and dried 7
 7a. Larger leaf of the anisophyllous pair generally subfalcate; nanophyllous leaves lanceolate. Fruits with longitudinal furrows 3. *A. subfalcifolium*
- 7b. Larger leaf of the anisophyllous pair not subfalcate; nanophyllous leaves cordiform, ovate or lanceolate. Fruits without furrows but rarely with 5 ribs 8
 8a. The larger of the anisophyllous leaf pair basally unequal-sided or oblique; nanophyllous leaves cordiform 9
 9a. Stems and leaf veins pubescent. Leaves herbaceous or coriaceous. Corolla up to ca. 6 mm long 10
 10a. Plant a rosette or creeping with generally short internodes and obovate to oblanceolate leaves 4. *A. densifolium*
- 10b. Plant erect with obvious internodes and lanceolate to linear leaves 5. *A. ophirensis*
- 9b. Stems and leaves glabrous or glabrate. Leaves herbaceous to membranaceous. Corolla 8–9 mm long 6. *A. anisophyllum*
- 8b. The larger of the anisophyllous leaf pair basally equal-sided; nanophyllous leaves ovate, elliptic, or lanceolate 11
 11a. Leaves without stiff pluricellular hairs 12
 12a. Leaves pubescent. Corolla ca. 4 mm long, lobes reflexed. Fruit with 5 ribs 12. *A. gaharuense*
- 12b. Leaves glabrous. Corolla more than 9 mm long, lobes not reflexed. Fruit without ribs 13
 13a. Stems pubescent. Leaves coriaceous with pale lower surfaces. Apical appendage ca. 1/3 of the anther length 7. *A. dulitense*
- 13b. Stems and whole plant glabrous. Leaves herbaceous to membranaceous, both sides of the same color. Apical appendage ca. 1/4 of the anther length 8. *A. apiculatum*
- 11b. Leaves with stiff pluricellular hairs in 3 or 5 rows 14
 14a. Corolla ca. 9 mm long or more; lobes ovate, spreading. Apical appendage less than 1/4 of the anther length 9. *A. burttii*
- 14b. Corolla ca. 7 mm long or less; lobes ovate or lanceolate, erect-spreading. Apical appendage ca. 1/3 of the anther length 15
 15a. Corolla lobes lanceolate, not pink in press. Stipules ovate to lanceolate 10. *A. rupestre*
- 15b. Corolla lobes ovate, often pink in press. Stipules ovate to cordiform 11. *A. geesinkii*
- 4b. Corolla generally cleft 1/2 its length or less; lobes recurved, erect, or spreading. Stamens shorter than the much-exserted stigma 16
 16a. Corolla cleft to less than 1/2 its length; lobes erect or spreading 17
 17a. Leaves distichous. Flowers solitary, almost sessile. Stigma disc-shaped and distinctly bifid 18. *A. gracile*
- 17b. Leaves not distichous. Flowers in up to 12-flowered inflorescences, rarely solitary, with peduncles. Stigma capitate and indistinctly bifid 19. *A. brachyantherum*
- 16b. Corolla cleft to at least 1/2 its length; lobes recurved 18
 18a. Corolla cleft to near the base. Stamens free at anthesis. Stigma slightly capitate 20. *A. brookei*
- 18b. Corolla cleft to ca. 1/2 its length. Stamens connate at anthesis. Stigma clavate 19

- 19a. Calyx lobes 2–6 mm long, distinctly reflexed. Style generally glabrous 20
 20a. Plant erect. Leaves basally acute to cuneate or attenuate and equal-sided 25. *A. psychotrioides*
 20b. Plant creeping. Leaves basally rounded to obtuse and unequal-sided 26. *A. variegatum*
 19b. Calyx lobes up to 1 mm long, erect. Style generally pubescent 21
 21a. Stems green, smooth. Nanophyllous leaves persistent, cordiform 24. *A. humifusum*
 21b. Stems in lower part generally pale brown to gray with elevated corky to papery longitudinal ridges. Nanophyllous leaves deciduous, lanceolate to linear 21. *A. havilandii*
 3b. Leaves isophyllous 22
 22a. Corolla cleft to near the base, starlike; lobes spreading or reflexed 23
 23a. Leaves membranaceous. Stipules persistent, broadly ovate to cordiform. Inflorescences 1–2-flowered. Apical anther appendages almost wanting 27. *A. bryophilum*
 23b. Leaves herbaceous. Stipules deciduous. Inflorescences 3–40-flowered. Apical anther appendages form open cylinders (Figs. 16, 17) 24
 24a. Plant 10–100 cm, erect. Stamens with short filaments and short apical appendages 13. *A. hameliifolium*
 24b. Plant 2–40 cm, more or less creeping. Stamens with long filaments and long apical appendages 14. *A. moultonii*
 22b. Corolla cleft to ca. ½ its length; lobes recurved 25
 25a. Stems generally pale brown to gray with elevated corky to papery longitudinal ridges, without scars. Anther cone with connate apical appendages. Stigma clavate. Fruit smooth 26
 26a. Plant wholly covered with a dense indumentum of stiff long hairs 23. *A. trichosanthes*
 26b. Plant slightly pubescent with soft hairs 22. *A. calcicolum*
 25b. Stems generally black with wavy scars, without longitudinal ridges. Anther cone with free apical appendages. Stigma capitate. Fruit with emergences 15. *A. borragineum*

1. *Argostemma parvifolium* Benn., *Plantae Javanicae Rariores*. 1: 96. 1838. TYPE: Java(?), Sumatra: *Horsfield s.n.* (holotype, BM). Figure 4.

Erect, anisophyllous, densely pubescent herb. Stem 15–50 cm long, usually unbranched, densely pubescent; internodes 6–15 mm. Leaves opposite, very unequal; stipules persistent, 4–7 mm long, ovate to cordiform, acute to acuminate at apex; larger leaves of the anisophyllous pairs with pubescent petioles 3–6 mm long, the lamina 4–13 × 1.4–3 cm, generally oblanceolate or obovate to elliptic, basally acute and oblique, marginally serrulate, apically acuminate, herbaceous, pubescent on both surfaces; midrib and primary veins (9–18 pairs) distinct. Nanophyllous leaves persistent, 5–10(–32) mm long, cordiform to ovate. Inflorescences solitary or a few together, 1–9-flowered, corymbiform, pubescent; peduncle 0.9–3.2 cm long, bracts to 1 cm long, broadly ovate to lanceolate; lateral branches, if present, to 1.5 cm long; pedicels 0.7–1.4 cm long. Flowers 5-merous, slightly zygomorphic; calyx lobes 4–6 mm long, triangular to ovate, acuminate, pubescent; corolla 5–6 mm long, cleft to near the base, externally pubescent, internally glabrous; lobes triangular, spreading. Stamens 6–10 mm long, coherent; anther cells and apical appendages connate except

for the most apical part; anther cone narrowly ovoid, slightly upcurved; filaments short, unequal, curved; sacs opening completely and longitudinally; apical appendage ca. ½ the anther length, thin and smooth; connective distinct, smooth. Style 6–10 mm long, glabrous with a slightly capitate stigma, shortly exerted. Fruit without furrows or ribs.

There is a question mark after Java on the label of the type specimen, and on the label there is also written “Sumatra,” as is indicated in the protologue. *Argostemma parvifolium* grows on sandstone, sandy banks, and cliffs near streams, from 350 to 1,450 m. The species is based on non-Borneo material. The habit of the Borneo population is similar to the type of *A. parvifolium* var. *involutum* (Hemsl.) Bakh. f. I have not studied the complete variation of *A. parvifolium* outside Borneo, and so for now I avoid infraspecific taxa. Except for the inner floral parts, the whole plant is densely covered by long soft hairs. As in all *Argostemma* species, the flowers are slightly pendulous at anthesis, and in this species the flowers are slightly zygomorphic. The rotate corolla has at its center distinct green nectar guides on the upper half. The anther cone is bent upwards and the stamens, in the upper half of the flower, have curved filaments. It is the only Borneo species with these characters.

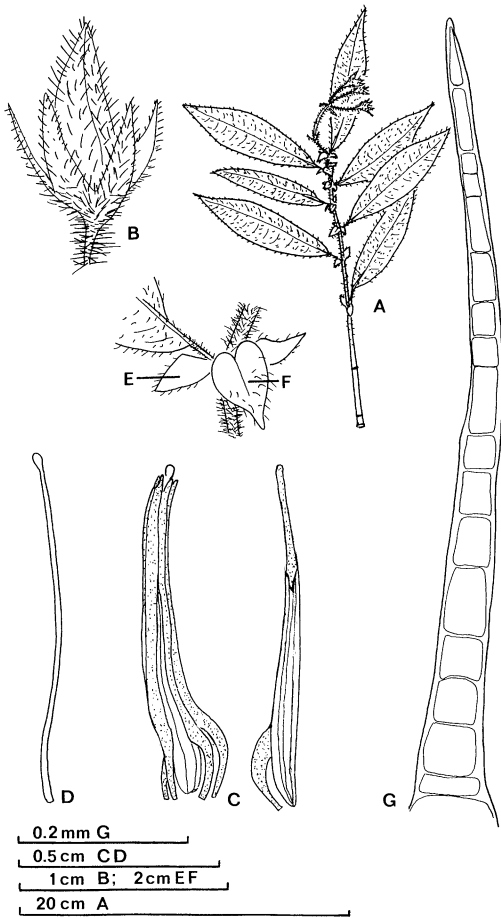


FIGURE 4. *Argostemma parvifolium*.—A. Branch.—B. Flower bud.—C. Anthers.—D. Style.—E. Stipule.—F. Nanophyllous leaf.—G. Hair from outer surface of the corolla. A, C–F from Burt 11521 (E); B, G from Winkler 767 (L).

Additional specimens examined. BORNEO. SARAWAK: 1st Div., Gunong Berumpit, 3,500 ft., 1962, Burt & Woods 2816 (E, SAR); 1st Div., Sabal, 350 m, 1979, Bremer 1652 (S, SAR); 4th Div., Mt. Lambir, 1962, Burt & Woods 2366 (E, SAR); 1979, Burt 11521 (E, S); 1,200–1,500 ft., 1978, Burt 11640 (E, S); 1,450 m, 1976, Ilias & Yeo S38349 (L, SAR); 7th Div., Hose Mts., 800 m, 1975, Chai et al. S37338 (K, L, MO, SAR). KALIMANTAN: W Prov., Bidang Menabei, 700 m, 1924, Winkler 767 (L).

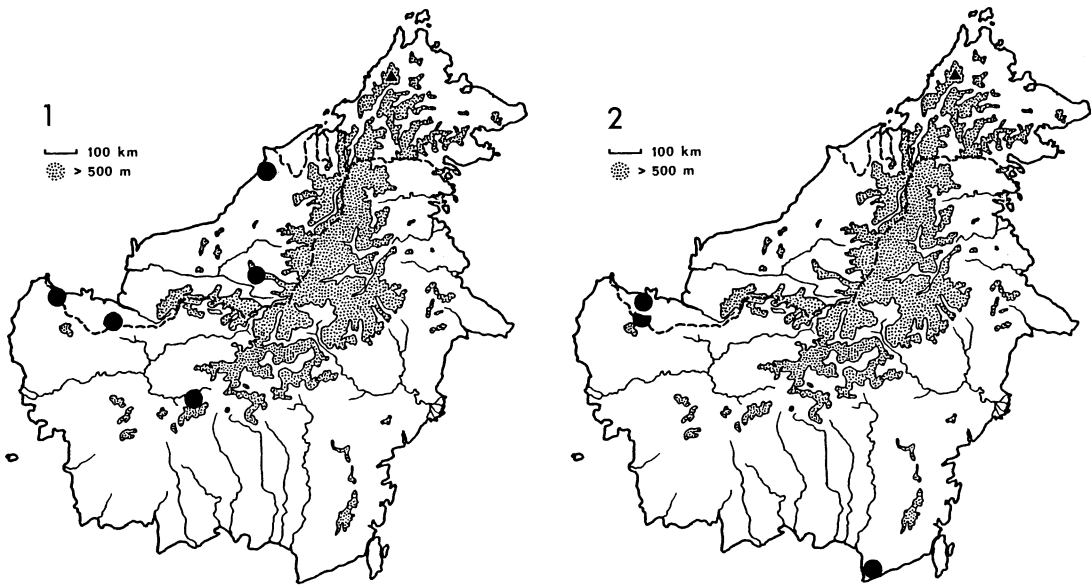
2. *Argostemma elatostemma* Hook. f., The Flora of British India 3(7): 45. 1880. TYPE: Penang, Griffith s.n. (lectotype, K; Bakh. f. in herb., confirmed here). Figure 5.

A. motleyi Ridley, J. Bot. 65: 39. 1927. TYPE: Borneo: Bangarmassing, 1857–1858, Motley 1174 (holotype, K).

Creeping, anisophyllous herb. Stem 2–36 cm long, slightly branched or unbranched, pubescent; internodes 5–25 mm. Leaves opposite, very unequal; stipules persistent, 4–10 mm long, ovate to broadly ovate or cordiform, acuminate to acute at apex; larger leaves of anisophyllous pairs with pubescent petioles 4–7 mm long; lamina 2–9.5 × 1.3–3.5 cm, obovate to ovate and slightly subfalcate, basally subcordate to auriculate with the lobes unequal, marginally entire, apically acute, herbaceous, glabrous above and with a few hairs on the veins below; midrib and primary veins (5–11 pairs) distinct. Nanophyllous leaves persistent, 4–12 mm long, cordiform. Inflorescences solitary, 1–20-flowered, densely corymbiform or umbelliform, pubescent; peduncle 0.8–4 cm long; bracts to 0.7 cm long, ovate or lanceolate; lateral branches, if present, to 2.5 cm long; pedicels 0.4–1 cm long. Flowers 5-merous; calyx lobes 1–2 mm long, ovate to triangular, acute, pubescent; corolla 5–6 mm long, cleft to near the base, externally pubescent, internally glabrous; lobes ovate to lanceolate, spreading. Stamens 5–6 mm long, coherent; anther cells and apical appendages connate; anther cone ovoid, straight; filaments short, equal, straight; sacs opening completely longitudinally; apical appendage ca. $\frac{1}{3}$ the anther length, thin and smooth; connective indistinctly passing over to the thecae, smooth. Style 5–7 mm long, glabrous with a slightly capitate stigma, shortly exserted. Fruit without furrows or ribs.

Hooker based *A. elatostemma* on two collections, by Lobb and Griffith. Both are suitable for lectotypification. Bakhuisen f. (in herb.) selected the Griffith specimen in K, and I follow his choice.

Argostemma elatostemma grows in wet shady forests, from 100 to 750 m. It occurs in the first division of Sarawak and on the southern tip of Kalimantan. The collections from these two areas are different. The Sarawak specimens are alike and similar to the type collection from the Malay Peninsula, while the Kalimantan specimen, described as *A. motleyi*, agrees well with the type of *A. elatostemma* var. *obovata* King (1904). In this study I have not dealt with any infraspecific taxa because I have not yet studied the complete variation outside Borneo. The specimen from Kalimantan is smaller with shorter leaves, and there is only one flower in the collection. *Argostemma elatostemma* is characterized by its creeping habit, rooting at the nodes, silvery mottled leaves, and unequal leaf bases. The stems, petioles, veins of the lower leaf surfaces, and the inflorescences are densely pubescent. The flowers are rotate with a long pale anther cone which blackens in the press.



MAPS 1, 2, Distributions in Borneo.—1. *Argostemma parvifolium*—2. *A. elatostemma*.

Additional specimens examined. BORNEO. SARAWAK: 1st Div., Mt. Matang 2,300 ft., 1979, *Bremer 1722* (S, SAR); 500 ft., 1954, *Brooke 9465* (L); 1962, *Burt & Woods 1959* (E); 1,500 ft., 1929, *Clemens*

20912 (NY); 2,500–3,000 ft., *Mjöberg s.n.* (US); 1893, *Ridley 12303* (BM, K, SING); 1st Div., Bau, S of Bukit Krian, 100 m, 1964, *Anderson et al. S20288* (L); Gunong Tra-an, 300 ft., 1975, *Burt 8175* (E); 1893, *Ridley 11753* (BM, K, SING).

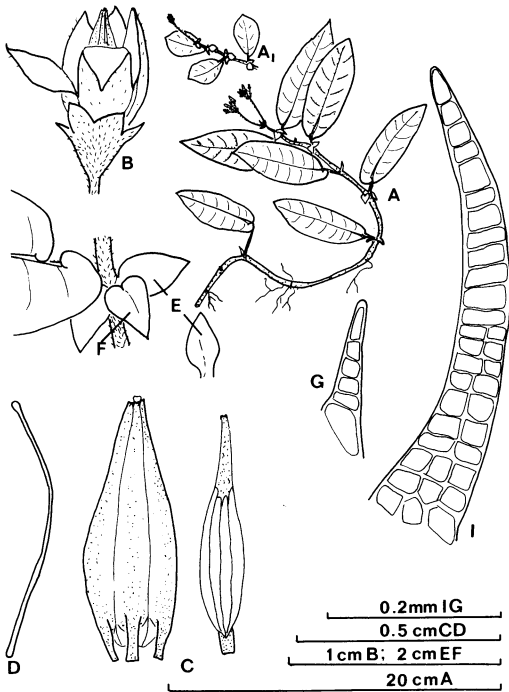
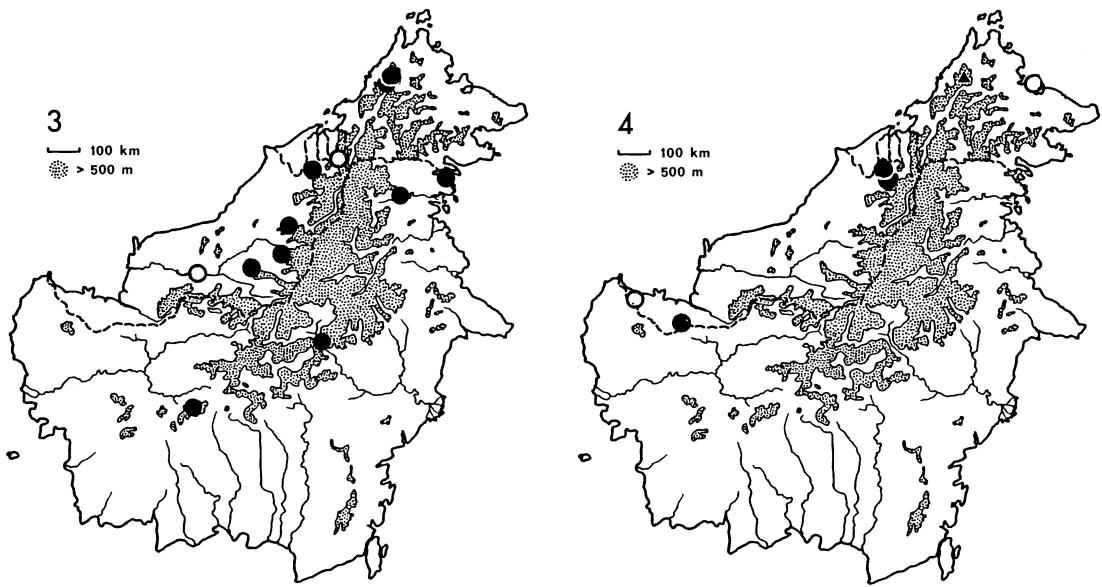


FIGURE 5. *Argostemma elatostemma*.—A. Habit.—B. Flower.—C. Anthers.—D. Style.—E. Stipules.—F. Nanophyllous leaf.—G. Hair from outer surface of the corolla.—I. Stiff, pluricellular leaf hair. A–I from *Bremer 1722* (S); A₁ from *Motley 1174* (K).

3. *Argostemma subfalcatifolium* Bakh. f., *Blumea* 7: 332. 1953. TYPE: Borneo. Sarawak: Mt. Dulit, Dulit trail, ca. 100 m, 1932, *Richards 2090A* (holotype, K). Figure 6.

Erect, anisophyllous herb. Stem 15–35 cm long, unbranched, glabrous or sparsely pubescent; internodes 7–23(–45) mm long. Leaves opposite, very unequal; stipules deciduous or persistent, 5–12 mm long, ovate to lanceolate or broadly ovate, acute at apex; larger leaves of the anisophyllous pairs with glabrous or sparsely pubescent petioles 2–12 mm long; lamina 7–22 × 1.5–5 cm, generally subfalcate to lanceolate or ovate to obovate, basally acute and oblique, marginally entire or rarely serrulate, apically acuminate or rarely acute, herbaceous, generally glabrous on both surfaces or finely pubescent on the veins below; midrib and primary veins (6–15 pairs) distinct, rarely obscure. Nanophyllous leaves deciduous or persistent, 7–12 mm long, lanceolate. Inflorescences solitary or a few together, to 45-flowered, laxly corymbiform; peduncle 1.5–6 cm long, glabrous; bracts to 0.7 cm long, ovate to lanceolate; lateral branches 1–3.3 cm long, glabrous or pubescent; pedicels 0.5–1.2 cm long, pubescent. Flowers 5-merous; calyx lobes 2–4 mm long, ovate to triangular to lanceo-



MAPS 3, 4. Distributions in Borneo.—3. *Argostemma subfalcatifolium*.—4. *A. densifolium*.

late, acute to acuminate, \pm glabrous; corolla 5–6.5 mm long, cleft to near the base, glabrate on both sides; lobes ovate to lanceolate, spreading.

Stamens 5–7 mm long, coherent; anther cells and apical appendages connate except for the most apical part; anther cone ovoid, straight; filaments short, equal, straight; sacs opening completely longitudinally; apical appendage ca. $\frac{1}{3}$ the anther length, thin and smooth; connective indistinctly passing over to the thecae, smooth. Style 5–7.5 mm long, glabrous with a slightly capitate stigma, shortly exserted. Fruit with distinct longitudinal furrows.

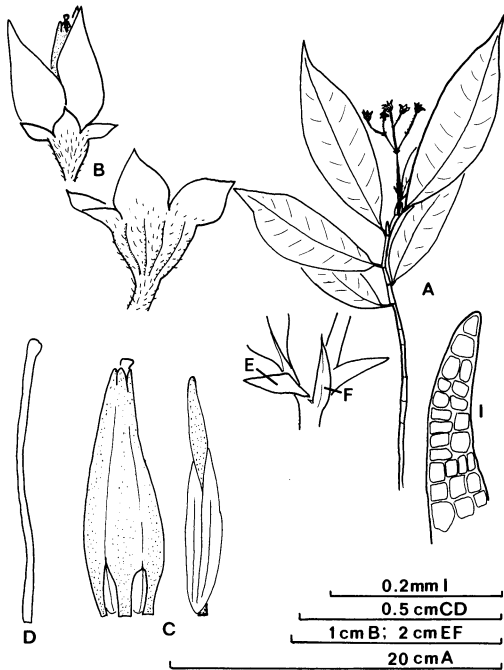


FIGURE 6. *Argostemma subfalcatifolium*.—A. Flowering branch.—B. Flower and fruit.—C. Anthers.—D. Style.—E. Stipule.—F. Nanophyllous leaf.—I. Stiff, pluricellular leaf hair. A, B (fruit) from Clemens 30650 (NY); B (flower)—I from Burt 8228 (E).

Argostemma subfalcatifolium grows in damp shady places in the lowland rainforest at altitudes from 100 to 1,500 m. It tends to have subfalcate leaves. The species is characterized by rather long calyx lobes and by furrowed fruits. The stems are glabrate and sometimes slightly pubescent. The peduncles and lateral branches of the inflorescence are mostly glabrous, whereas the pedicels, ovary, and lower part of the calyx lobes are pubescent. The flowers are rotate, and the buds are distinctly angular in cross section. The staminal cone is high. From the outside the thecae are completely shed by the connectives but can be seen as immersed sacs between the filaments.

There are a few aberrant specimens. *Anderson 4090*, from Bako in Sarawak, consists of very small plants. They were collected on fallen tree trunks and have a peculiar habit, but no other details contradict inclusion in this species. *Meijer 2286*, from Kalimantan, has nearly cordiform nanophyllous leaves, but otherwise fits. *Brooke 9194*, from Sarawak, has very narrow leaves with obscure primary veins.

Additional specimens examined. BORNEO. SABAH: W Coast Res., Kinabulu, Penibukan, 4,000 ft., 1933, *Clemens* 30650 (BM, BO, GH, K, L, NY, UC); Penibukan, 4,000 ft., 1933, *Clemens* 31963 (BM, GH, L, NY, UC); Gurulau ridge, 30–40 m, 1965, *Kanis & Kuripin* 53966 (K, L). SARAWAK: 4th Div., Gunong Mulu, 100 ft., 1975, *Burt* 8228 (E); 130 m, *Hansen* 20 (K); 5th Div., one day from Maputi, 2,000 ft., 1955, *Brooke* 10183 (BM, L); 5th Div., Ulu Sungei Melinau, Paku, 400 ft., 1961, *Anderson* 4090 (L); 7th Div., Hose Mts., Ulu Tamalad, 900 m, 1964, *Ashton* S17606 (K, L); 7th Div., ridge E of Sungei Tellini, 2,800 ft., 1987, *Burt* 11419 (E). KALIMANTAN: W Prov., Bukit Mehigit, 500 m, 1924, *Winkler* 660 (HBG); W Prov., Bidang Menabai, 700 m, 1924, *Winkler* 791 (HBG, NY); E Prov., W Kutei, near Kemoel, 1,600 m, 1925, *Endert* 4327 (BO, L); E Prov., Camp Mailinau, 1982, *Axelius* 314 (S); Nanukan, N of Tarakan, low alt., 1953, *Meijer* 2286 (K, L).

4. *Argostemma densifolium* Ridley, J. Bot. 65: 39. 1927. TYPE: Borneo. Puak (near Lundu?), 1894, *Ridley* 12448 (holotype, K; isotype, SING). Figure 7.

Argostemma densifolium var. *latifolium* Ridley, J. Bot. 65: 40. 1927. TYPE: British North Borneo: Bongaya, 1897, *Ridley s.n.* (holotype, SING).

Rosette or creeping, anisophyllous herb. Stem 5–16 cm long, slightly branched or unbranched, pubescent; internodes very short to 15 mm. Leaves opposite, very unequal; stipules persistent, 4–6 mm long, ovate to cordiform, obtuse to acuminate at apex; larger leaves of the anisophyllous pairs with pubescent petioles to 5 mm long; lamina 4–14 × 1–4.5 cm, obovate to oblanceolate, basally acute to subcordate and oblique or with the lobes unequal, marginally entire or serrulate, apically obtuse or acute, herbaceous, glabrous above and pubescent on the veins below; midrib and primary veins (10–17 pairs) distinct. Nanophyllous leaves persistent, 4–10 mm long, cordiform. Inflorescences solitary or a few together, 3–20-flowered, laxly to densely corymbiform; peduncle 1.5–7 cm long, pubescent or rarely glabrous; bracts to 0.2 cm long, ovate or lanceolate; lateral branches, if present, to 3 cm long, glabrous or pubescent; pedicels to 2 cm long, pubescent or rarely glabrous. Flowers 5-merous; calyx lobes ca. 1 mm long, stiff, narrowly triangular, acute, pubescent; corolla ca. 5 mm long, cleft to near the base, glabrous on both surfaces, the lobes lanceolate, spreading. Stamens ca. 5 mm long, coherent; anther cells and apical appendages connate; anther cone ovoid, straight; filaments short; sacs opening completely longitudinally(?); apical appendage thin and smooth; connective indistinctly passing over to the thecae, smooth. Style ca. 6 mm long, glabrous with a slightly capitate stigma, shortly exserted. Fruit without furrows or ribs.

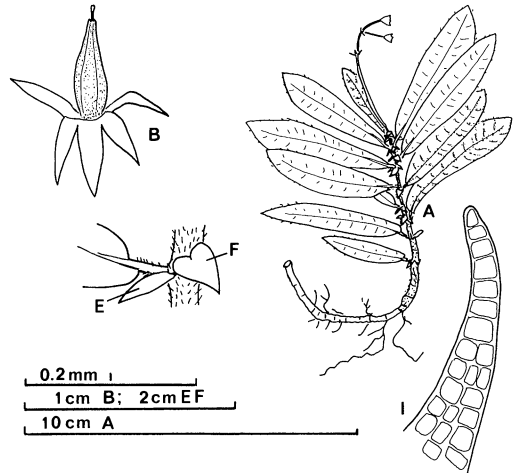


FIGURE 7. *Argostemma densifolium*.—A. Habit.—B. Flower.—E. Stipule.—F. Nanophyllous leaf.—I. Stiff, pluricellular leaf hair. A, E–I from *Sylvester Tong* S34346 (K); B from *Nielsen* 538 (K).

There are only a few collections of this species, and they are in bad condition. The description of the flowers was prepared from undissected flowers, and so some information is lacking. The scanty information on its habitat indicates that it grows on steep sandstone slopes and on gentle slopes on litter. It was collected at low altitude in southwestern and northeastern parts of Sarawak and in Sabah. I have not managed to find the locality “Bongaya,” but according to Steenis-Kruseman (1950), Ridley visited the Kudat, Sandakan, and Lubak Bay in 1897, so it must be somewhere in this area. Ridley (1927) described two varieties of this species. I agree with him that the two populations are different. The southwestern population (Fig. 7A), including the type of *A. densifolium*, has narrow leaves and glabrous inflorescences, while the northeastern population, including the type of var. *latifolium*, has denser foliage with larger, broader leaves and pubescent inflorescences. In this study, however, I have chosen not to deal with infraspecific taxa. On herbarium labels, Bakhuizen f. has treated these taxa as synonyms of *A. ophirense*. *Argostemma ophirense* and its allies are complex, but *A. ophirense* and *A. densifolium* from Borneo are two distinct taxa, in my opinion. *Argostemma densifolium* has a different leaf shape, denser foliage, and long peduncles.

Additional specimens examined. BORNEO. SARAWAK: 1st Div., Sabal, 1974, *Sylvester Tong* S34346 (K, L, MO); 4th Div., Melinau gorge pathway, 1962, *Burt & Woods* 2214 (E); 7th Div., Gunong Mulu, Melinau gorge, 100 m, 1978, *Nielsen* 538 (AAU, K); 200 m, 1978, *Nielsen* 445 (AAU).

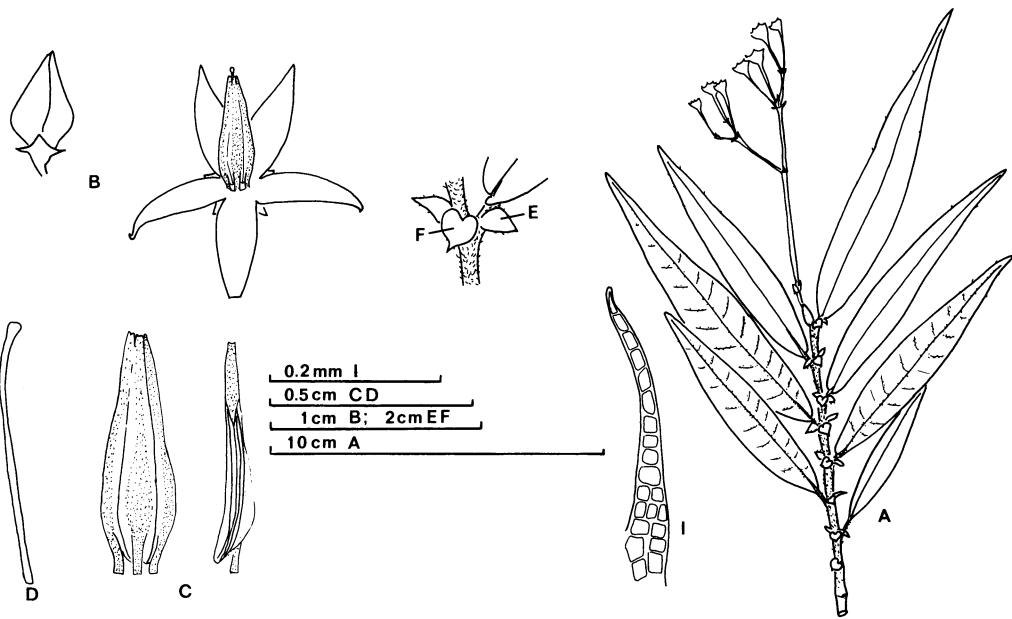


FIGURE 8. *Argostemma ophirens*. —A. Flowering branch. —B. Flowers. —C. Anthers. —D. Style. —E. Stipule. —F. Nanophyllous leaf. —I. Stiff, pluricellular leaf hair. A, E, F from *Bremer 1688* (S); B–D, I from *Burt & Woods 2701* (E).

5. *Argostemma ophirens* Maingay ex Hook.
f., *The Flora of British India* 3(7): 45. 1880.
TYPE: Malacca. Mt. Ophir, 1867–1868,
Maingay 2578 (holotype, K). Figure 8.

A. salicifolium Ridley, *J. Straits Branch Roy. Asiat. Soc.*
61: 14. 1912. TYPE: Mt. Matang, *Ridley 11751*
(holotype, SING; isotypes, BM, K).

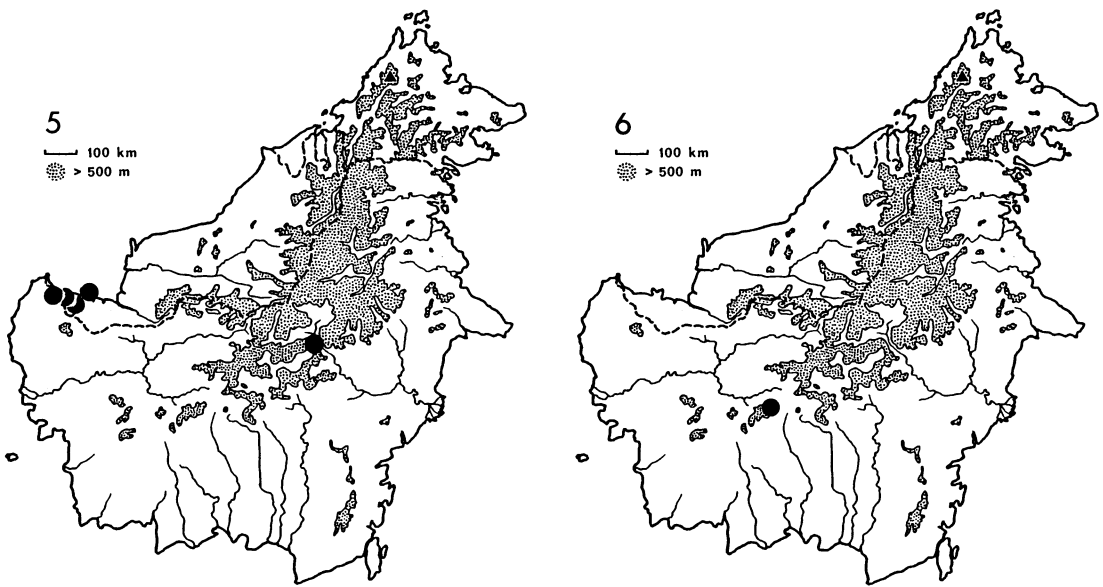
Erect, anisophyllous herb. Stem 7–30 cm long, slightly branched or unbranched, pubescent; internodes 3–15 mm. Leaves opposite, very unequal; stipules persistent, 3–5 mm long, ovate to lanceolate or oblanceolate, acute to obtuse; larger leaves of the anisophyllous pairs with pubescent petioles, to 5 mm long; lamina 5–16 × 0.4–3 cm, lanceolate to linear, basally cuneate or acute to subcordate and oblique or with the lobes unequal, marginally entire, apically acuminate to narrowly acuminate, herbaceous to coriaceous, with a few stiff pluricellular hairs on the upper surface, pubescent on the veins below; midrib and primary veins (10–20 pairs) distinct, at least below. Nanophyllous leaves persistent, 3–5 mm long, cordiform. Inflorescences solitary or a few together, 7–18-flowered, laxly corymbiform, glabrous; peduncle 1–3 cm long; bracts to 0.5 cm long, ovate to linear; lateral branches 1–2 cm long; pedicels 0.4–0.7 cm long. Flowers 5-merous; calyx lobes ca. 1 mm long, stiff, narrowly triangular, acute, glabrous;

corolla 4–5 mm long, cleft to near the base, glabrous on both surfaces; lobes ovate, acute, spreading. Stamens 4–6 mm long, coherent; anther cells and apical appendages connate except for the most apical part; anther cone ovoid, straight; filaments short, equal, straight; sacs opening completely longitudinally; apical appendage ca. $\frac{1}{3}$ the anther length, thin and smooth; connective indistinctly passing over to the thecae, smooth. Style 4–7.5 mm long, glabrous, with a slightly capitate stigma, shortly exserted. Fruit without furrows or ribs.

When Ridley (1912) described *A. salicifolium* he stated that the specimens are preserved in the Singapore Gardens Herbarium. Bakhuizen f. indicated, on the herbarium label, the K specimen as the type (= holotype). The SING specimen must be treated as the holotype and the K specimen as an isotype, as Ridley (1912) said that the specimens are preserved in SING.

Argostemma ophirens grows on ground or on rocks in forest from 50 to 1,300 m; most collections are from under 1,000 m.

There is little morphological variation in this species except for variation in leaf width and distinctness of foliar veins. It is characterized by indumentum on the stems, petioles, and veins beneath. The leaves are generally lanceolate with oblique bases. The cordiform nanophyllous leaves



MAPS 5, 6. Distributions in Borneo.—5. *Argostemma ophirense*.—6. *A. anisophyllum*.

and stipules are persistent. The inflorescences are lax cymes. The type specimens of *A. salicifolium*, probably collected from near the summit of Mt. Matang, have very narrow leaves with indistinct primary veins on the upper side. The specimens from Kalimantan have more obovate leaves.

Additional specimens examined. BORNEO. SARAWAK: 1st Div., Berumpit, 1954, *Brooke 8670* (L); 3,000

ft., 1962, *Burt & Woods 2762* (E, SAR); 1st Div., Mt. Poi (= Pueh), 1929, *Clemens field no. 6958* (NY); 1929, *Clemens field no. 7083* (NY); 3,000 ft., 1955, *Purseglove & Shah 4811* (K, L, SING); 1st Div., Sungei Lundu, 1962, *Burt & Woods 2701* (E, SAR); 1st Div., Lundu, 1929, *Clemens s.n.* (NY); 1st Div., Bako, at Serai path, 1979, *Bremer 1688* (S, SAR); Telok Delima, 200 ft., 1956, *Purseglove 4987* (K, L, SAR, SING, NY); 1st Div., Mt. Matang, 1,200 ft., 1954, *Brooke 9517* (BM, L); 1,000 ft., 1955, *Brooke 9743* (L); 2,000 ft., 1962,

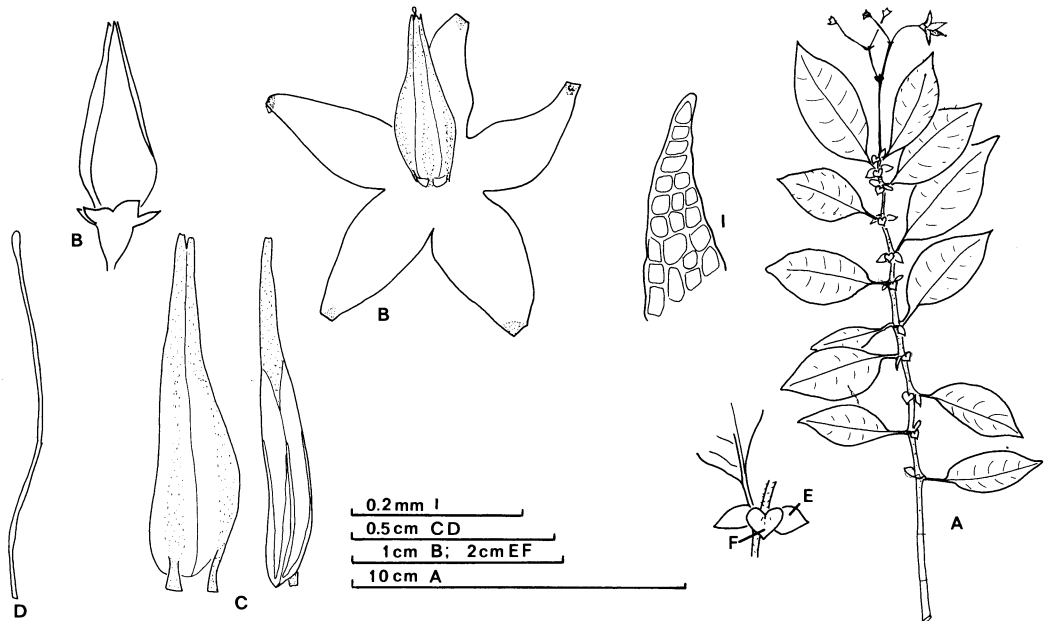


FIGURE 9. *Argostemma anisophyllum*.—A. Flowering branch.—B. Flower.—C. Anthers.—D. Style.—E. Stipule.—F. Nanophyllous leaf.—I. Stiff, pluricellular leaf hair. From *Winkler 897* (HBG).

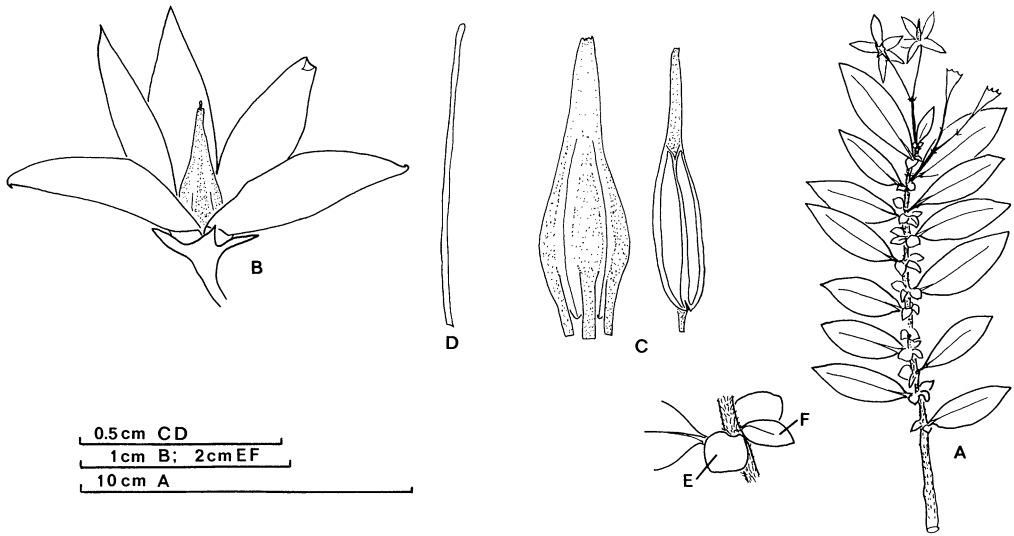


FIGURE 10. *Argostemma dulitense*. —A. Flowering branch. —B. Flower. —C. Anthers. —D. Style. —E. Stipule. —F. Nanophyllous leaf. A from *Richards 1711* (K); B–F from *Richards 2101* (K).

Burt & Woods 2512 (E, SAR); 2,500 ft., 1962, *Burt & Woods 2518* (E, SAR); 1,500 ft., 1929, *Clemens 20910* (K, NY, SAR); 1,500 ft., 1929, *Clemens 20911* (BO, K, NY); 2,000–3,000 ft., 1890, *Hullett s.n.* (SING); 1927–1928, *native collector s.n.* (NY); 1,000 ft., 1924, *Mjöberg 205* (NY, SING, UC); 1924, *Mjöberg 206* (NY, UC); 2,500–3,000 ft., *Mjöberg s.n.* (UC); 1890?, *Ridley 11751* (BM, K, SING). KALIMANTAN: E Prov., Gunong Beratus (Peak of Balikpapan), 800–900 m, 1952, *Kostermans 7437* (BO, L); 750 m, 1952, *Meijer 687* (BO, L).

6. *Argostemma anisophyllum* Merr., Mitt.
Inst. Allg. Bot. Hamburg 7: 278. 1937. TYPE:
West Borneo. Bukit Raja, 1,250 m, 1924,
Winkler 897 (holotype, HBG; isotype, NY).
Figure 9.

Erect, anisophyllous herb. Stem 10–30 cm long, slightly branched or unbranched, glabrous or glabrate; internodes 5–25 mm. Leaves opposite, very unequal; stipules persistent, 4–5 mm long, broadly ovate to lanceolate, acute at apex; larger leaves of the anisophyllous pairs with glabrous petioles 3–7 mm long; lamina 2–6.2 × 1.2–2.2 cm long, obovate to oblanceolate, basally acute to attenuate and oblique, marginally entire, apically acuminate, herbaceous to membranaceous, with a few stiff pluricellular hairs on the upper surface, glabrous below; midrib and primary veins (6–10 pairs) distinct. Nanophyllous leaves persistent, 2–4 mm long, cordiform. Inflorescences solitary, 1–5-flowered, laxly corymbiform, glabrous; peduncle 2–2.8 cm long; lateral branches 1–1.5 cm long; bracts ca. 0.1 cm long, lanceolate or triangular; pedicels 1–2.2 cm long. Flowers 5-merous; calyx lobes ca. 1

mm long, stiff, narrowly triangular, acute, glabrous; corolla 8–9 mm long, cleft to near the base, glabrous on both surfaces; lobes ovate to broadly ovate, spreading. Stamens 9–11 mm long, coherent; anther cells and apical appendages connate except for the most apical part; anther cone narrowly ovoid or ovoid, straight; filaments short, equal, straight; sacs opening completely longitudinally; apical appendage ca. ½ the anther length, thin and smooth; connective indistinctly passing over to the thecae, smooth. Style 10–12 mm long, glabrous, with a slightly capitate stigma, exerted. Fruit without furrows or ribs.

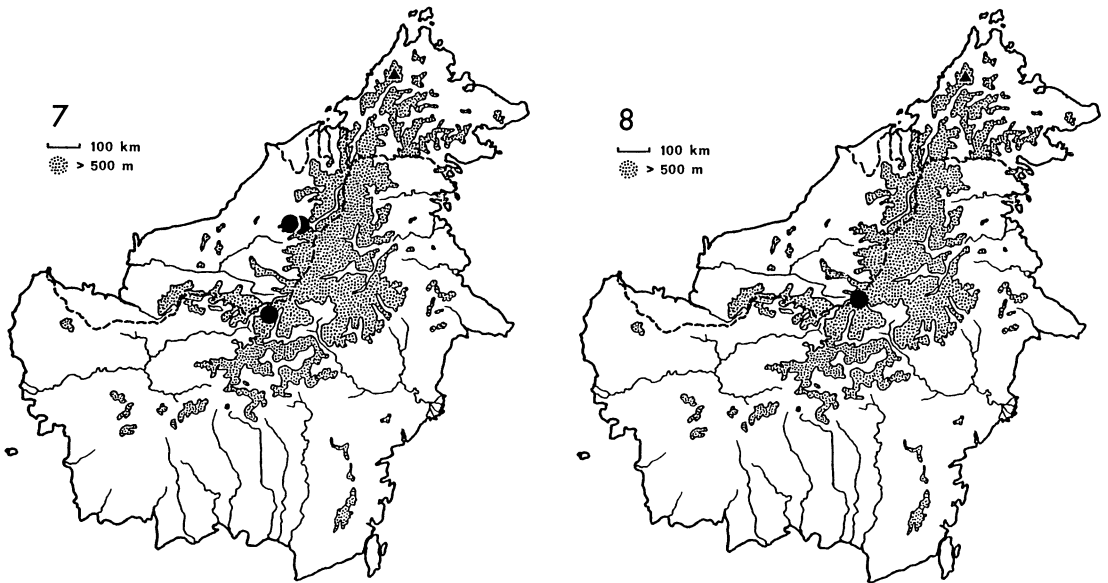
Argostemma anisophyllum grows from 1,250 to 1,400 m at Bukit Raja.

It has been treated as a synonym of *A. ophirensis* by Bakhuizen f. on herbarium labels. *Argostemma anisophyllum* has fewer hairs on the stems, much smaller and thinner leaves, longer peduncles and pedicels, and much larger flowers.

Additional specimen examined. BORNEO. KALIMANTAN: Bukit Raja, 1,400 m, 1924, *Winkler 950* (HBC).

7. *Argostemma dulitense* Merr., Sarawak Mus.
J. 3: 554. 1928. TYPE: Borneo. Sarawak: Mt. Dulit, 1,200–1,500 m, 1923, *Mjöberg 8* (holotype, UC). Figure 10.

Erect anisophyllous herb. Stem 10–40 cm long, slightly branched or unbranched, densely pubescent; internodes to 8 mm. Leaves opposite, very unequal; stipules persistent, 2–4 mm long, broadly ovate, acute at apex; larger leaves of the aniso-



MAPS 7, 8. Distributions in Borneo.—7. *Argostemma dulitense*.—8. *A. apiculatum*.

phyllous pairs with glabrous petioles ca. 3 mm long; lamina 2–6 × 0.4–1.5 cm, lanceolate or narrowly elliptic to obovate, basally cuneate to attenuate and with the lobes equal, marginally entire, apically acute to acuminate, coriaceous, glabrous on both surfaces; midrib distinct, primary veins generally obscure. Nanophyllous leaves persistent, ca. 5 mm long, ovate. Inflorescences solitary or a few together, 1–3-flowered, glabrous; peduncle 1–2.5 cm long; bracts to 0.3 cm long, ovate to triangular or lanceolate; pedicels 1–2.7 cm long. Flowers 5-merous; calyx lobes ca. 2 mm long, stiff, narrowly triangular, glabrous. Corolla 9–12 mm long, cleft to near the base, glabrous on both surfaces; lobes ovate to lanceolate, spreading. Stamens ca. 7 mm long, coherent; anther cells and apical appendages connate except for the most apical part; anther cone ovoid or narrowly so, straight; filaments short, equal, straight; sacs opening completely longitudinally; apical appendage ca. 1/3 the anther length, thin and smooth; connective indistinctly passing over to the thecae, smooth. Style ca. 8 mm long, glabrous with a scarcely widened stigma, shortly exerted. Fruit without furrows or ribs.

Argostemma dulitense grows in shady places on tree trunks or on rocks near waterfalls in moss and heath forests.

It is characterized by its glossy dark green upper leaf surfaces, pale lower leaf surfaces and very firm leaf texture. The stems are covered by appressed hairs; otherwise it is glabrous. The corolla is large and rotate with green spots at the base, and the

anther cone is high. The specimens from Kalimantan have distinct primary veins, while the Sarawak specimens have obscure veins.

Additional specimens examined. BORNEO. SARAWAK: 4th Div., Dulit Ridge 1,250 m, 1932, *Richards 1711* (K); 1,000 m, 1932, *Richards 2101* (K, L); 4th Div., Gunong Dulit, at Long Atun, 1,300 m, 1965, *Asahak Luang S22752* (K, L); 1,200–1,500 m, 4th Div., Ulu Tinjar, 2,600 ft., 1974, *Sylvester Tong S34847* (K, L). KALIMANTAN: E Prov., Boekit Batue Ajah, 1896–1897, *Jaheri in exp. Nieuwenhuis 1636* (BO, L).

8. *Argostemma apiculatum* B. Bremer, sp. nov. TYPE: Borneo. Sarawak: 7th Div., summit of Bukit Tibang, 5,000 ft., 1969, *Anderson & Ilias Paie S28657* (holotype, K; isotypes, E, L). Figure 11.

Herba erecta, glabra, inflorescentiis floribus paucis. Folia opposita, illis parium inaequalissimis. Inflorescentia corymbosa, floribus grandibus. Lobi calycis rigidi, anguste triangulares, acuti. Lobi corollae apiculati. Antherae et appendices apicales connatae praeter partem apicalissimam. Appendix apicalis 1/4 anthera brevior, tenuis, laevis. Connectivum indistinctum. Stylus glaber stigmatem vix dilatato.

Argostemma burttii simile sed planta glabra, lobis corollae apiculatis differt.

Erect, anisophyllous, glabrous herb. Stem 2–30 cm, unbranched; internodes 6–16 mm. Leaves opposite, very unequal; stipules persistent, 5–7 mm long, ovate to cordiform, acute at apex; larger leaves of the anisophyllous pairs with petioles 3–5 mm long, the lamina 3–8.5 × 0.8–1.9 cm, narrowly elliptic, basally cuneate to attenuate with

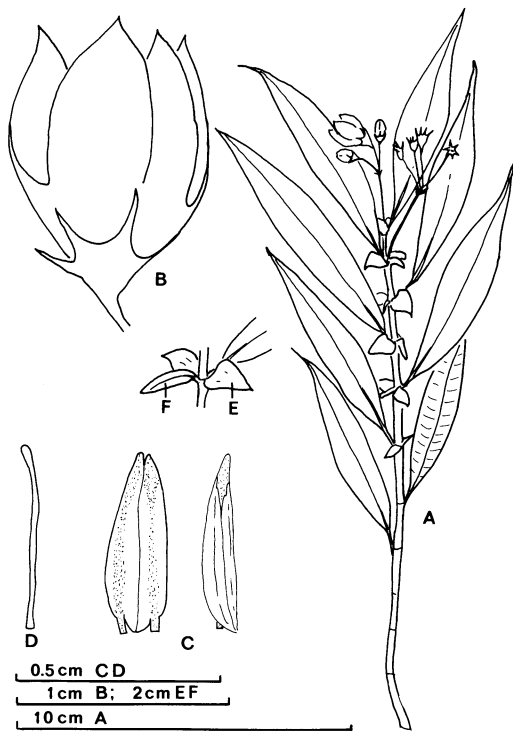


FIGURE 11. *Argostemma apiculatum*.—A. Flowering branch.—B. Flower.—C. Anthers.—D. Style.—E. Stipule.—F. Nanophyllous leaf. From *Anderson & Ilias Paie S28657* (K).

the lobes equal, marginally entire, apically acuminate, herbaceous to membranaceous; midrib distinct, the primary veins (10–16 pairs) obscure. Nanophyllous leaves persistent, 5–6 mm long, elliptic to lanceolate. Inflorescences 1–4-flowered, laxly corymbiform, solitary or a few together; peduncle 1.5–2 cm; bracts to 0.5 cm long, lanceolate; pedicels to 0.8 mm. Flowers 5-merous; calyx lobes ca. 3 mm long, stiff, narrowly triangular, acute, glabrous; corolla 10–12 mm long, cleft to near the base; lobes ovate to broadly so, pointed, spreading. Stamens 4.5–5 mm long, coherent; anther cells and apical appendages connate except for the most apical part; anther cone ovoid, straight; filaments short, equal, straight; sacs opening completely longitudinally; apical appendage less than $\frac{1}{4}$ the anther length, thin and smooth; connective indistinctly passing over the thecae, smooth. Style ca. 5 mm long, glabrous, with a scarcely widened stigma, shortly exserted. Fruit without furrows or ribs.

Argostemma apiculatum was collected once at Bukit Tibang, on igneous soil at 1,600 m in mossy forest.

It is a glabrous plant with large, broad, pointed

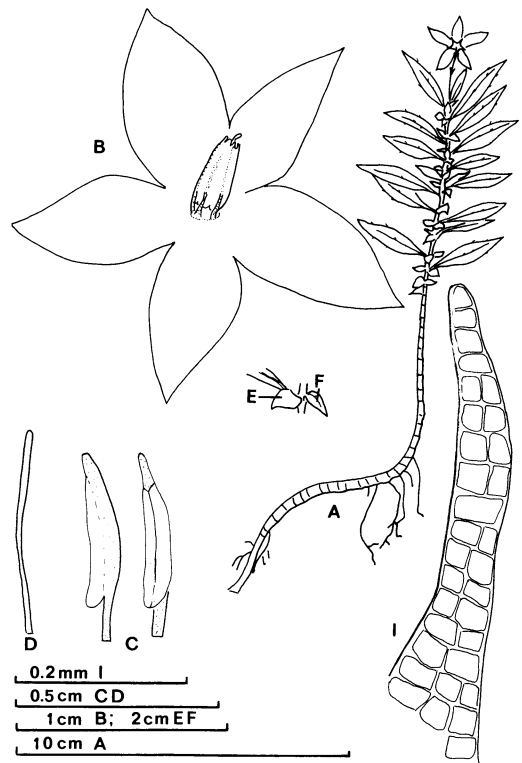


FIGURE 12. *Argostemma burttii*.—A. Habit.—B. Flower.—C. Anthers.—D. Style.—E. Stipule.—F. Nanophyllous leaf.—I. Stiff, pluricellular leaf hair. From *Burt & Martin 4986* (E).

corolla lobes. The apical appendages of the anthers are short. It is similar to *A. burttii* because of its large corollas and the short apical appendages. *Argostemma apiculatum* differs from that species by its apiculate corolla lobes and erect glabrous habit.

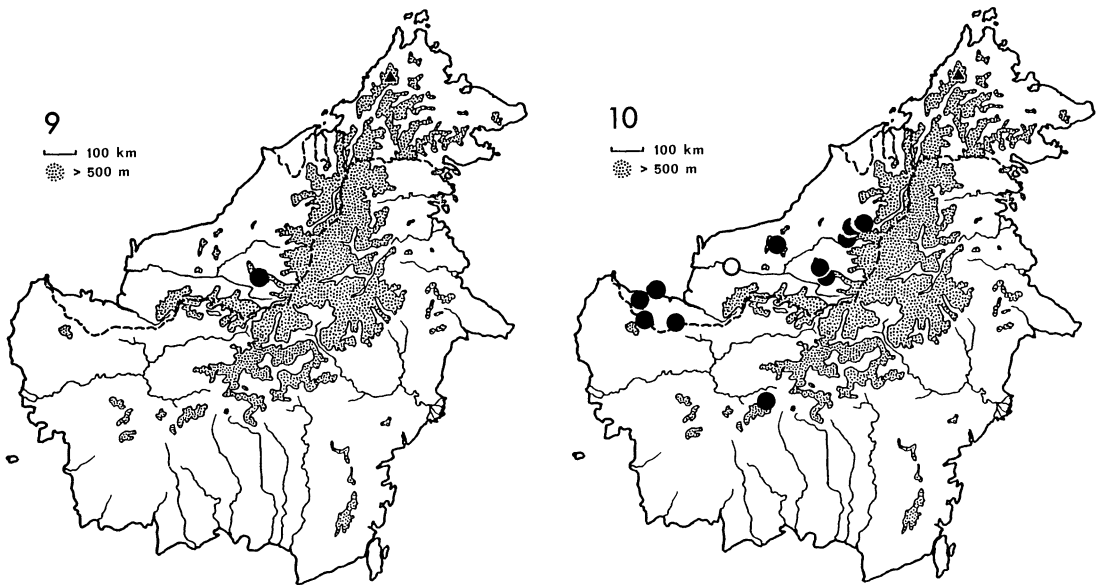
9. *Argostemma burttii* B. Bremer, sp. nov.

TYPE: Borneo. Sarawak: SE of Hose Mts., above Ulu Melinau Falls, ca. 4,000 ft., 1967, *Burt & Martin 4986* (holotype, E). Figure 12.

Herba repens vel suberecta, inflorescentiis floribus solitariis paucisve. Folia opposita, illis parium inaequalissimis, serrulata. Inflorescentia monochasialis, floribus grandibus. Lobi calycis rigidi, anguste triangulares, acuti. Antherae et appendices apicales connatae praeter partem apicalissimam. Appendix apicalis $\frac{1}{4}$ anthera brevior, tenuis, laevis. Connectivum indistinctum. Stylus glaber stigmatate vix dilatato.

Argostemma apiculatum simile sed foliis serrulatis, lobis corollae non apiculatis differt.

Creeping or suberect, anisophyllous herb. Stem to 20 cm, slightly branched or unbranched, glabrous; internodes 2–4 mm. Leaves opposite, very



MAPS 9, 10. Distributions in Borneo.—9. *Argostemma burtii*.—10. *A. rupestre*.

unequal; stipules 2–4 mm long, broadly ovate to cordiform, acute at apex. Larger leaves of the anisophyllous pairs with glabrous petioles 1–3 mm long; lamina 1–3.5 × 0.4–0.9 cm, narrowly elliptic, basally cuneate to attenuate with the lobes equal, marginally serrulate, apically acuminate, herbaceous to membranaceous, glabrous on both surfaces but with 3 or 5 rows of stiff pluricellular hairs on the upper surface; midrib distinct, the primary veins obscure. Nanophyllous leaves persistent, to 4 mm long, ovate to lanceolate. Inflorescences 1–2-flowered, monochasial, solitary or a few together; peduncle 1–2 cm, glabrous; bracts to 0.2 cm long, lanceolate to linear; pedicels 0.7–1.5 cm, glabrous. Flowers 5-merous; calyx lobes ca. 1.5 mm long, stiff, triangular to narrowly triangular, acute, glabrous; corolla 9–12 mm long, cleft to near the base, glabrous on both surfaces; lobes ovate, spreading. Stamens 4–5 mm long, coherent; anther cells and apical appendages connate except for the most apical part; anther cone ovoid, straight; filaments short, equal, straight; sacs opening completely longitudinally; apical appendage less than ¼ the anther length, thin and smooth; connective indistinctly passing over to the thecae, smooth. Style ca. 5 mm long, glabrous, with a scarcely widened stigma, shortly exerted. Fruit without furrows or ribs.

Argostemma burtii was found growing at bases of trees among mosses at ca. 1,300 m. It is a local endemic species from the Hose Mountains. Mr. B. L. Burt has collected it at three different places.

It is a beautiful little plant with very large flowers. The corolla is open and flat with green spots at the center, and the anther cone is cream-colored. The border between the filaments and the thecae is indistinct, as in, for example, *A. apiculatum*, *A. rupestre*, and *A. gesinkii*. With the last two it also shares the character of three or five rows of stiff, pluricellular hairs on the upper leaf surface. *Argostemma burtii* is most similar to *A. apiculatum*, both having large corollas and short apical appendages, but *A. burtii* differs by having serrulate leaves and creeping or suberect habit.

Additional specimens examined. BORNEO. SARAWAK: 7th Div., S Hose Mts., W of Bukit Sanpandai, 1980, *Burt* 12750 (E); E of Bukit Sanpandai, 4,500 ft., 1980, *Burt* 12817 (E).

10. *Argostemma rupestre* Ridley, J. Bot. 65: 41. 1927. TYPE: Borneo. On the hill near Matang, *Haviland* 1031 (holotype, K; isotypes, SAR, SING). Figure 13.

Creeping or suberect, anisophyllous herb. Stem 3–14 cm, generally unbranched, glabrous or with a few hairs; internodes very short to 7 mm. Leaves opposite, very unequal; stipules persistent, 2–7 mm long, ovate to lanceolate, acute at apex; larger leaves of the anisophyllous pairs with glabrous petioles to 5 mm long; lamina 1.3–5.5 × 0.2–1.8 cm, narrowly elliptic to lanceolate or oblanceolate, rarely elliptic or linear; basally cuneate to attenuate with the lobes equal; marginally serrulate, apically acuminate; herbaceous to membranaceous, gla-

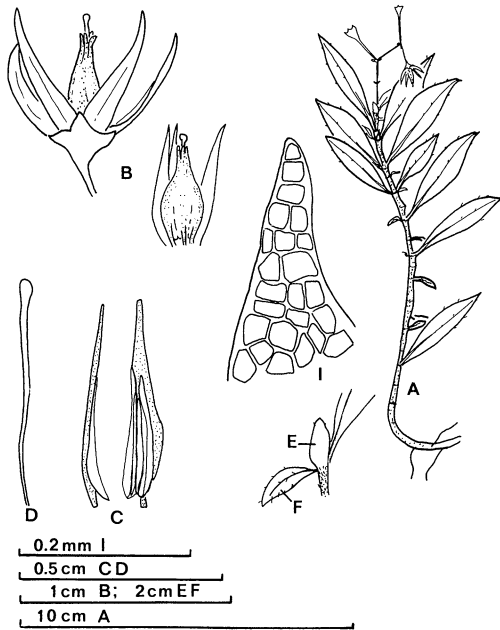


FIGURE 13. *Argostemma rupestre*.—A. Habit.—B. Flower.—C. Anthers.—D. Style.—E. Stipule.—F. Nanophyllous leaf.—I. Stiff, pluricellular leaf hair. From *Bremer 1665* (S).

brous on both surfaces except for 3 or 5 rows of stiff pluricellular hairs above; midrib distinct, the primary veins obscure. Nanophyllous leaves persistent, 2–10 mm long, ovate to elliptic or lanceolate. Inflorescences 1–3(–5)-flowered, laxly corymbiform, solitary or a few together; peduncle 1–3 cm, glabrous or pubescent; bracts 0.1–0.3 cm long, lanceolate; pedicels 0.5–1.5 cm, glabrous or pubescent. Flowers 5-merous; calyx lobes ca. 1 mm long, stiff, triangular to narrowly triangular, acute, glabrous; corolla 4–7 mm long, cleft to near the base; lobes lanceolate, acute to acuminate, erect-spreading. Stamens 5–7 mm long, coherent; anther cells and apical appendages connate except for the most apical part; anther cone ovoid, straight; filaments short, equal, straight; sacs opening completely longitudinally; apical appendage ca. $\frac{1}{3}$ the anther length, thin and smooth; connective indistinctly passing over to the thecae, smooth. Style 6–8 mm long, glabrous, with a slightly capitate stigma, shortly exerted. Fruit without furrows or ribs.

Argostemma rupestre is a small herb growing on wet sandstone boulders or other wet places in or near streams or waterfalls, chiefly among mosses. It occurs from low altitudes up to ca. 1,500 m in mossy forests.

This anisophyllous herb has glabrous leaves ex-

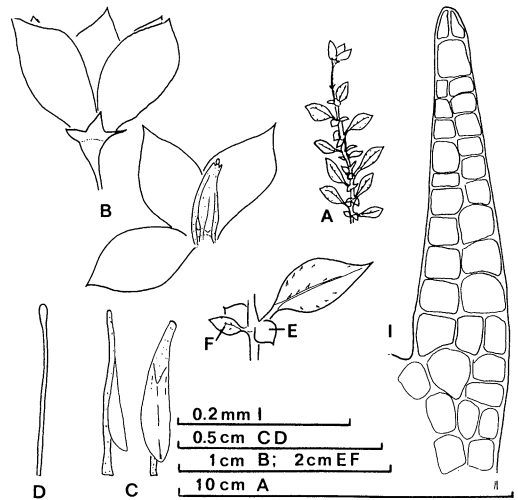
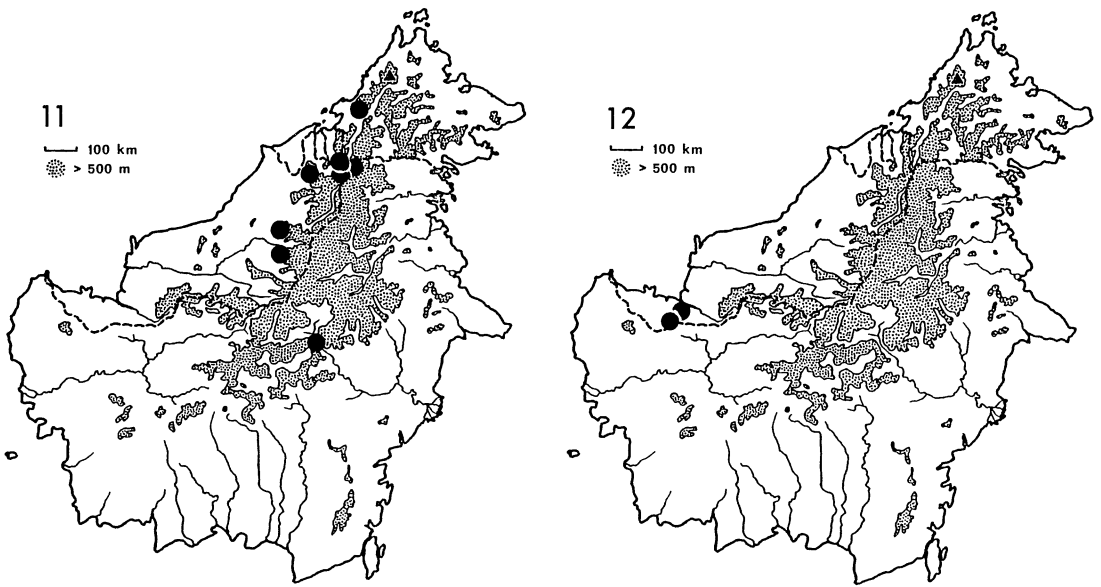


FIGURE 14. *Argostemma gesinkii*.—A. Flowering branch.—B. Flower.—C. Anthers.—D. Style.—E. Stipule.—F. Nanophyllous leaf.—I. Stiff, pluricellular leaf hair. From *Geesink 9272* (L).

cept for three or five rows of stiff pluricellular hairs on the midrib and along the margins. The marginal hairs make the leaves serrulate. The lower surface of the leaves is pale. The stipules and nanophyllous leaves are similar in shape. The corolla is cleft to near the base into narrow and erect-spreading lobes. The anther cone is high with a pale yellow color near the base and whitish at the apex. The inflorescences are lax cymes with one to five flowers. The peduncles and pedicels are narrow and generally glabrous. The specimens from Bako are all pubescent on the peduncles, pedicels, and ovaries and have somewhat broader corolla lobes. There are two collections from different areas (*Brooke 9131* and *Richards 2455*) with very narrow leaves; both were collected in or near streams and may be ecotypes. *Clemens 21737* came from an uncertain locality: on the herbarium label is written “Gat, Upper Rajang River,” while on the attached field label both “Gat” and “Mt. Matang” are written. This plant has pubescent pedicels, as does the Bako population.

Additional specimens examined. BORNEO. SARAWAK: 1st Div., N slopes of Mt. Penrissen, 1,000–1,100 m, 1958, *Jacobs 5065* (B, G, K, L, SAR, UC); 1st Div., Bako, on slopes just N of the office, 1979, *Bremer 1675* (S, SAR); at Serai path S of the office, 1979, *Bremer 1687* (S, SAR); Telok Asam, 100 m, 1956, *Purseglove 5095* (K, L, NY, SAR, SING); Telok Asam, 100 m, 1957, *Purseglove 5534* (K, L, SAR, SING); 1st Div., Sabal, 350 m, 1979, *Bremer 1665* (S, SAR); 3rd Div., Teneong, 1954, *Brooke 9131* (BM, L); 4th Div., Ulu Mersing, Ulu Anap, 100 m, 1963, *Ashton S17691* (K, L, SAR); 4th Div., Mt. Dulit, 300 m, 1932, *Richards*



MAPS 11, 12. Distributions in Borneo.—11. *Argostemma geesinkii*.—12. *A. gaharuense*.

2455 (K, L); 4th Div., Ulu Sungei Chipidi, Ulu Tinjar, 2,300 ft., 1974, *Chai* S34797 (K, L, MO, SAR); 7th Div., Sungei Melinau, 450 ft., 1980, *Burt* 12667 (E); 7th Div., Hose Mts., Bukit Salong, 1982, *Burt* 12734 (E); Bukit Sanpandai, 4,500 ft., 1980, *Burt* 12796 (E); without loc., *Clemens* 21737 (NY). KALIMANTAN: W Prov., Bukit Raja, 1,400 m, *Winkler* 951 (HBC).

11. *Argostemma geesinkii* B. Bremer, sp. nov.

TYPE: Borneo. Kalimantan Timur, between Papadi and Pamilau, 1,400 m, 1981, *Geesink* 9272 (holotype, L). Figure 14.

Herba pusilla, repens, inflorescentis floribus solitariis aut duobus. Folia opposita, illis parium inaequalissimis, serratula vel integra. Inflorescentia monochasialis, floribus mediocribus. Lobi calycis, rigidi, anguste triangulares, acuti. Lobi corollae erecto-patentes, in exsiccatis subrosei. Antherae et appendices apicales connatae praeter partem apicalissimam. Appendix apicalis $\frac{1}{3}$ longitudinem antherae aequans, tenuis, laevis. Connectivum indistinctum. Stylus glaber stigmatem leviter capitato.

Argostemma rupestre simile sed planta pusilla, lobis corollae latis erecto-patentibus differt.

Small, creeping, anisophyllous herb. Stem 2–20 cm, slightly branched or unbranched, glabrous; internodes very short to 5 mm. Leaves opposite, very unequal; stipules 2–4 mm long, ovate to cordiform, acute to obtuse at apex; larger leaves of the anisophyllous pairs with glabrous petioles 1–2 mm long; lamina 2.5–7 × 0.6–1.5 cm, elliptic to obovate, basally cuneate to attenuate with the lobes equal, marginally serrulate or entire, apically acute to shortly acuminate or rarely obtuse, membranaceous, glabrous on both surfaces but with 3 or 5

rows of stiff pluricellular hairs on the upper surface; midrib distinct, the primary veins generally obscure. Nanophyllous leaves persistent, 2–5 mm long, ovate to elliptic, acute. Inflorescences 1–2-flowered, monochasial, solitary or a few together; peduncle 0.2–1 cm, glabrous; bracts ca. 1 mm long, lanceolate to triangular; pedicels 0.5–1 cm, glabrous. Flowers 5-merous; calyx lobes ca. 1 mm long, stiff, narrowly triangular, acute, glabrous; corolla 5–7 mm long, cleft to near the base, glabrous on both surfaces; lobes ovate to broadly ovate, acute, erect-spreading. Stamens 4–5 mm long, coherent; anther cells and apical appendages connate except for the most apical part; anther cone ovoid, straight; filaments short, equal, straight; sacs opening completely longitudinally; apical appendage ca. $\frac{1}{3}$ the anther length, thin and smooth; connective indistinctly passing over to the thecae, smooth. Style 4–5 mm long, glabrous, with a slightly capitate stigma, shortly exerted. Fruit without furrows or ribs.

Argostemma geesinkii grows on tree trunks and on boulders among mosses, from 950 to 1,500 m. A few collections are from sandstone.

Argostemma geesinkii is a very small creeping species with small anisophyllous leaves and cordiform stipules. It is glabrous except for the stiff pluricellular hairs in three or five rows on the upper leaf surfaces. The flowers are generally solitary on thin pedicels. The corolla lobes are broad and often become pinkish in the press. All specimens except *Endert* 3916 are very similar. This aberrant spec-

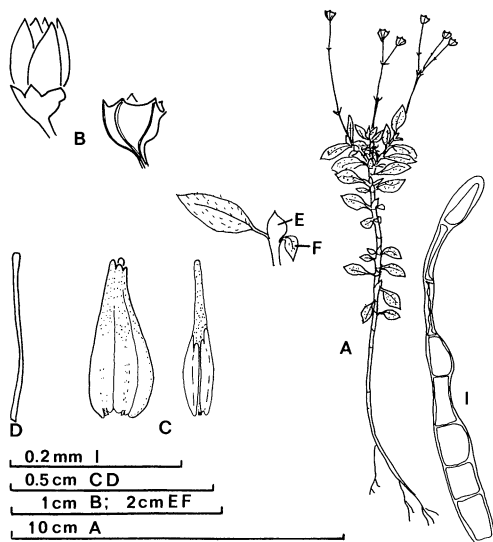


FIGURE 15. *Argostemma gaharuense*.—A. Habit.—B. Flower and fruit.—C. Anthers.—D. Style.—E. Stipule.—F. Nanophyllous leaf.—I. Hair from upper surface of leaf. From *Burt 2655* (E).

imen lacks stiff hairs and has thicker leaves and prominent primary veins, but there are no floral differences between it and the other collections of *A. gesinkii*. There is another specimen from the same area (*Endert 3800*) that does not deviate from the others. Perhaps *Endert 3916* is a different taxon.

Additional specimens examined. BORNEO. SABAH: Kimanis road, Keningau, 4,400 ft., 1979, *Collenette 4179* (E). SARAWAK: 4th Div., Gunong Mulu, 4,000 ft., 1962, *Burt & Woods 1185* (E); 5th Div., Bakelalan, 4,000 ft., 1955, *Brooke 10411* (L); 5th Div., Kalabit Highlands, Apa Balu Buli, 1,700 m, 1970, *Nooteboom & Chai 2198* (L); 7th Div., ridge NW of Sungei Tellini, 2,900 ft., 1978, *Burt 11443* (E); 7th Div., Bukit Lamut, Ulu Amau, 950 m, 1964, *Ashton S21265* (L). KALIMANTAN: E Prov., between Long Bawan and Panado, 1,800 m, 1981, *Geesink 9113* (L); E Prov., W Kutei, near Kemoel, 1,200 m, 1925, *Endert 3800* (L); 1,500 m, 1925, *Endert 3916* (A, K, L, SING).

12. *Argostemma gaharuense* B. Bremer, sp. nov. TYPE: Borneo. Sarawak: 1st Div., Bukit Gaharu, 2,000 ft., 1962, *Burt 2655* (holotype, E). Figure 15.

Herba pusilla, ramosa, inflorescentibus floribus solitariis vel paucis. Folia opposita, illis parium inaequalissimis, pubescentia. Inflorescentia corymbosa, floribus pusillis. Lobi calycis triangulares, acuti. Lobi corollae reflexi. Antherae et appendices apicales connatae praeter partem apicalissimam. Appendix apicalis $\frac{1}{2}$ longitudinem antherae aequans, tenuis, laevis. Connectivum indistinctum. Stylus glaber, stigmatum vix dilatato.

Argostemma rupestre simile sed planta pubescens, ramosa, lobis corollae reflexis, fructu costato differt.

Small, creeping(?) herb. Stem to 20 cm, branched, glabrous; internodes very short to 4 mm. Leaves opposite, very unequal; stipules 2–3 mm long, ovate to cordiform, acute at apex; larger leaves of the anisophyllous pairs with glabrous petioles 1–2 mm long; lamina 0.4–0.6 × 0.2–0.4 mm, elliptic to narrowly so, basally cuneate to attenuate with the lobes equal, marginally entire, apically acute, coriaceous, pubescent above and glabrous below; midrib distinct but without primary veins. Nanophyllous leaves persistent, 2–3 mm long, ovate to elliptic, acute. Inflorescences 1–6-flowered, laxly corymbiform, many together; peduncle 1.4–2.8 cm, glabrous; bracts ca. 1 mm long, lanceolate; pedicels 0.5–1.4 cm, glabrous. Flowers 5-merous; calyx lobes ca. 1 mm long, triangular, acute, glabrous; corolla ca. 4 mm long, cleft to near the base, glabrous on both surfaces; lobes ovate, acute, reflexed. Stamens 3.5–4 mm long, coherent; anther cells and apical appendages connate except for the most apical part; anther cone ovoidal, straight; filaments very short, equal, straight; sacs opening completely longitudinally; apical appendage ca. $\frac{1}{2}$ the anther length, thin and smooth; connective indistinctly passing over to the thecae, smooth. Style ca. 4.5 mm long, glabrous, with a scarcely widened stigma, shortly exerted. Fruit with 5 distinct ribs corresponding to the middle vascular strands of the calyx lobes.

Argostemma gaharuense was collected by Burt at 660 m at Bukit Gaharu. Its habit is not given on the herbarium label.

On the label of the type specimen is written: "Leaves dark green above, white below. Corolla white, lobes strongly reflexed. Base of anther cone green, tips white." It is a small, easily recognized plant. The leaves are dark and pubescent on the upper surfaces, and below they are white and glabrous. The stems are distinctly branched distally with many apical inflorescences, each with one to six flowers in lax cymes. The vascular strand to each calyx lobe becomes a distinct rib, making the fruit five-ribbed. The habit is similar to that of *A. rupestre*, *A. gesinkii*, and *A. burtii*, but *A. gaharuense* differs from these by having monoseriate leaf hairs, branched stems, and reflexed corolla lobes. The leaf and stipule shapes are the same as those of *A. gesinkii*. The specimen from Gunong Apeng has narrower leaves than the type, and there is only one inflorescence with two flowers. However, it has reflexed corolla lobes and the same kind of indumentum.

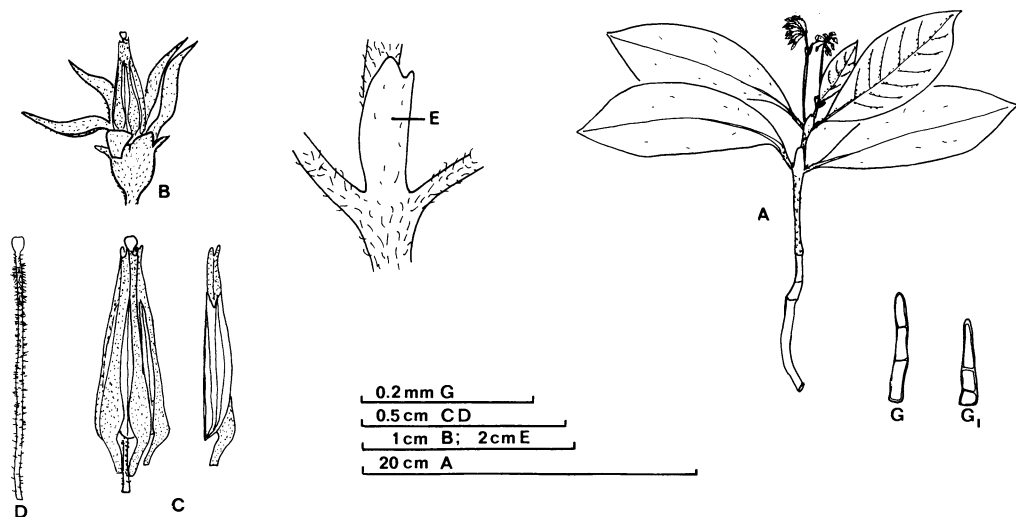


FIGURE 16. *Argostemma hameliifolium*.—A. Flowering branch.—B. Flower.—C. Anthers.—D. Style.—E. Stipule.—G. Hair from outer surface of the corolla.—G₁. Hair from inner surface of the corolla. A, E from *Bremer 1752* (S); B–D, G from *Richards 1799* (L).

Additional specimen examined. BORNEO. SARAWAK: 2nd Div., Gunong Apeng, 3,000 ft., 1961, *Collette s.n.* (K).

13. *Argostemma hameliifolium* Wernham in Gibbs, *J. Linn. Soc. Bot.* 42: 89. 1914. TYPE: British North Borneo. Kinabalu: before Lobang rock, 5,000 ft., 1910, *Gibbs 4101* (holotype, K; isotype, BM). Figure 16.

A. hullettii Ridley, *J. Bot.* 65: 35. 1927. TYPE: Borneo. Sarawak: Matang, 2,000 ft., 1884, *Hullett 329* (lectotype, SING; Bakh. f. in herb., confirmed here).

A. isophyllum Merr., *Mitt. Inst. Allg. Bot. Hamburg* 7: 279. 1937. TYPE: West Borneo: Bukit Raja, 1,400 m, 1924, *Winkler 949* (holotype, HBG; isotype, NY).

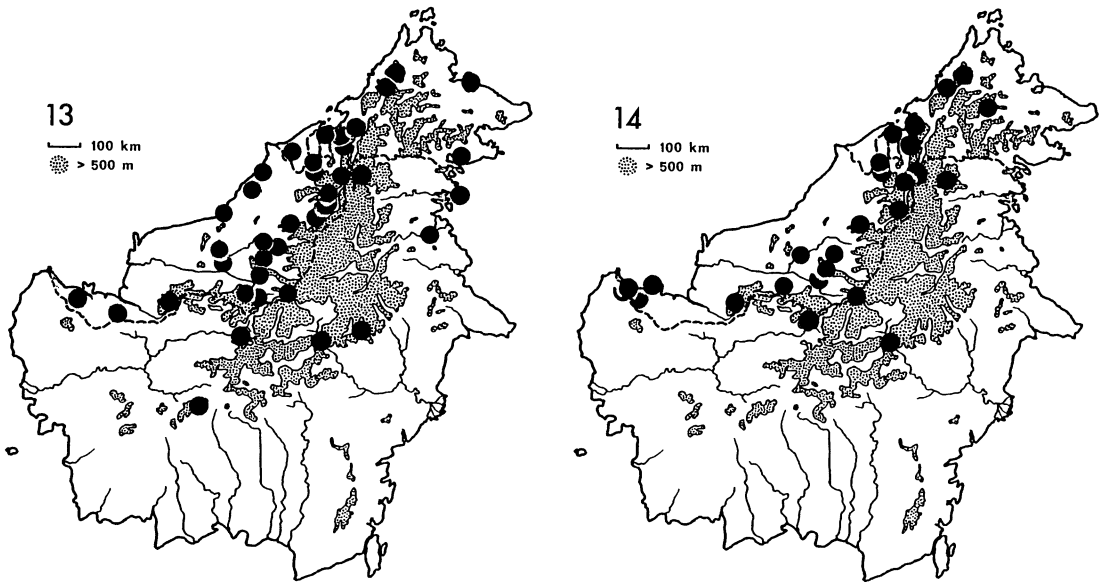
Large, erect, isophyllous herb. Stem 10–100 cm, unbranched, glabrous to pubescent, rarely with corky or papery bark; internodes 10–85 mm. Leaves opposite, equal; stipules deciduous, 5–27 mm long, oblong to lanceolate to ligulate, entire or slightly bifid, acute to acuminate or obtuse at apex; petiole 4–30 mm long, glabrous to pubescent; lamina 5–19 × 1–8.7 cm, oblanceolate or obovate to lanceolate or ovate, basally attenuate to acute or cuneate with the lobes equal, marginally entire, apically acuminate to acute or rarely obtuse, herbaceous, glabrous to finely pubescent above, glabrous to pubescent below; midrib and primary veins (6–12 pairs) distinct. Inflorescences 3–40-flowered, umbelliform and rarely with 2 or 3 scorpioid branches, generally solitary; peduncle 2–7.5 cm, almost glabrous; bracts to 5(–10) mm long, lan-

ceolate to linear; lateral branches, if present, to 3.5 cm long, almost glabrous; pedicels 6–12 mm long, finely pubescent. Flowers 5-merous; calyx lobes 1–1.5 mm long, triangular to ovate, acute, finely pubescent; corolla 4–7 mm long, cleft to near the base, externally glabrous or pubescent, internally glabrous to pubescent; lobes lanceolate, spreading to reflexed. Stamens 3–6 mm long, coherent; anther cells and apical appendages connate except for the free and incurved most apical parts, each of these formed into an open cylinder; anther cone ovoid, straight; filaments generally short, equal, straight or bent; sacs opening completely longitudinally; apical appendage ca. $\frac{1}{4}$ – $\frac{1}{3}$ the anther length, thin and smooth; connective distinct, generally smooth. Style 4.5–7.5 mm long, pubescent or rarely glabrous, with a capitate stigma, shortly exserted. Fruit without furrows or ribs.

Ridley based *A. hullettii* on three collections, by *Haviland* and by *Hullett*. All are suitable for lectotypification. Bakhuisen f. (in herb.) selected the single *Hullett* specimen in SING, and I follow his choice. The elevation mentioned in the protologue is indicated only on that specimen.

Argostemma hameliifolium is common and is widely collected. It grows from low altitude to 2,000 m. Most collections are from sandstone; a few are from limestone. It grows on boulders or sand in wet places near streams or waterfalls.

Argostemma hameliifolium is part of a big, poorly understood complex, which includes *A. moultonii* (see discussion under that species). Ap-



MAPS 13, 14. Distributions in Borneo.—13. *Argostemma hameliifolium*.—14. *A. moultonii*.

proximately 100 specimens have been referred to *A. hameliifolium*, all large plants with large, equal, opposite leaves and more or less erect stems. The leaves vary in shape and size and in distinctness of nervation. In a few cases the leaves are very broad and obtuse; these are similar in appearance to *A. borragineum*. The stipules, of which only the upper first to third pairs are persistent, are large, ovate to ligulate, and entire or slightly cleft. The flower buds are narrowly ovate in outline. The anther cone is high with short, free apical appendages and generally short filaments. The margins are longer than the central part and incurved so that each apical appendage forms an open cylinder. The style is generally hairy with a distinct capitate and slightly bifid, slightly exserted stigma. In this treatment I maintain *A. hameliifolium* separate from *A. moultonii*. There are many distinguishing characters, though not always constant, and many specimens are impossible to determine with certainty. *Argostemma hameliifolium* is more erect and has larger vegetative organs. Its anthers have short apical appendages and shorter filaments.

Additional specimens examined. BORNEO. BRUNEI: Kuala Belalong, Temburong, 200 ft., 1957, *Ashton* 42 (K); Belatai District, Labi area, 1969, *van Niel* 4580 (L). SABAH: W Coast Res., Kinabalu, E shoulder, 6,500 ft., 1961, *Chew et al.* 1041 (K, L, SING); Ulu Liwagu and Ulu Mesilau, 1961, *Chew et al.* 2875 (BO, K, L, SING); Dallas, 3,000 ft., 1931, *Clemens* 26033 (BM, BO, G, GH, K, L, NY, UC); Tenompok, 4,500 ft., 1931, *Clemens* 26990 (BM, BO, G, GH, L, NY, UC); Tenompok, 5,000 ft., 1932, *Clemens* 29538 (BM, BO, G, K, L, NY); Marai Parai, 5,000 ft., 1933, *Clemens* 32578

(A, BM, BO, L, NY, UC); Penibukan, 4,000 ft., 1933, *Clemens* 35137 (BM); Penibukan, 4,000–5,000 ft., 1933, *Clemens* s.n. (BM); Kiau, 1915, *Clemens* 10059 (UC); 1958, *Collenette* 116 (BM); 1,650 m, 1966, *Ding Hou* 220 (L); 1937, *Grieswold* 29 (GH); western route, 1,780 m, 1963, *Fuchs* 21031 (L); Penibukan, 1,200 m, *Nootboom & Aban* 1552 (L); Penibukan, 1,400 m, *Nootboom & Aban* 1593 (L); W Coast Res., Kandusan, 4,500 ft., 1957, *Cox* 957 (L); 4,000 ft., 1966, *Sidek Kiah* 2 (L); Sandakan Res., Bettotan near Sandakan, 1927, *Kloss SFN*19154 (K, L, NY, SING, UC); Sandakan Res., Sandakan, 1977, *Anderson* 4284 (MO, UC); Tawau Res., Tawau Hill, 1978, *Fedilis & Sumbing* SAN88281 (K, L); Interior Res., Tenom District, along Sungei Bekuku, 1979, *Madani* 90812 (L). SARAWAK: 1st Div., Mt. Matang, 1888, *Haviland* s.n. (SING); 1,000 ft., 1924, *Mjöberg* s.n. (UC); the boundary between 1st and 2nd Div., Gunong Bari, 1975, *Martin & Ismaui* S36861 (L, SAR); 2nd Div., Bukit Lanjak, 4,300 ft., 1974, *Chai* S33836 (L, SAR); 4th Div., Mt. Lambir, 250 m, 1979, *Bremer* 1752 (S, SAR); 1962, *Burt & Woods* 2372 (E); Sungei Lapoh, 1978, *Burt* 11565 (E, S); 4th Div., Gunong Subis, 1972, *Anderson* S31672 (L); 4th Div., Bintulu, 1963, *Ashton* S18063 (K, SAR); 4th Div., Bukit Mersing, Tau Range, 3,000 ft., 1956, *Purseglove* 5256 (A, K, L, NY, SAR, SING); 4th Div., Sungei Tau, 300 ft., 1956, *Purseglove* 5129 (K, L, NY); 4th Div., Mt. Dulit, under 300 m, 1932, *native collector* 1256 (K); Dulit ridge, 1932, *native collector* 1428 (L); under 300 m, 1932, *Richards* 1052 (K); 1,100 m, 1932, *Richards* 1799 (A, BO, L); Dulit trail, 100 m, *Richards* 7090 (K); 4th Div., Gunong Api, 3,000 ft., *Chai* S30081 (K, L); 4th Div., Gunong Mulu, 4,000 ft., *Burt & Woods* 2182 (E, SAR); N of Sungei Lansat, 1978, *Nielsen* 204 (K); 800–1,000 m, *Nielsen* 494 (AAU); 4th Div., Upper Baram River, *van Niel* 3558 (L); 4th Div., Kalabit Highlands, Bario, 1,000 m, 1970, *Nootboom & Chai* 1704 (L); Batu Lawi, 1,250 m, 1970, *Nootboom & Chai* 2307 (B, L, SAR, US); 5th Div., Maputi, 1955, *Brooke* 10123 (L); 5th Div., Lawas, 1955, *Brooke* 10283 (BM, L); 5th

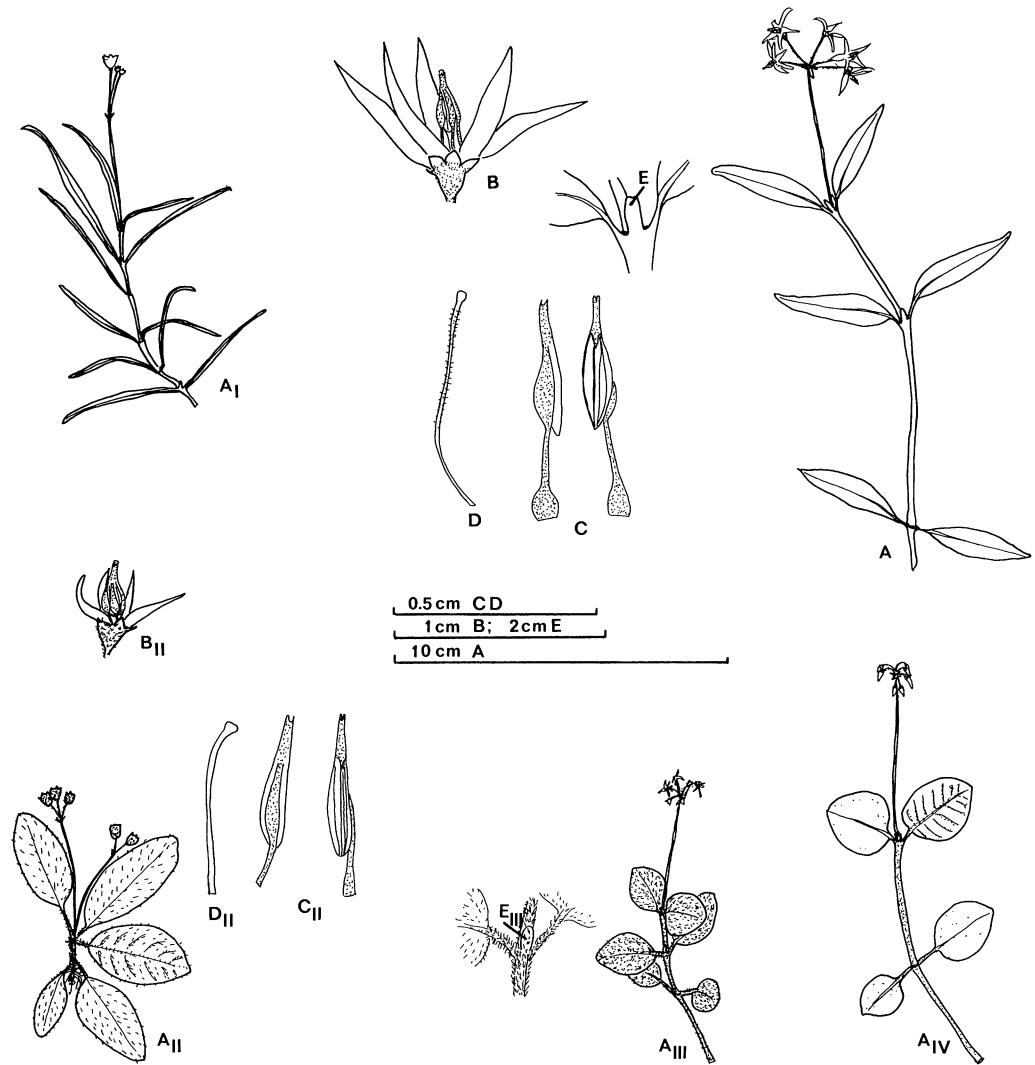


FIGURE 17. *Argostemma moultonii*.—A. Flowering branch.—B. Flower.—C. Anthers.—D. Style.—E. Stipule. A–E from *Burt & Martin* 5326 (E); I from *Chai* S34832 (K); II from *Nooteboom* 921 (L); III from *Mjöberg* 82 (K); IV from *Moulton* 6695 (SING).

Div., Bakelalan, 4,000 ft., 1955, *Brooke* 10448 (BM, L); 7th Div., Sungei Mengiong, a tributary to Ulu Balleh, 1979, *Bremer* 1747 (S, SAR); 7th Div., Sungei Putai, a tributary to Ulu Balleh, 1979, *Bremer* 1725 (S, SAR); 7th Div., Bukit Tibang, 3,700 ft., 1969, *Anderson* S28735 (K, L); 7th Div., Wong Pelagus, 1954, *Brooke* 8984 (BM, K); 7th Div., Teneong, 1954, *Brooke* 9128 (BM, L); 7th Div., Giam Pasang, 1954, *Brooke* 9258 (BM, L); 7th Div., Ulu Melinau, 1980, *Burt* 12896 (E); 7th Div., Bukit Dema, 1978, *Burt* 11338 (E, S); 7th Div., Sungei Nawai, 2,600 ft., 1978, *Burt* 11461 (E, S); 7th Div., Sungei Linau, 1978, *Burt* 11274 (E, S); low alt., 1975, *Chai* S36485 (L, SAR). KALIMANTAN: W Prov., Liang Gagang, 1893–1894, *Hallier* 2779 (L); W Prov., Amai Ambit, 1893–1894, *Hallier* 3230 (BO, L); E Prov., between Long Bawan and Pando, 1,200 m, 1891, *Geesink* 9036 (L); E Prov., between Papadi and Pamilau, 700 m, 1981, *Geesink* 9226 (L); E Prov., Banyankara,

1982, *Axelius* 198 (S); E Prov., Nanukan Island, southern part, 1954, *Kostermans* 9216 (K, L); Sungei Simengkadu, few m alt., 1953, *Meijer* 2343 (L); E Prov., W Kutei, near Kemoel, 1,500 m, 1925, *Endert* 4172 (A, BO, K, L); E Prov., Kutei, near Tabang, 50 m, 1955, *Kostermans* 10570 (L).

14. *Argostemma moultonii* Ridley, J. Bot. 65: 36. 1927. TYPE: Borneo. Gunong Semapok, Upper Baram, 3,000 ft., 1920, *Moulton* 6695 (lectotype, K; Bakh. f. in herb., confirmed here; isolectotype, SING). Figure 17.

A. moultonii var. *hirta* Ridley, J. Bot. 65: 36. 1927. TYPE: Borneo: Gunong Semapok, Upper Baram, 1,000 ft., 1920, *Moulton* 6654 (holotype, K; isotype, SING).

- A. parvulum* Ridley, J. Bot. 65: 36. 1927. TYPE: Borneo: Lio Matu, Upper Baram, 500 ft., 1920, *Moulton 6726* (holotype, K).
- A. velutinum* Ridley, J. Bot. 65: 35. 1927. TYPE: Borneo: Serapi, 2,800 ft., *Haviland 684* (lectotype, K; Bakh. f. in herb., confirmed here).
- A. mjoebergii* Merr., Sarawak Mus. J. 3: 534. 1928. TYPE: Borneo. Sarawak: Mt. Poi, 4,500–5,500 ft., 1924, *Mjöberg s.n.* (holotype, UC).
- A. murudense* Merr., Sarawak Mus. J. 3: 535. 1928. TYPE: Borneo. Sarawak: Mt. Murud, 1,900–2,400 m, 1922, *Mjöberg 82* (holotype, UC; isotype, K).

Creeping to erect, isophyllous herb. Stem 2–40 cm, unbranched or slightly branched, glabrous to densely pubescent, rarely with corky or papery bark; internodes 5–60 mm. Leaves opposite, equal; stipules deciduous, 2–12 mm long, ovate to lanceolate, entire or slightly bifid, obtuse to acuminate at apex; petiole 3–11 mm long, glabrous to pubescent; lamina 1.2–6.5 × (0.2–)0.6–3.1 cm, linear to broadly ovate, basally rounded to attenuate, with the lobes equal or oblique, marginally entire or serrulate, apically obtuse with a short point or acute or acuminate, herbaceous, pubescent on both surfaces to glabrous; midrib distinct, the primary veins (4–7 pairs) distinct to obscure. Inflorescences 1–9-flowered, umbelliform, generally solitary; peduncle (1–)3–8 cm, glabrous; bracts to 5 mm long, ovate to lanceolate; pedicels 0.2–1.2 cm, pubescent. Flowers 5(–6)-merous. Calyx lobes ca. 1 mm long, triangular to ovate, acute, pubescent at least in lower parts. Corolla 3–9(–18) mm long, cleft to near the base, generally glabrous on both surfaces; lobes lanceolate, spreading to reflexed. Stamens 3–6 mm long, coherent; anther cells and apical appendages connate except for the most apical parts, these free and incurved, forming an open cylinder; anther cone ovoid, straight; filaments generally long, equal, straight or bent; sacs opening completely longitudinally; apical appendage ca. $\frac{1}{3}$ – $\frac{1}{2}$ of the anther length, thin and smooth; connective distinct, generally smooth. Style 3.5–6.5 mm long, pubescent or rarely glabrous, with a capitate stigma, shortly exserted. Fruit without furrows or ribs.

Bakhuizen f. (pers. comm. and on herbarium labels) treated *A. parvulum* as a synonym of *A. hameliifolium*; he believed it to be a dwarf form. However, I have found that *A. parvulum* is better accommodated as a synonym of *A. moultonii*.

Argostemma moultonii grows in wet, damp places among mosses on tree trunks, on cliffs, or on sandy or clayey soil, and a few collections are from limestone. It grows from low altitude up to ca. 2,000 m; most specimens are from ca. 1,000 m.

Ridley based *A. moultonii* on two collections by *Moulton*, in K. Both are suitable for lectotypifi-

cation. Bakhuizen f. (in herb.) selected one of the specimens, *Moulton 6695*, and I follow his choice.

Ridley based *A. velutinum* on three collections, in K, by *Haviland*, *Moulton*, and himself. All are suitable for lectotypification. Bakhuizen f. (in herb.) selected the *Haviland* specimen, and I follow his choice.

Argostemma moultonii and *A. hameliifolium* form a complex in which a number of species have been recognized (see above). This complex is well defined as a group by unique characters: equal, opposite leaves; long, glabrous peduncles; pubescent pedicels; corolla cleft to near the base and with narrow, spreading or reflexed lobes; and connate anthers with distinct apical appendages which are free in the upper part and have margins longer than the central parts and incurved to form an open cylinder. There are at least two species (*A. hameliifolium* and *A. moultonii*) involved in the complex. I cannot recognize more in spite of the fact that this group is the most widely collected in Borneo. There are a few specimens similar in habit to the highly variable species *A. aequifolium* Ridley (1901) from the Malay Peninsula and Sumatra, but this species does not have the unique stamen characters. Specimens similar to the type of *A. hameliifolium*, erect, large plants, are referred to *A. hameliifolium*, but the rest could be separated into several variable groups within *A. moultonii*. There would be many specimens that could not be placed with certainty.

Argostemma moultonii needs further study. I have dealt with it in a manner similar to Dr. Bakhuizen f. (pers. comm.). *Argostemma moultonii* generally can be characterized and separated from *A. hameliifolium* by having a smaller, creeping habit, generally longer internodes, smaller stipules, and anthers with long filaments and long apical appendages. Within *A. moultonii* at least six local populations with distinct morphological characters can be identified. From some localities different populations are found without continuous variation between them. Characters separating these populations are indumentum of the stems, leaves, and floral parts and the shape, texture, and nervation of the leaves. The following examples illustrate this. At the summit of Mt. Matang the plants (including the type of *A. velutinum*) have ovate leaves with acuminate apices, distinct primary veins, and long petioles, and the plants are covered by long hairs. Close to that locality, at Lundu and Berumput, the collections (including the type of *A. mjoebergii*) are similar in habit but less pubescent and have shorter petioles and less distinct veins. At Gunong Murud several different populations occur. One is

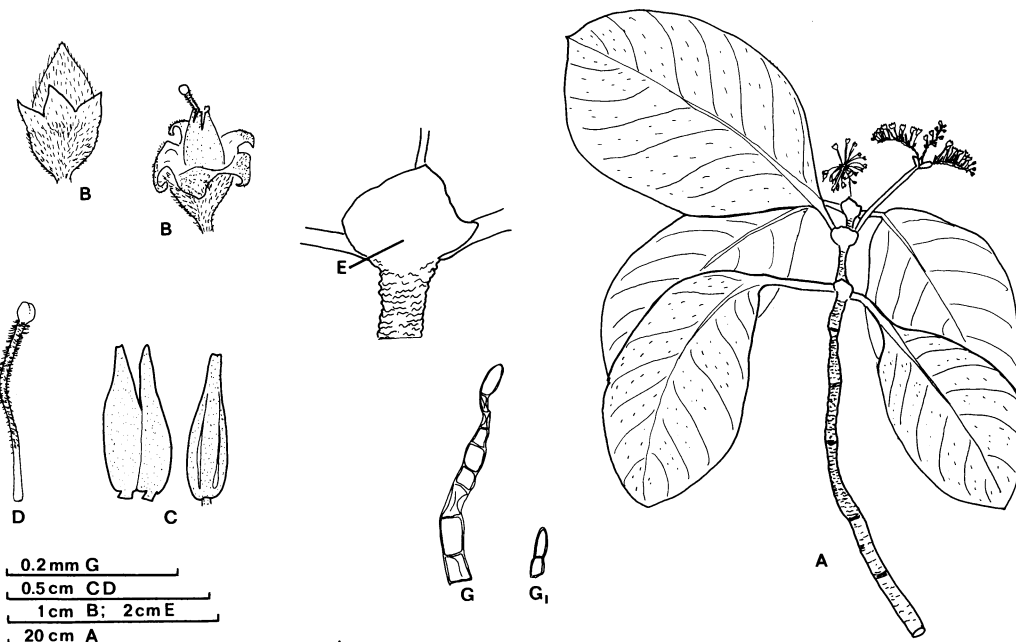


FIGURE 18. *Argostemma borragineum*.—A. Flowering branch.—B. Flower.—C. Anthers.—D. Style.—E. Stipule.—G. Hair from outer surface of the corolla.—G₁. Hair from inner surface of the corolla. From Bremer 1668 (S).

almost glabrous (dry specimens) with very thick, veinless, elliptic, acuminate leaves and with very long internodes (Burt & Martin 5326, *Nooteboom* & Chai 1935). Except for the very long internodes, they are similar to the type of *A. parvulum* from Baram. Another population includes the type of *A. murudense* with small, broad, ovate to rounded, obtuse to acute, densely pubescent leaves. These specimens are similar to the type of *A. moultonii* from the upper Baram. Martin 38848 represents a different population with glabrous, obovate leaves with distinct prominent veins. From Ulu Tinjar in Baram, there is a collection (Chai 34832) with glabrous linear leaves. From Mt. Kinabalu, there are several different populations—one (Gardner 88) is glabrous with thick, veinless leaves but different from the glabrous specimens from Gunong Mulu. There are also specimens with ovate to obovate, slightly pubescent leaves. Plants from Kutei and Gunong Tapa Sia in Kalimantan (Endert 3614, 4238 and Axelius 112B) are small rosettes with ovate, obtuse leaves having very long hairs. These collections are similar to *Nooteboom* 921 from Gunong Alab in Sarawak. Perhaps these represent something different and distinct from *A. moultonii*, but based on the scanty material available, it is impossible to decide.

Additional specimens examined. BORNEO. BRUNEI: Kuala Belalong, 1959, Ashton 199 (K). SABAH: W Coast

Res., Kinabalu, Silau Silau trail, 1,400 m, 1979, Anderson 4349 (MO, UC); Bebangon River, 5,000 ft., 1964, Chew & Corner RSNB4618 (K); Tenompok, 5,000 ft., 1932, Clemens 28250 (BM, BO, K); Tenompok, 5,500 ft., 1932, Clemens 29499 (BM, K); Columbon basin, 4,500 ft., 1933, Clemens 40049 (BM, BO, NY); Masilau, 6,000–8,000 ft., 1933, Clemens 51670 (BM, NY); Marai Parai, 6,000 ft., 1958, Collette 60 (BM); 1937, Grieswold 27 (GH); Lumu-Lumu, 1957, Sinclair 9212 (E, L); W Coast Res., Gunong Alab, Crocker range, 1,600 m, 1980, Argent 1308 (E); 1,400 m, 1969, *Nooteboom* 921 (B, L); 1,600 m, 1969, *Nooteboom* 1035 (L); Sandakan Res., Tawau Plateau, 50 m, 1977, Gardner 88 (E, L); Interior Res., Sipitang, Ulu Moyah, 2,750 ft., Wood SAN16695 (L, SING). SARAWAK: 1st Div., Mt. Matang (= Gunong Serapi), near summit, 2,700 ft., 1966, Anderson S25106 (K); 1865, Beccari 1716 (L); near summit, 2,700 ft., 1919, Bremer 1719 (S, SAR); ca. 2,500 ft., 1962, Burt & Woods 2516 (E, SAR); near summit, 2,500 ft., 1929, Clemens 223221 (NY); 2,500–3,000 ft., Mjöberg s.n. (UC); 1927, native collector s.n. (UC); 1905, Ridley 12304 (BM, K, SING); 1st Div., Santubong, near summit, 1909, Brooke 1034 (BM); 1st Div., Gunong Gading, 2,800 ft., 1962, Burt & Woods 2682 (E); 1st Div., Mt. Poi, 5,000–6,000 ft., 1929, Clemens field no. 6891, 6920, 6973 (NY); 1st Div., Gunong Berumpit, 4,800 ft., 1954, Brooke 8564 (BM, L); 300 ft., 1962, Burt & Woods 2761 (E); 3,500 ft., 1962, Burt & Woods 2845 (E); 2nd Div., E of Bukit Sadon, 1982, Axelius 112B (S); 4th Div., Mt. Dulit, Dulit trails, 800 m, 1932, Richards 1537 (K, L); Dulit ridge, 1,100 m, 1932, Richards 1790 (K, L); 4th Div., Bario, 1,000 ft., 1970, *Nooteboom* & Chai 1744 (B, L, SAR, US); 4th Div., Mt. Murud, 1,900–2,400 ft., 1922, Mjöberg 85 (UC); 1,900–2,400 ft., 1922, Mjöberg 88 (NY, UC); 1914, Moulton 105 (probably cited as 165 in the

protologue of *A. velutinum* (SING); 1,100 m, 1970, *Nooteboom & Chai 1856* (L, SAR, US); 1,700 m, *Nooteboom & Chai 1935* (B, L, US); 4th Div., Sungei Melinau, 1962, *Burt & Woods 2293* (E); 4th Div., Gunong Mulu, 4,200 ft., *Anderson S4516* (K, SAR); 1,700 m, *Argent & Jermy 1038* (E), 1,300 m, 1978, *Argent & Coppins 1076* (E); 1962, *Burt & Woods 2090* (E); 4,500 ft., 1962, *Burt & Woods 2095* (E, SAR); 4,500 ft., 1962, *Burt & Woods 2152* (E); 150 m, 1978, *Hansen 187* (K); 1,300 m, 1977, *Martin S38848* (L, SAR); 1,800 m, 1978, *Nielsen 838* (AAU); 5th Div., 1½ days from Maputi, 2,500 ft., *Brooke 10177* (BM, L); 5th Div., Bakelalan, 4,000 ft., 1955, *Brooke 10408* (L); 5th Div., from Bakelalan to Gunong Murud, 6,000 ft., 1967, *Burt & Martin 5326* (E); 7th Div., Bukit Bakar (= ?Bakak), 980 m, 1975, *Ilias Paie S36357* (L); 7th Div., Sungei Nai Punan Bah, 1973, *Chai et al. S33328* (L, MO); 7th Div., near Punan Bah, 1979, *Tong & Banyeng S33271* (K, L, MO, SAR); 7th Div., Sungei Brearan, 1978, *Burt 11355* (E, S), *11356* (E); 7th Div., Sungei Dema-nawai, 1978, *Burt 11431* (E); 7th Div., Sungei Tellini, 2,800 ft., 1978, *Burt 11401* (E); 2,850 ft., 1978, *Burt 11409* (E, S); 7th Div., S Hose Mts., Bukit Salong, 1980, *Burt 12709, 12908* (E); 950 m, 1976, *Chai S37296* (K, L, SAR); 7th Div., S Hose Mts., E of Bukit Sanpandai, 1980, *Burt 12797* (E); 7th Div., Ulu Mujong, 200 m, 1964, *Ashton S12132* (K, L); 900 m, 1964, *Ashton S21238* (L, SAR); 200 m, 1964, *Ashton S21249* (A, L); 7th Div., Bukit Tibang, 3,000 ft., 1969, *Ilias Paie S28445* (A, E, K, L), *S28566* (K, L). KALIMANTAN: W Prov., ?Goenseng Kenepai, 1893–1894, *Hallier 1720* (BO, L); E Prov., W Kutei, 1925, *Endert 3614* (BO, L); near Kemoel, 1,300 m, 1925, *Endert 3874* (BO, L); near Kemoel, 1,600 m, 1925, *Endert 4238* (BO, L); E Prov., between Papadi and Pamilau, 1,200 m, 1981, *Geesink 9255* (L); E Prov., Gunong Tapa Sia, 1,800 m, 1981, *Geesink 9112* (L).

15. *Argostemma borragineum* Blume ex DC.,
Prod. 4: 417. 1830. TYPE: *Blume* in G-DC
(holotype, G-DC, not seen; microfiche, LD!).
Figure 18.

- A. borragineum* var. *rotundifolium* Valeton in H. Winkler, Bot. Jahrb. 44: 548. 1910. TYPE: S.O. Borneo: Batu Babi in Lumowia, 1908, *Winkler 2853* (lectotype, L; Bakh. f. in herb., confirmed here; isolecotypes, BM, BO).
- A. streblisifolium* Valeton, Icones Bogorienses 4: 271. 1914. TYPE: Borneo: Oeloe Tjihon, 1898–99, *Amdjah 319* (lectotype, BO; Bakh. f. in herb., confirmed here).
- A. nutans* var. *borneense* Ridley, J. Bot. 65: 33. 1927. TYPE: Borneo: Gunong Semapok ("Temapok" Ridley, 1927, sphalm.), 1,000 ft., 1920, *Moulton 6653* (holotype, K; isotype, SING).

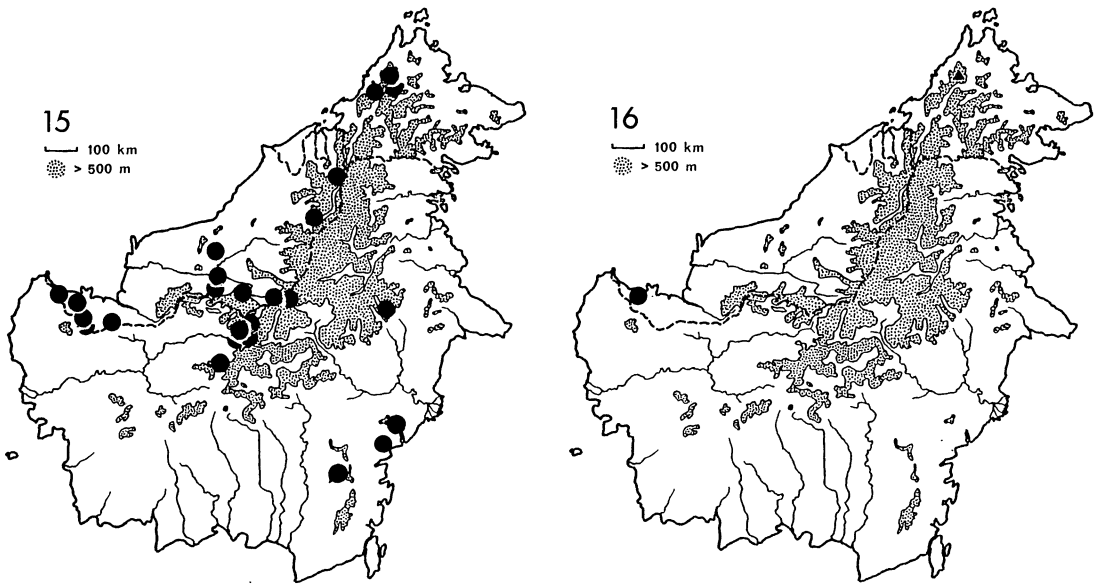
Large, erect, isophyllous herb. Stem to 100 cm, glabrous to finely pubescent, black, with distinct scars in upper part; internodes 5–45 mm. Leaves opposite, equal; stipules persistent, ca. 10 mm long, broadly ovate, obtuse to acute at apex; petiole 0.5–7 cm, pubescent to glabrous; lamina 4.5–21 × 2.5–13 cm, broadly ovate to broadly obovate, basally rounded or acute to attenuate with the lobes

equal, marginally entire or serrulate, apically obtuse, then sometimes with a point, or acute, herbaceous, glabrous to pubescent, most prominently pubescent on the veins below; midrib and primary veins (4–12 pairs) distinct. Inflorescences 25–160-flowered, umbelliform or with 2 or 3 scorpioid branches, solitary or a few together; peduncle 2–8 cm, glabrous to pubescent; bracts to 1 cm long, oblong to ovate; branches, if present, to 5 cm, glabrous to pubescent; pedicels to 2 cm, pubescent. Flowers 5-merous; calyx lobes 1–2 mm long, ovate to triangular or lanceolate, pubescent at least on basal parts; corolla 4–5 mm long, cleft to about middle, externally pubescent, internally glabrous to pubescent on the lobes; lobes ovate to triangular, recurved. Stamens 2–4 mm long, coherent, coriaceous; anther cells and apical appendages connate except for the most apical part; anther cone ovoid or shortly so, straight; filaments very short, equal, straight; sacs opening completely longitudinally; apical appendage ca. ½ the anther length, thin and smooth; connective indistinctly passing over to the thecae, smooth. Style 5–6 mm long, pubescent, with a capitate stigma, long-exserted. Fruit without furrows or ribs but covered with emergences.

Winkler based *A. borragineum* var. *rotundifolium* on one collection with several specimens. All specimens are suitable for lectotypification. Bakhuisen f. (in herb.) selected the specimen in L and I follow his choice.

Valeton did not indicate any collection in the protologue of *A. streblisifolium*. In the Bogor herbarium (BO) there is only one specimen (*Amdjah 319*) that fits the picture and the protologue. Bakhuisen f. (in herb.) has selected that specimen, and I follow his choice.

Argostemma borragineum is one of the most common *Argostemma* species from low altitudes to ca. 2,000 m. It often grows near shady streams. All notes concerning its habitat place it on sandy, loamy soil, sandstone, or sedimentary rocks. It is highly variable. The majority of the plants are large, to 1 m high, with black and scarred stems. The opposite leaves are equal, large, and rounded, and the stipules are broad and distinctive. The inflorescences are densely pubescent and generally very large, sometimes with more than 150 flowers. They commonly develop two or three scorpioid branches, which become most prominent after anthesis. The corollas are cleft for about half their length into recurved lobes. The stamens are unique. The entire stamen is coriaceous and (on dry specimens) dark, and no differences can be discerned between the connective and the thecae, at least not from the dorsal side. The apical appendages



MAPS 15, 16. Distributions in Borneo.—15. *Argostemma borragineum*.—16. *A. flavescens*.

are separated in a characteristic way. The style is generally densely pubescent and bears a distinct capitate stigma strongly exserted. There are also plants uniformly smaller in all organs except for the flower, with smooth stems and more densely pubescent inflorescences, but there are also other small plants which have scarred stems. Several different populations have been collected from Mt. Kinabalu. I have not found any correlation between the morphological variation and any pattern of distribution.

Additional specimens examined. BORNEO. SABAH: W Coast Res., Gunong Alab, 1,500 m, 1969, *Nooteboom 1031* (B, L, US); W Coast Res., Kinabalu, below Kamarangan, 6,000 ft., 1962, *Bogle 545* (GH); Kiau, 1915, *Clemens 10058* (BO, UC); Penibukan, 4,000–5,000 ft., 1932, *Clemens s.n.* (BM); ridge above Pina Taki, 4,000–5,000 ft., 1933, *Clemens 31077* (BM, BO, GH, NY); Marai Parai spur, 5,000 ft., *Clemens 32962* (A, BO); Marai Parai, Gigisan Creek, 4,500 ft., 27 Mar. 1933, *Clemens 33962* (BM, G, L, UC); headwater of Sadikan, 5,000 ft., 5 May 1933, *Clemens 33962* (NY, must be wrongly numbered cf. the one before); Lumu-Lumu, 6,100 ft., 1957, *Sinclair et al. 9215* (E, L, US); between Kinabalu and Ranau, 5,000 ft., 1954, *Darnton 568* (BM). SARAWAK: 1st Div., Sungei Lundu below Gunong Perigi, 1962, *Burt & Woods 2710* (E, SAR); 1st Div., Mt. Matang, near summit, 2,300 ft., 1979, *Bremer 1720* (S, SAR); 1955, *Brooke 9749* (BM, L, SAR); 1,500 ft., 1929, *Clemens 22372* (NY, SAR); 1,000 ft., 1924, *Mjöberg s.n.* (UC); 1913, *Moulton's native collectors 365* (BM); 2,000 ft., 1960, *Sinclair 10355* (E); 1st Div., Kampong Grumbing, Padawan, 30 m, 1975, *Othman Ismawi S37437* (L, MO, SAR); 1st Div., Mt. Penrissen, 4,400 ft., 1924, *Mjöberg 218* (NY, UC); 1st Div., Sabal, 500 m, 1979, *Bremer 1668* (S, SAR); above the forestry

office, 1979, *Bremer 1673* (S, SAR); 4th Div., Bukit Mersing, 3,000 ft., 1956, *Purseglove 5282* (A, K, L, SAR, SING); 5th Div., route from Bakelalan to Gunong Murud, 3,800 ft., 1967, *Burt & Martin 5216* (E); 7th Div., Sungei Bena area, 1980, *Burt 13003* (E); 7th Div., Bukit Goram, 1975, *Chai S36137* (L, MO); 7th Div., junction of Sungei Tekalit and Sungei Mengiong, 1979, *Bremer 1742, 1743* (S, SAR); 7th Div., Ulu Sungei Sadampa, 1,500 ft., 1969, *Anderson & Ilias Paie S28295* (E, L); 7th Div., foothills of Bukit Batu Tibang, 3,100 ft., 1969, *Anderson S28396* (A, K, L); 7th Div., Sungei Balang, 1969, *Anderson & Ilias Paie S28881* (A, E, K, L, SAR). KALIMANTAN: E Prov., Balikpapan District, Mentawir region, 1955, *Kostermans 10121* (L); S of Gunong Balikpapan, 1985, *Axelius 217* (S); E Prov., W Kutei, near Laih Leng, 200 m, 1925, *Endert 2952* (BO, L); W Prov., Bukit Raja, 1,250 m, 1924, *Winkler 879* (HBG, NY); 1,400 m, 1924, *Winkler 1007* (HBG, NY); W Prov., Sungei Malang, 70 m, 1925, *Winkler 1282* (HBG, NY); W Prov., Bukit Obat, 150 m, *Winkler 1353* (HBG); W Prov., Nanga Era, 100 m, 1925, *Winkler 1562* (HBG); W Prov., Liang Gagang, 1893–1894, *Hallier 2686* (BO, L).

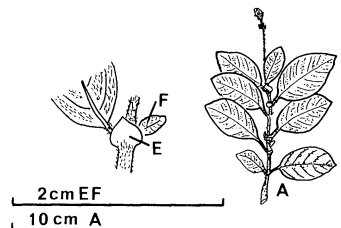


FIGURE 19. *Argostemma flavescens*.—A. Flowering branch.—E. Stipule.—F. Nanophyllous leaf. From *Haviland 84/75* (SING).

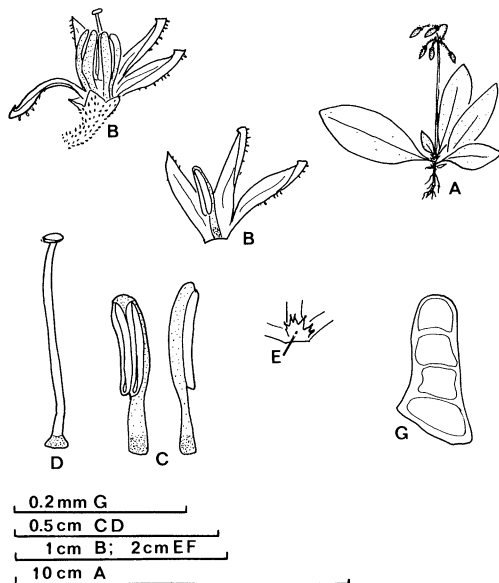


FIGURE 20. *Argostemma chaili*.—A. Habit.—B. Flower.—C. Anthers.—D. Style.—E. Stipule.—G. Hair from outer surface of the corolla. From Brooke 10268 (L).

16. *Argostemma flavescens* Bakh. f., *Blumea* 7: 331. 1953. TYPE: Borneo. Path to Matang, *Haviland 84/75* (holotype, SING). Figure 19.

Creeping, anisophyllous herb. Stem ca. 10 cm, branched, pubescent; internodes 4–8 mm. Leaves opposite, very unequal; stipules persistent, to 3 mm long, ovate to cordiform, acute at apex; larger leaves of the anisophyllous pairs with pubescent petioles 3–8 mm long; lamina 1–3 × 0.1–1.5 cm, obovate to ovate or elliptic, basally obtuse to acute and oblique, marginally entire to serrulate, apically acute, herbaceous, pubescent between the veins; midrib and primary veins (5–7 pairs) distinct. Nanophyllous leaves persistent, ca. 3 mm long, ovate. Inflorescences 1–3-flowered, solitary; peduncle 1–2 cm, pubescent; bracts to 0.3 cm, lanceolate; pedicels 0.5–0.8 cm, pubescent. Flowers 5-merous; calyx lobes ca. 1 mm long, broadly ovate, acute, pubescent in lower part; corolla 4 mm long. Stamens 5. Style pubescent, with an elliptic stigma, long-exserted.

Argostemma flavescens is known from only two very poor collections. Both were examined, but there is still a great deal of information missing about the species. It has a characteristic habit, and its leaves are densely pubescent, particularly between the veins. In all other Borneo species the indumentum is more dense on the veins. The information on the flowers in the description is taken

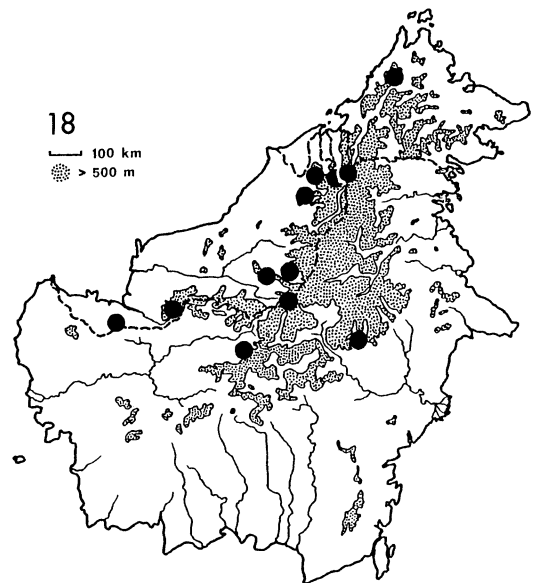
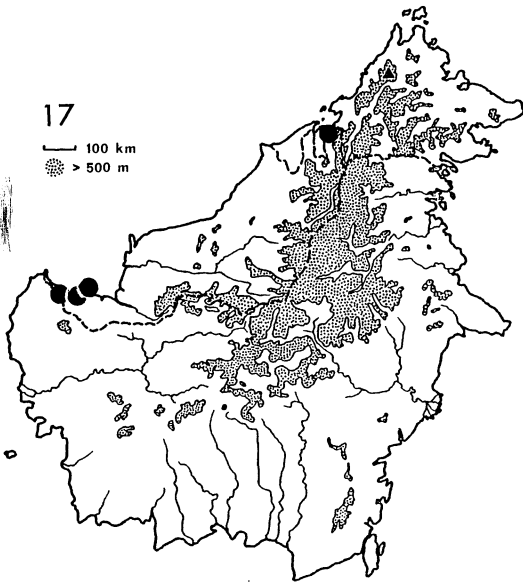
from Bakhuizen f. (1953, and pers. comm.). He placed *A. flavescens* close to *A. borragineum* because of its stamens. In my opinion it is not possible to determine its closest relatives within *Argostemma* at this time.

Additional specimen examined. BORNEO. SARAWAK: 1st Div., Mt. Matang, *Beccari 621* (L).

17. *Argostemma chaili* B. Bremer, nom. nov. *Argostemma nerve* Ridley (non Ridley 1912), nom. illeg., *J. Bot.* 65: 28. 1927. TYPE: Borneo. Sarawak: *native collector 1227* (holotype, K). Figure 20.

Small, erect, isophyllous herb. Stem very short to 11 cm, unbranched or slightly branched, glabrous; internodes very short to 10 mm long. Leaves opposite, subequal; stipules persistent, ca. 1 mm long, broadly ovate to cordiform, apically fringed with each point ending in a gland; petiole 3–9 mm long, glabrous; lamina 1.2–7 × 0.8–4.5 cm, ovate or elliptic or rarely lanceolate, basally acute to attenuate with the lobes equal, marginally entire, apically acute to obtuse, herbaceous to coriaceous, glabrous or with a few hairs above; midrib distinct, the primary veins obscure or absent. Inflorescences 2–15(–25)-flowered, umbelliform, solitary or a few together; peduncle 2–10 cm, glabrous; bracts to 0.6 cm long, ovate to lanceolate; pedicels 0.3–1.2 cm, pubescent or glabrous. Flowers 5-merous; calyx lobes 0.5–1 mm long, ovate to triangular, acute, glabrous to pubescent; corolla 3–5 mm long, clef to near the base, externally pubescent or glabrous, internally glabrous; lobes lanceolate to oblong, erect-spreading. Stamens 3–4 mm long, at anthesis probably free; anther cells free, the apical appendage first connate then free, not forming a cone; filaments ca. ½ as long as the anthers, equal, straight; sacs opening completely longitudinally; apical appendages very short, thick and smooth; connective distinct, smooth. Style ca. 3–6 mm long, glabrous, with a discoid stigma, long-exserted. Fruit without furrows or ribs.

This species is named after Mr. Paul Chai of the Forest Department, Sarawak. *Argostemma chaili* grows on dead wood, wet rocks, or wet ground in the lowland rainforest, to 300 m. This species is a very small herb, with leaves more or less condensed into rosettes. Its primary veins are obscure, and the stipules are broad and fringed apically with colleters. The flowers are characteristic, with thick corolla lobes and free anthers. The filaments are wide, fixed at the base of the corolla, and adnate with it for a short distance. The stigma is discoid.



MAPS 17, 18. Distributions in Borneo.—17. *Argostemma chaili*.—18. *A. gracile*.

Argostemma chaili is a rare species collected from two different areas in Sarawak. The collections from the 5th Division are hairy on the pedicels, calyx, and on the outside of the corolla. The leaves also have scattered hairs. From the 1st Division the plants (including the type specimen) are glabrous in all parts. From Mt. Matang in the 1st Division the leaves are distinctly larger than from other localities.

Bakhuizen f. (pers. comm.) has treated this taxon as a synonym of *A. inaequale* (Bennett, 1838). Their habits are similar, but their flowers are different. *Argostemma inaequale* does not have the thick corollas nor the discoid stigma, and its anthers have long apical appendages, while the anther appendages of *A. chaili* are very short.

Additional specimens examined. BORNEO. SARAWAK: 1st Div., Bako, Telok Asam, 100 ft., 1956, *Purse-glove* 5096 (SING); 1st Div., Mt. Matang, 800 ft., 1954, *Brooke* 9474 (L), 9478 (BM, L); 1st Div., Krangi, 1954, *Brooke* 8502, 8512 (BM, L); 4th Div., G. Mulu, 120 m, 1978, *Nielsen* 368 (AAU); 5th Div., Lawas, 1955, *Brooke* 10542, 10268 (BM, L).

18. *Argostemma gracile* Stapf, Trans. Linn. Soc. London Bot. 4: 168. 1894. *Argostemella gracilis* (Stapf) Ridley, J. Bot. 65: 41. 1927. TYPE: Borneo. Kinabalu, Penokok, 3,500 ft., *Haviland* 1325 (holotype, K; isotypes, SAR, SING). Figure 21.

A. podochiloides Merrill, Mitt. Inst. Allg. Bot. Hamburg 7: 279. 1937. Type: West Borneo: Bukit Tilung,

750 m, 1925, *Winkler* 1479 (holotype, HBG; isotype, NY).

Small, creeping, anisophyllous herb. Stem 5–20 cm, slightly branched or unbranched, glabrous;

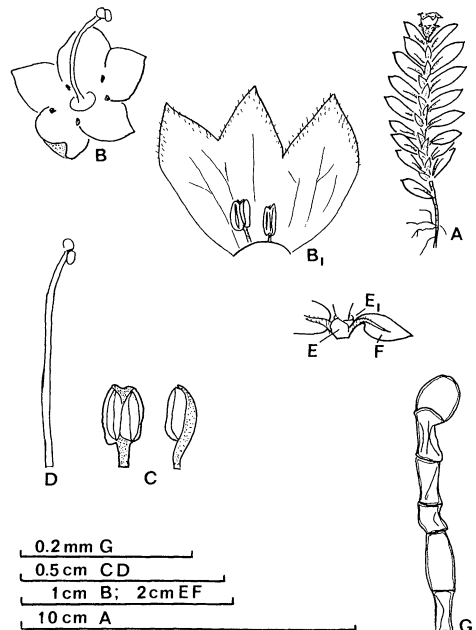


FIGURE 21. *Argostemma gracile*.—A. Habit.—B. Flower, inner surface of calyx.—B₁. Inside view of part of a corolla.—C. Anthers.—D. Style.—E. Stipule.—E₁. Amplexicaul sheath.—F. Nanophyllous leaf.—G. Hair from outer surface of the corolla. A from *Bremer* 1667 (S); B–G from *Argent & Coppins* 1142 (E).

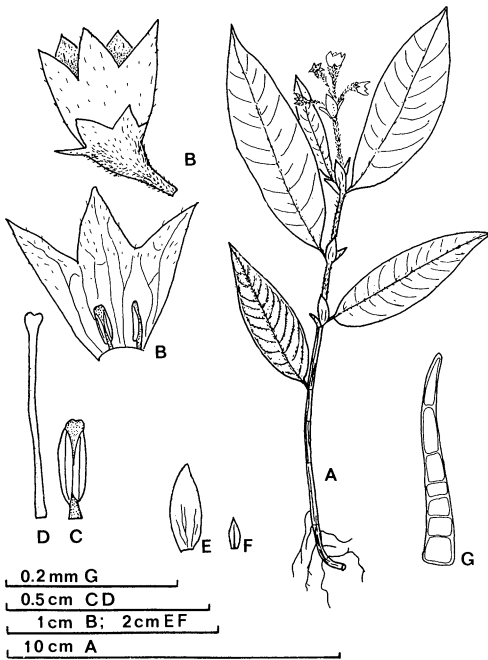


FIGURE 22. *Argostemma brachyantherum*. —A. Habit.—B. Flower.—C. Anther.—D. Style.—E. Stipule.—F. Nanophyllous leaf.—G. Hair from outer surface of the corolla. A from Bogle *et al.* 389 (GH); B–G from Hou 225 (L).

internodes 2–5 mm. Leaves opposite, very unequal, distichous, pale silvery underneath; stipules persistent, ca. 2 mm long, broadly ovate or cordiform to auriculiform, ending apically in a distinct point; stipules and petioles \pm fused into an amplexicaul sheath. Larger leaves of the anisophyllous pairs with pubescent petioles 0.5–1.5 mm long; lamina 0.6–1.7 \times 0.3–0.7 cm, oblong to narrowly oblong or rarely obovate, basally rounded or acute with the lobes equal or oblique, marginally entire, apically obtuse or obtuse with a point, or acute, herbaceous to coriaceous, glabrous or with scattered hairs somewhat concentrated along the midrib on both sides; midrib distinct but without primary veins. Nanophyllous leaves persistent, 4–5 mm long, ovate. Inflorescences 1-flowered, solitary, without peduncle; pedicel 0.2 cm, pubescent. Flowers 5(or 6)-merous; calyx lobes 2–3 mm long, triangular to cordiform, pubescent in lower parts; corolla ca. 8 mm long, cleft less than $\frac{1}{3}$ its length, externally glabrous and internally pubescent only along the margins of the lobes; lobes broadly triangular, spreading. Stamens ca. 2.5 mm long, free; anther cells and apical appendage free, not forming a cone; filaments ca. $\frac{1}{3}$ – $\frac{1}{2}$ as long as the anthers, equal, straight; sacs opening completely longitudinally; apical appendages almost absent, thick and

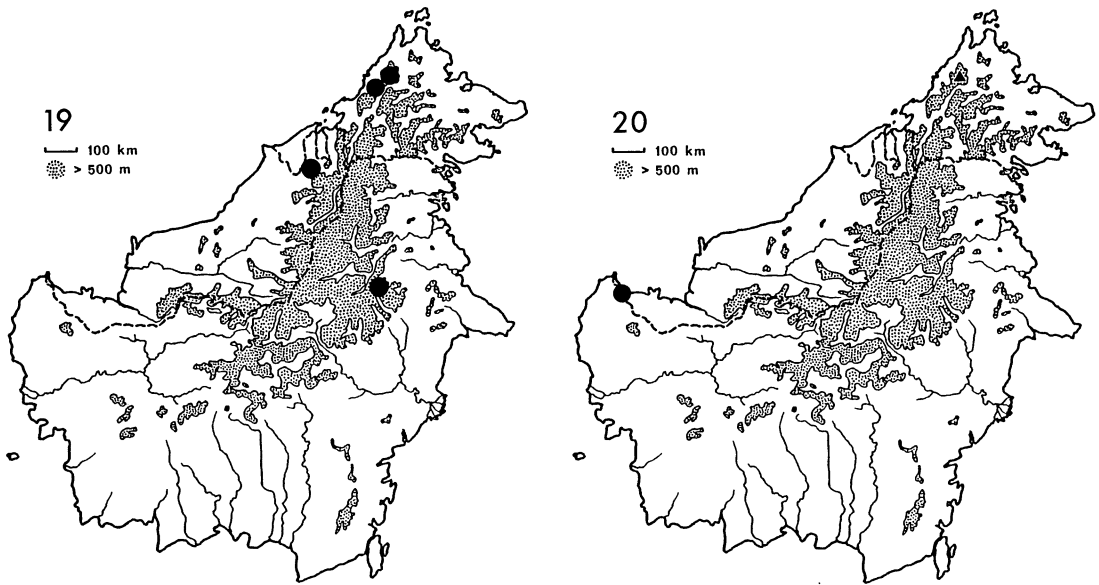
slightly papillose; connective distinct, smooth. Style ca. 5 mm long, glabrous, with a discoid, bifid stigma, long-exserted. Fruit without furrows or ribs.

Argostemma gracile grows on fallen rotten logs or on rocks among mosses in submontane or montane forests from 1,000 to 1,600 m. One collection (Bremer 1667) is from low elevation, 350 m, in an area of lowland rainforest with big boulders covered by mosses.

Argostemma gracile is easily recognized, with its creeping habit and distichous, anisophyllous leaves, the nanophyllous leaves above the larger leaves. The leaves are thick with a distinct midrib but without other visible veins. They are silvery white beneath. The petiole and midrib have a few hairs on both surfaces, but one exception is the type specimen of *A. podochiloides* with completely glabrous leaves. The stipules and petioles are more or less connate with the amplexicaul sheath. This character, combined with the glabrous leaves, has been used for recognition of *A. podochiloides*, a species not accepted here. Flowers in *A. gracile* are solitary on very short pedicels and without peduncles. The corolla is campanulate with spreading lobes. The stamens are free, and there are practically no apical appendages. The stigma is distinctly bifid and discoid.

Additional specimens examined. BORNEO. SABAH: W Coast Res., Kinabulu, Ulu Langanani, 3,800 ft., 1961, Chew *et al.* 1713 (A, K, L, SAR, SING); Tenompok, 5,000 ft., 1932, Clemens 26926A (BM, BO, K, L, NY); Columbon River, 4,500 ft., 1933, Clemens 34110 (BM, BO, GH, L, NY, UC); Penibukan, 4,000 ft., 1933, Clemens 32113 (B, BO, BM, G, GH, K, NY, UC); Penibukan, 4,000–5,000 ft., 1932, Clemens *s.n.* (BM, NY); Marai Parai spur, 1915, Clemens 11076 (UC). SARAWAK: 1st Div., Sabal, 350 m, 1979, Bremer 1667 (S, SAR); 2nd Div., Lubok Antu District, near Bukit Sengkajang, 1974, Chai S34006 (K, L, SAR); 4th Div., Gunong Mulu, W ridge near camp 3, 1,300 m, 1978, Argent & Coppins 1142 (E); near camp 4, 4,000 ft., 1962, Burt & Woods 2176 (E, SAR); 1,180 m, 1976, Martin S38185 (L, SAR); 4th Div., Mt. Dulit ridge, 1,200 m, 1932 Richards 1689 (K, L); S slope, 1,800 m, Nielsen 833 (AAU); 5th Div., Bakelalan, 4,000 ft., 1955, Brooke 10461 (BM, L); 5th Div., route from Bakelalan to Gunong Mulu, 3,800 ft., 1967, Burt & Martin 5211 (E); 7th Div., Belaga District, 2,900 ft., 1978, Burt 11444 (E); 7th Div., S Hose Mts., W of Bukit Sanpandai, 1980, Burt 12750A (E); camp 6, 4,600 ft., 1980, Burt 12848 (E); 7th Div., summit ridge of Bukit Tibang, 5,000 ft., 1069 Anderson & Ilias Paie S28667 (KLU, L, SAR). KALIMANTAN: E Prov., W Kutei, near Tabang, 600 m, 1956, Kostermans 12851 (L).

19. *Argostemma brachyantherum* Stapf, Trans. Linn. Soc. London Bot. 4: 168. 1894. *Argostemmella brachyanthera* (Stapf) Ridley, J. Bot. 65: 41. 1927. TYPE: Borneo. Kin-



MAPS 19, 20. Distributions in Borneo.—19. *Argostemma brachyantherum*.—20. *A. brookei*.

abalu, 3,000 ft., *Haviland 1326* (holotype, K). Figure 22.

A. kinabaluense Wernham in Gibbs, J. Linn. Soc. Bot. 42: 88. 1914. TYPE: British North Borneo. Kinabalu, near Dahobang and Kinitaki rivers, 4,000–5,000 ft., 1910?, *Gibbs 4056* (holotype, BM; isotype, K).

Erect, anisophyllous herb. Stem 3–40(–80) cm, slightly branched or unbranched, densely pubescent in upper part, in lower part with corky or papery bark; internodes 2–20(–45) mm. Leaves opposite, very unequal; stipules deciduous or persistent, 4–10 mm long, oblong to lanceolate, acute to acuminate at apex; larger leaves of the anisophyllous pairs with pubescent petioles 2–5 mm long; lamina 2.5–9 × 1–3 cm, obovate or oblanceolate or elliptic to narrowly elliptic, basally acute to obtuse with the lobes equal or oblique, marginally entire or serrulate, apically acute to acuminate, herbaceous, glabrous or with scattered hairs above, pubescent on the veins below; midrib and primary veins (6–14 pairs) distinct. Nanophyllous leaves deciduous or persistent, 3–10 mm long, ovate to lanceolate, acute to acuminate. Inflorescences 1–6(–12)-flowered, umbelliform, solitary or a few together; peduncle 1–3 cm, pubescent; bracts 0.2–0.7 cm long, ovate to lanceolate; pedicels 0.5–1.5 cm long, pubescent. Flowers 5-merous; calyx lobes 2–5 mm long, ovate to triangular, acute, sparsely pubescent; corolla campanulate, cleft less than 1/3 their length, externally pubescent, internally papillose to pubescent only on the lobes; lobes triangular, acute, erect(?). Stamens 2–3(–4) mm long,

free; anther cells and apical appendages free, not forming a cone; filaments short, equal, straight; sacs opening completely longitudinally; apical appendage 1/4–1/2 the anther length, thick and slightly papillose; connective distinct, smooth. Style 3–6 mm long, glabrous, with a capitate stigma, long-exserted. Fruit without furrows or ribs.

Argostemma brachyantherum grows in submontane or montane forest between 1,000 and 2,100 m in northeastern Borneo.

This species is generally small to medium sized with anisophyllous leaves and a few large, campanulate flowers with free, very short anthers. The indumentum, particularly on the leaves, differs among the collections, otherwise the species is rather uniform. The specimen *Argent & Coppins 1081* is much larger than those of other collections and also has many more flowers. Some characters of this specimen deviate from the typical range for the species and are enclosed in parentheses in the description.

Additional specimens examined. BORNEO. SABAH: W Coast Res., Kinabalu, vicinity of Kamaranga, 7,040 ft., 1962, *Bogle et al. 389* (GH); Tenompok, 5,000 ft., 1932, *Clemens 28179* (BM, BO, G, K, L, NY); Marai Parai, 5,000 ft., 1933, *Clemens 35136* (BM, BO, L, NY, UC); Marai Parai spur, 1915, *Clemens 10981* (UC); Upper Kinabalu, 6,000 ft., 1933, *Clemens 51020* (BM, G, K, NY); Marai Parai, 5,000 ft., 1958, *Collenette A77* (BM); on ridge parallel to Kinataki River, 45 ft., *Collenette A103* (BM); 1,650 m, 1966, *Ding Hou 225* (K, L); Kamarangoh, 7,000 ft., 1967, *Price 194* (K); W Coast Res., Gunong Alab, 1,400 m, 1969, *Nooteboom*

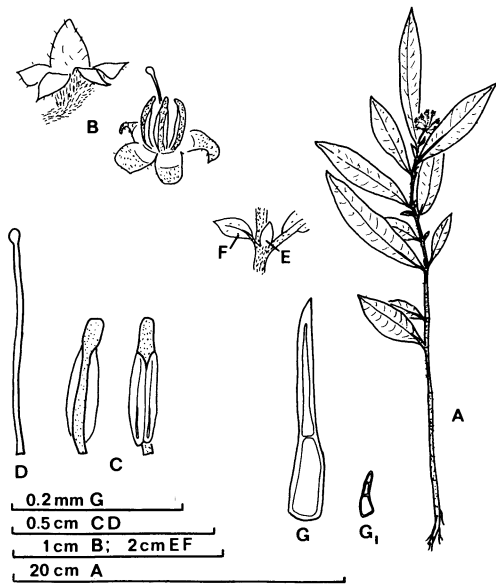


FIGURE 23. *Argostemma brookei*. —A. Habit.—B. Flower.—C. Anthers.—D. Style.—E. Stipule.—F. Nanophyllous leaf.—G. Hair from outer surface of the corolla.—G₁. Hair from inner surface of the corolla. A from Brooke 8562 (G); B–G from Clemens 20064 (NY).

922 (L). SARAWAK: 4th Div., Gunong Mulu, west ridge, 1,800 m, 1978, *Argent & Coppins 1081* (E); ridge at about 5,000 ft., 1962, *Burt & Woods 2150* (E); 4,000 ft., 1962, *Burt & Woods 2178, 2187* (E); path from Milinau Paku, 4,200 ft., 1961, *Anderson 4516* (K, L). KALIMANTAN: E Prov., W Kutei, 1925, *Endert 4171* (A, BO, K, L).

20. *Argostemma brookei* B. Bremer, sp. nov.

TYPE: Borneo. Sarawak: 1st Div., Berumput, 4,800 ft., 1954, *Brooke 8562* (holotype, L; isotypes, BM, G, UC). Figure 23.

Herba inflorescentibus valde pubescentibus, staminibus liberis. Folia opposita, illis parium inaequalissimis. Inflorescentia umbelliformis, floribus pusillis. Lobi calycis ovati ad triangulares, acuti, patentes. Corolla profunde fissa. Lobi corollae recurvi. Stamina libera, sed approximata. Appendix apicalis $\frac{1}{4}$ longitudinem antherae aequans, crassa, laevis. Connectivum distinctum. Stylus glaber, stigmatibus leviter capitato.

Argostemma havilandii, *A. calcicolum*, *A. trichosanthos*, *A. humifusum*, *A. psychotrioides*, *A. variegatum* simile sed lobis corollae profunde fassis, staminibus liberis differt.

Erect, anisophyllous herb. Stem 5–22 cm, slightly branched or unbranched, finely pubescent; internodes 3–15 mm. Leaves opposite, generally very unequal; stipules deciduous or persistent, 4–6 mm long, ovate, acuminate at apex; larger leaves of the anisophyllous pairs with pubescent petioles 2–35 mm long; lamina 3–70 × 0.8–2.2 cm, ob-

lanceolate to narrowly elliptic, basally acute with the lobes equal, marginally entire, apically acuminate, rarely acute or obtuse, herbaceous, glabrous above, pubescent on the veins below; midrib and primary veins (6–10 pairs) distinct. Nanophyllous leaves deciduous or persistent, 4–10 mm long, ovate to lanceolate, acute to acuminate. Inflorescences 5–16-flowered, umbelliform, solitary or a few together; peduncle 0.8–1.7 cm, pubescent; bracts ca. 0.5 cm long, lanceolate; pedicels 0.6–1.0 cm, pubescent. Flowers 5-merous; calyx lobes ca. 2 mm long, ovate to triangular, acute, sparsely pubescent, spreading; corolla cleft to near the base, externally with a few hairs, internally pubescent only on the distal part of the lobes; lobes ovate to triangular, recurved. Stamens ca. 3 mm long, free but close together; anther cells and apical appendage free; no true cone; filaments short, equal, straight; sacs opening completely longitudinally; apical appendage ca. $\frac{1}{4}$ the anther length, thick and smooth; connective distinct, smooth. Style ca. 6 mm long, glabrous, with a slightly capitate stigma, long-exserted. Fruit without furrows or ribs.

Argostemma brookei has been collected from the ground in the forest in the Poi (= Pueh) range at elevations of 1,000 to 2,000 m.

It is medium sized with oblanceolate, anisophyllous leaves. The upper part of the stems, the peduncles, and the whole inflorescences are covered by rather stiff hairs. The length of the calyx lobes is intermediate between the short ones, most common among the Borneo species, and the long lobes of *A. psychotrioides*.

Most specimens of this taxon have been determined as *A. brachyantherum*, another mountain species, which occurs mainly at Kinabalu. In habit they are similar, but *Argostemma brookei* has many small flowers with deeply cleft corollas having evidently recurved lobes. The free anthers are longer and stand close together, like a cone; the apical appendages are much longer, and the filaments are shorter than in *A. brachyantherum*.

Additional specimens examined. BORNEO. SARAWAK: 1st Div., Mt. Poi (= Pueh), summit ridge, northern end, 4,400 ft., 1956, *Bell 2068* (BM); 6,000 ft., 1929; *Clemens 20064* (K, NY); forested slopes, 1929, *Clemens 20331* (NY); 4,500–5,500 ft., 1924, *Mjöberg s.n.* (UC); 1st Div., Gunong Berumput, 3,000 ft., 1954, *Brooke 8599* (L); 4,870 ft., 1962, *Burt & Woods 2800* (E).

21. *Argostemma havilandii* Ridley, J. Straits Branch Roy. Asiat. Soc. 61: 13. 1912. TYPE: Borneo: Kuching, 1893, *Haviland 2958* (holotype, SING; isotypes, BM, BO, K). Figure 24.

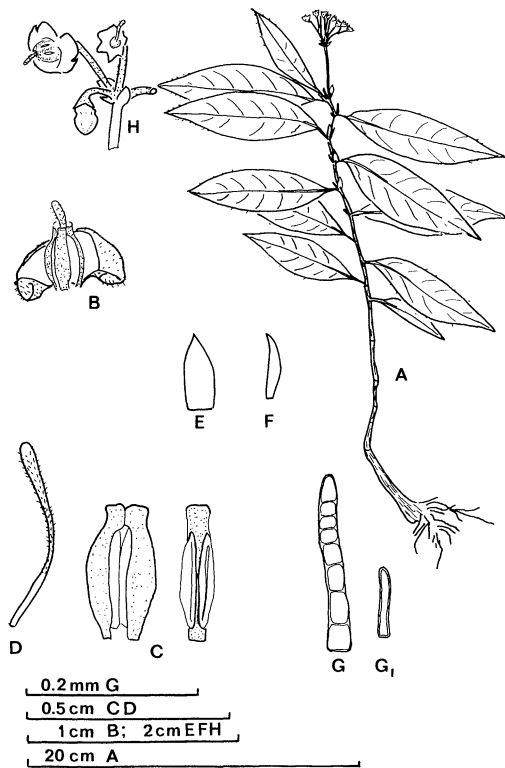
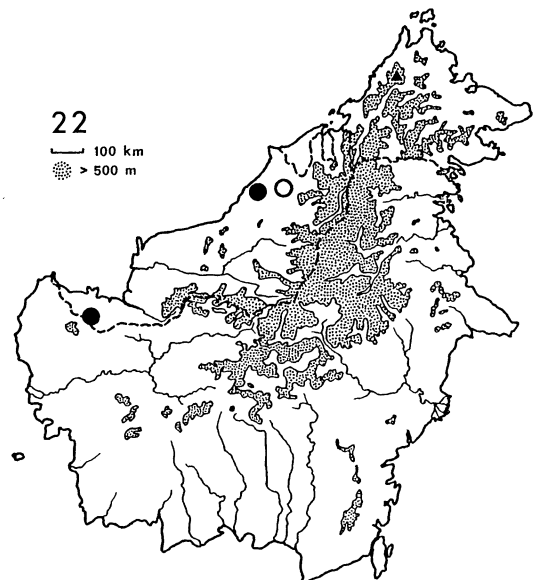
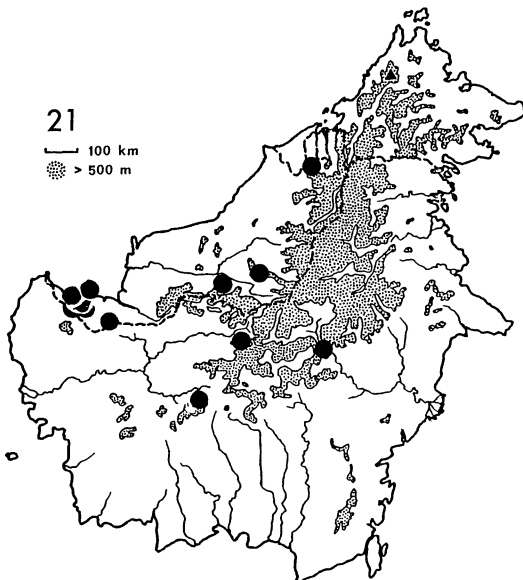


FIGURE 24. *Argostemma havilandii*.—A. Habit.—B. Flower.—C. Anthers.—D. Style.—E. Stipule.—F. Nanophyllous leaf.—G. Hair from outer surface of the corolla.—G₁. Hair from inner surface of the corolla.—H. Inflorescences. A, E, F from *Bremer 1689* (S); C, D, G, H from *Bremer 1662* (S).

- A. hallieri* Valetton, *Icones Bogorienses* 4: 267. 1914. TYPE: Borneo: Amai Ambit, *Hallier B3228* (holotype, BO; isotypes, BO, L).
- A. lanceolatum* Valetton, *Icones Bogorienses* 4: 269. 1914. TYPE: Borneo: *Teysmann 11292* (lectotype, L; Bakh. f. in herb., confirmed here).
- A. sarawakense* W. Smith, *Notes Roy. Bot. Gard. Edinburgh* 8: 318. 1915. TYPE: Borneo. Sarawak: 1913, *native collector 85* (holotype, E).
- A. hallieri* var. *sparsipilum* Merr., *Mitt. Inst. Allg. Bot. Hamburg* 7: 279. 1937. TYPE: West Borneo: Sungei Bika, 50 m, 1925, *Winkler 1428* (holotype, HBG; isotypes, HBG, NY).

Erect, anisophyllous herb. Stem 10–60 cm, unbranched or slightly branched, glabrous or rarely slightly pubescent, lower and older parts pale brown with elevated corky to papery longitudinal ridges and/or with transverse bars; internodes 9–30 mm. Leaves opposite, very unequal; stipules deciduous, 4–7 mm long, ovate to broadly ovate, obtuse at apex. Larger leaves of the anisophyllous pairs with glabrous or finely pubescent petioles 4–8 mm long; lamina 4–13 × 1.2–5 cm, obovate or oblanceolate to ovate to lanceolate, basally cuneate to acute or attenuate with the lobes equal, marginally entire, apically acuminate or rarely acute to obtuse, herbaceous to coriaceous, glabrous above or with a few hairs on the veins and margins, glabrous or generally pubescent on the veins below; midrib distinct, primary veins (6–11 pairs) generally distinct. Nanophyllous leaves deciduous, 4–10 mm long, lanceolate to linear. Inflorescences 4–18-flowered, umbelliform, solitary or a few together; peduncle 1.7–4.5 cm, glabrous; bracts to 0.6 cm long, ovate to broadly ovate; pedicels 0.7–1.8 cm,



MAPS 21, 22. Distributions in Borneo.—21. *Argostemma havilandii*.—22. *A. calcicolum*.

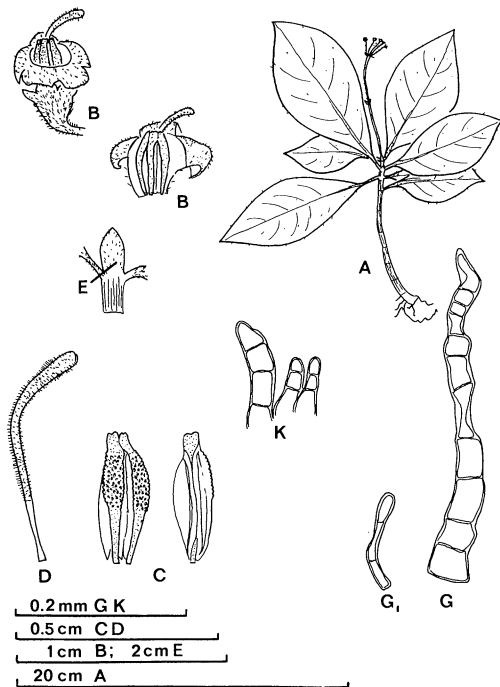


FIGURE 25. *Argostemma calcicolum*. —A. Habit. —B. Flower. —C. Anthers. —D. Style. —E. Stipule. —G. Hair from outer surface of the corolla. —G_i. Hair from inner surface of the corolla. —K. Hairs from the connectives. A, E from Burt & Woods 2005 (E); B–D, G, I from Bremer 1707 (S).

pubescent or rarely glabrous. Flowers 5-merous; calyx lobes ca. 1 mm long, ovate to orbicular, obtuse or acute, pubescent; corolla 3–4 mm long, cleft to about $\frac{1}{2}$, externally pubescent, internally papillose to pubescent only on the lobes; lobes ovate to triangular, recurved. Stamens 3–4 mm long, coherent; anther cells free, the apical appendages connate; anther cone ovoid to shortly so, straight; filaments very short, equal, straight; sacs opening completely longitudinally; apical appendage $\frac{1}{4}$ – $\frac{1}{2}$ the anther length, thick, coriaceous, smooth; connective coriaceous, distinct, generally smooth. Style ca. 3–6 mm long, pubescent, with a clavate stigma, long-exserted. Fruit without furrows or ribs.

Valeton based *A. lanceolatum* on four collections by Teysmann and Hallier, in BO and L. All are suitable for lectotypification. Bakhuizen f. (in herb.) has selected Teysmann 11292 in L, and I follow his choice.

Bakhuizen f. selected the K specimen of *A. havilandii* as the type (= holotype). This is a mistake because Ridley (1912) stated that the plants are preserved in the Singapore Botanical Gardens (note under *A. ophirensis*).

Argostemma havilandii has a scattered distribution. Most, if not all, collections are from limestone. It grows from 50 to 1,100 m elevation on litter or more or less as an epiphyte on tree trunks, usually in lowland rainforest.

It is easily distinguished. The stem is black on the upper part (on dry specimens), and the lower part is pale brown to gray and papery to corky with elevated ridges and with more or less distinct transverse bars. The corolla is cleft to about its middle into recurved lobes. The anther cone is low and pale yellow to creamish. The connectives are distinct, and the thecae are separated from each other at anthesis. The broad, thick apical appendages are connate along their whole length.

Argostemma havilandii is easily circumscribed. There is little variation among the populations except for width and hair cover of the leaves. From around Gunong Api there is a population with a very dense hair cover, even more distinctive than the densely pubescent specimens from Sungei Bika in Kalimantan, where they have been described as *A. hallieri* var. *sparsipilum*.

Additional specimens examined. BORNEO. SARAWAK: 1st Div., Mt. Matang: 500 ft., 1954, Brooke 9487 (L); 1,400 ft., 1927–1928, native collector 5181 (NY, UC); 1st Div., Bau, Seburan, 200 ft., 1960, Anderson 8982 (K, L, SAR); Seburan, 300 ft., 1960, Anderson 12915 (K, L, SAR); Seburan, 200 ft., 1960, Anderson 14600 (K, L, SAR); Jambusan, 100 ft., 1960, Anderson 12581 (K, L, SAR); Bidi Gunong Umbut, 1979, Bremer 1717 (S, SAR); 1st Div., Sabal, 1979, Bremer 1662 (S, SAR); 1st Div., Setapok, mi. 4½ Batu Kawa Road, 1975, James Mamit S35046 (L); 1st Div., Bako, 1979, Bremer 1689 (S, SAR); 1st Div., Kuching, 1955, Brooke 9770, 10792 (BM, L); 1893, Haviland s.n. (BM, L); 1913, native collector s.n. (E); 1st Div., Semengoh, 300 ft., 1958, Anderson 9106 (L, SAR); 1979, Bremer 1647 (S, SAR); 4th Div., Gunong Mulu, 1975, Burt 8300 (E); 4th Div., Gunong Api, 2,900 ft., 1971, Anderson S30826 (E, K, L); 1,000 ft., 1977, Argent et al. 666 (E); 3,500 ft., 1970, Chai S30085 (K, L, SAR); 7th Div., Bukit Salong, 1980, Burt 12734 (E); without loc., native collector 1232 (A); 1914, native collector 2403 (A). KALIMANTAN: E Prov., W Kutei, near Tabang, 1956, Kostermans 12845 (L); without loc., Teysmann 11921 (BO, K).

22. *Argostemma calcicolum* B. Bremer, sp. nov. TYPE: Borneo. Sarawak: 1st Div., Bukit Manok, halfway between Teng Bukap and Padawan, low alt., 1979, Bremer 1707 (holotype, S; isotypes, K, L, SAR). Figure 25.

Herba caulibus porcatibus et suberosis ad papyraceis. Folia opposita, illis parium aequalibus. Inflorescentiae umbelliformes aut ramis duobus scorpioides. Lobi calycis triangulares ad ovatis, acuti. Corolla ad dimidio fissa. Lobi corollae recurvi. Antherae liberae. Appendices apicales connatae, $\frac{1}{4}$ – $\frac{1}{2}$ longitudinem antherarum aequans, cras-

sae, coriaceae, laeves. Connectivum distinctum, papillosum. Stylus pubescens, stigmatе clavato.

Argostemma havilandii simile, sed planta plus pubescens, foliis oppositis aequalibus differt.

Erect, isophyllous herb. Stem 5–30 cm, slightly branched or unbranched, slightly pubescent, the lower and older parts pale brown with elevated corky to papery longitudinal ridges and/or with transverse bars; internodes 4–10 mm. Leaves opposite, equal or subequal; stipules deciduous, 5–10 mm long, ovate to oblong, acute to obtuse at apex; petiole 3–14 mm long, pubescent; lamina 5–17 × 2–7 cm, obovate to elliptic, basally cuneate to attenuate with the lobes equal, marginally entire or serrulate, apically acuminate, herbaceous, pubescent on both surfaces; midrib and primary veins (7–9 pairs) distinct. Inflorescences 3–30-flowered, umbelliform or with 2 scorpioid branches, solitary or a few together; peduncle 3–4.5 cm, pubescent, the bracts to 0.5 cm long, lanceolate; pedicels 0.5–0.7 cm, pubescent. Flowers 5-merous; calyx lobes ca. 1 mm long, triangular to ovate, acute, pubescent; corolla ca. 4 mm long, cleft to about ½, externally pubescent, internally papillose to pubescent only on the lobes; lobes ovate to triangular, recurved. Stamens ca. 3.5 mm long, coherent; anther cells free, the apical appendages connate; anther cone ovoid to shortly so, straight; filaments very short, equal, straight; sacs opening completely longitudinally; apical appendage ¼–½ the anther length, thick, coriaceous, smooth; connective coriaceous, distinct, papillose. Style 5–6 mm long, pubescent, with a clavate stigma, long-exserted. Fruit without furrows or ribs.

This rare species has been collected only four times. Haviland and Hose made the first collection, noting only the locality as Baram. Different collectors recorded it as growing on limestone. Anderson said "frequent in crevices on vertical limestone rocks." My collection is from low altitude in a limestone area. The earlier collections were all determined as *A. borragineum* because of the equal, opposite leaves. However, the stems, stipules, anthers, and style are quite different. It is close to *A. havilandii* and shares various characters with this species: lower stems pale brown to grayish, these having papery to corky surfaces and elevated ridges; anther shape; and clavate pubescent styles. However, *Argostemma calcicolum* differs from *A. havilandii* by its denser pubescence even on the peduncles and stipules, isophyllous leaves, and the upper part of the connectives distinctly papillose to hairy. The hairs on the connectives are not homologous to those on the anthers of *A. psycho-*

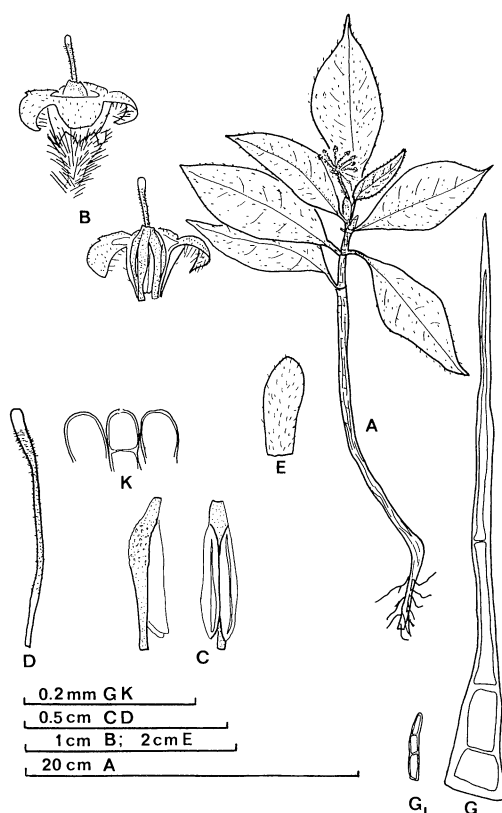


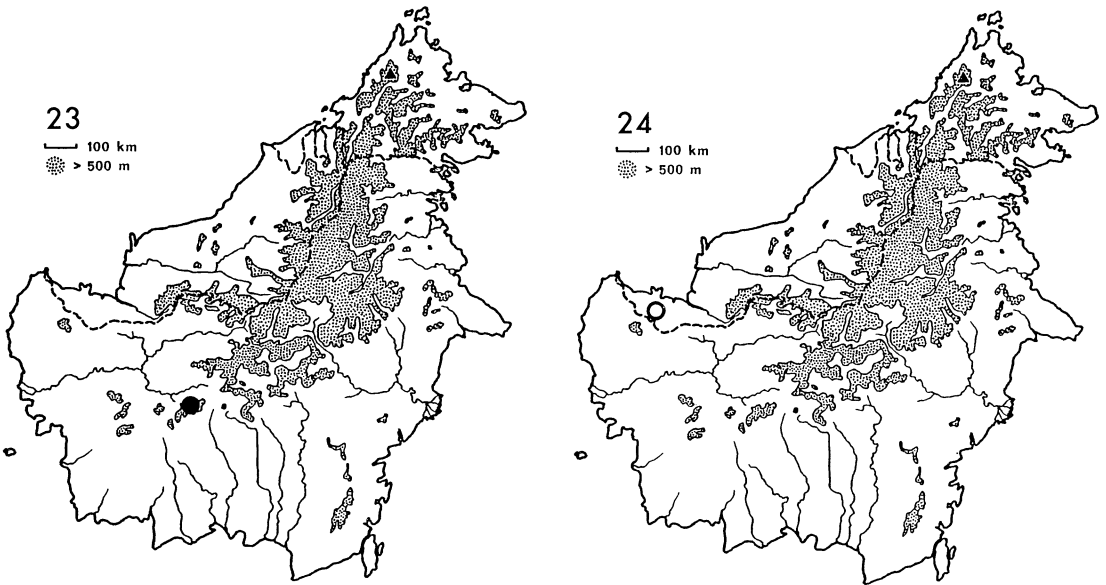
FIGURE 26. *Argostemma trichosanthes*.—A. Habit.—B. Flower.—C. Anthers.—D. Style.—E. Stipule.—G. Hair from outer surface of the corolla.—G₁. Hair from inner surface of the corolla.—K. Papillae or hairs from the connectives. From *Winkler 781* (NY).

trioides, which has smooth connectives but papillose to hairy thecae and apical appendages. In *A. calcicolum* these parts are smooth.

Additional specimens examined. BORNEO. SARAWAK: 4th Div., Gunong Subis, 1972, *Anderson S31672* (A); 4th Div., Penkalan Lobang Niah Caves, *Burt & Woods 2005* (E); 4th Div., Baram, 1894, *Haviland & Hose 3409* (K).

23. *Argostemma trichosanthes* Merr., Mitt.
Inst. Allg. Bot. Hamburg 7: 280. 1937. TYPE: West Borneo. Bidang Menabei, 700 m, 1924, *Winkler 781* (holotype, HBG; isotype, NY).
Figure 26.

Erect, densely pubescent, isophyllous herb. Stem ca. 25 cm, unbranched, densely pubescent, lower and older parts pale brown with elevated corky to papery longitudinal ridges and/or with transverse bars; internodes 7–15 mm. Leaves opposite, equal; stipules deciduous, 8–10 mm long, ovate, obtuse at apex; petiole 5–12 mm long, pubescent; lamina



MAPS 23, 24. Distributions in Borneo.—23. *Argostemma trichosanthes*.—24. *A. humifusum*.

6–11 × 3–5 cm, obovate to elliptic, basally cuneate to attenuate with the lobes equal, marginally serrulate, apically acuminate, herbaceous, pubescent on both sides; midrib and primary veins (ca. 8 pairs) distinct. Inflorescences 10–20-flowered, umbelliform, solitary; peduncle 1.5–3.2 cm, pubescent; bracts to 0.6 cm long, lanceolate to linear; pedicels 0.5–0.7 cm, pubescent. Flowers 5-merous; calyx lobes less than 1 mm long, triangular or ovate, acute, pubescent; corolla 3–5 mm long, cleft to about $\frac{1}{2}$, externally pubescent, internally papillose to pubescent only on the lobes; lobes ovate to triangular, recurved. Stamens ca. 3.5 mm long, coherent, the anther cells free, the apical appendages connate; anther cone ovoid to shortly ovoid, straight; filaments very short, equal, straight; sacs opening completely longitudinally; apical appendage $\frac{1}{4}$ – $\frac{1}{5}$ the anther length, thick, coriaceous, smooth; connective coriaceous, distinct, papillose in upper part. Style ca. 6 mm long, pubescent, with a clavate stigma, long-exserted. Fruit without furrows or ribs.

Argostemma trichosanthes is known only from the type. It was collected at Bidang Menabei on Kalimantan at 700 m.

Argostemma trichosanthes is close to *A. havilandii* and *A. calcicolum*, with which it shares the stem characters pale brown to gray, papery to corky, and with elevated ridges on the lower stems. With *A. calcicolum* it shares opposite isophyllous leaves. *Argostemma trichosanthes* is easily distin-

guished by its dense indumentum. The upper part of the stems, particularly the younger leaves and most parts of the inflorescences, are densely covered by stiff, long, thick-walled hairs.

24. *Argostemma humifusum* W. Smith, Notes Roy. Bot. Gard. Edinburgh 8: 317. 1915. TYPE: Borneo. Sarawak: Gunong Bayat (= ?Gunong Sebayat near Kuching), 1914, native collector D131 (holotype, E; isotypes, E, K, SAR). Figure 27.

Erect, anisophyllous herb. Stem 6–16 cm, slightly branched or unbranched, glabrous; internodes 4–15 mm. Leaves opposite, very unequal; stipules persistent, 6–8 mm long, cordiform or broadly ovate, acuminate at apex. Larger leaves of the anisophyllous pairs with finely pubescent petioles 5–16 mm long; lamina 4–9 × 2–4.5 cm, obovate, basally acute to obtuse with the lobes unequal, marginally serrulate, apically shortly acuminate, membranaceous to herbaceous, pubescent on both surfaces; midrib and primary veins (6–10 pairs) distinct. Nanophyllous leaves persistent, 5–10 mm long, ovate. Inflorescences 5–10-flowered, umbelliform, solitary or a few together; peduncle 1.7–2.5 cm, glabrous; bracts very small, ovate to linear; pedicels 0.3–0.6 cm, with a few hairs. Flowers 5-merous; calyx lobes less than 1 mm long, ovate, acute, pubescent; corolla ca. 4 mm long, externally pubescent, internally glabrous(?). Stamens ca. 3 mm long, coherent; anther cells free,

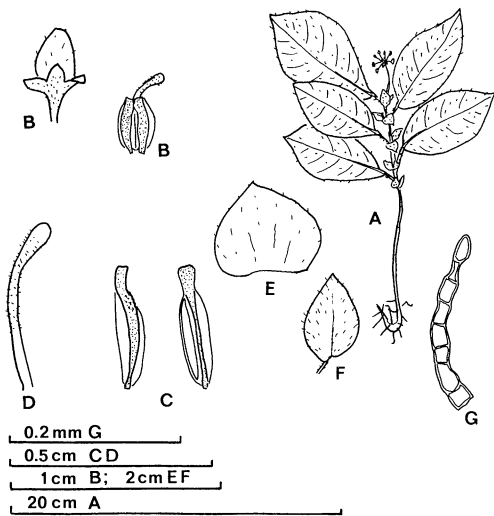


FIGURE 27. *Argostemma humifusum*.—A. Habit.—B. Flower bud, and anther cone.—C. Anthers.—D. Style.—E. Stipule.—F. Nanophyllous leaf.—G. Hair from outer surface of the corolla. From native collector D131 (E, K).

the apical appendages connate; anther cone ovoid to shortly ovoid, straight; filaments very short, equal, straight; sacs opening completely longitudinally; apical appendage $\frac{1}{4}$ – $\frac{1}{5}$ the anther length, thick, coriaceous, smooth; connective coriaceous, distinct, papillose in upper part. Style ca. 5 mm long, glabrous to pubescent, with a clavate stigma, long-exserted. Fruit without furrows or ribs.

Argostemma humifusum has been collected twice, but nothing was recorded about its habit or habitat.

This species is characterized by its broad, ovate leaves and large cordiform stipules. Because of incomplete material, I do not know the shape of the corolla. It has a thin corolla similar to those generally cleft halfway into recurved lobes. Internally the corolla seems to be glabrous, but among the other species with thin corollas, the lobes are usually pubescent. The upper part of the connective is probably papillose to pubescent as in *A. calcicolum* and *A. trichosanthes*.

Additional specimen examined. BORNEO. SARAWAK: Kutein, 1865–1867, *Beccari 150* (K, L).

25. *Argostemma psychotrioides* Ridley, J. Bot. 65: 38. 1927. TYPE: Borneo: *Haviland 689* (holotype, K; isotype, SAR). Figure 28.

Erect, anisophyllous herb. Stem 10–100 cm, slightly branched or unbranched, finely pubescent

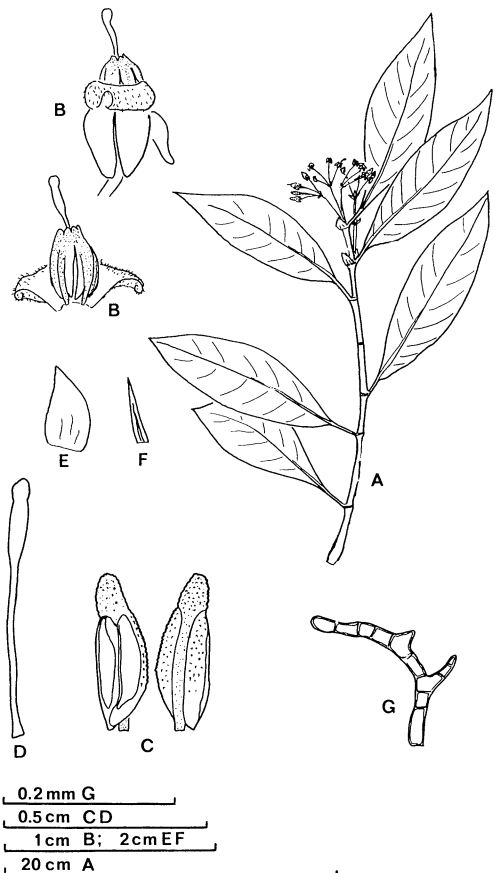
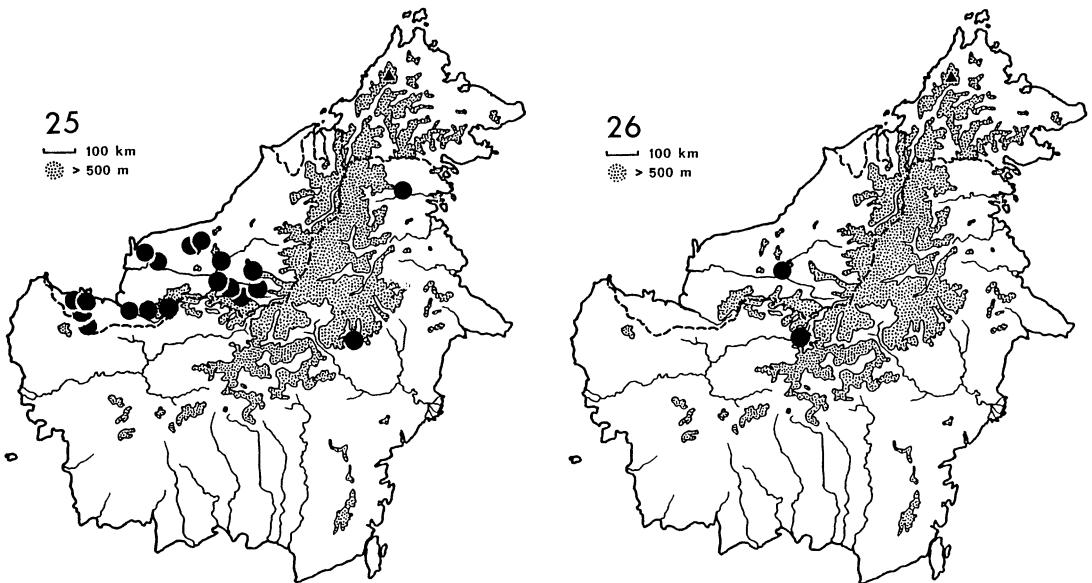


FIGURE 28. *Argostemma psychotrioides*.—A. Flowering branch.—B. Flower.—C. Anthers.—D. Style.—E. Stipule.—F. Nanophyllous leaf.—G. Hair from outer surface of the corolla. From *Burt & Martin 4991* (E).

or glabrous; internodes 7–30 mm long. Leaves opposite, very unequal; stipules deciduous, 6–20 mm long, ovate to lanceolate, acuminate at apex; larger leaves of the anisophyllous pairs with finely pubescent or glabrous petioles 3–19 mm long; lamina 5–18 × 1–6 cm, obovate or oblanceolate to ovate or lanceolate, basally acute to attenuate with the lobes equal, marginally entire, apically acuminate or rarely acute to obtuse, herbaceous, glabrous above, glabrous to finely pubescent on the veins below; midrib and primary veins (7–15 pairs) distinct. Nanophyllous leaves deciduous, 5–13 mm long, ovate to lanceolate, acuminate. Inflorescences 3–30-flowered, umbelliform, rarely with lateral branches to corymbiform, solitary or a few together; peduncle 1–4 cm, pubescent or glabrous; bracts 0.7 cm long, ovate or lanceolate to linear; lateral branches, if present, to 3 cm, pubescent; pedicels 0.5–1.5 cm, pubescent. Flowers 5-merous; calyx



MAPS 25, 26. Distributions in Borneo.—25. *Argostemma psychotrioides*.—26. *A. variegatum*.

lobes 2–6 mm long, subspatulate or ovate to oblong, acute, reflexed and pressed against the ovary concealing it even before anthesis, pubescent to glabrous; corolla 3–5 mm long, cleft to about $\frac{1}{2}$ its length, externally pubescent, internally papillose to pubescent only on the lobes; lobes ovate to triangular, recurved. Stamens 2–4 mm long, coherent; anther cells free, the apical appendages connate; anther cone ovoid to shortly ovoid, straight; filaments very short, equal, straight; sacs opening completely longitudinally; apical appendage $\frac{1}{4}$ – $\frac{1}{2}$ the anther length, thick, coriaceous, papillose; connective coriaceous, distinct, generally smooth. Style 4–7 mm long, glabrous or rarely with a few hairs, with a clavate stigma, long-exserted. Fruit without furrows or ribs.

Argostemma psychotrioides is found mostly at altitudes less than 250 m, although it occurs up to 1,000 m. It grows in shady, wet places on exposed roots and pneumatophores in swampy forests and on boulders in streams. It also grows under drier conditions on limestone and at higher altitudes in mossy forests.

It is easily identified by its strongly reflexed calyx lobes which in living material are green with white margins and tips. The corolla is thin and pubescent to densely pubescent and has recurved lobes. The anther cone is low, pale yellow to creamish. Only the apical appendages are connate, and the thecae are free. The thick apical appendages and the back of the thecae are distinctly papillose to hairy, while the connectives are smooth (cf. *A. trichosanthes*).

There is little variation in the characters of the flowers, but a few specimens (*Bremer 1730, 1744, 1748*) from the 7th Division have shorter calyx lobes. The shape and size of the leaves as well as the occurrence of hairs are variable and do not correlate with distribution patterns.

Additional specimens examined. BORNEO. SARAWAK: 1st Div., Kuching, 1893, *Haviland 2960* (BO, L, SAR); 1894, *Haviland s.n.* (BM, L); 1894, *Haviland & Hose s.n.* (A, GH); 1905, *Ridley 12302* (BM, K, SING); 1st Div., Setapok, 1966, *Anderson S19690* (K, L, SAR); 1st Div., Mt. Matang, 1924, *Mjöberg 216* (BO, NY, SING, UC); 2,000 ft., 1927, *native collector s.n.* (UC); 1st Div., Padawan area, Gunong Maja, 1979, *Bremer 1703* (S, SAR); 1st Div., Bukit Manok, halfway between Teng Bukap and Padawan, 1979, *Bremer 1706* (S, SAR); 1st Div., Semengoh, 1979, *Bremer 1643* (S, SAR); *Banyeng ak Nudong & Sibat ak Luang S25355* (K, L, SAR); 2nd Div., Simangang, 1955, *Brooke 10716* (BM, L); 2nd Div., Bukit Sadok, 1982, *Axelius 86, 93* (S); 2nd Div., between Entalau and Tisak, 1982, *Axelius 122* (S); 2nd Div., Bukit Sengkajang, Lanjak-Entimau, 3,100 ft., 1974, *Chai S33980* (L); 3rd Div., Kelapaan, 1954, *Brooke 8840* (BM, G, L, SING); 3rd Div., Sibuluan, Naman, low alt., *Sanusi Tahir 8954* (BO, K, L, SING); 3rd Div., Ulu Sungei Arip, 1965, *Sibat ak Luang S23664* (AAU, K, L, SAR); 4th Div., Ulu Muput Kanan, 1963, *Chai S19532* (L, SAR); 7th Div., Nanga Pelagos, 1938, *Daud & Tachun SFN35678* (A, G, K, SAR, SING); 7th Div., Hose Mts., above Melinau Falls, 4,000 ft., 1967, *Burt & Martin 4991* (E); E of Bukit Sanpandai, 1980, *Burt 12839* (E); 7th Div., Sungei Melinau, Nanga Tunoh, 450 ft., 1980, *Burt 12666* (E); 7th Div., Ulu Balleh, Sungei Putai, 1979, *Bremer 1724* (S, SAR); junction of Sungei Tekalit and Sungei Mengiong, 1979, *Bremer 1730, 1744* (S, SAR); Sungei Mengiong, 1979, *Bremer 1748* (S, SAR); 7th Div., Sungei Bene, 1980,

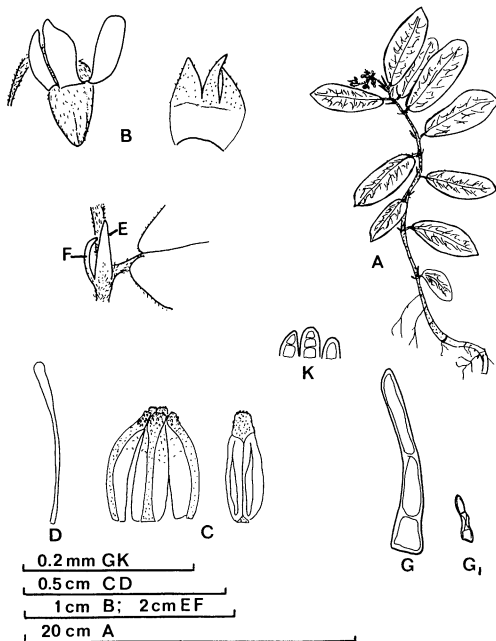


FIGURE 29. *Argostemma variegatum*.—A. Habit.—B. Flower bud and part of the corolla from the inner surface.—C. Anthers.—D. Style.—E. Stipule.—F. Nanophyllous leaf.—G. Hair from outer surface of the corolla.—G₁. Hair from inner surface of the corolla.—K. Papillae or hairs from the apical appendages. From *Winkler 1561* (HBG, NY).

Burt 12935, 12951 (E); 7th Div., Gat, 1929, *Clemens* 21738, 12740 (NY); without loc., *native collector* 294, (A, UC), 408, (A, K, UC), 1244 (A, UC); *Lobb s.n.*, *Lowe s.n.* (K). KALIMANTAN: E Prov., Camp Malinau along Sungei Adat, 1982, *Axelius* 315 (S); E Prov., C Kutai, NW of Tabang, 100–150 m, 1979, *Murata et al.* 1192 (L).

26. *Argostemma variegatum* Merr., Mitt. Inst. Allg. Bot. Hamburg 7: 280. 1937. TYPE: West Borneo. Nanga Era, 100 m, 1925, *Winkler 1561* (holotype, HBG; isotype, NY). Figure 29.

Creeping anisophyllous herb. Stem 10–20 cm, slightly branched or unbranched, pubescent; internodes 3–17 mm long. Leaves opposite, very unequal; stipules persistent, 3–6 mm long, lanceolate, acuminate at apex; larger leaves of the anisophyllous pairs with pubescent petioles 2–5 mm long; lamina 3.5–7 × 1.4–3.4 cm, obovate to oblanceolate, basally rounded or obtuse with the lobes unequal, marginally entire or serrulate, apically obtuse or obtuse with a point, herbaceous, glabrous above, finely pubescent on the veins and margins below; midrib and primary veins (7–9 pairs) distinct. Nanophyllous leaves persistent, ca. 5 mm

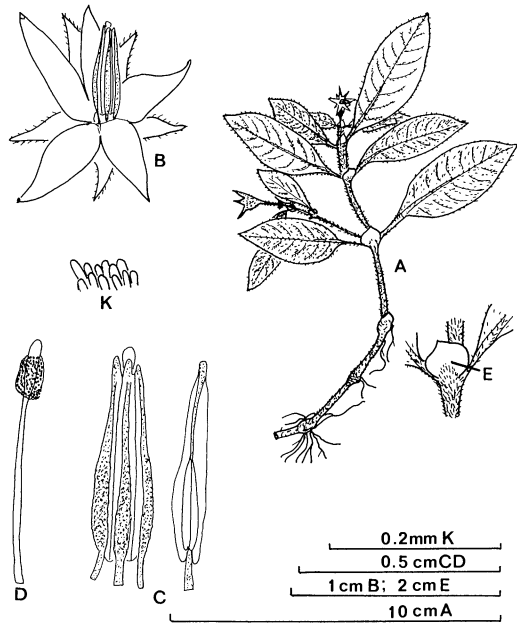
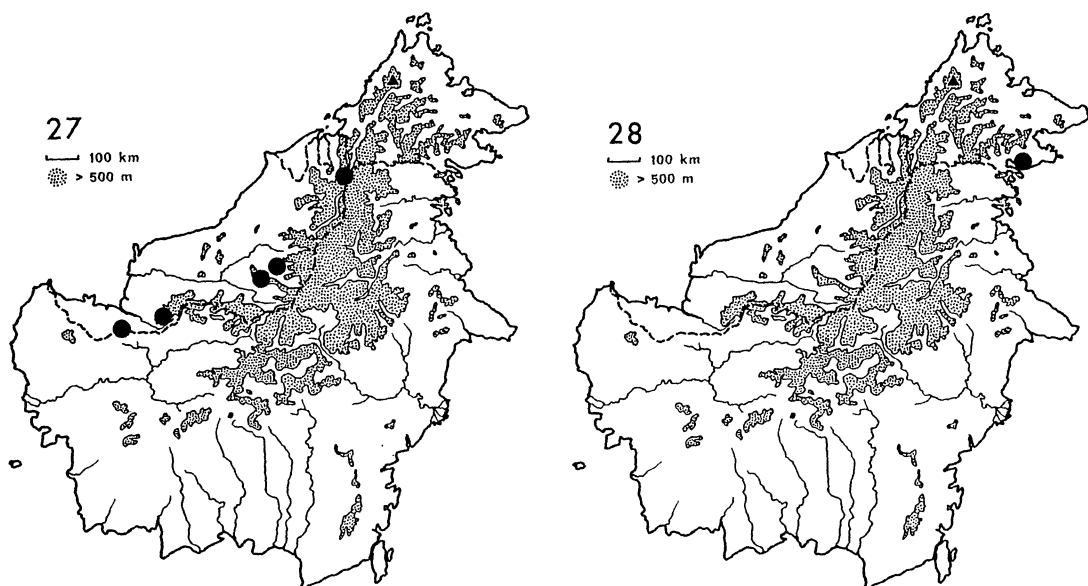


FIGURE 30. *Argostemma bryophilum*.—A. Habit.—B. Flower.—C. Anthers.—D. Style with pollen at apex.—E. Stipule.—K. Papillae from the connectives. From *Burt* 12800 (E).

long, linear, petiolelike. Inflorescences ca. 7-flowered, umbelliform, solitary; peduncle 1–3 cm, pubescent or almost glabrous; bracts ca. 0.5 cm long, linear; pedicels 0.5–0.9 cm, pubescent. Flowers 5(or 6)-merous; calyx lobes 3–4 mm long, subspatulate or ovate to oblong, acute, reflexed and pressed against the ovary concealing it even before anthesis, pubescent to glabrous; corolla ca. 3 mm long, cleft to about ½, externally pubescent, internally papillose to pubescent only on the lobes; lobes ovate to triangular, recurved. Stamens 2.5–3 mm long, coherent; anther cells free, the apical appendages connate; anther cone ovoid to shortly ovoid, straight; filaments very short, equal, straight; sacs opening completely longitudinally; apical appendage ¼–½ the anther length, thick, coriaceous, papillose; connective coriaceous, distinct, generally smooth. Style ca. 5 mm long, glabrous, with a clavate stigma, long-exserted. Fruit without furrows or ribs.

Argostemma variegatum has been collected on steep soil banks in disturbed primary forest and in primary forest at ca. 100 m. Its habit is like that of *A. elatostemma* and *A. densifolium*, that is, creeping with anisophyllous leaves, the larger ones with unequal leaf-base lobes. The stems, petioles, and veins are distinctly pubescent. The flowers,



MAPS 27, 28. Distributions in Borneo.—27. *Argostemma bryophilum*.—28. *A. neurocalyx*.

however, are different from the above species; they are similar to those of *A. psychotrioides*. The calyx lobes are long and reflexed, the corollas are cleft to about half their length into pubescent, recurved lobes. The original collection has silvery mottled leaves while the other does not (perhaps due to drying). *Argostemma variegatum* is close to *A. psychotrioides*; the similarities to *A. elatostemma* are superficial.

Additional specimen examined. BORNEO. SARAWAK: 7th Div., Bukit Raya, 1969, *Smith S28234* (A, K, L).

27. *Argostemma bryophilum* Schumann in Schumann & Lauterb., *Nachträge zur Flora der Deutschen Schutzgebirge in der Südsee*. 393. 1905. TYPE: from Kaiser Wilhelmsland, not seen. Figure 30.

Small, creeping to erect, generally isophyllous herb. Stem 2–10 cm, unbranched or slightly branched, densely pubescent; internodes 3–20 mm. Leaves opposite, generally equal; stipules persistent, to 4 mm long, broadly ovate to cordiform, acute to obtuse at apex; petiole 3–11 mm long, pubescent; lamina 1.5–4.2 × 0.6–1.9 cm, ovate or elliptic to lanceolate, basally cuneate to attenuate with the lobes equal, marginally serrulate or entire, apically acute to acuminate or obtuse with a point, membranaceous, pubescent on both surfaces, below most prominent on the veins; midrib and primary veins (5–8 pairs) distinct. Inflorescences 1–2-flowered, solitary or a few together;

peduncle 3–6 mm long, almost glabrous; bracts ca. 4 mm long, lanceolate or triangular; pedicels ca. 7 mm long, pubescent. Flowers 5-merous; calyx lobes 2–4 mm long, triangular, acuminate; corolla cleft to near the base, glabrous on both surfaces; lobes 5–7 mm long, ovate to lanceolate, acuminate, spreading. Stamens 4–5 mm long, coherent; anther cells and apical appendages connate except for the most apical part; anther cone ovoid, straight; filaments short, equal, straight; sacs of different length, opening completely longitudinally; apical appendage very short, glabrous; connective ± distinct, papillose. Style 4–5.5 mm long, glabrous, with a clavate stigma, shortly exserted. Fruit without furrows or ribs.

Argostemma bryophilum grows on wet rocks, boulders, or banks among mosses from 350 to 1,500 m.

It is the first species described in a large complex from New Guinea and the Philippines with more than ten taxa. Bakhuizen f. (pers. comm.) has treated the complex as a single species. All details of the complex are not known and so I have only accepted one variable species. This is the first report from Borneo. The collections from Borneo are all rather similar, with the exception of *Axelius 112A*, which has anisophyllous leaves. The Borneo specimens form a homogenous group and may in the future be recognized as a distinct taxon separate from the New Guinea and Philippine members of the complex. It is a small plant with pale green, thin, and hairy leaves. With one exception, all

collections have isophyllous, opposite leaves, very pubescent stems, and cordiform, glabrate stipules. The flowers are solitary, starlike and with long, bright yellow anther cones. The thecae distinguish this species from all others: the inner pollen sac of each theca is only ca. half as long as the outer one, which is almost as long as the whole anther, and there is no distinct apical appendage. The stigma is distinctly clavate with papillae covering the clavate area. In all flowering specimens (five of the seven known specimens), the stigma is totally covered by germinated pollen grains. The pollen is probably from the same flower, because the stigma is partly covered by the apical anther parts. I have not found more than a few pollen grains on the stigmas of any other species. Probably this species is autogamous.

Specimens examined. BORNEO. SARAWAK: 1st Div., Sabal, 350 m, 1979, *Bremer 1664* (S, SAR); 2nd Div., Bukit Sadok, 1982, *Axelius 112A* (S); 5th Div., Bakelalan, 4,000 ft., 1955, *Brooke 10406, 10464* (BM, L); 7th Div., Hose Mts., Bukit Salong, 1980, *Burt 12733* (E); Bukit Sanpandai, 4,500 ft., 1980, *Burt 12800* (E); 7th Div., Bukit Dema, 1978, *Burt 11328* (E).

28. *Argostemma neurocalyx* Miq., Ann. Mus. Bot. Lugd.-Bat. 4: 229. 1869. TYPE: Sumatra?: *Junghuhn s.n.* (holotype, U). Figure 31.

A. platyphyllum Merr., Univ. Calif. Publ. Bot. 15: 275. 1929. TYPE: British North Borneo: Tawao, 1922–1923, *Elmer 21138* (lectotype, K; Bakh. f. in herb., confirmed here; isolectotypes, BO, BR, G, GH, NY, S, SING, U, UC, US).

Erect anisophyllous herb with an apical rosette of 2–4 leaves. Stem 4–8 cm, unbranched, glabrous or glabrate, without distinct internodes. Leaves verticillate, compressed in an apical rosette; stipules(?) persistent, 4–9 mm long, lanceolate, acuminate at apex; petiole absent; lamina 2–15 × 12.7–7.6 cm, suborbicular or ovate to elliptic, basally obtuse or shortly attenuate and equal, marginally entire, apically acute to shortly acuminate, membranaceous, pubescent above, below with a few hairs on the veins; midrib and primary veins (7–9 pairs) distinct. Inflorescences 4–15-flowered, umbelliform, solitary or a few together; peduncle 2.3–5.5 cm, glabrous; bracts to 0.5 cm long, ovate; pedicels 0.4–0.7 cm, pubescent. Flowers 4(or 5?)-merous; calyx lobes 1–2 mm long, ovate to broadly ovate, acute, glabrous; corolla ca. 5 mm long, cleft less than 1/3 its length, glabrous on both surfaces; lobes ovate to triangular, erect. Stamens ca. 3 mm long; free, not forming a cone; filaments ca. 1/2 as long as the anthers, equal, straight; sacs opening by pores; without apical appendages; connective dis-

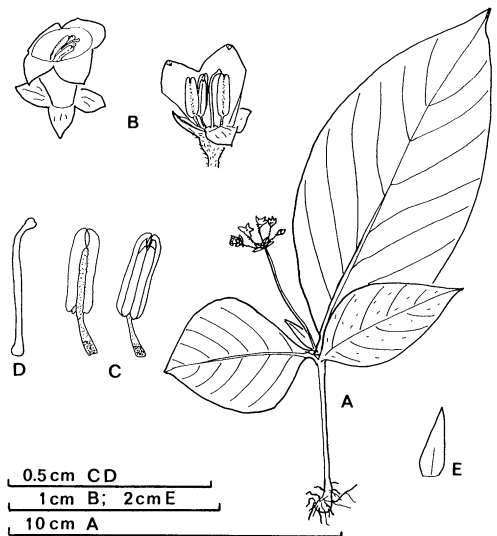


FIGURE 31. *Argostemma neurocalyx*. — A. Habit. — B. Flower. — C. Anthers. — D. Style. — E. Stipule? From *Elmer 21138* (G, SING).

tinct, smooth. Style ca. 4 mm long, glabrous, with a capitate stigma, exserted. Fruit without furrows or ribs.

Merrill based *A. platyphyllum* on one collection by *Elmer*; no specimen is indicated. All specimens are suitable for lectotypification. Bakhuizen f. (in herb.) has selected the K specimen, and I follow his choice.

Argostemma neurocalyx was collected just once on Borneo, by *Elmer*, near Tawau, and was described by Merrill as *A. platyphyllum*. The protologue says “a succulent erect herb in dense forests on moss-covered basaltic rocks over which water trickles.” It is not only the sole collection of the species on Borneo, it is also the only collection representing this section of the genus from Borneo. Possibly it was erroneously labeled in the herbarium by *Elmer* or Merrill. However, it is an easily distinguished species with two or four verticillate, slightly unequal leaves. On dry specimens, the leaves are very thin and membranaceous. It is difficult to determine from the herbarium specimens if there are stipules or just smaller leaves. The umbelliform inflorescences have long glabrous peduncles, rather large, ovate bracts, and pubescent pedicels. The flowers are tetramerous and campanulate, and the corolla lobes seem to be reflexed. The stamens are free with long filaments and connectives ending below the thecae. The pollen sacs open by pores formed by short, broad slits in the upper part of each pollen sac. The pores (slits) are placed between the sacs of each theca. As the dorsal sacs are larger

than the ventral sacs, only the pores of the dorsal ones can be seen (from the inside of the flower), and the pores of the ventral sacs are hidden by the longer dorsal sacs.

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APPENDIX I

INDEX TO COLLECTIONS

The species number is given within parentheses after each collection number. Only cited specimens from Borneo are listed.

(5), field n 6973 (14), field n 7083 (5), s.n. (5), s.n. (13), s.n. (15), s.n. (18); **Collenette** 60 (14), 116 (13), 4179 (11), A77 (19), A103 (19), s.n. (12); **Cox** 957 (13); **Darnton** 568 (15); **Daud & Tachun** SFN35678 (25); **Ding Hou** 220 (13), 225 (19); **Elmer** 21138 (28); **Endert** 2952 (15), 3614 (14), 3800 (11), 3874 (14), 3916 (11), 4171 (19), 4172 (13), 4238 (14), 4327 (3); **Fedilis & Sumbing** SAN 88281 (13); **Fuchs** 21031 (13); **Gardner** 88 (14); **Geesink** 9036 (13), 9112 (14), 9113 (11), 9226 (13), 9255 (14), 9272 (11); **Gibbs** 4056 (19), 4101 (13); **Grieswold** 27 (14), 29 (13); **Hallier** 1720 (14), 2686 (15), 2779 (13), 3230 (13), B3228 (21); **Hansen** 20 (3), 187 (14); **Haviland** 684 (14), 689 (25), 1031 (10), 1325 (18), 1326 (19), 2958 (21), 2960 (25), 8475 (16), s.n. (13), s.n. (21), s.n. (25); **Haviland & Hose** 3409 (22), s.n. (25); **Hullett** 329 (13), s.n. (5); **Ilias Paie** S28445 (14), S36357 (14); **Ilias & Yeo** S38349 (1); **Jacobs** 5065 (10); **Jaheri in exp. Nieuwenhuis** 1636 (7); **James Mamit** S35046 (21); **Kanis & Kuripin** 53966 (3); **Kloss** SFN19154 (13); **Kostermans** 7437 (5), 9216 (13), 10121 (15), 10570 (13), 12845 (21), 12851 (18); **Lobb** s.n. (25); **Lowe** s.n. (25); **Madani** 90812 (13); **Martin** S38185 (18), S38848 (14); **Martin & Ismawi** S36861 (13); **Meijer** 687 (5), 2286 (3), 2343 (13); **Mjöberg** 8 (7), 82 (14), 85 (14), 88 (14), 205 (5), 206 (5), 216 (25), 218 (15), s.n. (2), s.n. (5), s.n. (13), s.n. (14), s.n. (14), s.n. (15), s.n. (20); **Motley** 1174 (2); **Moulton** 105 (14), 6695 (14), 6726 (14); **Moulton's native collectors** 365 (15); **Murata et al.** 1192 (25); **native collector** 85 (21), 294 (25), 408 (25), 1227 (17), 1232 (21), 1244 (25), 1256 (13), 1428 (13), 2403 (21), 5181 (21), D131 (24), s.n. (5), s.n. (14), s.n. (21), s.n. (25); **Nielsen** 204 (13), 368 (17) 494 (13), 538 (4), 833 (18), 838 (14); **Nooteboom** 921 (14), 922 (19), 1031 (15), 1035 (14); **Nooteboom & Aban** 1552 (13), 1593 (13); **Nooteboom & Chai** 1704 (13), 1744 (14), 1856 (14), 1935 (14), 2198 (11), 2307 (13); **Othman Ismawi** S37437 (15); **Price** 194 (19); **Purseglove** 4987 (5), 5095 (10), 5096 (17), 5129 (13), 5256 (13), 5282 (15), 5534 (10); **Purseglove & Shah** 4811 (5); **Richards** 1052 (13), 1537 (14), 1689 (18), 1711 (7), 1790 (14), 1799 (13), 2090A (3), 2101 (7), 2455 (10), 7090 (13); **Ridley** 11751 (5), 11753 (2), 12302 (25), 12303 (2), 12304 (14), 12448 (4), s.n. (4); **Sanusi Tahir** 8954 (25); **Sibat ak Luang** S23664 (25); **Sidek Kiah** 2 (13); **Sinclair** 9212 (14), 10355 (15); **Sinclair et al.** 9215 (15); **Smith** S28234 (26); **Sylvester Tong** S34346 (4), S34847 (7); **Teysmann** 11292 (21), 11921 (21); **Tong & Banyeng** S33271 (14); **van Niel** 3558 (13), 4580 (13); **Winkler** 660 (3), 767 (1), 781 (23), 791 (3), 879 (15), 897 (6), 949 (13), 950 (6), 951 (10), 1007 (15), 1282 (15), 1353 (15), 1428 (21), 1479 (18), 1561 (26), 1562 (15), 2853 (15), **Wood** SAN16695 (14).

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APPENDIX II

INDEX TO TAXA

Accepted names are in boldface, synonyms in italics.