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THE GENUS XANTHOPHYTUM (RUBIACEAE)
Taxonomy, phylogeny and biogeography

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SUMMARY

The genus *Xanthophytum* (Rubiaceae) from Borneo, Java, the Philippines, New Guinea, and Fiji is revised. Thirty species are recognized. Twelve new species are described, viz. *X. alopecurum*, *X. brookei*, *X. cylindricum*, *X. foliaceum*, *X. glabrum*, *X. grandiflorum*, *X. magnisepalum*, *X. minus*, *X. nitens*, *X. pubistylosum*, *X. sessile*, and *X. setosum*. Two varieties have been raised to species, *X. borneense* (Valeton) Axelius and *X. semiorbiculare* (Bakh. f.) Axelius. A key, descriptions, typifications, illustrations and distribution maps are provided for all species. A hypothesis of the phylogenetic relationships is given, in the form of a cladogram, and discussed. An area cladogram for *Xanthophytum* and its biogeographic implications are presented as well as a new extended general area cladogram for the Indo-Pacific.

INTRODUCTION

This study presents a revision of the genus *Xanthophytum* (Rubiaceae), of which all species are trees or small shrublets, sometimes called 'tropical herbs' or monocaul dwarfs (Robbrecht, 1988), i.e. undershrubs with a more or less green, slim, lignified stem with leaves mostly at the upper nodes. *Xanthophytum* often grows on steep slopes along small rivers or paths and appears to reproduce mainly by runners. The flowers are small and mostly white and always very few at a time. The genus seems to be fairly common but overlooked due to their inconspicuous appearance.

The genus was described by Blume on Reinwardt material. First it appeared in a catalogue (Blume, 1823), but merely as a name not accompanied by any description. The proper description came three years later (Blume, 1826-27) on *X. fruticulosum* from Java. It was followed in the end of the nineteenth century by descriptions of one species from Fiji and one from the Philippines. New species were added in the beginning of our century and in the 1920s 14 species were recognized. The latest contribution was two new species described by Bakhuizen van den Brink Jr (1953).

Two small genera, *Paedicalyx* and *Xanthophytopsis* from China and Indo-China, were described by Pitard (1922). The diagnostic characters are weak and the two genera have been reduced to synonyms of *Xanthophytum* (Bakhuizen van den Brink Jr, 1953). The new combinations were made by Lo (1986), who by doing that added three species to *Xanthophytum*.

The genus was originally placed in Hedyotideae, subfamily Rubioideae. In 1952 Bremekamp moved the genus to a new tribe Pomazoteae in a new subfamily Pomazotoideae because of the said absence of raphides. Axelius (1987) found raphides and transferred *Xanthophytum* back to Hedyotideae, subfamily Rubioideae.

The species of *Xanthophytum* have hitherto been very poorly understood and no list or revision has been published. In Sarawak and Kalimantan I have had the opportunity to study and collect 10 species in the field and I discovered 5 of the new species myself. Altogether 30 species are recognized in this treatise, 12 of them described here for the first time, another two raised from varieties. Undoubtedly there are still many undescribed species, especially in Kalimantan, but I have refrained from describing new species on one sheet only, unless the material was very rich. Hopefully it will be possible to recognize some more species before their extinction but the present deforestation of Borneo gives little hope for the future. The big fire in Kalimantan in 1982/83 was a spectacular proof that the rain forests on Borneo are more or less doomed. The blaim was, as allways, put on the traditional slash-and-burn cultivation but it is clear that the colonialistic opening of the Bornean rain forests to economic ventures is the underlying inevitable cause.

MATERIAL AND METHODS

This revision is based on field studies and on material from the following herbaria: A, B, BM, BO, C, CANB, CAS, DS, FI (photographs only), G, GH, GOET, HBG, K, L, LAE, P, PE, PNH, PR, S, SING, SYS (photographs only), U, and UC. I have also personally visited the following herbaria: BM, BO, K, L, S, SAR and SING. I have seen all types and examined all collections cited. All lectotypes, except that of *X. calycinum*, are chosen by me.

The descriptions are based on the variation range observed and thus sometimes probably more or less incomplete due to lack of material. In species with few collections they must therefore be regarded as preliminary. The drawings are made by myself. The floral parts are drawn from boiled material. Seeds were boiled, critical-point dried and platina-coated before investigation by SEM.

To be able to present a hypothesis on the phylogeny of the genus I performed a cladistic analysis. An interpretation of the characters was made by outgroup comparison and the data matrix was run in 'HENNIG86' (Farris, 1988). Options used were ccode-., mhennig*, and bb*. All characters were treated as having the same weight and the ccode-. command treats them as nonadditive, i.e. any two distinct states are separated by a single step; mhennig* constructs several trees, each by a single pass. The shortest trees are saved and branch-swapping is applied to each of them. One tree is then saved for each of the initial ones.

COMMENTS ON MORPHOLOGY

Raphides — As mentioned in my work on *Lerchea* (Axelius, 1987) I have found raphides in *Xanthophytum*. Even if they are fewer than in *Lerchea*, they are found at least in fruit and hypanthium tissue. In some species there are cells with a reddish

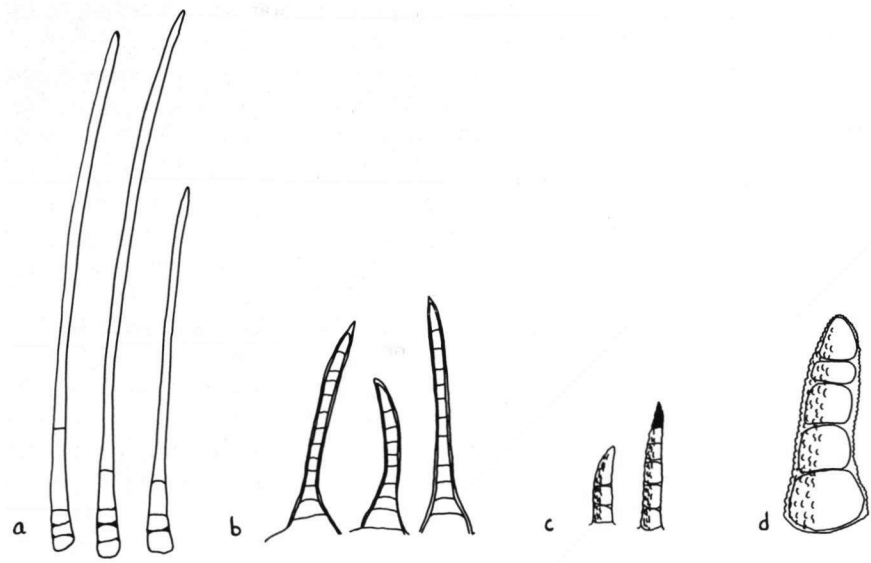


Fig. 1. Types of hairs in *Xanthophytum* described in the text. a. Ordinary ferrugineous hairs, × 100; b. setose hairs, × 100; c. short stiff hairs, × 200; d. stout sturdy hairs, × 200.

content (probably tannins). They are especially abundant in *X. borneense*, where the red cells are easily observed in the tissue of the calyx lobes.

Hairs — The synapomorphy for *Xanthophytum* is the ferrugineous indumentum. This may vary a lot, both in colour and density. The extremes are on one side *X. ferrugineum* and *X. borneense* which are hairy all over with a dark copper coloured indumentum, and on the other *X. foliaceum* and *X. involucratum* with only the youngest pair of leaves covered with a sparse light golden indumentum.

The hairs of *Xanthophytum* are mainly of two kinds. Those on the vegetative parts and on the outside of the calyx and corolla are septate hairs, i.e. hairs made up of distinct cells (Verdcourt, 1958). The hairs from the inside of the corolla are instead thin-walled, striate, and one-celled. The septate hairs are all cylindrical (Robbrecht, 1988) and may in their turn be separated into four different types even if intermediates occur.

The first type is the ordinary more or less copper-coloured, c. 1.5 mm long, slim, soft hairs with a living basal cell but with the upper part of the hair more or less unseptate and filled with the reddish substance that gives *Xanthophytum* its special ferrugineous look. The walls are smooth (fig 1a). This hair-type occurs on all vegetative parts and also on the outside of the hypanthium, calyx and corolla.

The second type is the stiff ferrugineous hairs, in this treatise called setose hairs. They are c. 0.5 mm long, broader than the first type, and with a swollen, big, basal cell protruding from the leaf surface. Here too the upper part of the hairs is filled with the reddish substance and only the lower cells seem alive. The whole hair is

septate. The walls are thick and smooth (fig 1b). This hair type occurs only on the vegetative parts, making the leaves look dotted and the peduncles shaggy.

The third type of hairs mainly occurs on the outside of the hypanthium, calyx, and corolla. They are also stiff but small, c. 0.15 mm long. The whole hair is septate and most cells are alive. The hairs are mainly white but the top may be more or less brown. The walls are slightly tuberculate and striate (fig 1c).

The fourth type of hairs is restricted to the Indo-Chinese species. These hairs are found on the outside of the corolla lobes and are broad, sturdy, fully septate hairs, c. 0.3 mm long and c. 0.1 mm wide. All cells are alive, the hairs are colourless, and the walls are tuberculate (fig 1d).

Colleters — i.e. pluricellular mucilage-secreting structures, are found on the inside of the stipules and at the base of the calyx lobes.

Leaves — The leaves in *Xanthophytum* are opposite, though in one species they are pseudo-alternate. The outline is lanceolate to oblong, ovate or obovate, the size variable. The veins are numerous and closely placed, distinct on the upper side, prominent on the lower. The lower side of the blade is often considerably paler than the upper. Form, size, hairiness, and colour vary considerably. Some species with thin, rather small, and narrow leaves get a very special light greyish-green colour when dry, as, for example, *X. balansa* and *X. nitens*. Others have leaves that are longer and broader, for example, *X. foliaceum* and *X. grandifolium*. Leaf characters have not been used in recognition of the species or in the key, but the first greyish green type was used in the cladistic analysis.

Stipules — Stipules in *Xanthophytum* are interpetiolar and show a wide range of variation. The most common type varies from very small and narrow up to rather broad and large, sometimes with a split top. They are always hairy at least on the margin. The other type includes large, foliaceous stipules. They are broad and often blunt and more loosely attached to the node. They wilt, get brown, and drop easily.

Some species in the New Guinea group show a unique character in having stipules with an extremely long caudate apex.

Inflorescence — The inflorescences in *Xanthophytum* are axillary. They consist of cymes or fascicles in peduncled more or less branched panicles, or of peduncled to sessile head-like flower-clusters, here called heads, or, very rarely, of a few sessile flowers.

As in *Lerchea* the inflorescence seems to be a very changeable character. Prolongation or reduction of the main axis and the side branches are common. In some species the inflorescence is intermediate between a panicle and a head, in others between a sessile and a peduncled head. In the New Guinea group of taxa flowering often starts before the inflorescence has reached its mature state. The inflorescence may be a head at anthesis but later both the main axis and the side-branches prolong so that the inflorescence becomes a panicle in fruit. The peduncle too may grow after anthesis. The cladistic analysis shows that both prolongation of the inflorescence and reduction to a head must have occurred several times in the evolution of the genus.

Though the inflorescences in *Xanthophytum* may be both numerous and ample, only one or two flowers mature at the same time. Thus the flowering material is always limited.

Flower — The flower of *Xanthophytum* is in most species heterostylous, as in related genera. Either the style or the stamens protrude beyond the opening of the corolla tube. In some species studied in the field I also observed that the flower looked slightly zygomorphic because the stamens protruded together from the lower side of the corolla.

Calyx lobes — The calyx lobes are mostly very small and triangular. If they are prolonged, the length varies both within species and within specimens. Some species have lobes that are more separated from each other at base, being narrower at the base than higher up. Their shape could be anything from lanceolate to spatulate. In this group we find the former *Xanthophytopsis* and *Paedicalyx* but also several other species. Here too the form and size vary, both within species and individuals. This type of calyx lobes is broader, larger, and thinner. The veins are often easily observed on the lobes, in sharp contrast to the often very thick lobes of the other species.

Corolla — The colour of the corolla has always been reported as white. However, in two of the species that I had the opportunity to study in the field it was purple. It also seemed to change from white buds over purple flowers to brown very quickly. The colour has not been used as a diagnostic character, since it is unknown for most species.

The inside of the corolla tube has a hair-ring consisting of thin-walled, not truly septate hairs. The hair-ring is either narrow, that is a little bit broader than the length of an anther, or broad, that is covering half or more of the corolla tube.

The placement of stamens and stigma also varies. The majority of the heterostylous species have a narrow hair-ring and the anthers and the stigma are placed at the ring and clearly above the ring, respectively (e.g. *X. longipedunculatum* fig.15 or *X. capitatum* fig. 17). The heterostylous species with a broad hair-ring vary more. The stigma is situated either clearly above the ring or at the lower part of the ring. The anthers may in brevistylous flowers be either above, just at, or under the upper margin of the hair-ring. In longistylous flowers the anthers are situated anywhere at the ring (e.g. *X. foliaceum* fig. 8; *X. semiorbiculare* fig. 7; *X. cylindricum* fig. 10). In the homostylous species with a narrow hair-ring the anthers are placed at the ring with the stigma just above (e.g. *X. fruticulosum* fig. 22; *X. ferrugineum* fig. 23). Lastly, the homostylous species with a broad hair-ring have the anthers placed at the margin of the ring with the stigma placed clearly above the ring and anthers (e.g. *X. papuanum* fig. 35).

Stamens — The type of attachment of the filament to the corolla is a character hard to interpret. Most of the species have free filaments or filaments that are fused with the corolla only at the base. Species in the New Guinea group always have filaments that are fused with the corolla for nearly all their length. The rest of the species are more diverse. The filaments are fused from one third to two thirds of their length. The degree of attachment also varies. In some species the attached part of the filament is completely fused with the corolla tissue, in others it is easily separated. Also, on old specimens the filaments may look fused while on fresh material they are free. Perhaps extra thin filaments and very firm pressing could be an explanation.

Fruits — The fruits are bilocular. Generally, each loculus has a very hard endocarp thus making the fruit indehiscent. In some species, however, the endocarp is thin and the fruits open by splitting, first separating the two fruit-halves and then opening each loculus.

Seeds — As in *Lerchea*, the seeds are numerous in each loculus and very small, c. 0.2 mm, so-called dust seeds. The testa cells are minute, c. 40 µm in diameter, and have the form of irregular penta- or hexagons. The outer wall is thin while the inner walls are thick and tuberculate, exactly as in *Lerchea*.

XANTHOPHYTUM

Xanthophytum Blume, Bijdr. Fl. Ned. Ind. (1825/27) 989. —Type species: *X. fruticulosum* Blume.
Paedicalyx Pierre ex Pitard, in Lecomte, Fl. Gén. Indo-Chine 3 (1922) 88. — Type species: *P. attopevensis* Pierre ex Pitard.
Xanthophytopsis Pitard, in Lecomte, Fl. Gén. Indo-Chine 3 (1922) 90. — Type species: *X. balansae* Pitard.

Trees, treelets or monocaul dwarfs, i.e. one-stemmed more or less herb-like shrublets, not or few-branched. At least upper part of stem, branches or branchlets, and youngest pair of leaves with a golden to ferrugineous indumentum. Raphides present. *Leaves* often only at upper nodes, opposite or pseudo-alternate (*X. capitellatum*), petiolate, entire, herbaceous, lanceolate to oblong, ovate or obovate, cuneate to attenuate at base, acute to acuminate or caudate at apex, glabrous or often hairy above, hairy at least on the veins below; midrib and lateral veins distinct above, prominent below; stipules interpetiolar, triangular to lanceolate to ovate, sometimes more or less foliaceous, entire, seldom bifid, often with colleters adaxialy at base. *Inflorescences* axillary, consisting of small cymes or fascicles, either in more or less branched panicles on short to very long peduncles, sometimes reduced and head-like, or peduncled to sessile heads, sometimes reduced to only a few sessile flowers; bracts minute to foliaceous. *Flowers* pentamerous, hermaphrodite, protandrous, heterostylous or homostylous. *Calyx* pubescent (glabrous in *X. glabrum*), with or without a tube; lobes triangular, rounded, band-shaped or spatulate, very short, up to 6 mm, often persistent in fruit; colleters often present at the base of the lobes. *Corolla* white or purple, tubiform to infundibuliform; aestivation valvate; outside glabrous or pubescent; inside with a ring of hairs at the upper part of the tube; lobes acute to rounded, more or less recurved at anthesis. *Stamens* alternate with the corolla lobes, exserted or not; filaments glabrous or hairy, either free from the corolla or adnate for c. $^1/_3$ to up to the main part of their length; anthers situated above or at the ring of hairs, elliptic to narrowly elliptic, introrse, opening by slits; connective sometimes continuing above the pollen sacs. *Ovary* bilocular; ovules numerous on a peltate placenta inserted at the middle of the septum. Disc fleshy at anthesis, glabrous, persistent. Style filiform, glabrous or hairy, exserted or not; stigma clavate to slightly bifid, papillose. *Fruit* bilocular, either a subglobose indehiscent two-roomed nut with hard endocarps or a more or less ovoid capsule splitting first into the two fruit-halves, then opening each loculus. *Seeds* brown, numerous, angular, minute, c. 0.2 mm; testa cells 40 µm.

KEY TO THE SPECIES

1a. Leaves pseudo-alternate (Malaya) ..... **30. X. capitellatum**
b. Leaves opposite 2
2a. Leaves with setose hairs (fig 1a) 3
b. Leaves without setose hairs 4
3a. Inflorescence a peduncled head ..... **13. X. capitatum**
b. Inflorescence a panicle ..... **14. X. setosum**
4a. Inflorescence a peduncled to sessile head, or consisting of a few sessile flowers 5
b. Inflorescence a panicle 18
5a. Flowers > 4.5 mm high 6
b. Flowers < 3.5 mm high 11
6a. Corolla-lobes long, > 2 mm. Flowers homostylous. Fruits > 3.4 mm, dehiscent 7
b. Corolla-lobes short, < 2 mm. Flowers heterostylous. Fruits < 3.4 mm, dehiscent or indehiscent 9
7a. Calyx-lobes rounded, large, c. 3 mm broad ..... **29. X. magnisepalum**
b. Calyx-lobes lanceolate, narrower 8
8a. Peduncle > 5 cm long ..... **28. X. grandiflorum**
b. Peduncle very short or none ..... **27. X. papuanum**
9a. Heads peduncled or subsessile, surrounded by involucral bracts. Slim treelet **6. X. foliaceum**
b. Heads sessile, without involucral bracts but behind large stipules 10
10a. Large many-flowered heads. Stipules rounded to reniform. Connective continuing as a knob above the pollen sacs ..... **5. X. semiorbiculare**
b. Smaller medium sized heads. Stipules ovate to spatulate. No knob above the pollen sacs ..... **4. X. glomeratum**
11a. Heads peduncled 12
b. Heads sessile or subsessile 15
12a. Heads surrounded by large involucral bracts ..... **1. X. involucratum**
b. Heads not surrounded by large involucral bracts 13
13a. Flowers heterostylous 14
b. Flowers homostylous ..... **18. X. ferrugineum**
14a. Calyx-lobes > 1.5 mm long, spatulate (Indo-China) .. **22. X. attopevense**
b. Calyx-lobes c. 1 mm long, triangular ..... **15. X. olivaceum**
15a. Heads large. Fruits dehiscent (China) ..... **21. X. kwangtungense**
b. Heads small or few sessile flowers. Fruits indehiscent 16
16a. Heads distinct, subsessile. Flowers homostylous .... **18. X. ferrugineum**
b. Heads sessile, or a couple of sessile flowers at lower nodes. Flowers heterostylous 17

17a. Flowers in sessile heads. Calyx-lobes inside glabrous or with a few hairs **2. X. sessile**
b. Flowers few at lower part of stem. Calyx-lobes inside pubescent **3. X. minus**
18a. Fruits dehiscent 19
b. Fruits indehiscent 22
19a. Fruits big, ovate. Height of endocarp > 3 mm 20
b. Fruits small, rounded. Height of endocarp < 3 mm 21
20a. Flowers > 4.5 mm high 7
b. Flowers < 4.5 mm high . . . . . **26. X. nitens**
21a. Peduncle < 4 cm, calyx-lobes band-shaped, c. 2.5 mm (Fiji) **25. X. calycinum**
b. Peduncle > 4 cm, calyx-lobes rounded, c. 2 mm (China) . . **24. X. balansae**
22a. Calyx with short stiff hairs (fig 1c) 23
b. Calyx with other types of hairs or glabrous 26
23a. Flowers > 4.5 mm high. Inflorescence with conspicuous bracts **7. X. grandifolium**
b. Flowers < 4 mm high. Inflorescence with inconspicuous bracts 24
24a. Inflorescence tail-like. Style more or less hairy 25
b. Inflorescence not tail-like. Style glabrous . . . . . **10. X. brookei**
25a. Inflorescence condensed, spike-like. Filaments sparsely hairy **8. X. cylindricum**
b. Inflorescence long, lax. Filaments glabrous . . . . . **9. X. alopecurum**
26a. Flowers with a broad hair-ring. Corolla with multicellular hairs (fig 1d) (Indo-China) . . . . . **23. X. polyanthum**
b. Flowers with a narrow hair-ring. Corolla without multicellular hairs 27
27a. Peduncle long, > 4 cm, often up to 15 cm 28
b. Peduncle short, < 4 cm 30
28a. Calyx and corolla very hairy . . . . . **16. X. borneense**
b. Calyx and corolla very slightly hairy or glabrous 29
29a. Calyx-tube present. Calyx-lobes inconspicuous. Calyx very slightly hairy **12. X. longipedunculatum**
b. Calyx-tube hardly or not present. Calyx-lobes present. Calyx completely glabrous . . . . . **11. X. glabrum**
30a. Calyx and corolla very hairy 31
b. Calyx and corolla slightly hairy 33
31a. Flowers homostylous 32
b. Flowers heterostylous . . . . . **15. X. olivaceum**
32a. Inflorescence a small, lax panicle . . . . . **17. X. fruticulosum**
b. Inflorescence condensed, head-like . . . . . **18. X. ferrugineum**
33a. Style hairy . . . . . **19. X. pubistylosum**
b. Style glabrous . . . . . **20. X. johannis-winkleri**

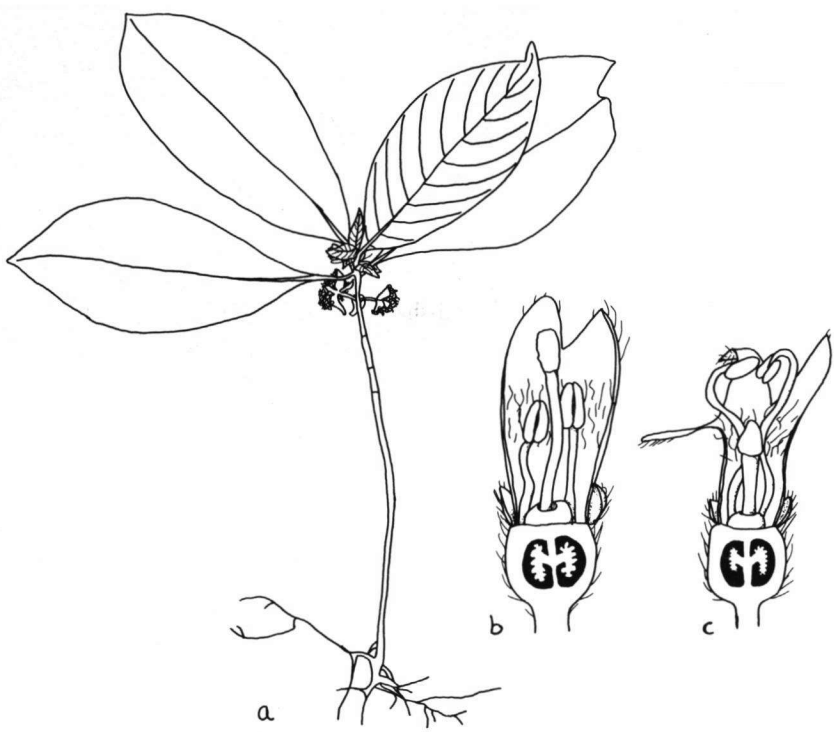


Fig. 2. *Xanthophytum involucratum* Merrill. a. Habit, × 0.35; b. macrostylous flower, × 9; c. microstylous flower, × 9 (a–c *Axelius 160*).

1. Xanthophytum involucratum Merrill – Figs. 2, 5a.

Xanthophytum involucratum Merrill, Philipp. Journ. Scienc. Bot. 13 (1918) 121. — T y p e: *Native coll., Bur. Science 2591*, Feb.–June 1914, Mt Merinjak, Sadong, Sarawak (K, lecto).
N o t e. The type should be in Manila, but seems to be lost. The sheet at Kew has no specified locality on the label. The locality above is cited from the description.

Monocaul dwarf, erect, c. 30 cm tall. Young shoots and leaves with pale indumentum. *Leaves* at the upper nodes; *blade* thick, oblong to obovate, 8–19 by 3–6 cm, cuneate to attenuate at base narrowing into an up to 4.5 cm long (but often much shorter) petiole, acute to caudate at apex, upper side shiny with only scattered hairs, lower side distinctly paler and sparsely pubescent with short hairs; lateral veins 8–14 pairs; stipules large, broad, ovate, up to 2 by 1 cm, soon becoming brown, later deciduous; colleters abundant. *Inflorescence* dense, head-like, in fruit up to 1.5 cm in diam.; bracts surrounding the head ovate, c. 1.5 cm long, slightly recurved, the outermost brown; peduncle 0.5–2.2 cm long. *Calyx* pubescent with long hairs outside; tube short; lobes c. 0.3 mm; colleters large, alternate with the calyx lobes. *Corolla* white with long hairs on the outside of the lobes, cyathiform to tubiform, later with recurved lobes; tube c. 2 mm, inside with a narrow ring of hairs at the

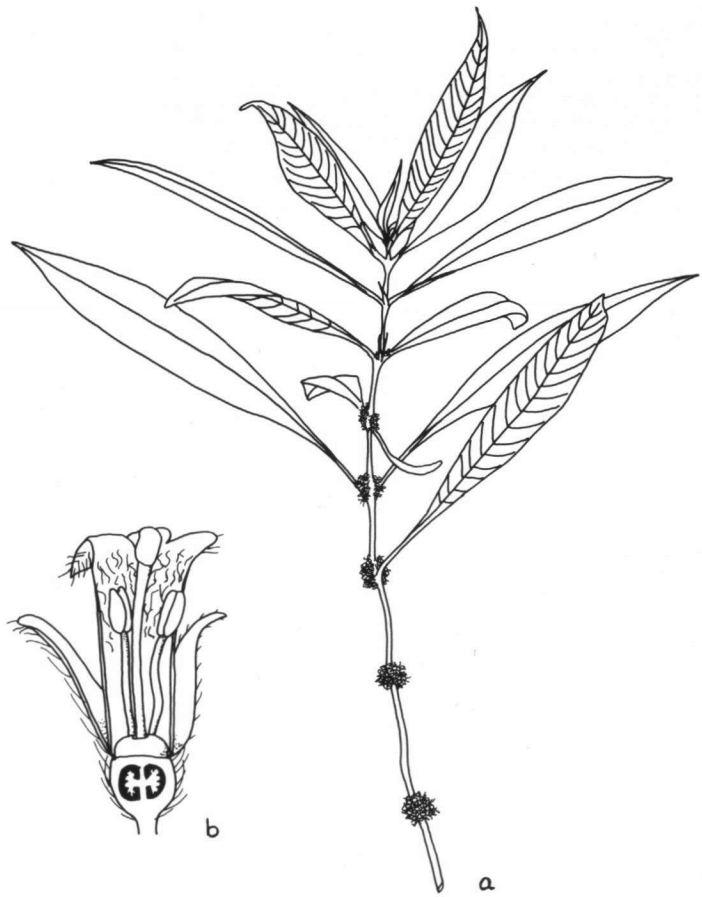


Fig. 3. *Xanthophytum sessile* Axelius. a. Habit, × 0.35; b. flower, × 9 (a, b *Axelius 147*).

throat; lobes c. 1.2 mm. *Stamens* of different lengths, either c. 2 mm or c. 3.4 mm, glabrous; anthers c. 0.6 mm. Style either c. 1.4 mm or c. 3 mm, glabrous. *Fruit* indehiscent, c. 2 mm.

Note. This species is easy to recognize. The leaves are shining and thicker than ordinary *Xanthophytum* leaves. The hairiness is very weak. The stipules soon become brown and drop. The heads are surrounded by large involucral bracts.

Collections. Sarawak: Kpg Kuap (Quop) 5 miles N of Mile 10 Kuching-Serian road, *Brooke 9989* (BM, L); *Axelius 160* (K, L, S); Genjing, Serian, *Brooke 9577* (K, L); Mt Merinjak, Sadong, *Native collector BS 2591* (K). — Kalimantan: Landak, *Teijsmann 19303* (L).

2. Xanthophytum sessile Axelius, *spec. nov.* – Figs. 3, 5b.

Suffrutex erectus saepe tenuissimus, ad 1,5 m altus. Surculi juvenes indumento nitenti et subroseo vestiti. Folia anguste lanceolata vel oblanceolata, lamina 5–9 × 1,5–4,3 cm, basi cuneata

vel attenuata, in petiolum usque 2,5 cm longum angustata, apice acuta/caudata, supra parum pubescentia, subtus distincte pallentior et pubescentior; nervis primariis 12–17 paribus; stipulae lanceolatae, marginibus leviter pubescentes, c. 1 × 0,3 cm, in statu juniore circum caulem curvatae, saepe apice caudata; colleteres praesentes. Inflorescentia capitata, sessilis, condensata, usque 1 cm diametro, e axillis foliorum vel nodis nudis. Calyx extra pubescens; tubus brevis, usque 1 mm longus; lobi lanceolati c. 2 mm longi, post anthesin ad instar stellae effusi, postea denuo simul plicati, curvi vel recti; colleteres quinque, cum lobis alternantes. Corolla alba, tubiformis vel infundibuliformis; tubus c. 3 mm longus, intra parte superiore annulo pilorum ornatus; lobi c. 0.8 mm, postea recurvati, extra pilis rectis et rubris. Stamina c. 2,2 mm; antherae c. 0,8 mm. Stylus 3–4 mm; discus carnosus. Fructus indehiscens, c. 2 mm. — T y p u s: *Haviland 681*, Matang, Sarawak (K, holo).

Monocaul dwarf, slender, erect, up to 1.5 m tall. Young shoots with a shiny pinkish indumentum. *Blade* narrowly lanceolate to oblanceolate, 5–9 by 1.5–4.3 cm, cuneate to attenuate at base, narrowing into an up to 2.5 cm long petiole, acute-caudate at apex, upper side sparsely pubescent, lower side distinctly paler and with more hairs; lateral veins 12–17 pairs; stipules lanceolate, slightly hairy on the margins, c. 1 by 0.3 cm, at upper nodes curved around the stem, often with a caudate apex; colleters present. *Inflorescence* sessile, of condensed heads, up to 1 cm in diam., in the leaf-axils or at leafless nodes. *Calyx* pubescent outside; tube short, up to 1 mm; lobes lanceolate, c. 2 mm, after anthesis spreading, star-like, then again folded together, curved inward or straight; colleters five, alternate with the lobes. *Corolla* white, tubiform to infundibuliform; tube c. 3 mm, inside with a broad ring of hairs in the upper part; lobes c. 0.8 mm, later recurved, with straight red hairs outside. *Stamens* c. 2.2 mm, glabrous; anthers c. 0.8 mm. Style 3-4 mm, glabrous; disc fleshy. *Fruit* indehiscent, c. 2 mm.

N o t e s. This species was recognized and named 'sessile' on herbarium specimens already by Ridley and afterwards by Bakhuizen van den Brink Jr.

The morphology of the flower is a bit unclear. The species seems to be homostylous but with a unique type of style which grows during anthesis. The elongation moves the stigma from its position just above the anthers, as in *X. fruticulosum* and *X. ferrugineum*, to a position outside the corolla tube, thus making the flower resembling a longistyled heterostylous one.

C o l l e c t i o n s. Sarawak: Mt Matang, *Axelius 147* (L, S); *Beccari 1425* (FI, K), *1669* (FI, K); *Clemens 22299* (BM, K); *Haviland 681* (K); *Native coll. 5183* (UC); *Ridley 11846* (K), *12306* (K); Mt Wa, *Beccari 2810* (FI).

3. Xanthophytum minus Axelius, *spec. nov.* – Figs. 4, 5b.

Suffrutex parvus, usque 22 cm altus. Omnes partes juvenes vegetativae indumento brunello vestitae. Folia parium juniorum subter pilis argenteis-subroseis et nitentibus tecta. (Color in statu sicco evanescens.) Lamina lanceolata vel anguste oblonga vel elliptica, 7–13 × 2,5–4,5 cm, basi cuneata vel attenuata et in petiolum usque 2.5 cm longum angustata, apice acuta, pagina inferiore brunniore; nervis primariis 7–14 paribus; stipulae angustae, caudatae usque 1,6 cm longae. Inflorescentia ex floribus paucis sessilibus ad nodos inferiores constans. Calyx utrinque pubescens; tubus brevissimus vel nullus; lobi lanceolati vel taeniati apice acuta, parum inaequales, 1,2–1,8 mm longi; colleteres non vidi. Corolla mox brunnea pallida, tubiformis vel infundibuliformis lobis recurvatis; tubus c. 3 mm, extra glaber, intra parte superiore taenia pilorum ornatus; lobi c. 1,2 mm,

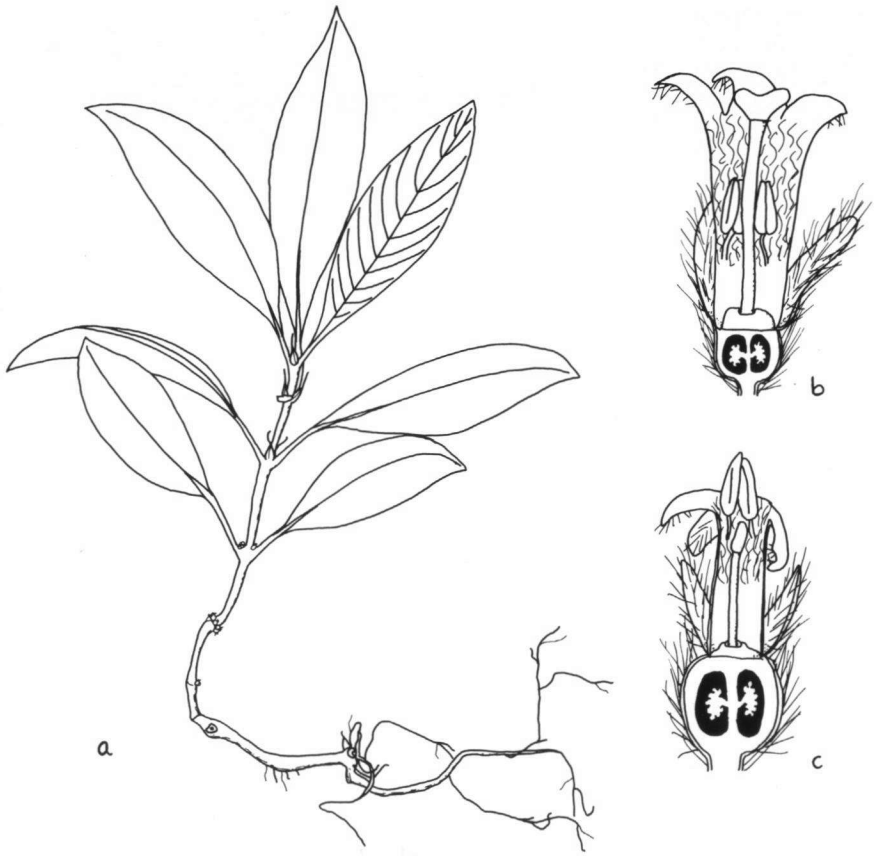


Fig. 4. *Xanthophytum minus* Axelius. a. Habit, × 0.35; b. macrostylous flower, × 9; c. microstylous flower, × 9 (a, c *Axelius 121*; b *Axelius 131*).

extra pubescentes. Stamina c. 2 vel 3,5 mm, ad corollam adnata paene cum totis longitudinibus; antherae c. 0,9 mm. Stylus c. 2 vel 3,5 mm. Fructus indehiscens c. 2 mm. — T y p u s: *Axelius 121*, 20 Oct. 1982, by the path between Entalau and Tisak, near Bkt Sadok, Sarawak (S, holo; L, S, iso).

Small shrublet, maximum height observed 22 cm. All younger vegetative parts with a brownish indumentum, dense and tomentose on young stem, petioles and veins. *Leaves* of the youngest pair covered with silvery-pinkish shining hairs below (colour more or less lost when dry). *Blade* lanceolate to narrowly oblong or elliptic, 7–13 by 2.5–4.5 cm, cuneate to attenuate at base, narrowing into an up to 2.5 cm long petiole, acute at apex, lower side browner; lateral veins 7–14 pairs; stipules narrow, tail-like, up to 1.6 cm long. *Inflorescence* consisting of a few sessile flowers at the lower nodes. *Calyx* pubescent both inside and outside; tube very short or none; lobes lanceolate to band-shaped with acute apex, slightly unequal, 1.2–1.8 mm long;

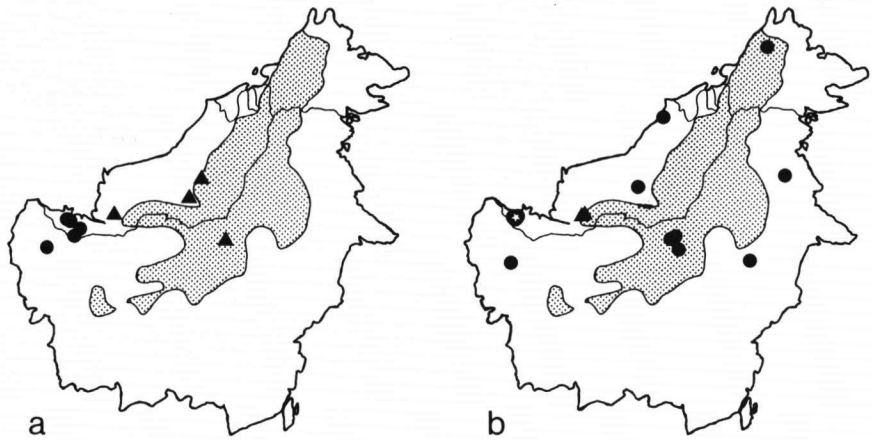


Fig. 5a. Known distribution of *Xanthophytum involucratum* Merrill (●) and *X. glomeratum* Bakh. f. (▲). — Fig. 5b. Known distribution of *X. sessile* Axelius (✪), *X. minus* Axelius (▲), and *X. semiorbiculare* (Bakh. f.) Axelius (●).

colleters not seen. *Corolla* soon turning light brown, tubiform to infundibuliform with recurved lobes; tube c. 3 mm, glabrous outside, inside with a broad belt of hairs in the upper part; lobes c. 1.2 mm, hairy outside. *Stamens* either c. 2 or c. 3.5 mm, adnate to the corolla for nearly all their length, glabrous; anthers c. 0.9 mm. Style either c. 2 or c. 3.5 mm, glabrous. *Fruit* indehiscent, c. 2 mm.

N o t e. This species is based on two collections made quite near each other and that are very much alike. It resembles *X. glomeratum* in leaves and habit, but differs in having narrow stipules, no calyx tube, and flowers at the lower nodes. The flower arrangement could be a result of chopping the stem, however, since the specimens found grew in a rubber plantation.

C o l l e c t i o n s. Sarawak: Mt Sadok, *Axelius 121* (L, S); Sg Antu near Entalau, Sg Skrang, *Axelius 131* (S).

4. Xanthophytum glomeratum Bakh.f. – Figs. 5a, 6.

Xanthophytum glomeratum Bakh.f., Blumea 7 (1953) 335. — T y p e: *Clemens 21721*, 1929, Gat, Upper Rejang River, Sarawak (K, holo).

Monocaul dwarf. Younger parts with a dense, copper-coloured, somewhat shining indumentum. *Blade* lanceolate to narrowly obovate or oblong, 6–16 by 1.5–3.5 cm, cuneate to attenuate at base, narrowing into an up to 2.5 cm long petiole, cuneate to acuminate at apex; lateral veins 9–15 pairs; stipules large, obovate to spatulate, often reflexed, c. 1.3 by 0.8 cm; colleters present. *Inflorescence* of sessile heads; bracts small. *Calyx* pubescent outside; tube glabrous inside, c. 0.7 mm long; lobes band-shaped to lanceolate, hairy inside, c. 3 mm long; colleters, if any, small and inconspicuous. *Corolla* tubiform; tube c. 3.8 mm, inside with a broad ring of hairs;

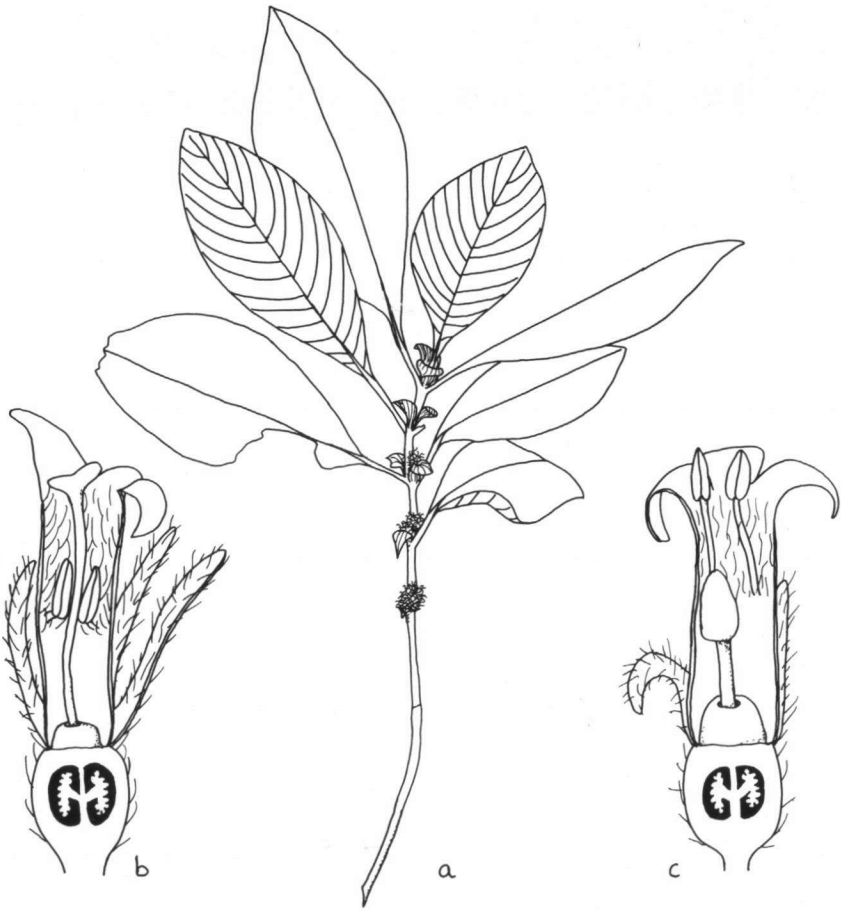


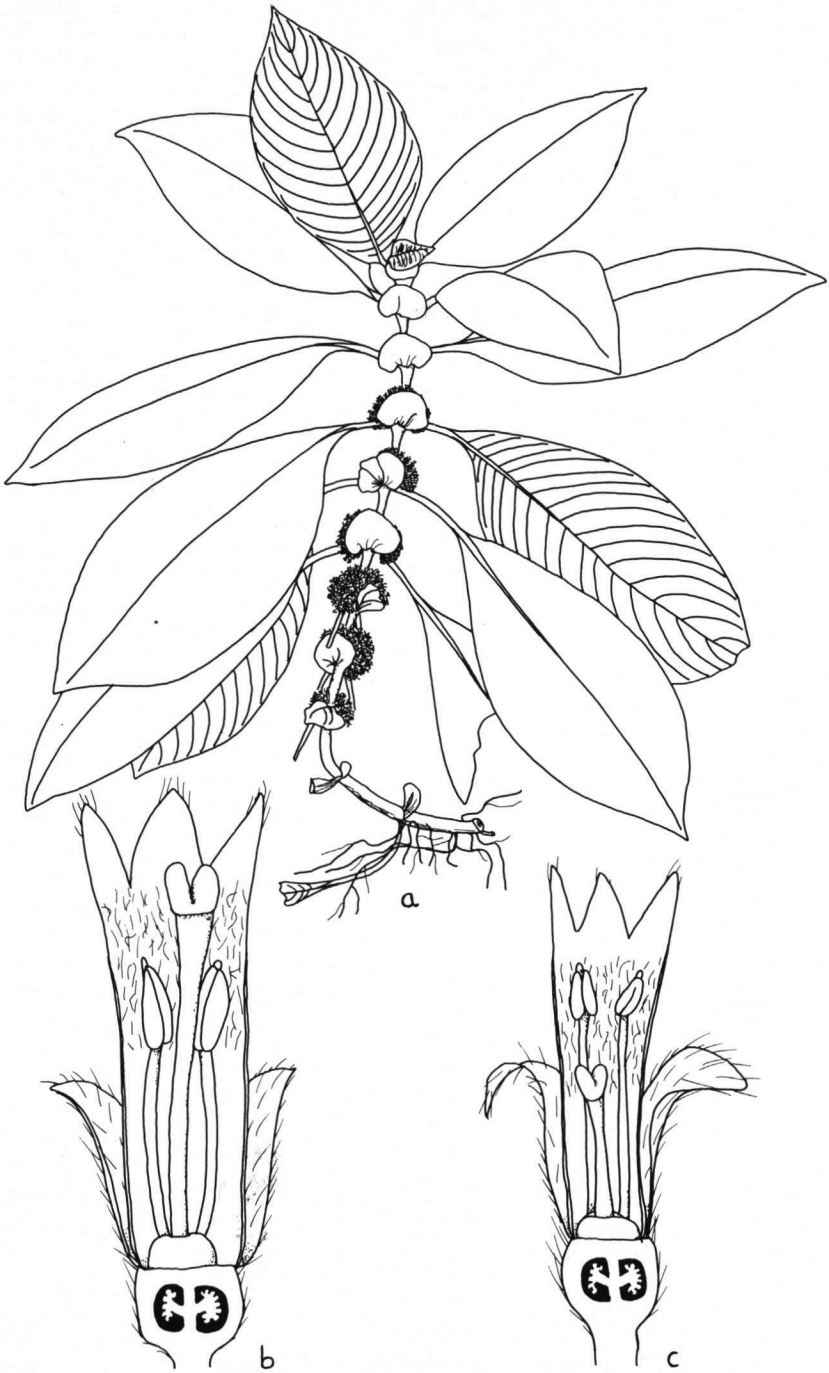
Fig. 6. *Xanthophytum glomeratum* Bakh. f. a. Habit, × 0.35; b. macrostylous flower, × 9; c. microstylous flower, × 9 (a *Clemens 21721*; b *Beccari 3797*; c *Jaheri 1177*).

lobes c. 1.5 mm, with a few hairs outside. *Stamens* apparently adnate to the corolla for most of their length, either c. 2.5 or c. 4.4 mm, glabrous; anthers c. 0.9 mm. Style either c. 2.4 mm or c. 3.7 mm, glabrous. *Fruit* indehiscent, c. 2.5 mm.

N o t e. This species is distinguished by its large reflexed stipules, its long calyx tube and its long band-shaped calyx lobes which are hairy inside.

C o l l e c t i o n s. Sarawak: Betong, *Brooke 8275* (BM, L); Gat, *Clemens 21721* (K); Belaga, *Beccari 3797* (FI, L). — Kalimantan, E: Sg Bloe-oe, *Jaheri 427* (L).

Fig. 7. *Xanthophytum semiorbiculare* (Bakh. f.) Axelius. a. Habit, × 0.35; b. macrostylous flower, × 9; c. microstylous flower, × 9 (a–c *Axelius 197*).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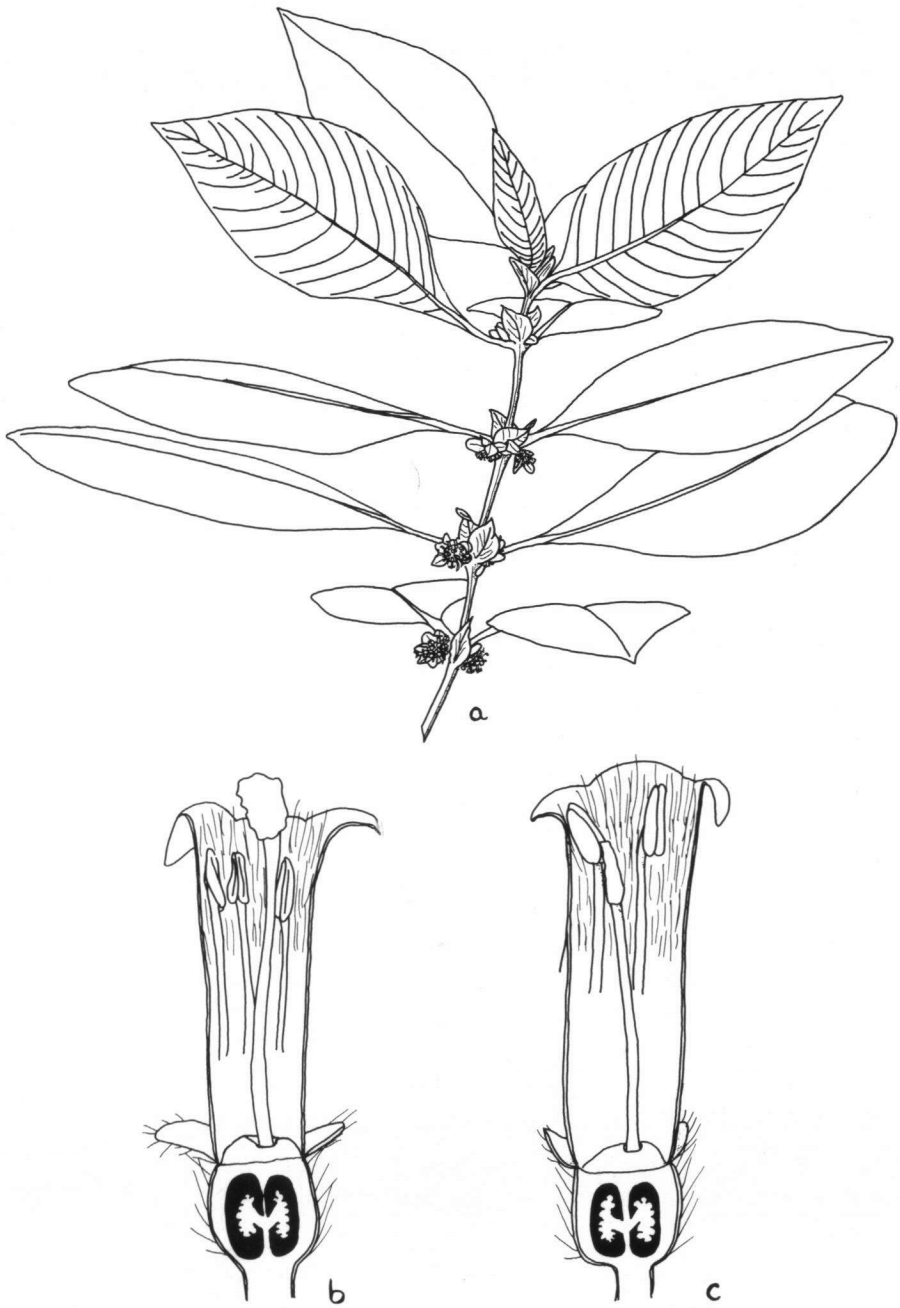

Fig. 8. *Xanthophytum foliaceum* Axelius. a. Habit, × 0.25; b. macrostylous flower, × 9; c. microstylous flower, × 9 (a–c *Axelius 322*).

5. Xanthophytum semiorbiculare (Bakh.f.) Axelius, *stat. nov.* – Figs. 5b, 7.

Xanthophytum glomeratum Bakh.f. var. *semiorbiculare* Bakh. f., Blumea 7 (1953) 335. — T y p e: *Jaheri 375*, Sg Bloe-oe, E Kalimantan, Borneo (BO, holo).

Monocaul dwarf but with leaves on all nodes, maximum height observed c. 35 cm. All vegetative parts with appressed brown indumentum. Young shoots and leaves with a denser more shining indumentum. Stems woody for the most part. *Leaves* abundant; *blade* elliptic to oblong, 8–20 by 4–9.5 cm, cuneate to attenuate at base, narrowing into an up to 5.5 cm long petiole, acute to caudate at apex, lower side somewhat paler; lateral veins 12–21 pairs; stipules large, semiorbicular or reniform to broadly ovate, 1.3 by 2 cm, partly covering the inflorescence. *Inflorescence* large, dense, sessile heads in pairs in the leaf axils, together 2–3 cm broad. *Calyx* green to dark purple, pubescent both inside and outside, but very variable; tube up to 1.3 mm; lobes slightly unequal, band-shaped to narrowly spatulate with acute apex, 1.5–4.5 by 1 mm; colleters five, very thin, alternate with the calyx lobes, sometimes situated a bit down the tube. *Corolla* purple outside, becoming white inside, tubiform to infundibuliform; tube c. 4.5 mm, outside glabrous, inside with a broad belt of hairs in the upper half; lobes c. 1 mm, thickened and outside with hairs on the nerve. *Stamens* either c. 3.8 or c. 4.7 mm, adnate to the corolla or not, glabrous; anthers c. 1.3 mm; connective continuing in a knob above the pollen sacs. Style either c. 2.7 or c. 5 mm, glabrous; stigma deeply two-lobed. *Fruit* more or less obovate in outline, c. 2 mm, with endocarp thinner than in ordinary fruits, sometimes dehiscent.

N o t e. The stamens are said to be adnate halfway (Bakhuizen van den Brink Jr, 1953) and this is the case in the Jaheri collections. In my own collections, and also in some others, all stamens are completely free. The hairiness also varies a lot, as does the length of the calyx tube. However, the habit, the inflorescences, the large, nearly reniform stipules, and the characteristic connective apex keep the specimens of this variable species together

C o l l e c t i o n s. Sarawak: Nanga Mujong, *Brooke 9294* (L); Ulu Luak, Miri, *Haron 21327* (K, L). — Kalimantan, W: Landak, *Teijsmann 11224* (BO, K, L); Mt Kasian, *Jaheri 1046* (BO); Sg Pary, *Jaheri 1134* (BO); Sg Bloe-oe, *Jaheri 378* (BO). — Kalimantan, E: Jelini, Sg Beleyan, Tabang, *Murata et al. 1269* (L); Banyangkara, Sg Bahau, *Axelius 197* (K, L, S). — Sabah: Dallas, *Clemens s.n.* (BM).

6. Xanthophytum foliaceum Axelius, *spec. nov.* – Figs. 8, 11a.

Frutex gracilis vel arbor parva c. 2 m alta. Partes vegetativae glabra vel indumento minuto. Surculi juvenes foliacum tantum indumento leviter densiore vestiti, statu sicco nitenti. Lamina late oblonga vel ovata, magna, 17–22 × 6–9 cm, basi cuneata vel acuminata in petiolum usque 3 cm longum angustata, apice acuta vel acuminata, subtus pallentior; nervis primariis 13–16 paribus; stipulae magnae, foliaceae, late ovatae vel rotundae marginibus undulatis, 3 × 2,5 cm, apice acuta; colleteres praesentes. Inflorescentia brevipedunculata vel subsessilia, dense capitulata, c. 1,5 cm diametro bracteis magnis circumcincta; bracteae lanceolatae vel ovatae usque ad 1,5 × 1 cm. Calyx interdum leviter lilacinus, extra parum pubescens; tubus brevissimus vel nullus; lobi triangulares, parum inaequales c. 1 mm longi; colleteribus cum lobis calycis alternantibus. Corolla lilacina, tubiformis per anthesin lobis valde recurvatis; tubus c. 5 mm, extra glaber, intra parte superiore annulo

Fig. 9. *Xanthophytum grandifolium* Bakh. f. a. Habit, × 0.35; b. macrostylous flower, × 9; c. microstylous flower, × 9 (a *Ashton 17721*; b *Paie 19853*; c *Axelius 197*).

pilorum ornatus; lobi c. 0,8 mm, raro parte exteriore paucis pilis sparsis. Stamina parte tertia inferiore corollam adnata, 4,6 vel 5,9 mm longa; antherae c. 1 mm longae. Stylus 5,2 vel 6 mm interdum pilis paucis vestitus. Fructus indehiscens, in statu immaturo solum visus. — T y p u s: *Axelius 322*, 23 Dec. 1982, Sg. Lunok, Camp Malinau, Muara Pangean near Long Bia, Sg Bahau, Kalimantan Timur, Borneo (S, holo).

Slender shrub or small tree, c. 2 m tall. Vegetative parts very sparsely hairy or glabrous. Only young shoots and leaves with slightly denser, when dry shining, indumentum. *Blade* broadly oblong to ovate, large, 17–22 by 6–9 cm, cuneate to acuminate at base, narrowing into an up to 3 cm long petiole, acute to acuminate at apex, lower side paler than upper side; lateral veins 13–16 pairs; stipules large, leaf-like, broadly ovate to rounded with undulated margins, 3 by 2.5 cm, acute at apex; colleters present. *Inflorescence* of short-peduncled or subsessile dense heads, c. 1.5 cm in diam. surrounded by large bracts; bracts lanceolate to ovate, up to 1.5 by 1 cm. *Calyx* sometimes slightly purple coloured, sparsely pubescent outside; tube very short or absent; lobes bluntly triangular, slightly unequal, c. 1 mm; colleters alternate with the calyx lobes. *Corolla* purple, tubiform with strongly recurved lobes at anthesis; tube c. 5 mm, outside glabrous, inside with a broad belt of hairs in the upper part; lobes c. 0.8 mm, seldom with a few sparse hairs on the outside. *Stamens* adnate to the corolla for the lower third, either c. 4.6 or c. 5.9 mm, glabrous; anthers c. 1 mm. Style either c. 5.2 mm or c. 6 mm, very rarely with a few hairs. *Fruit* indehiscent, only seen in immature state.

N o t e. The dimorphism in this species is not so distinct. The ring of hairs is very broad and the anthers are situated at the ring in both types of flowers. This feature, together with the partly adnate stamens, the long flower tube and the lilac colour may be due to a different mode of pollination.

C o l l e c t i o n. Kalimantan, E: Ma Pangean, Long Bia, *Axelius 322* (S).

7. Xanthophytum grandifolium Bakh. f. – Figs. 9, 11a.

Xanthophytum grandifolium Bakh. f., Blumea 7 (1953) 336. — T y p e: *Teijsmann 8011*, Loembu Boukit, Penein Mt, W Borneo (L, holo).

N o t e. In the original description Bakhuizen van den Brink Jr stated that the holotype of *Teijsmann* is without a number. However, the sheet with the locality Penein Mt and also marked by Bakhuizen as holotype has the number *8011*.

Treelet or monocaul dwarf up to 4 m tall. Young shoots and leaves with a golden to light copper-coloured indumentum. *Leaves* large; *blade* lanceolate to oblong or ovate, 11–30 by 2–7 cm, cuneate to attenuate at base, narrowing into an up to 5 cm long petiole, cuneate to acuminate at apex, upper side with a few hairs on veins and midrib, lower side paler, sparsely but evenly pubescent; lateral veins 11–22 pairs; stipules narrowly ovate, up to 1.5 by 0.6 cm, with hairy vein and margins; colleters abundant. *Inflorescence* a panicle, 1.5–5 cm long, flowers in head-like fascicles on c. 2 cm long, sometimes reflexed branches; bracts prominent, c. 1.5 cm long; peduncle in fruit 3–12 cm long. *Calyx* with short, setose, pale hairs; tube very short; lobes ovate to rounded, c. 0.8 mm; colleters one to many, alternate with the calyx lobes. *Corolla* white with short hairs outside, narrowly cyathiform to tubiform; tube 4–5

Fig. 10. *Xanthophytum cylindricum* Axelius. a. Habit, × 0.35; b. macrostylous flower, × 9; c. microstylous flower, × 9 (a, c *Wiriadinata 673*; b *Wiriadinata 676*).

mm, (longistyled flowers are the shorter ones), inside with a broad ring of ascending hairs at the upper part; lobes 0.8–1 mm. *Stamens* either c. 2.5–4 mm or c. 4–5.2 mm long, upper part of filament with soft, curly hairs, lower part of filament adnate to the corolla; anthers c. 0.9 mm. Style either c. 3.7 or 4.2–5.6 mm long, pubescent, especially at upper part. *Fruit* indehiscent, c. 2.5 mm.

Note: This species is easy to identify since it is the only one with an inflorescence that consists of a branched panicle with large bracts everywhere. It is also very distinct with its hairy stamens and style. It seems to be fairly common all over Borneo.

Selected collections. Sarawak: Rayang, *Haviland 712* (K, SAR); Sg Tau, *Purseglove 5156* (L); Bkt Goram, Ulu Sg Kapit, *Chai 36059* (L, SAR); Kapit, *Clemens 21404* (K, SAR); Bintulu, *Beccari 4017* (FI, K); Pelagus, *Chai et al 33114* (K, L, SAR); Gat, *Clemens 21774* (K), *21776* (K, SAR); Long Bah, *Brooke 9013* (L), *9049* (L); Ulu Tubau, Bintulu, *Ashton 18425* (K, SAR); Tubau-Belaga divide, *Ashton 17721* (K, L, SAR, SING); Belaga, *Brooke 9327* (L, SAR); Punan Busang, Belaga, *Geh & Sansuri 123* (SAR, SING); Ungka, Sg Melinau, *Burtt 12647* (SAR); N Amau, Mujong, Baleh, *Ashton 12124* (K, SAR); *Paie 19853* (K, SAR); Bkt Kajang, Hose Mt, *Banyeng 17223* (K, L, SAR); Bkt Salong, Ulu Sg Melinau, *Chai 37267* (K, L, SAR); Mt Dulit, *Richards 1039* (K, L); Balang Baleh, Ulu Baleh, *Anderson 28453* (K, SAR); Lio Matu, Baram, *Moulton 6701* (BM, K). — Kalimantan, W: Bkt Lumbu, Penein, *Teijsmann 8011* (L); Lianggagang, *Hallier 2634* (K, L, U), *2755* (L); Bkt Milie, *Amdjah 381* (BO); Sg Magne, *Jaheri 627* (BO); Sg Boleng, *Amdjah 114* (BO, L). — Kalimantan, E: Sg Ketaman, Ulu Sg Pujungan, *Axelius 297* (S); Pujungan, *Axelius 232* (S); Long Aran, Sg Bahau, *Axelius 216* (S).

8. Xanthophytum cylindricum Axelius, *spec. nov.* – Figs. 10, 11b.

Suffrutex c. 1 m altus. Partes juvenes vegetativae indumento ferrugineo vestitae. Lamina oblonga vel elliptica, 10–26,5 × 4,5–11,5 cm, basi cuneata vel attenuata et in petiolum usque 4,5 cm longum angustata, apice caudata acuta, supra pilis paucis dispersis, subtus pallentior, leviter pubescens; nervis primariis 13–18 paribus; stipulae latae, ovatae, caudatae, primum integrae, postea plus minusve fimbriatae, pubescentes, c. 1 × 0,6 cm; sine colleteres. Inflorescentia paniculata tenuis cylindrica et spiciformis, 2,5–4 cm longa, ramis brevissimis; pedunculus 3–6 cm longus. Calyx pilis setosis; tubus brevis; lobi triangulares usque 0,5 mm longi; colleteres cum lobis calycis alternantibus. Corolla glabra vel extra paucis pilis brevibus et setosis, anguste tubiformis, c. 3,5 mm longa, intra pubescens fauce circulo pilorum densorum. Stamina plus quam dimidio longitudinis, corollam adnata parte superiore pilis vestita, 2,4 vel 2,9 mm longa; antherae c. 0,6 mm. Stylus praesertim parte superiore pubescens, c. 1,3 vel 3,2 mm; discus prominens. Fructus indehiscens, c. 2 mm. — Typus: *Wiriadinata 673*, 28 June 1975, Long Bagun, Camp Tikah, East Kalimantan, Borneo (BO, holo).

Monocaul dwarf or slender shrublet c. 1 m. Young vegetative parts with a ferrugineous indumentum. *Leaves* oblong to elliptic; *blade* 10–26.5 by 4.5–11.5 cm, cuneate to attenuate at base, narrowing into an up to 4.5 cm long petiole, acute and caudate at apex, upper side with a few scattered hairs, lower side paler, sparsely pubescent; lateral veins 13–18 pairs; stipules broad, ovate, caudate, first entire, later more or less fringed, hairy, c. 1 by 0.6 cm; no colleters. *Inflorescence* a spike-like, slim, cylindric panicle, 2.5–4 cm long, with very short branches; peduncle 3–6 cm long. *Calyx* with short bristle-hairs; tube short; lobes triangular up to 0.5 mm long; colleters alternate with the calyx lobes. *Corolla* glabrous or with a few very short setose hairs outside, narrowly tubiform, c. 3.5 mm long, inside hairy with a broad

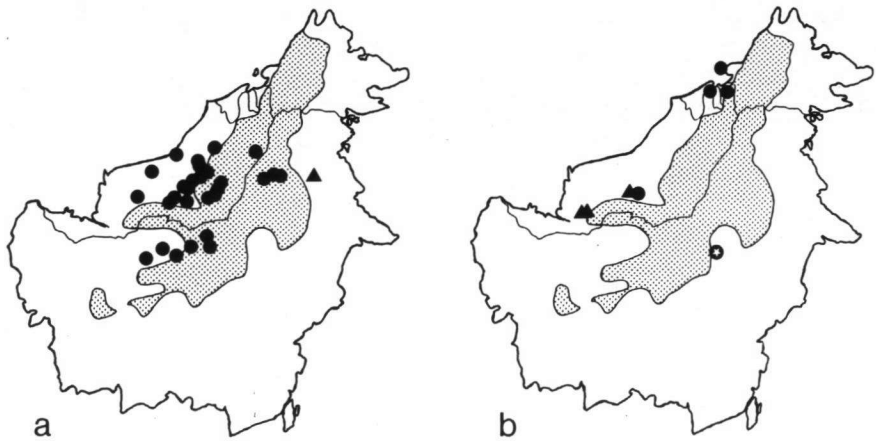

Fig. 11a. Known distribution of *Xanthophytum foliaceum* Axelius (▲) and *X. grandifolium* Bakh. f. (●). — Fig. 11b. Known distribution of *X. cylindricum* Axelius (✪), *X. alopecurum* Axelius (▲), and *X. brookei* Axelius (●).

ring of dense hairs situated at the throat. *Stamens* either c. 2.4 or c. 2.9 mm, adnate to the corolla for more than half of their length, upper part with soft curly hairs; anthers c. 0.6 mm. Style either c. 1.3 or c. 3.2 mm, pubescent, especially at upper part; disc prominent. *Fruit* indehiscent, c. 2 mm.

N o t e. This new species is recognized by its inflorescence. The spike-like form resembles those in the genus *Lerchea* (Axelius, 1987). The leaves are broad and large.

C o l l e c t i o n s. Kalimantan, E: Long Bagun, *Wiriadinata 673* (BO), *676* (BO, K).

9. Xanthophytum alopecurum Axelius, *spec. nov.* – Figs. 11b, 12.

Suffrutex c. 1 m altus. Partes superiores indumento denso ferrugineo vestitae. Lamina lata, oblonga-elliptica, 11–23 × 4–9 cm, basi cuneata vel attenuata et in petiolum usque 2 cm longum angustata, apice acuta vel acuminata, supra praesertim ad nervos parum pubescentes, subtus pallentes, nervis parum pubescentibus; nervis primariis 14–22 paribus; stipulae pubescentes magnae, latae, c. 1,2 × 0,6 cm, nervo prominenti; colleteres tenues. Inflorescentia paniculata caudata usque 25 cm longa; rami breves, effusi vel leviter reflexi; partes superiorae cymarum floribus paucis; bracteae minutae; pedunculus 10–25 cm longus. Calyx parum pubescens pilis setosis plus minusve incoloratis, pilis vulgaribus ferrugineis; tubus brevis; lobi parvi triangulares c. 0,2 mm; sine colleteres. Corolla extra pilis setosis paucis, infundibuliformis vel tubiformis, postea lobis recurvatis; tubus c. 2,4 mm longus, intra annulo tenui sparsorum pilorum ornatus; lobi c. 1,2 mm. Stamina c. 2,4 mm vel 4,6 mm; antherae c. 0,7 mm. Stylus c. 1,4 mm vel 3,0 mm, parum pubescens. Fructus indehiscens c. 2,5 mm. — T y p u s: *Axelius 97*, 15 Oct. 1982, Bukit Sadok, Sarawak (S, holo; K, L, S, iso).

Monocaul dwarf or shrublet c. 1 m. Upper parts with a dense ferrugineous indumentum. *Blade* broad, oblong to elliptic, 11–23 by 4–9 cm, cuneate to attenuate at

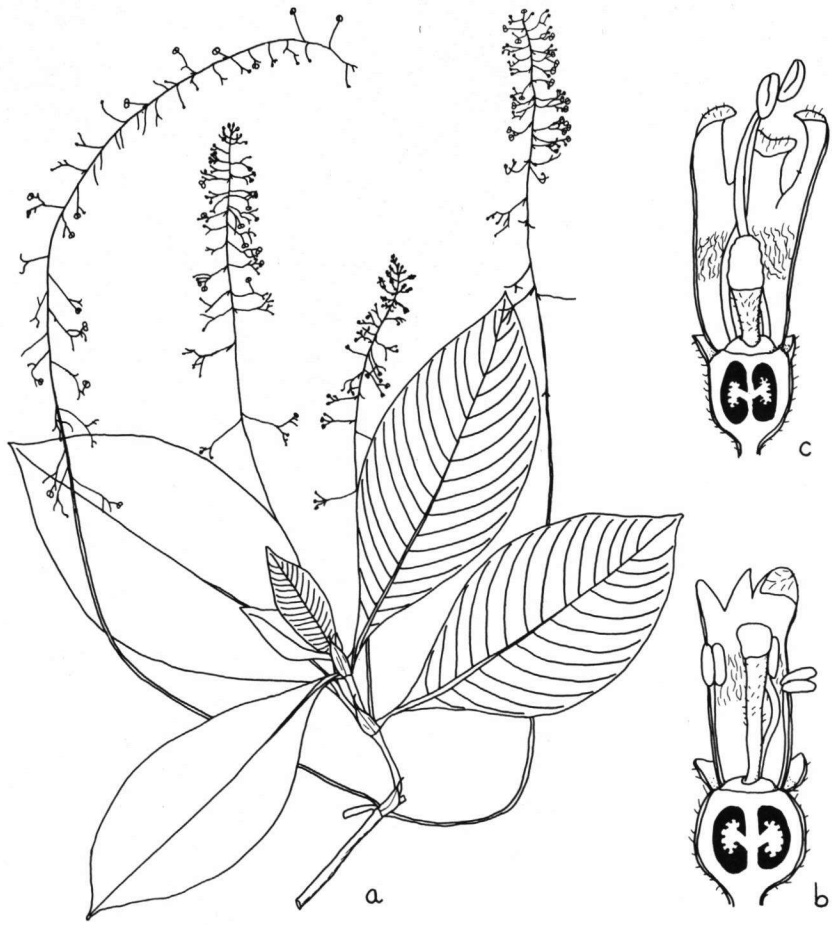

Fig. 12. *Xanthophytum alopecurum* Axelius. a. Habit, × 0.35; b. macrostylous flower, × 9; c. microstylous flower, × 9 (a–c *Axelius 97*).

base narrowing into an up to 2 cm long petiole, acute to acuminate at apex, upper side sparsely hairy especially on the nerves, lower side pale, sparsely hairy on the nerves; lateral veins 14–22 pairs; stipules large, broad, c. 1.2 by 0.6 cm, hairy and with a prominent nerve; colleters thin. *Inflorescence* an up to 25 cm long, tail-like panicle; branches short, spreading or slightly reflexed, in upper part with few-flowered cymes or single flowers; bracts minute; peduncle 10–25 cm long. *Calyx* sparsely hairy, with both short, stiff, more or less colourless hairs and ordinary ferrugineous hairs; tube short; lobes small, triangular, c. 0.2 mm; no colleters. *Corolla* white with a few short, stiff hairs outside, infundibuliform to tubiform, later with recurved lobes; tube c. 2.4 mm long, inside with a narrow sparse ring of hairs; lobes

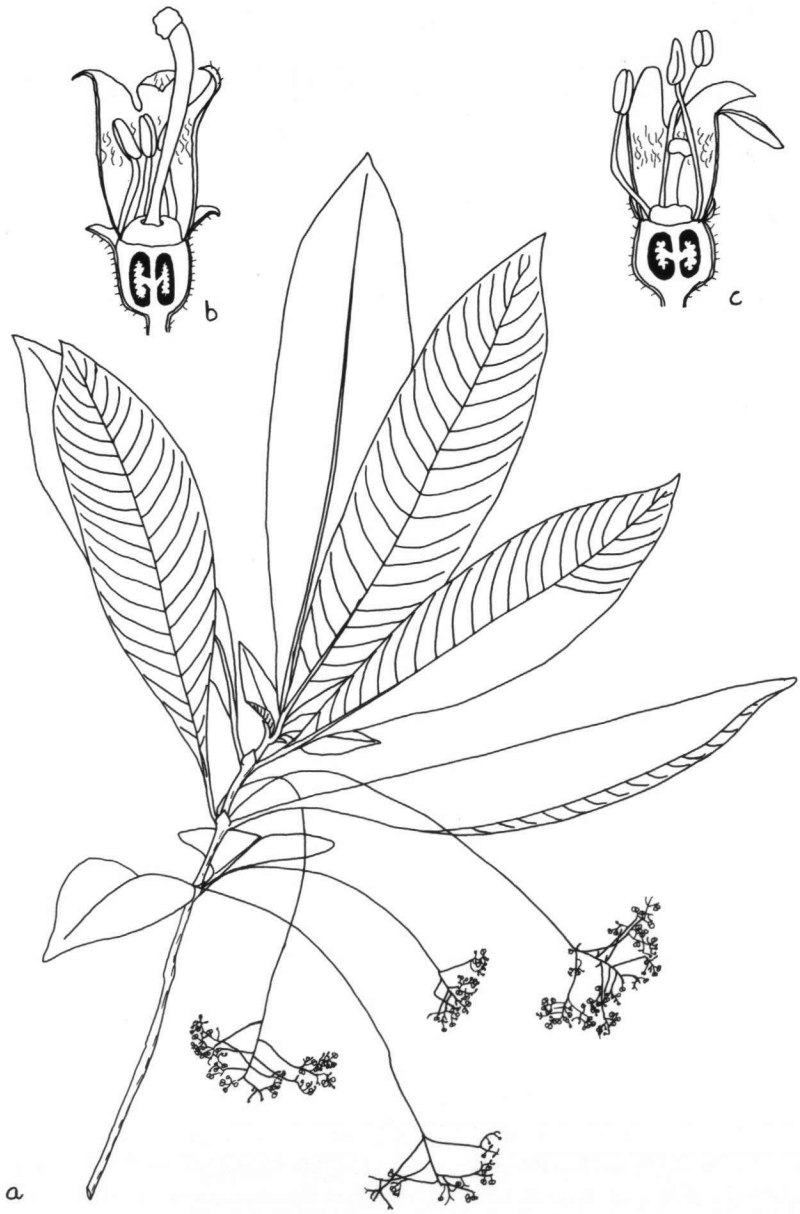

Fig. 13. *Xanthophytum brookei* Axelius. a. Habit, × 0.35; b. macrostylous flower, × 9; c. microstylous flower, × 9 (a *Bremer & Bremer 1751*; b *Brooke 9959*; *c.s. coll. 286*).

c. 1.2 mm. *Stamens* free from the corolla, either c. 2.4 mm or c. 4.6 mm, glabrous; anthers c. 0.7 mm. Style either c. 1.4 mm or c. 3 mm, sometimes very sparsely hairy. *Fruit* indehiscent, c. 2.5 mm.

Notes. This new species has a characteristic inflorescence. It resembles that of *X. longipedunculatum* in habit but is much longer and with a slim top that has no branches. The hairiness of the corolla and style represents a somewhat intermediate condition between *X. longipedunculatum* and *X. cylindricum*.

I found this new species at Bkt Sadok in Sarawak. It could be a local endemic but one collection, *Brooke 9274* (BM, L), from Wong Pelagus shows a strong resemblance. This collection has the long peduncle, the type of indumentum on the inflorescence and the stipules of *X. alopecurum*. However, the inflorescence with still shorter branches and lacking the single-flowered tail-like apex of *X. alopecurum* looks more 'condensed'. The sheet has no mature flowers so the present placement under *X. alopecurum* is tentative.

Collections. Sarawak: Bkt Sadok, *Axelius 97* (K, L, S); between Entalau and Tisak, Sg Skrang, *Axelius 85* (S); Wong Pelagus, *Brooke 9274* (BM, L).

10. Xanthophytum brookei Axelius, *spec. nov.* – Figs. 11b, 13.

Suffrutex c. 1 m altus. Lamina late lanceolata vel oblonga ad leviter obovata, 8,5–25,5 × 2–7,5 cm, basi cuneata vel attenuata et in petiolum ad 2,5 cm longum angustata, apice acuta-caudata, supra pilis dispersis vestitis, subtus pallentior parum pubescens; nervis primariis 15–25 paribus; stipulae ovatae vel triangulares, c. 1 × 0,6 cm, pubescentes; colleteres parvi vel nulli. Inflorescentia paniculata thyrsoidea, 1–5 cm longa; rami effusi, inferiores usque 4 cm longi; bracteae parvae; pedunculus longus, 3–17 cm. Calyx pilis pallidis et setosis; tubus brevissimus; lobi triangulares vel rotundati c. 4 mm longi; colleteres cum lobis calycis alternantes. Corolla extra pilis brevibus, tubiformis vel leviter urceolata, lobis postea plus minusve recurvatis; tubus c. 1,6 mm, intra annulo pilorum altitudine antherarum vel stigmatum locato; lobi c. 1,2 mm. Stamina c. 1,6 vel 3,2 mm; antherae 0,6 mm. Stylus c. 1,5 vel 3,4 mm; stigma clavatum. Fructus indehiscens, c. 2,5 mm. — Typus: *Brooke 9959*, 24 May 1955, Lawas, div. 5, Sarawak (L, holo; BM, L, iso).

Monocaul dwarf or slender shrublet, c. 1 m. *Blade* broadly lanceolate to oblong to slightly obovate, 8.5–25.5 by 2–7.5 cm, cuneate to attenuate at base, narrowing into an up to 2.5 cm long petiole, acute-caudate at apex, upper side with scattered hairs, lower side paler, sparsely pubescent; lateral veins 15–25 pairs; stipules ovate to triangular, c. 1 by 0.6 cm, hairy; colleters very small or none. *Inflorescence* a thyrsoid panicle, 1–5 cm long; branches spreading, often at right angle, the lower ones up to 4 cm long, bracts small; peduncle long, 3–17 cm. *Calyx* with pale, short bristle hairs; tube very short; lobes triangular to rounded, c. 4 mm; colleters alternate with the calyx lobes. *Corolla* with short hairs outside, tubiform to slightly urceolate, later with more or less recurved lobes; tube c. 1.6 mm, inside with a narrow ring of hairs situated at the level of the anthers resp. of the stigma; lobes c. 1.2 mm. *Stamens* either c. 1.6 or c. 3.2 mm, glabrous; anthers 0.6 mm. Style either c. 1.5 or c. 3.4 mm, glabrous; stigma clavate. *Fruit* indehiscent, c. 2.5 mm.

Note. This new species resembles *X. longipedunculatum* but is distinguished by very short brown bristle-hairs both on the calyx and corolla. The peduncle and its

Fig. 14. *Xanthophytum glabrum* Axelius. a. Habit, × 0.35; b. macrostylous flower, × 9; c. microstylous flower, × 9 (a, c *Winkler 1335*; b *Andersson 28866*).

side-branches are long. The distribution seems to be centered around Brunei Bay though there is a single but very typical collection from Ulu Baleh in Sarawak.

Collections. Sarawak: Ulu Baleh, *Bremer & Bremer 1751* (S); Limbang, *Hose 755* (BM); Labuan, *Lobb s.n.* (K); Lawas, *Brooke 9959* (BM, L).

11. Xanthophytum glabrum Axelius, *spec. nov.* – Figs. 14, 16a.

Suffrutex gracilis 1–1,5 m altus. Pars superior caulis pilis appressis vestita. Lamina lanceolata vel oblonga, 4,5–22 × 2–7 cm, basi cuneata vel attenuata, in petiolum ad 2 cm longum angustata, apice acuta vel caudata, supra venis pilis paucis vestitis pagina inferiore, pallentior, parum sed

aequabiliter pubescenti; nervis primariis 9–21 paribus; stipulae angustissime triangulares vel lanceolatae, apice caudato, marginibus saepe dentatis, c. 1 × 0,4 cm, pubescentes; colleteres praesentes. Inflorescentia paniculata thyrsoidea, 3–6 cm longa, rami inferiores usque ad 5 cm longi; pedunculus longus, 3–16 cm. Calyx glaber; tubus brevissimus vel nulus; lobi triangulares, 0,5 mm longi; colleteres quinque cum lobis calycis alternantes. Corolla extra glabra, tubiformis vel infundibuliformis, lobis postea plus minusve recurvatis; tubus c. 2 mm longum, intra annulo pilorum altitudine antherarum vel stigmatum locatus; lobi c. 1,5 mm. Stamina c. 1,7 vel 4 mm; antherae 0,6 mm. Stylus c. 2 vel 3,5 mm, leviter clavatus. Fructus indehiscens c. 2,5 mm.—T y p u s: *Hans Winkler 1335*, 29 Jan. 1925, Bukit Obat, West Kalimantan, Borneo (HBG, holo).

Slender shrublet or monocaul dwarf, 1–1.5 m tall. Upper part of stem with appressed hairs. *Blade* lanceolate to oblong,4.5–22 by 2–7 cm, cuneate to attenuate at base, narrowing into an up to 2 cm long petiole, acute to caudate at apex, upper side with a few hairs on the veins, lower side paler, sparsely but evenly pubescent; lateral veins 9–21 pairs; stipules very narrowly triangular to lanceolate, with caudate apex, often with toothed margins, c. 1 by 0.4 cm, hairy; colleters present. *Inflorescence* a thyrsoid panicle, 3–6 cm long; lower branches up to 5 cm long, glabrous; peduncle long, 3–16 cm with a few appressed hairs. *Calyx* glabrous; tube very short or none, black and a bit shining when dry; lobes triangular, c. 0.5 mm long; colleters five, alternate with the calyx lobes. *Corolla* glabrous outside, tubiform to infundibuliform, later with more or less recurved lobes; tube c. 2 mm, inside with a narrow ring of hairs situated at the level of the anthers or of the stigma resp.; lobes c. 1.5 mm. *Stamens* either c. 1.7 or c. 4 mm, glabrous; anthers 0.6 mm. Style either c. 2 mm or c. 3.5 mm, slightly clavate, glabrous. *Fruit* indehiscent, c. 2.5 mm.

N o t e. This species is easy to identify by its flowers which are totally glabrous outside. No other species lacks hairs completely on the outside of the calyx. This absence makes the inflorescence look black and often shining when dry.

C o l l e c t i o n s. Sarawak: Bkt Kemantan, Ulu Muput Kanan, Anap, *Paie 19509* (K, SAR, SING); Ulu Sg Kapit, *Chai 36024* (L); Gat, *Clemens 21772* (K, SAR); Bkt Raya, *Smith 27702* (K, L); Ulu Sg Sedampa, *Anderson 28866* (K, L); Mt Subis area, Niah, *Mohidin 21651* (K, L, SING); Ulu Sg Sah, Niah, Miri, *Paie 39086* (SAR); Sg Liam Libau, Lambir, *Burtt 11509* (SAR); Mile 18, Lambir, *Chai 39430* (SAR); Baram, *Haviland & Hose 3413* (K); Ulu Sg Berar, Mt Mulu, *Chai 39430* (SAR); Mt Murud, *Moulton 120* (K). — Kalimantan, W: Bkt Obat, *Hans Winkler 1335* (HBG). — Brunei: Sg Temburong, 1/2 mile above Kuala Belalong, *Smythies, Wood & Ashton 1705* (K,L). — Sabah: Ulu Sg Kuroput, Kota Belud, *Mujin 18844* (K); Tinopok trail, Mt Kinabalu, *Clemens 26422* (BM, G, K, UC); Kiau, Mt Kinabalu, *Clemens 10189* (UC); Sg Kaindangan, Sugut, *Cockburn 82534* (K).

12. Xanthophytum longipedunculatum Merrill – Figs. 15, 16a.

Xanthophytum longipedunculatum Merrill, J. Mal. Branch Roy. Asiat. Soc. 1 (1923) 43. — T y p e: *Ramos 1926*, Nov. 1920, Batu Lima, near Sandakan, North Borneo (K, lecto).

Monocaul dwarf or erect slender shrublet, c. 0.5–1 m tall, with appressed hairs at upper parts. *Blade* oblong to narrowly obovate, 6–22 by 2–5 cm, attenuate at base narrowing into an up to 2 cm long petiole, acute to acuminate at apex, upper side with a few hairs on the veins, lower side paler, sparsely pubescent; lateral veins 10–21 pairs; stipules triangular to ovate, c. 0.6 by 0.4 cm, pubescent; colleters present.

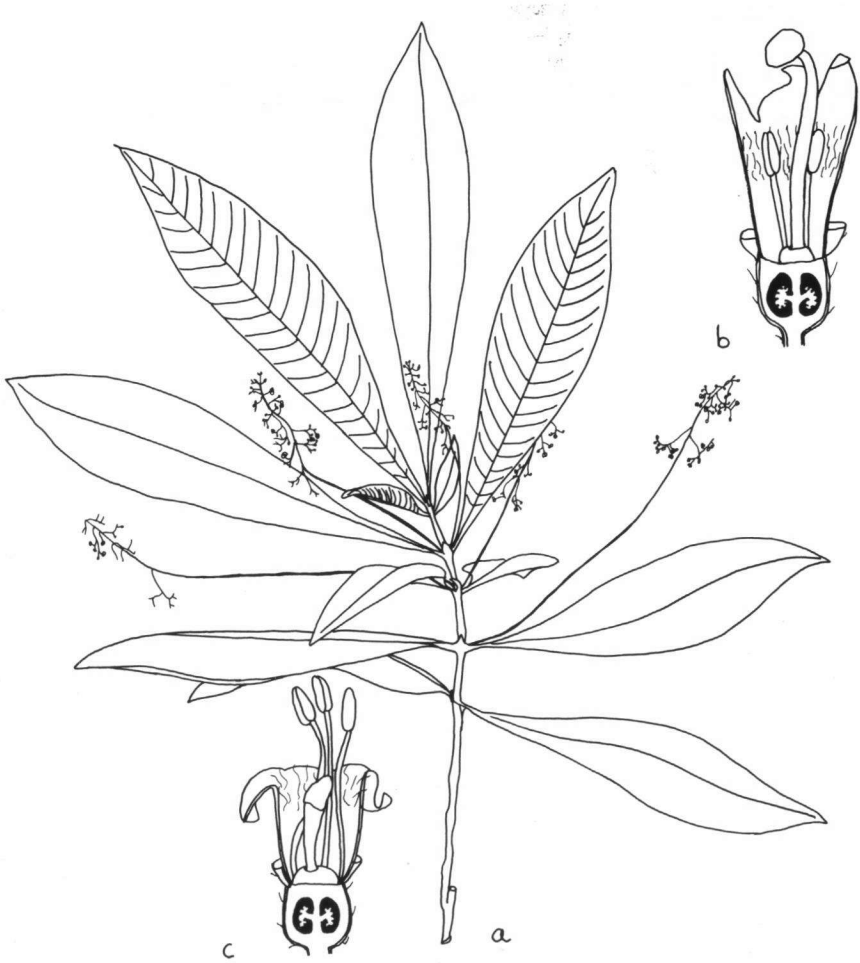

Fig. 15. *Xanthophytum longipedunculatum* Merrill. a. Habit, × 0.35; b. macrostylous flower, × 9; c. microstylous flower, × 9 (a, b *Meijer 2108*; c *Ramos 1271*).

Inflorescence a panicle 2–5.5 cm long; branches short, reflexed; peduncle long, 2–10 cm. *Calyx* with very few hairs, c. 0.6 mm long; tube c. 0.6 mm, slightly expanding; lobes nil or very short, rounded; colleters small, a bit down the tube. *Corolla* glabrous outside, infundibuliform to cyathiform, later with more or less recurved lobes; tube c. 2 mm, inside with a narrow ring of hairs at the level of the anthers or of the stigma respectively; lobes c. 1.2 mm long. *Stamens* either c. 1.8 or c. 3.4 mm, glabrous; an-thers 0.6 mm. Style either c. 1.7 or c. 4 mm, glabrous. *Fruit* indehiscent, c. 2 mm.

N o t e. This species could perhaps superficially be confused with *X. brookei* but the distinct calyx tube without lobes and the glabrous corolla make it easy to identify when in flower. The distribution is also different, *X. longipedunculatum* being restricted to the eastside of Borneo.

C o l l e c t i o n s. Kalimantan, E: Nunukan, *Meijer 1994* (BO), *2108* (BO, L), *2253* (BO); *Kostermans 9085* (L). — Sabah: Sandakan, *Creagh s.n.* (K); *Ramos 1271* (L, P), *1926* (K); *Sinanggul 36612* (K); Bettotan, *Kloss 19152* (K); Kebun China, *Meijer 28851* (K); Ulu Sg Dusun, *Leopold & Aloysius 77362* (K).

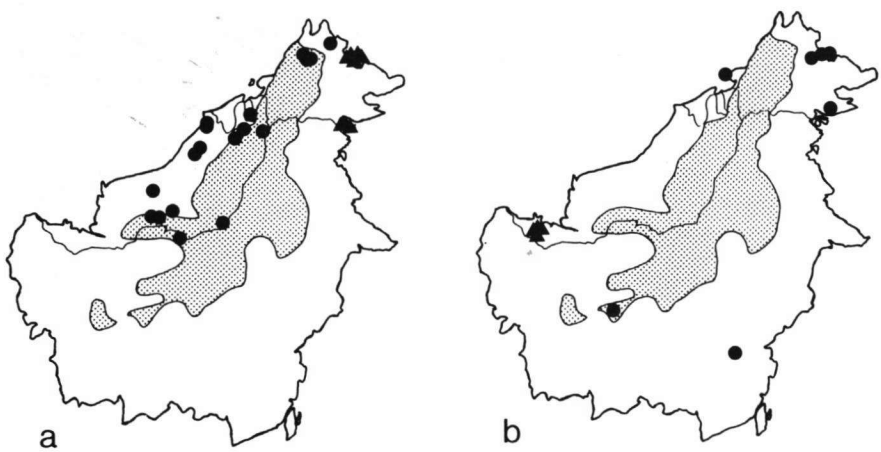

Fig. 16a. Known distribution of *Xanthophytum glabrum* Axelius (●) and *X. longipedunculatum* Merrill (▲). — Fig. 16b. Known distribution of *X. capitatum* Valeton (●) and *X. setosum* Axelius (▲).

13. Xanthophytum capitatum Valeton – Figs. 16b, 17.

Xanthophytum capitatum Valeton, Bot. Jahrb. (Engler) 44 (1910) 542. — T y p e: *Hub. Winkler 2825*, 10 July 1908, between Batu Babi and Lumowia, SE Borneo (WRSL, lecto; BM, G, K, SING, iso).

Monocaul dwarf c. 1 m tall. The whole plant with dense tomentose indumentum consisting of ordinary long, thin, basal-celled hairs (fig. 1a) and setose septate hairs with a big, swollen basal cell (fig. 1b). *Blade* oblong to obovate, 8–18.5 by 2.5–7 cm, cuneate to attenuate at base, narrowing into an up to 3.5 cm long, densely setose petiole, acute to acuminate at apex, upper side with setose indumentum making the leaves 'dotted', lower side a bit paler and with a denser indumentum; lateral veins 11–16 pairs; stipules triangular to ovate, more or less cuneate at apex, c. 0.7 by 0.4 cm, hairy; colleters long and thin. *Inflorescence* of condensed heads, up to 1.5 cm in diameter, surrounded by a few narrow, up to 1 cm long basal bracts, all covered by a

Fig. 17. *Xanthophytum capitatum* Valeton. a. Habit, × 0.35; b. macrostylous flower, × 9; c. microstylous flower, × 9 (a, b *Elmer 21905*; c *Boden Kloss 18995*).

dense setose indumentum; peduncle 0.5–3 cm. *Calyx* densely pubescent both inside and outside; tube very short; lobes bluntly triangular, c. 0.6 mm; colleters sparse. *Corolla* tubiform to slightly infundibuliform, later with some lobes recurved; tube c. 1.8 mm, inside with a narrow ring of hairs in the upper part of the tube; lobes c. 0.7 mm long, often very unequal in size and with red setose hairs at the outside. *Stamens*

either c. 1.4 mm or c. 2 mm, glabrous; anthers c. 0.6 mm. Style either c. 1.4 or c. 3 mm, glabrous; disc prominent, fleshy, c. 0.2 mm high. *Fruit* indehiscent, c. 2.5 mm.

Note. This species is, like *X. setosum*, recognized by its setose indumentum. Unlike that species, the inflorescences of *X. capitatum* are small dense heads.

Collections. Kalimantan, W: Sg Gulu, near Nanga Serawai, *Hans Winkler 166* (HBG). — Kalimantan, E: Between Batu Babi and Lumowia, *Hubert Winkler 2825* (BM, G, K, SING). — Sabah: Kudat, Labuan Forest Res, *Orolfo s.n.* (K); Mile 75.5, Telupid road, Sandakan, *Gibot 91254* (K, L); Mile 32, Labuk road, Sandakan, *Nooteboom 1611* (L); Mile 31, Labuk road, Sandakan, *Mikil s.n.* (K); Bettotan near Sandakan, *Kloss 18995* (SING, UC); Tawao, Elphinstone prov, *Elmer 21905* (DS, K, UC).

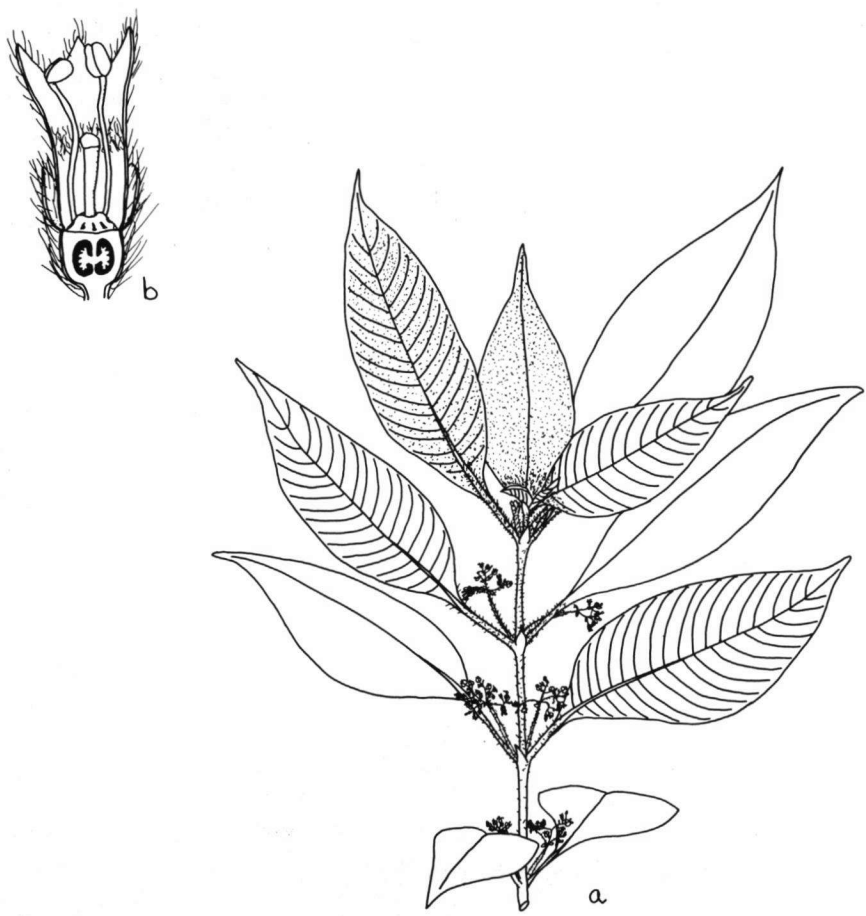

Fig. 18. *Xanthophytum setosum* Axelius. a. Habit, × 0.35; b. microstylous flower, × 9 (a *Mamit 33432*; b *Brooke 8008*).

14. Xanthophytum setosum Axelius, *spec. nov.* – Figs. 16b, 18.

Suffrutex gracilis usque ad 0,6 m altus, partibus omnibus indumento denso et tomentoso vestitis, partibus juvenibus indumento setoso; indumentum album vel in statu sicco saepe brunneum; pili vulgati tenues, longo cellula basali necnon pili setosi septati cellula basali grandi. Lamina late lanceolata vel oblonga, 7–16 x 2,5–6,6 cm, basi cuneata vel attenuata et in petiolum ad 4 cm longum angustata, apice acuta vel caudata, supra indumento paulo denso et setoso quasi-punctata, subtus leviter pallentior et indumento densiore; petiolus dense setosus; nervis primariis 12–19 paribus; stipulae lanceolatae vel triangulares vel ovatae, c. 1 x 0,4 cm, preasertim marginibus pubescentes; colleteres praesentes. Inflorescentia paniculata c. 1,5 cm longa; rami effusi; bracteae minutae; pedunculus usque 3,5 cm longus. *Calyx* utrinque dense pubescens; tubus brevissimus vel nullus; lobi triangulares c. 1 mm longi; colleteres saepe bini. Corolla tubiformis, sed ad lobos infundibuliformis; tubus c. 1.8 mm, intra annulo angusto pilorum subter marginem ornatus, extra parum pubescens; lobi c. 1,2 mm, extra omnis pubescens. Stamina c. 2,8 mm; antherae c. 0,5 mm. Stylus c. 1,2 mm. Fructus indehiscens, c. 2 mm. — T y p u s: *Mamit 33432*, 4 Dec. 1973, kampong Sadir, 50 miles from Kuching, Sarawak (K, holo; L, SAR, iso).

Monocaul dwarf, up to 0.6 m tall. All parts covered with dense tomentose indumentum, in younger parts setose; some parts white or, when dried, often brown. Hairs both ordinary, thin, long, basal-celled (fig. 1a), and setose septate with a big swollen basal cell (fig. 1b). *Blade* broadly lanceolate to oblong, 7–16 by 2.5–6.6 cm, cuneate to attenuate at base, narrowing into an up to 4 cm long densely setose petiole, acute to caudate at apex, upper side with rather dense setose indumentum making the blade 'dotted', lower side slightly paler and with a denser indumentum; lateral veins 12–19 pairs; stipules lanceolate to triangular to ovate, c. 1 by 0.4 cm, hairy especially at margin; colleters present. *Inflorescence* a panicle, c. 1.5 cm long; branches spreading; bracts minute; peduncle up to 3.5 cm long. *Calyx* densely pubescent inside and outside; tube very short or absent; lobes bluntly triangular, c. 1 mm; colleters often in pairs. *Corolla* tubiform, enlarged infundibuliform by the lobes; tube c. 1.8 mm, inside with a narrow ring of hairs a bit down from the brim, outside sparsely hairy; lobes c. 1.2 mm, outside hairy all over. *Stamens* in brevistyled flowers c. 2.8 mm, glabrous; anthers c. 0.5 mm. Style c. 1.2 mm, glabrous. *Fruit* indehiscent, c. 2 mm.

N o t e. This new species is easily identified by its setose indumentum and is distinguished from *X. capitatum* by its branched inflorescence. The flowers are heterostylous. Only brevistyled flowers have been found, but the large difference in size of stamens and style and their placement in relation to the narrow hair-ring are fully in accordance with other brevistyled flowers of the ordinary type. The form of the corolla is similar to that of *X. fruticulosum* and *X. ferrugineum*.

C o l l e c t i o n s. Sarawak: Kuching, *Brooke 8008* (BM, L, SAR, SING); *Haviland & Hose 3400* (BM, K, L, SAR); *Haviland 1681* (K, SAR); kampong Sadir, *Mammit 33432* (K, L, SAR).

15. Xanthophytum olivaceum Merrill – Figs. 19, 21a.

Xanthophytum olivaceum Merrill, Mitt. Inst. Allg. Bot. Hamb. 7 (1937) 270. — T y p e: *Hans Winkler 780*, 12 Dec. 1924, Bidang Menabei, West Borneo (HBG, lecto; iso).

Monocaul dwarf, c. 1 m tall, leaves mostly in upper half; upper parts often with a rather thick ferrugineous indumentum. *Blade* oblong, 8–20 by 2.5–6.5 cm, cuneate

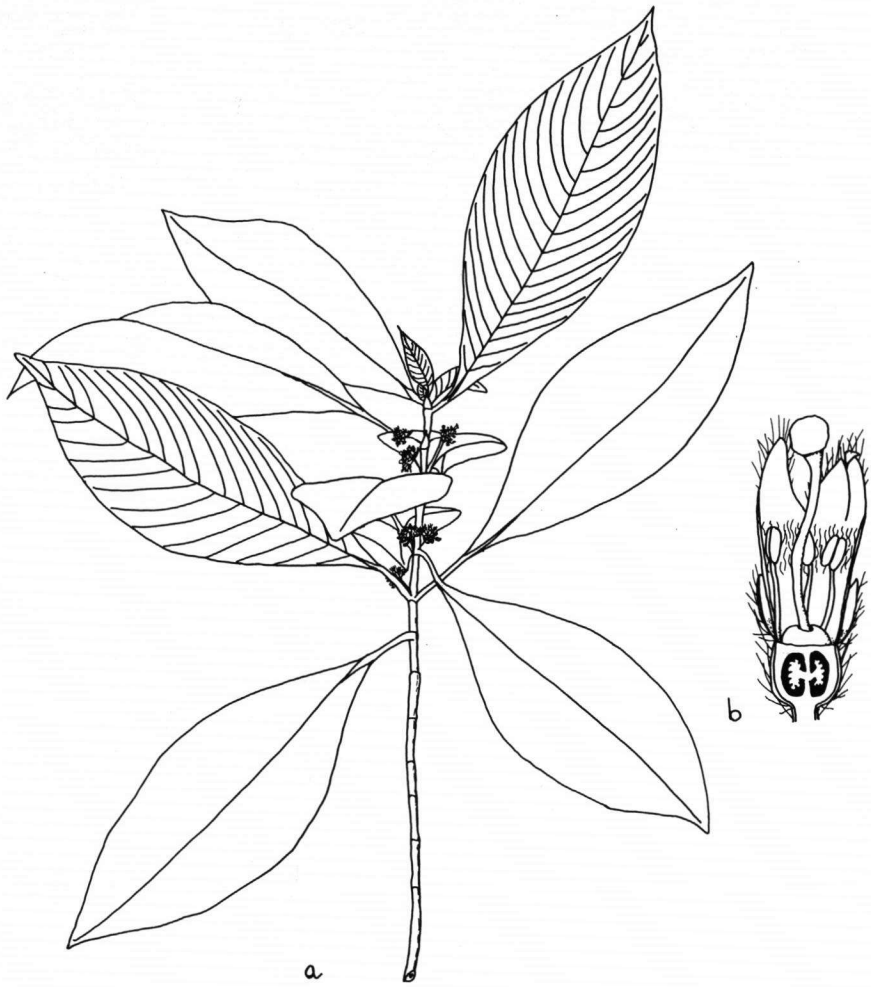

Fig. 19. *Xanthophytum olivaceum* Merrill. a. Habit, × 0.35; b. macrostylous flower, × 9 (a *Axelius 133*; b *Axelius 136*).

to attenuate at base, narrowing into an up to 3.5 cm long petiole, acute to acuminate at apex, upper side hairy at least on the veins, lower side with more hairs; lateral veins 10–21 pairs; stipules narrowly triangular, c. 0.7 cm long, hairy; colleters few and small. *Inflorescence* an up to 1.5 cm long, rather dense, short-branched panicle; peduncle up to 1.5 cm long. *Calyx* hairy outside; tube very short; lobes triangular, glabrous inside, c. 1 mm long; colleters minute or lacking. *Corolla* white, tubiform, hairy outside; tube c. 2 mm long, inside with a narrow ring of hairs; lobes c. 1.1 mm long, often not recurved. *Stamens* adnate to the corolla at base only, c. 1.8 mm long in longistyled flowers, glabrous; anthers c. 0.6 mm. Style c. 3.5 mm long in longi-

styled flowers. *Fruit* indehiscent, c. 2–3 mm, the persisting calyx lobes first spreading, later folding together.

Notes. *Xanthophytum olivaceum* is a name connected with two collections from southwest Kalimantan. With no flowers and an unknown range of variation of the vegetative characters I cannot keep it apart from a possibly new species from the Lundu area in Sarawak. Further collections may connect the distribution areas or may confirm *X. olivaceum* as a distinct species separated from the Lundu one. *Xanthophytum olivaceum* is nearly glabrous on vegetative parts while the Lundu material is clearly pubescent. But hairiness is very variable and the Winkler collections from Kalimantan could just be exeptional in being hairless.

Xanthophytum olivaceum is characterized by its small, nearly head-like panicles and its light coloured, nearly orange indumentum on the inflorescences. The flower somewhat resembles that of *X. fruticulosum* and *X. ferrugineum* in form but differs fundamentally by being heterostylous.

Collections. Sarawak: Mt Poi, *Clemens 20391* (K); *Native Coll. s.n.* (UC); Mt Gading, *Anderson 112* (SING); *Axelius 133* (S), *136* (S); *Clemens 22225* (K); *Chai 18471* (K); Lundu, *Brooke 8399* (BM, L); Bau, *Purseglove & Shah 4466* (K, L, SING).

16. Xanthophytum borneense (Valeton) Axelius, *stat. nov.* – Figs. 20, 21a.

Xanthophytum fruticulosum Blume var. *borneensis* Valeton, Icon. Bogor. 4 (1912) 157. — Type: *Hallier 2583*, Mar.-Apr. 1894, Liang Gagang, Borneo (L, lecto; BO, iso).

Erect slender shrublet, often repeatedly branched, with an abundance of leaves and inflorescences; young vegetative parts with a well developed, dense, soft indumentum. *Blade* very varying in size, broadly lanceolate, 4.5–20 by 1.5–6.5 cm, cuneate to attenuate at base, narrowing into an up to 2.5 cm long petiole, acute to acuminate at apex, upper side with hairs all over but especially on the nerves, lower side often densely hairy with long soft hairs, lateral veins 12–21 pairs; stipules ovate to narrowly triangular, acute to acuminate at apex, c. 1 by 0.3 cm; colleters very few and small if any. *Inflorescence* an up to 3.5 cm long panicle on a 2–9.5 cm long peduncle. *Calyx* densely long-haired outside; red-coloured cells abundant in all tissues, easily visible in lobes; tube very short; lobes lanceolate, often hairy inside, up to 3 mm long; colleters minute or lacking. *Corolla* shortly tubiform, apparently soon deciduous, hairy outside; tube c. 2 mm long, inside with a narrow ring of hairs; lobes c. 1 mm. *Stamens* adnate to the corolla at base only, either c. 1.7 or c. 2.8 mm, glabrous; anthers c. 0.6 mm. Style either c. 1.3 or c. 3 mm, glabrous. *Fruit* indehiscent, c. 2–3 mm, crowned by the often spreading calyx lobes.

Note. This species is recognized by its hairiness, its abundance of reticulations and the red coloured cells in the calyx lobes. It seems to be fairly common all over Borneo.

Collections. Sarawak: Saribas, Paku, *Haviland & Hose 3398* (BM, K); Bkt Goram, *Chai 36177* (L); Bkt Morsing, Tau Range, *Purseglove 5186* (K, L); Ulu Kakus, Anap, *Haron 29975* (K, L); Gat, upper Rayang, *Clemens 21724* (K), *21771* (K), Belarga, *Brooke 9112* (BM, L); *Native Coll. 5257* (UC); Bkt Mentagai, Bok-Tisam, *Sibat 23270* (K, L); Dulit trail, *Richards 1454* (K); Lio-Matu Baram, *Moulton 27* (SING); Long Dam, Ulu Dapoi, *Paie 22960* (K, L); Sg Bakong,

Fig. 20. *Xanthophytum borneense* (Valeton) Axelius. a. Habit, × 0.35; b. macrostylous flower, × 9; c. microstylous flower, × 9 (a *Winkler 1371*; b *Jugah 24351*; c *Haviland & Hose 3398*).

Miri, *Sibat 24458* (K, L); Ulu Bakong, Miri, *Jugah 24351* (K, L). — Kalimantan, W: Liang Gagang, *Hallier 2583* (BO, L); Tadjoek, *Jaheri 195* (BO, L); Sg Obat, *Winkler 1371* (HBG); Bkt Tilung, *Hans Winkler 1520* (HBG). — Kalimantan, E: Camp Tikah, Long Bagun, *Wiriadinata 701* (K, L); Sg Adai, Muara Pangean, *Axelius 316* (S); Sg Susuk, E Kutei, *Kostermans 5464* (K, L).

17. Xanthophytum fruticulosum Blume – Figs. 21b, 22.

Xanthophytum fruticulosum Blume, Bijdr. Fl. Nederl. Ind. (1826/27) 989. — T y p e: *Reinwardt s.n.*, Java (L,lecto).

Weak monocaul dwarf, c. 50 cm; upper parts with appressed copper-coloured indumentum. Young shoots with a dense, lighter, more shining indumentum. *Blade* lanceolate to narrowly oblong or obovate, 4.5–13.5 by 1.5–4.5 cm, cuneate to attenuate at base, narrowing into an up to 3.8 cm long petiole, acute to acuminate at apex, lower side distinctly paler than upper; lateral veins 9–18 pairs; stipules lan-

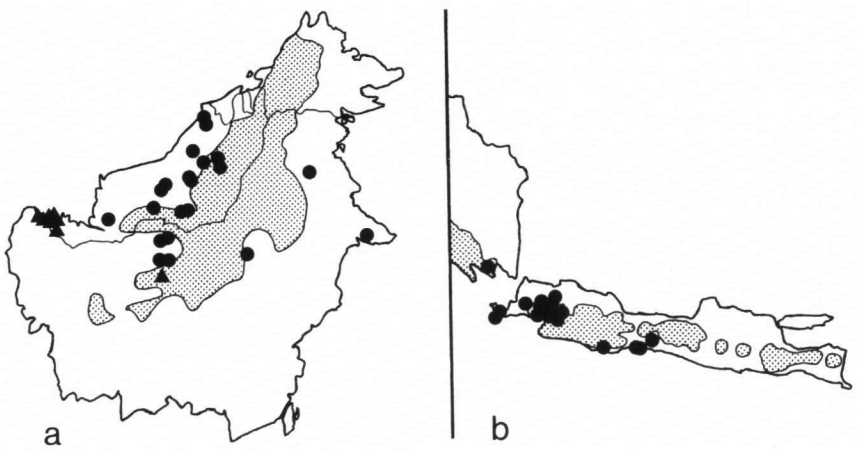

Fig. 21a. Known distribution of *Xanthophytum olivaceum* Merrill (▲) and *X. borneense* (Valeton) Axelius (●). — Fig. 21b. Known distribution of *X. fruticulosum* Blume (●).

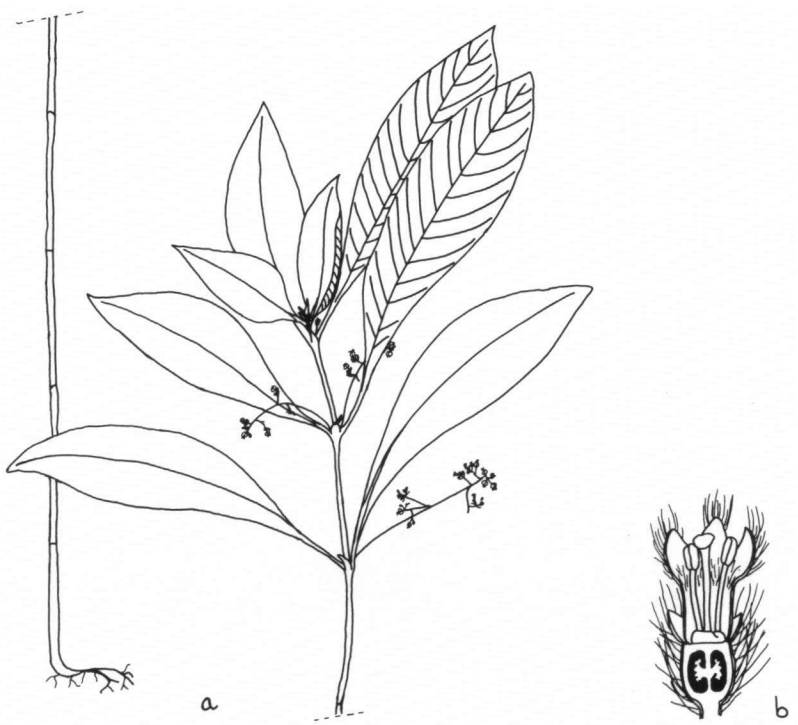

Fig. 22. *Xanthophytum fruticulosum* Blume. a. Habit, × 0.35; b. flower, × 9 (a, b *Lanjouw 29*).

Fig. 23. *Xanthophytum ferrugineum* (DC.) Merrill. a. Habit, × 0.35; b. flower, × 9 (a, b *Sulit 21601*).

ceolate to ovate, c. 0.6 by 0.3 cm; colleters many, thin. *Inflorescence* a panicle 1.5–2.5 cm long; branches spreading, sometimes slightly reflexed; bracts minute; peduncle up to 3.5 cm long. *Calyx* pubescent both inside and outside; tube very short or none; lobes triangular c. 0.8 mm; colleters five, alternate with the calyx lobes. *Corolla* white, in lower part tubiform, but at the lobes urceolate, this caused by the upper part of the tube being slightly enlarged and the lobes being curved inwards; tube c. 1.4 mm, inside with a narrow ring of hairs; lobes c. 0.6 mm, hairy outside. *Stamens* c. 1.5 mm, glabrous; anthers c. 0.4 mm. Style c. 1.5 mm, glabrous. *Fruit* indehiscent, c. 3 mm.

N o t e. This species is homostylous and style and stamens are of nearly equal length. In some flowers the style, in others the stamens are superior. In each case both stamens and style are placed on the same side, the upper, of the hair-ring. With its small leaves this species resembles *X. ferrugineum*, the flowers of which are similar and also homostylous. *Xanthophytum fruticulosum* differs in having more narrow stipules, a more lax inflorescence and often a more delicate habit. *Xanthophytum fruticulosum* is, unlike any other member of the genus, mainly distributed in Java. However, there is one collection from an unidentified locality in Sumatra and one, divergent, from Banguran Island

S e l e c t e d c o l l e c t i o n s. Sumatra: Helling Rate Rate (?), Telanggaran, Lampong, *Iboet 12* (K, L). — Java: Mt Pajung, Udjong Kulon, *Wirawan 173* (K, L); Tjibadak near Halimoen, Preanger, *Bakhuizen van den Brink 3125* (L, U); Mt Serendet near Djasinga, *Backer 10457* (P); Mt Tjiputi near Tjampea, *Bakhuizen van den Brink 4190* (K, L, U); Mt Pantjar, *Hochreutiner 1820* (G); W Pangrango, Pasir Padjang, *de Voogd s.n.* (K, L);Mt Madur near Bajah, *Backer 1631* (K, L); Babakan river, Nusa Kambangan, *Kostermans & van Woerden 75* (L); Solok Babakan to Karanganjar, *Kostermans & van Woerden 116* (K, L). — Banguran Island: Mt. Ranai, eastslope, *van Steenis 1396* (U).

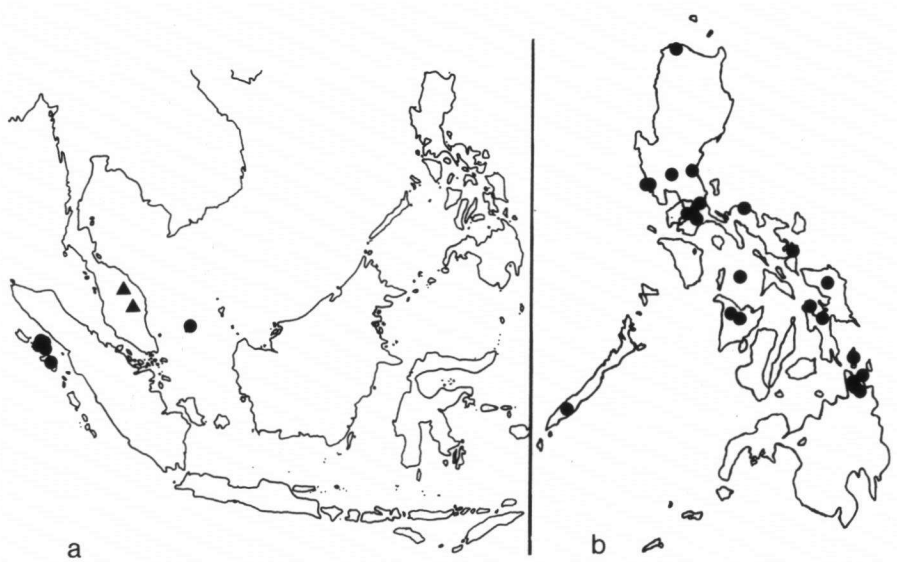

Fig. 24a. Known distribution of *Xanthophytum ferrugineum* (DC.) Merrill outside the Philippines (●) and *X. capitellatum* Ridley (▲). — Fig. 24b. Known distribution of *X. ferrugineum* (DC.) Merrill in the Philippines (●).

18. Xanthophytum ferrugineum (DC.) Merrill – Figs. 23, 24a, b.

Xanthophytum ferrugineum (DC.) Merrill, in Mitt. Inst. Allg. Bot. Hamb. 7 (1937) 270. — *Metabolus ferrugineus* DC., Prod. 4 (1830) 436. — T y p e: *Haenke s.n.*, Sorsogon, Luzon, Philippines (PR, holo; GOET, PR, iso).

Xanthophytum villarii Vidal, Rev. Pl. Vasc. Filip. (1886) 150. — T y p e: *Vidal 392*, Oct. 1883, San Mateo, Prov. Manila, Philippines (K, lecto; MA, iso).

Xanthophytum fruticulosum Blume var. *brevipes* Valeton, Icon. Bogor. 4 (1912) 157. — T y p e: *Raap 233*, 20 Sept. 1896, Tanahmasa, Batu Isl. (BO, lecto).

Fig. 25. *Xanthophytum pubistylosum* Axelius. a. Habit, × 0.35; b. macrostylous flower, × 9; c. microstylous flower, × 9 (a *Axelius 158*; b, c *Axelius 159*).

Slender shrublet or monocaul dwarf, c. 50 cm tall; upper vegetative parts with copper-coloured, more or less shining appressed indumentum. *Blade* lanceolate to narrowly oblong or obovate, thin, 3–18 by 1–7 cm, cuneate to attenuate at base, narrowing into an up to 3.5 cm long petiole, lower side paler than upper; lateral veins 9–18 pairs; stipules broadly ovate, acuminate at apex, c. 0.7 by 0.6 cm, hairy especially at the margins; colleters present. *Inflorescence* of short-peduncled to subsessile, lax heads. *Calyx* pubescent outside; tube very short or none; lobes bluntly triangular, seldom with a few hairs inside, unequal in size, 0.6–1.2 mm long; colleters five, large, alternate with the calyx lobes. *Corolla* in lower part tubiform but at the lobes often urceolate, this caused by the upper part of the tube being slightly enlarged and the lobes being curved inwards; tube 1.4–2 mm, inside with a very narrow ring of hairs or sometimes glabrous; lobes 0.6–1 mm long. *Stamens* 1.4–2 mm, glabrous; anthers 0.4–0.6 mm. Style 1.7–2.3 mm, glabrous. *Fruit* indehiscent, c. 3 mm.

Note. The leaves and flowers of *X. ferrugineum* very much resemble those of *X. fruticulosum*. However, *X. ferrugineum* has much broader stipules, a contracted inflorescence, and a coarser indumentum. This species has been considered a Philippine endemic but three collections from Anamba Isl., Batu, and Siberut, must be placed under this species. The material from these islands is poor, having no flowers, but the calyx, inflorescence, leaves, and habit place them under *X. ferrugineum*. The stipules are not as broad as in the Philippine specimens and the more delicate habit of the Siberut collection is atypical. These specimens are close to *X. fruticulosum* in habit. The distribution on the islands west of Sumatra is difficult to interpret since neither *X. ferrugineum* nor *X. fruticulosum* (with the exception of one arbitrary collection) have been found on the mainland of Sumatra.

Collections. Mentawai Islands: Tanah Masa, Batu, *Raap 185* (BO), *233* (BO), *305* (BO); Pini, Batu, *Raap 558* (BO); Siberut, *Kloss 13077* (K, SING). — Anambas Islands: Terempa, Siantan, *Henderson 20107* (BO); *van Steenis 691* (BO, L). — Phillipines. Palawan: Panalingajan River, *Edaño 77434* (A). Luzon: San Antonio, Laguna, *Ramos 10971* (BM), *20590* (BM); San Mateo, *Vidal 392* (K, MA); Bangui to Claveria, Ilocos Norte, *Ramos 32984* (A); Umiray, Tayabas, *Ramos & Edaño 28985* (A); Gaili (?), Laguna, *Loher 6324* (K); Lucban, Tayabas, *McGregor 47386* (G, UC); Paracale, Camarines, *Ramos & Edaño 33737* (L); Sorsogon, *Haenke s.n.* (GOET, PR). Sibuyan: Magallanes, Mt Giting-Giting, *Elmer 12365* (BM, G, K, L). Panay: Jamindao, Capiz, *Ramos & Edaño 31108* (BM); Dumarao, *Merrill 6695* (BM, P, L). Leyte: Dagami, *Wenzel 879* (A, BM, G); Mt Suiro, Biliran Isl, *Sulit 5432* (L, PNH). Samar: Mt Sarawag, *Edaño 15252* (A, K, L, PNH). Mindanao: Aros-asan, Surigao del Sur, *Univ. of San Carlos 795* (L); Surigao, *Ramos & Pascasio 34390* (K, UC); Mt Kabutuan, Surigao, *Mendoza & Convocar 10459* (A); Dinagat Isl., *Ramos & Convocar 83901* (A); Bucas Grande Isl., *Ramos & Pascasio 35113* (A, P).

19. Xanthophytum pubistylosum Axelius, *spec. nov.* – Figs. 25, 27a.

Suffrutex usque ad 1 m altus, partibus superioribus pilis appressis vestitis. Lamina lanceolata vel ovata, 5,5–27 × 2–7 cm, basi cuneata vel attenuata et in petiolum ad 3 cm longum angustata, apice acuta vel caudata, supra parum pubescens, subtus pallentior, parum sed aequabiliter pubescens; nervis primariis 9–17 paribus; stipulae lanceolatae vel anguste triangulares, caudatae, c. 1 × 0,4 cm, virides marginibus pubescentibus, costa pubescenti; colleteres praesentes. Inflorescentia paniculata 1–4 cm longa; rami effusi vel leviter reflexi interdum bracteis minutis instructi; pedunculus 1–2,5

cm. Calyx pilis paucis ferrugineis vestita; tubus brevissimus; lobi triangulares c. 0,5 mm, effusi in statu fructifero; colleteres deficientes vel parvuli in margine inter lobos positi. Corolla infundibuliformis vel cyathiformis, lobis postea plus minusve recurvatis; tubus c. 2,3 mm, intra annulo pilorum altitudine antherarum et stigmatum locatus; lobi c. 1,2 mm longi interdum pilis brevissimis, extra pilis rigidis vel usitatis. Stamina c. 2 vel 3,2 mm; antherae c. 0.6 mm; connectivum atratum. Stylus c. 1,5 vel 3,5 mm, praesertim parte infera pubescens; discus prominens. Fructus indehiscens, c. 2,5 mm. — T y p u s: *Axelius 158*, 5 Nov. 1982, at the base of the mountain, Santubong, Sarawak (S, holo; K, L, S, iso).

Monocaul dwarf up to 1 m tall. Upper parts with appressed hairs. *Blade* lanceolate to ovate, 5.5–27 by 2–7 cm, cuneate to attenuate at base, narrowing into an up to 3 cm long petiole, acute to caudate at apex, upper side with few hairs, lower side paler, sparsely but evenly pubescent; lateral veins 9–17 pairs; stipules lanceolate to narrowly triangular, caudate, c. 1 by 0.4 cm, green with hairy margins and midrib; colleters present. *Inflorescence* a panicle 1–4 cm long; branches spreading or slightly reflexed, occasionally with minute bracts; peduncle 1–2.5 cm. *Calyx* with a few ferrugineous hairs; tube very short; lobes triangular, c. 0.5 mm, in fruit spreading; colleters wanting or very small, situated at the margin between the lobes. *Corolla* infundibuliform to cyathiform, later with more or less recurved lobes; tube c. 2.3 mm, inside with a narrow ring of hairs situated at the level of anthers and of the stigma respectively; lobes c. 1.2 mm long, sometimes with very short and stiff or ordinary ferrugineous hairs outside. *Stamens* either c. 2 or c. 3.2 mm, glabrous; anthers c. 0.6 mm; connective dark coloured. Style either c. 1.5 or c. 3.5 mm long, pubescent, especially at lower part; disc prominent. *Fruit* indehiscent, c. 2.5 mm.

N o t e. This species is recognized by its hairy style and an inflorescence that is a small panicle. The other three species with hairy styles have different inflorescences, either spike-like and prolonged or with large bracts. The distribution is mainly centered around Santubong in Sarawak. The collections from Kalimantan are slightly different, with a hairiness of the flower that is much denser, especially on the corolla. Perhaps they will turn out to be a separate taxon. There are also a few divergent sheets, in very bad condition, wich suggest that there may be more undescribed hairy-styled species in Kalimantan.

C o l l e c t i o n s. Sarawak: Mile 15 Bau road, *Purseglove & Shah 4371* (K, L, SING); Bidi, *Ridley s.n.* (SING); Matang, *Ridley s.n.* (SING); Santubong: *Axelius 154* (K, S), *158* (K, L, S); *Beccari 2114* (FI, K); *Carrick & Enoch 210* (K, L); *Haviland & Hose 3399* (BM, K); *Paie 8305* (K, L); *Sinclair 38315* (BM, K, L); Sarawak River, *Haviland s.n.* (K). — Kalimantan, W: Mt Biong, Kapuas, *Teijsmann 8109* (FI, K, L). — Kalimantan, E: Loa Haur, Samarinda, *Kostermans 6945* (K, SING); Loa Djanan, Samarinda, *Kostermans 10798* (K, L).

20. Xanthophytum johannis-winkleri Merrill – Figs. 26, 27a.

Xanthophytum johannis-winkleri Merrill, Mitt. Inst. Allg. Bot. Hamb. 7 (1937) 271. — T y p e: *Hans Winkler 833*, 14 Dec. 1924, Bidang Menabei, West Borneo (HBG, lecto).

Monocaul dwarf. Only young leaves and upper part of new shoots with sparse ferrugineous indumentum. *Blade* elliptic to oblong, 8–19 by 3.5–7 cm, cuneate to attenuate at base, narrowing into an up to 5.5 cm long petiole, acute to caudate at

Fig. 26. *Xanthophytum johannis-winkleri* Merrill. a. Habit, × 0.35; b. microstylous flower, × 9 (a *Winkler 833*; b *Winkler 433*).

apex, upper side with a few hairs on the veins, lower side distinctly paler, sparsely pubescent at least on young leaves; lateral veins 12–17 pairs; stipules lanceolate, c. 0.6 cm long; colleters abundant. *Inflorescence* a panicle c. 2 cm long; branches spreading, lower ones c. 3 cm; bracts minute; peduncle c. 2.5 cm. *Calyx* sparsely hairy; tube very short; lobes triangular to rounded, c. 0.6 mm; colleters alternate with the calyx lobes. *Corolla* hairy outside, tubiform to infundibuliform, later with more or less recurved lobes; tube c. 2 mm, inside with a narrow ring of hairs; lobes c. 1 mm. *Stamens* in brevistyled flowers c. 3.2 mm, glabrous; anthers c. 0.6 mm. Style in brevistyled flowers c. 1.5 mm, glabrous. *Fruit* indehiscent, c. 2.5 mm.

N o t e. This species is known only from a few collections. With its small panicle it superficially resembles *X. pubistylosum* but the style is glabrous.

C o l l e c t i o n s. Kalimantan, W: Mt Klam, *Hallier 2501* (BO, K, L, SING, U); Bidang Menabei, *Hans Winkler 833* (HBG); Mt Mulu, *Hans Winkler 443* (HBG).

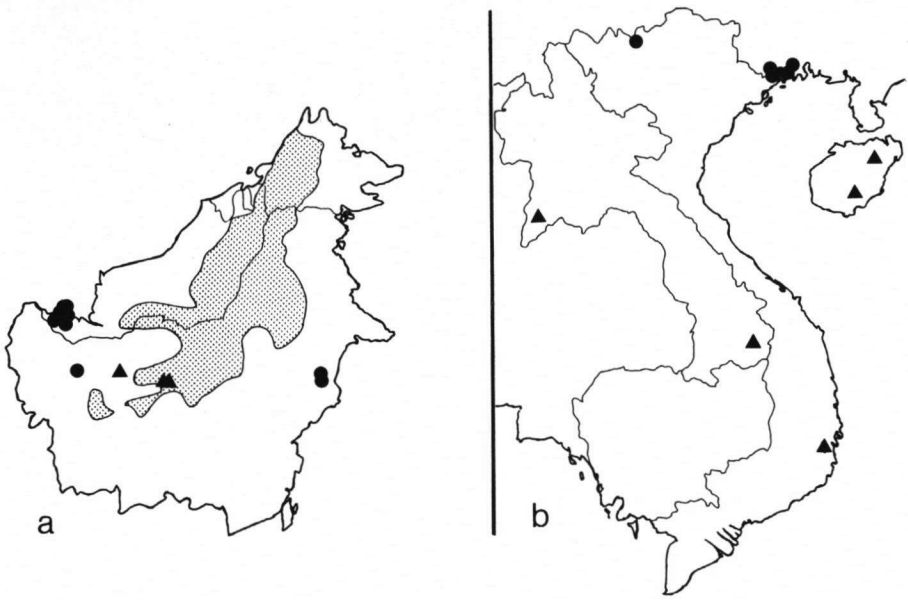

Fig. 27a. Known distribution of *Xanthophytum pubistylosum* Axelius (●) and *X. johannis-winkleri* Merrill (▲). — Fig. 27b. Known distribution of *X. kwangtungense* (Chun & How) Lo Hsien-Shui (●) and *X. attopevense* (Pierre ex Pitard) Lo Hsien-Shui (▲).

21. Xanthophytum kwangtungense (Chun & How) Lo Hsien-Shui – Figs. 27b, 28.

Xanthophytum kwangtungense (Chun & How) Lo Hsien-Shui, Bull. Bot. Res. 6 (4) (1986) 32. — *Xanthophytopsis kwangtungensis* Chun & How, Sunyatsenia 4 (1939) 14. — T y p e: *Tso 23359*, 20 July 1933, Sup-man-ta Shan, Na-fun village, Kwangtung (SYS, holo).

Monocaul dwarf, up to 1 m; younger parts densely brownish pubescent. *Blade* oblong to ovate, large, 5–20 by 2.5–7 cm, cuneate to attenuate at base, narrowing into an up to 2.5 cm long petiole, acute to acuminate at apex, lower side slightly paler than upper; lateral veins 9–16 pairs; stipules ovate to triangular, hairy, c. 1.2 by 0.5 cm; colleters present. *Inflorescence* a subsessile to shortly stalked, lax head, 1.5–2 cm in diam. *Calyx* pubescent outside, inside often with visible veins; tube very short or none; lobes long, band-shaped to slightly spatulate, varying in size, 1.7–4.1 by 1 mm; colleters five, alternate with the calyx lobes, often colourless. *Corolla* funnel-shaped; majority of lobes not recurved at anthesis; tube c. 2.2 mm, inside with a broad ring of hairs; lobes c. 1.3 mm long with stout multicellular hairs outside. *Stamens* either c. 1.9 or c. 2.5 mm long, glabrous; anthers c. 0.6 mm. Style either c. 1.6 or c. 2.7 mm, glabrous. *Fruit* totally split and up-rolled, crowned by the calyx lobes, c. 2 mm.

Fig. 28. *Xanthophytum kwangtungense* (Chun & How) Lo Hsien-Shui. a. Habit, × 0.35; b. macrostylous flower, × 9; c. microstylous flower, × 9 (a *Tsang 26721*; b *Tsang 29880*; c *Tsang 29015*).

N o t e. The holotype of this species was not sent on loan and thus only studied superficially on a photo. Since *X. kwangtungense* is very characteristic with its lax ample heads I judged this to be sufficient.

C o l l e c t i o n s. Vietnam: Laokai, *Wilson 2795* (K); Sai Wong Mo Shan, Dam-ha, *Tsang 29880* (C, G, K, L); Taai Wong Mo Shan, Ha-coi, *Tsang 27037* (C, K, P), *29015* (C, G, K, L, P); Taai Wong Mo Shan, Shui Mei, Ha-coi, *Tsang 29433* (C, G, K, L). — China: Shap Man Taai Shan, Shang-sze, *Tsang 22485* (BM, S); Pac-si, NE of Mon-cay, *Tsang 26923* (C, P); Kung P'ing Shan, T'aan Faan, *Tsang 26721* (C, K, P).

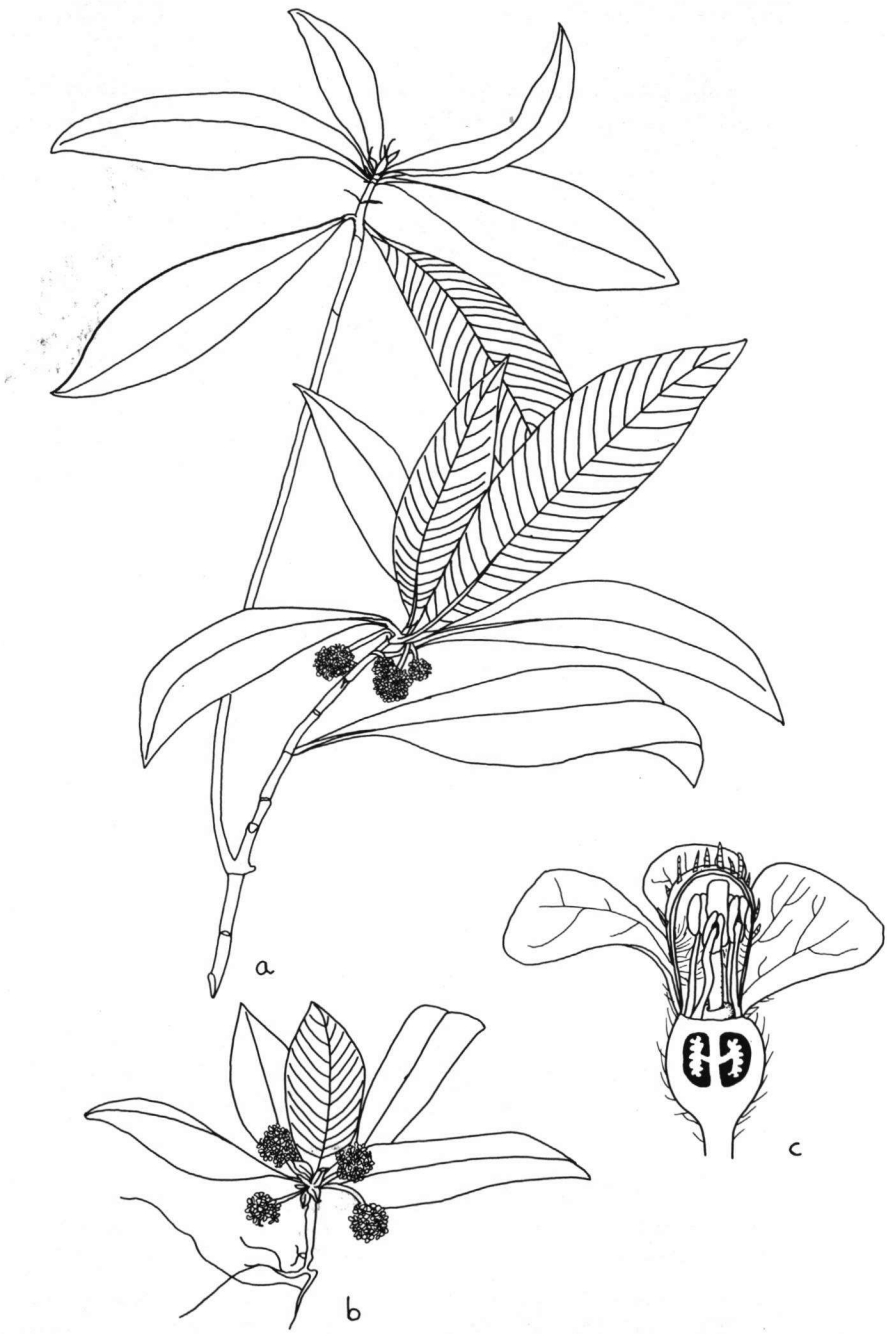

Fig. 29. *Xanthophytum attopevense* (Pierre ex Pitard) Lo Hsien-Shui. a, b. Habit, × 0.35; c. flower-bud, × 9 (a *Harmand 1099*; b, c *d'Alleizette s.n.*).

22. Xanthophytum attopevense (Pierre ex Pitard) Lo Hsien-Shui – Figs. 27b, 29.

Xanthophytum attopevense Lo Hsien-Shui, Bull. Bot. Res. 6 (4) (1986) 32. — *Paedicalyx attopevensis* Pierre ex Pitard in Lecomte, Fl. Gen. Indo-Chine 3 (1922) 88. — T y p e: *Harmand 1099*, sheet I, Feb. 1877, Phu Lek Pley, ENE of Attopeu, Bassac, Cochinchina (P, lecto; iso).

Monocaul dwarf or slender shrublet, all parts with a brownish indumentum. Young shoots with a lighter more shining indumentum. *Blade* broadly lanceolate to oblong, 11–20 by 3–5 cm, cuneate to attenuate at base, narrowing into an up to 2 cm long petiole, acute to acuminate at apex, upper side few-haired, lower side with hairs all over; lateral veins 20–24 pairs; stipules large, broad, ovate, acuminate at apex, c. 1.5 by 0.8 cm, hairy; colleters inconspicuous or none. *Inflorescence* dense, head-like, c. 1 cm; peduncle up to 1.5 cm. *Calyx* pubescent outside, glabrous inside, often with visible veins; tube very short; lobes slightly recurved, band-shaped to broadly spatulate, 1.5–2.5 mm long, up to 2 mm broad; colleters very sparse. *Flower* (according to Chun & How, 1939, and one examined bud): *Corolla* tubiform to slightly urceolate, in bud with a few hairs outside, later glabrous; tube c. 2 mm long, inside with a ring of hairs at the upper part; lobes c. 1 mm. *Stamens* adnate to the base of the corolla, c. 2 mm, glabrous; anthers c. 0.5 mm. Style c. 2.5 mm, glabrous. *Fruit* indehiscent, c. 2 mm.

N o t e s. As from all Indo-Chinese species the material is insufficient. Furthermore, I could not obtain a loan from Guangzhuo because of present flora work there on Rubiaceae. For *X. attopevense* the material available is also in very bad condition. The type-sheet contains an inflorescence in fruit and on one other sheet there are young buds. According to the picture in Chun & How (1939) the placement of the stamens and style seems to be that of a longistylous flower, though the authors do not mention anything about heterostylous flowers. The ring of hairs on the inside of the corolla is narrow on their picture, but this seems not to be the case in the examined bud.

One collection, *d'Alleizette s.n.*, June 1909, is completely stemless and has leaves and inflorescences in a rosette. Perhaps this turns out to be a distinct species, but by now, with no mature flowers known, I place it under *X. attopevense* because of its distinctly spatulate calyx lobes.

C o l l e c t i o n s. Laos: Pak-Lai, Mekong, *Thorel s.n.* (P); Phu-lek-Pley (Tey), Attopeu, *Harmand 1099* (P). — Vietnam: Nha Trang, *d'Alleizette s.n.* (L). — China, Hainan: Tongjia, Wenhua, *Liang 64654* (PE).

23. Xanthophytum polyanthum Pitard – Figs. 30, 32a.

Xanthophytum polyanthum Pitard in Lecomte, Fl. Gén. Indo-Chine 3 (1922) 91. — T y p e: *Eberhardt 3054*, Valley of Song Thuy-Cam, Prov. Thua-thiey, Vietnam (P, holo).

Monocaul dwarf with lower part of stem leafless, with light bark; indumentum often well developed. *Blade* broadly lanceolate to oblong, 9–30 by 3.5–8 cm, cuneate to attenuate at base, narrowing into an up to 5 cm long petiole, acute to acuminate at apex, upper side nearly glabrous, lower side hairy both on and between the

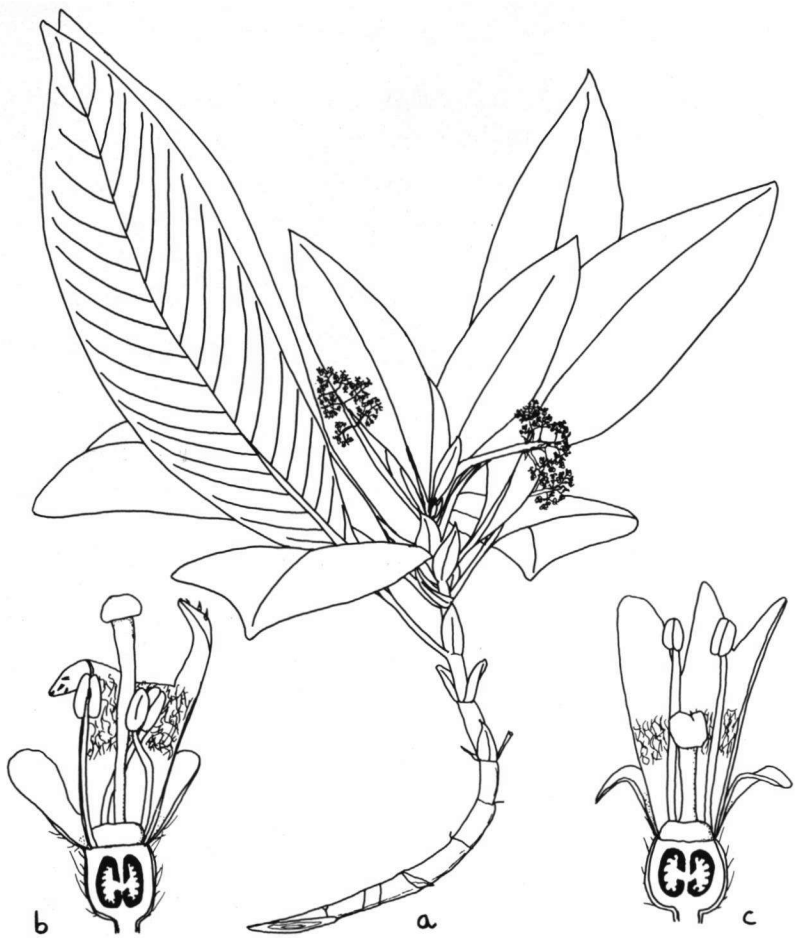

Fig. 30. *Xanthophytum polyanthum* Pitard. a. Habit, × 0.35; b. macrostylous flower, × 9; c. microstylous flower, × 9 (a *Clemens 3973*; b *Lau 3555*; c *Eberhardt 3054*).

veins; lateral veins 14–25 pairs; stipules large, broad, ovate, hairy at least on midrib and margins, c. 2 by 0.9 cm; apex acuminate and sometimes bifid. *Inflorescence* an up to 5 cm long panicle on an up to 6 cm long peduncle. *Calyx* pubescent outside, glabrous inside; tube very short; lobes band-shaped to ovate to sometimes slightly spatulate, 0.6–2.1 mm long; colleters sparse. *Corolla* tubiform to infundibuliform, glabrous or with a few stout hairs outside; tube c. 1.5–2 mm long, inside with a broad ring of hairs; lobes c. 0.5–1.5 mm, glabrous. *Stamens* loosely attached to the corolla for their lower third, either c. 2.5 mm or c. 3 mm, glabrous; anthers c. 0.6 mm. Style either c. 1.4 or c. 3 mm, glabrous. *Fruit* indehiscent, c. 2–3 mm.

N o t e. This species has a thick white stem, with leaves and inflorescences at the upper nodes. The flower-clusters are gathered together and the flowering seems

Fig. 31. *Xanthophytum balansae* (Pitard) Lo Hsien-Shui. a. Habit, × 0.35 (*Tsang 30704*).

ample. The size of the flower and fruit is varying, perhaps dividing the material into two types. Of the brevistyled flowers a few have a distinctly smaller corolla than the rest, representing the lower measurements for stamens and corolla above.

C o l l e c t i o n s. Vietnam: Kas pong, Hoa Binh, *Pételot s.n.* (P); Than-Hoa, *d'Alleizette s.n.* (L); Thuy-Cam River, Thua-thiey, *Eberhardt 3054* (P); Mt Bani, Da Nang, *Clemens 3973* (BM, G, K, U). — China, Hainan: Chim Fung Ling, Kan-en, *Lau 3555* (P, S).

24. Xanthophytum balansae (Pitard) Lo Hsien-Shui – Figs. 31, 32a.

Xanthophytum balansae Lo Hsien-Shui, Bull. Bot. Res. 6 (4) (1986) 31. — *Xanthophytopsis balansae* Pitard in Lecomte, Fl. Gén. Indo-Chine 3 (1922) 90. — T y p e: *Balansa 678*, 2 Nov. 1885, forêts au nord d'Ouonbi, Tonkin (P, holo).

Monocaul dwarf or slender shrublet, c. 1 m; upper parts with appressed, copper-coloured indumentum. *Blade* lanceolate to oblong, thin, 9–17.5 by 2.5–5 cm, cuneate to attenuate at base, narrowing into an up to 1 cm long petiole, acute to acuminate at apex, lower side distinctly paler than upper, lateral veins 11–15 pairs; stipules narrowly ovate with a strongly acuminate apex, whole length c. 1 cm, width c. 0.3 cm; a few colleters. *Inflorescence* a panicle up to 7 cm long and with branches up to 5 cm; bracts thin, small though sometimes leaf-like; peduncle 4–11 cm long. *Calyx* sparsely pubescent outside with visible veins; tube very short; lobes rounded to slightly spatulate, often overlapping, c. 1.8 by 1.2 mm; colleters small. Flowers not known. *Fruit* totally split and up-rolled, crowned by the calyx lobes, c. 2 mm.

Note. This species superficially resembles *X. calycinum*. It has the same thin light green leaves, slim copper-coloured stems, and a panicle. However, *X. calycinum* is said to be a small tree and they differ in the size of the panicle, i.e. the length of the peduncle and the side-branches, and the size and form of the calyx lobes. *Xanthophytum balansae* has shorter, more rounded lobes with a blunt apex which more resemble the calyx lobes of *X. attopevense*. The flowers are unknown, which is especially unfortunate since a flower of the New Guinae type would strengthen further the interesting connection between the Indo-Chinese and New Guinea species.

Collections. Vietnam: N of Ouonbi, *Balansa 678* (P); Kau Nga Shan, Tien-yen, *Tsang 30585* (G, K, L); Ho Yung Shan, Tien-yen, *Tsang 30704* (K, P). — China, Hainan: Sup Man Tai Shan, Shang-sze, *Liang 69884* (SYS, illustration only).

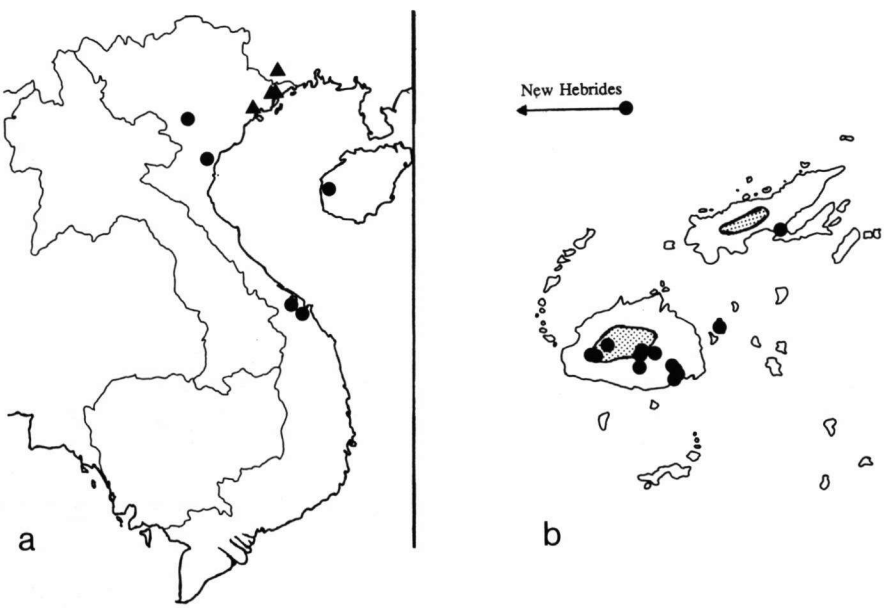

Fig. 32a. Known distribution of *Xanthophytum polyanthum* Pitard (●) and *X. balansae* (Pitard) Lo Hsien-Shui (▲). — Fig. 32b. Known distribution of *X. calycinum* (Gray) Benth. & Hook. ex Drake (●).

Fig. 33. *Xanthophytum calycinum* (Gray) Benth. & Hook. ex Drake. a. Habit, × 0.35; b. flower, × 9 (a *Parks 70142*; b *Parham 2204*).

Note on collections. I have not had the opportunity to examine the specimen from China. According to information obtained by Dr. Lo, there is only one sheet of *X. balansae* from China in herbarium SYS. It is *Liang 69884*, the particular specimen that is illustrated in the article by Chun & How cited above. This picture shows so clearly a specimen of *X. balansae* that I do not hesitate to list it among the examined collections.

25. Xanthophytum calycinum (Gray) Benth. & Hook. ex Drake – Figs. 32b, 33.

Xanthophytum calycinum (Gray) Benth. & Hook. ex Drake, Ill. Fl. Ins. Mar. Pacif. (1890) 186. — *Lerchea calycina* Gray, Proc. Amer. Acad. 4 (1859) 311. — T y p e: *U. S. Expl. Exped. US 48660*, 1840, Ovalau, Fiji (US, lecto, non vidi).
Note: The lectotype is chosen by Dr. A.C. Smith and Dr. S.P. Darwin in Flora Vitiensis Nova 4 (1988) 348–350..

Tree or treelet, 1–10 m high; younger vegetative parts with a golden to copper-coloured appressed indumentum. *Blade* lanceolate to oblong, thin, 5–20 by 1–5 cm, cuneate to attenuate at base, narrowing into an up to 2 cm (often shorter) petiole, acute to acuminate at apex, lower side distinctly paler than upper; lateral veins 10–21 pairs; stipules ovate to lanceolate, acuminate at apex, c. 0.7 by 0.3 cm, hairy; colleters present. *Inflorescence* a panicle up to 2 cm long; branches spreading after anthesis; bracts small; peduncle at anthesis c. 1.5 cm, in fruit longer, up to 4 cm. *Calyx* sparsely pubescent outside; tube very short; lobes slightly recurved, band-shaped to slightly spatulate, varying in size, 1.9–2.8 mm long, often with visible nerves; colleters sparse, colourless. *Corolla* tubiform with recurved lobes at anthesis; tube c. 3.2 mm, inside with a broad ring of hairs; lobes c. 1.3 mm, glabrous or just a few hairs outside. *Stamens* c. 3.7 mm, adnate to the corolla for most of their length; anthers placed just at the opening of the corolla tube, c. 0.7 mm. Style c. 4 mm, glabrous. *Fruit* on herbarium sheets found either split into two and sterile, or totaly split, up-rolled, and empty with the veins of the hypanthium left as an indistinct network; height of endocarp c. 2 mm, c. 1.8 times as long as wide, outline of flat side of mericarp ovate.

Notes. *Xanthophytum calycinum* is homostylous. Flowering material is abundant, but all collections show flowers with a long style protruding well beyond the hairy opening of the corolla tube. The stamens are adnate to the corolla for the main part of their length and the short filaments place the anthers just at the opening of the corolla tube surrounded by hairs. The ring of hairs is also very broad, filling the upper half of the tube. All these characters *X. calycinum* shares with the New Guinea taxa and they distinguish this group from the rest of the genus.

The fertility of the fruits is somewhat uncertain. On collections with totally split and uprolled fruit halves the capsules are of course empty. However, they have probably been full of mature seeds since seeds are often found loose on the sheet or saved in an envelope attached to the sheet. On the other hand, specimens that still have their fruits as two closed capsules, i.e. a state that precedes the uprolled one, are more or less sterile. The capsules contain no (or in a few cases, one to five) developed seeds. This may indicate the presence of two genetically different forms. Field work is needed to solve this problem.

Collections. Fiji. Viti Levu: Mt Korombamba, Rewa, *Gillespie 2331* (UC); *Parks 20140* (UC); N slopes of Mt Namendre, E of Mt Koromba, Mba, *Smith 4545* (K, L, S); N base of Korombasambasanga Rge, Wainavindram Creek, Namosi, *Smith 8664* (K); Korombasambasanga Rge, Namosi, *Parham 2204* (K); hills E of Navua R., Nakusere, *Smith 9106* (K, L, S, UC); Maquracagicagi, Medrausucu Rge, Naitasiri, *Kuruvoli & Mareko 15033* (K); Tamavua village, 7.5 miles from Suva, *Gillespie 2410* (DS, UC); Tamavua woods, 7 miles from Suva, *Gillespie 2113* (K, UC); Tholo-i-suva, Naitasiri, *Parks 20067* (CANB, UC). — Vanua Levu: Thakanndrove, Mt Mbatini, *Smith 658* (K, S, UC). — New Hebrides (Vanuatu): *Cheesman s.n.* (K).

26. Xanthophytum nitens Axelius, *spec. nov.* – Figs. 34, 36.

Frutex vel arbor parva, 1–2 m alta. Partes juvenes indumento aureo vel cupreo adpresso vestitae, foliis junioribus indumento argenteo et nitenti. Lamina lanceolata vel oblonga, tenua, 4–16,5 × 1,2–4 cm, basi cuneata vel attenuata et in petiolum ad 3 cm longum (saepe brevius) angustata,

apice acuta vel acuminata, supra nitida, subtus pallide viridis; nervis primariis 13–25 paribus; stipulae plus minusve acuminatae, cito cadentes, c. 0,9 × 0,3 cm, pubescentes. Inflorescentia paniculata laxa, in statu fructifero usque 4,5 cm longa, ramis effusis et bracteis parvis; pedunculus per anthesin c. 3 cm, in statu fructifero ad 7 cm longus. Calyx extra pubescens; tubus brevis; lobi recti, lanceolati vel anguste spathulati, 1,5–4 mm longi; colleteres pauci cum lobis calycis alternantibus. Corolla verosimiliter tubiformis lobis recurvatis; tubus minimum 2 mm longus, extra glaber, intra annulo pilorum denso et lato in parte supera ornatus; lobi c. 1 mm longi, glabri vel aliquot pilo-

Fig. 34. *Xanthophytum nitens* Axelius. a. Habit, × 0.35; b. flower, × 9 (a *Schodde 5377*; b *Katik 56253*).

rum. Stamina ad corollam adnata pro parte majore; antherae apud fila brevia locatae ad orificium tubi, c. 0,8 mm. Stylus minimum 2,5 mm. In speciminibus exsiccatis fructus paene semper in duobus partibus fissus, cassus; endocarpus c. 3,5 mm altus, c. 2,5 plo longior quam latior; circumferentia plana mericarpi oblonga vel obovata. — T y p u s : *Katik LAE 56253*, 17 June 1972, road to Mt Suckling, Rabaraba, 9°37' S,149°10' E, Milne Bay, Papua New Guinea (K, holo; CANB, L, LAE, iso).

Slender shrub or small tree, 1–2 m; younger parts with a golden to copper-toned appressed indumentum; on youngest leaves a silvery shiny indumentum. *Blade* lanceolate to oblong, thin, 4–16.5 by 1.2–4 cm, cuneate to attenuate at base, narrowing into an up to 3 cm long (often shorter) petiole; acute to acuminate at apex, upper side said to be glossy, lower side pale green; lateral veins 13–25 pairs; stipules more or less acuminate, soon deciduous, c. 0.9 by 0.3 cm, hairy. *Inflorescence* a loose panicle, in fruit up to 4.5 cm with spreading branches and small bracts; peduncle at anthesis c. 3 cm, in fruit up to 7 cm. *Calyx* pubescent outside; tube short; lobes straight, lanceolate to narrowly spatulate, 1.5–4 mm long; colleters one or a few, alternate with the calyx lobes. *Corolla* probably tubiform with recurved lobes; tube at least 2 mm long, outside glabrous, inside with a dense broad ring of hairs in the main upper part of the tube; lobes c. 1 mm long, glabrous or with a few hairs. *Stamens* adnate to the corolla for most of their length; anthers just at the opening of the tube, c. 0.8 mm. Style at least 2.5 mm, glabrous. *Fruit* on herbarium sheets nearly always found split in two and empty; height of endocarp c. 3.5 mm, c. 2.5 times as long as wide; outline of flat side of mericarp oblong to obovate.

N o t e s. Flowering material of this species is rare. The specimens that exist show homostyly and the same floral characters as *X. calycinum* and the rest of the New Guinea species. The style is protruding beyond the opening of the corolla tube, the anthers are placed at the throat and the filaments are adnate to the corolla for most of their length. They also seem to have had very low fertility since the fruit, even though it develops and splits into two, contains only undeveloped, or, in rare cases, one to five seeds.

This species shows characters of both *X. calycinum* and *X. papuanum*. The fact, though, that *X. calycinum* (except one collection from the New Hebrides) never has been found outside Fiji, makes any hypothesis of a hybrid origin unlikely.

C o l l e c t i o n s. New Guinea, Irian Jaya: *Mayer 481* (L). Note. The low number and the month given localize this collection to the eastside of the 'Vogelkop'. Whether the sheet is wrongly labelled or the species just under-collected in this part of New Guinea is impossible to say. — Papua: Astrolabe Rge, Port Moresby, *Stevens LAE 50405* (K, L, LAE); Mt Gauru, Rabaraba, Milne Bay, *Katik LAE 56253* (CANB, K, L, LAE); Mt Moiba, Simpson Rge, Milne Bay, *Schodde 5377* (K, L, LAE). — D'Entrecasteaux Islands: Mt Rumabubu, Normanby, *Benjamin LAE 67878* (LAE).

27. Xanthophytum papuanum Wernham – Figs. 35, 36.

Xanthophytum papuanum Wernham, J. Bot. 56 (1918) 70. — T y p e: *Forbes 769*, 1885-86, Mt Woriwori, Sogeri reg., New Guinea (BM, holo; L, iso).

Slender shrub or small tree (?), 0.5–2 m; younger parts with a copper-coloured appressed indumentum. *Blade* lanceolate to obovate or oblong, thin, 6–21 by 1.5–5

Fig. 35. *Xanthophytum papuanum* Wernham. a. Habit, × 0.35; b. flower, × 9 (a, b *Clemens 1763*).

cm, cuneate to attenuate at base, narrowing into an up to 3 cm long but often shorter petiole, acute to acuminate at apex, lower side paler than upper; lateral veins 12–26 pairs; stipules ovate, hairy especially at midrib and margins, total size 1.5 by 0.4 cm; apex acuminate, up to 1 cm long. *Inflorescence* a lax head, subsessile or with a short peduncle. *Calyx* pubescent outside with long thin hairs; tube short; lobes lanceolate,

2–4.6 mm long; colleters one or a few at the margin between the lobes. *Corolla* tubiform with recurved lobes; tube c. 4 mm long, outside glabrous, inside pubescent except for the lower fourth; hairs at the level of the anthers more or less straight and protruding, those lower down curly; lobes 1.5–2.5 mm long, hairy outside. *Stamens* adnate to the corolla for nearly all their length; anthers placed just at the opening of the tube, c. 1 mm long, thin. Style 4.2–6.2 mm long, glabrous. *Fruit* on herbarium sheets found either more or less split into two, empty, or totally split and up-rolled, empty; height of endocarp c. 3.4 mm, c. 2.5 times as long as wide, outline of flat side of mericarp oblong.

Note. This species is homostylous of the same type as the rest of the New Guinea group. Flowering seems ample but the fertility of the seeds seems to be low (see notes under *X. calycinum* and *X. nitens*). *Xanthophytum papuanum* is more hairy than the rest of the group, also on the flower.

Collections. New Guinea, Papua: Buso, Lae, *Kairo NGF 44210* (K, L, LAE); *Streiman NGF 45184* (L, LAE); Wareo, Morobe, *Clemens 1763* (G, L); Jatuna, Morobe, *Schlechter 17383* (C, G, K); Saru River, Garaina, Lae, *Streiman & students NGF 45021* (K, LAE); Mt Woriwori, Sogeri, *Forbes 769* (BM, L); Aisa River, Domara, *Brass 1409* (BM, K, P). — D'Entrecasteaux Islands: Esa'ala, *Fergusson 68673* (L, LAE).

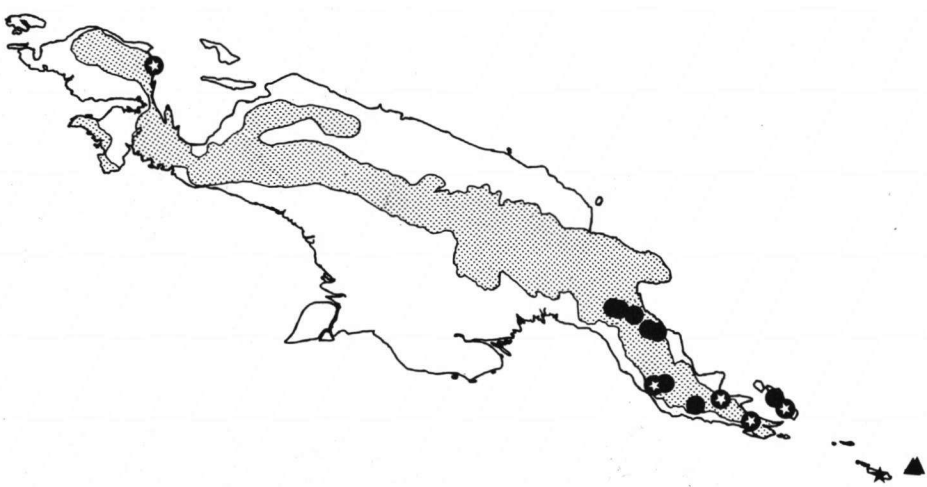

Fig. 36. Known distribution of *Xanthophytum nitens* Axelius (✪), *X. papuanum* Wernham (●), *X. grandiflorum* Axelius (★), and *X. magnisepalum* Axelius (▲).

28. Xanthophytum grandiflorum Axelius, *spec. nov.* – Figs. 36, 37a, 38a.

Frutex 0,5–2 m altus. Partes juvenes indumento aureo vel cupreo pallido, vestitae. Lamina lanceolata, tenua, 4,5–13,5 × 1–3 cm, basi cuneata vel attenuata et in petiolum ad 2 cm angustata, apice acuta vel acuminata, subtus leviter pallentior; nervis primariis 10–16 paribus; stipulae oblongae vel obovatae, omnino c. 1,2 × 0,4 cm apice caudato usque ad 0,8 cm longo incluso, subtus pubescentes; colleteres pauci. Inflorescentia sub anthesi capitulum laxum postea paniculam breviter

Fig. 37. a. *Xanthophytum grandiflorum* Axelius, × 0.35 (*Brass 27946*); b. *X. magnisepalum* Axelius, × 0.35 (*Brass 28481*).

ramosam pedunculo 7–9 cm longo. Calyx parum pubescens; tubus brevis; lobi recti, lanceolati, 3,8–5,2 mm longi; colleteres pauci, pallentes, cum lobis calycis alternantibus. Corolla tubiformis lobis effusis; tubus c. 5 mm longus, extra glaber, intra annulo pilorum denso in dimidio superiore ornatus; lobi c. 2,2 mm longi, extra ad venam pilis paucis vestiti. Stamina pro parte majore corollam adnata; antherae c. 1,3 mm. Stylus c. 6,3 mm. Fructus in speciminibus exsiccatis plus minusve in duobus partibus fissus, calyce praesenti, vel veterior omnino fissus, volutus et sine calyce sed cum venis hypanthii crassis quasi reticulatim persistentibus; endocarpus c. 4,8 mm altus; c. 3,1 plo longior quam latior; circumferentia plana mericarpi oblongus vel obovatus. — T y p u s: *Brass 27946*, 31 Aug. 1956, Mt Riu, Sudest Isl., Papua New Guinea (K, holo; CANB, L, LAE, iso).

Shrub 0.5–2 m tall; younger parts with golden to light copper-coloured indumentum. *Blade* lanceolate, thin, 4.5–13.5 by 1–3 cm, cuneate to attenuate at base, narrowing into an up to 2 cm long petiole, acute to acuminate at apex, lower side just slightly paler than upper; lateral veins 10–16 pairs; stipules oblong to obovate,totally c. 1.2 by 0.4 cm with an up to 0.8 cm long tail-like apex, hairy beneath; colleters few. *Inflorescence* at anthesis a lax head, later a short branched panicle on a 7–9 cm long peduncle. *Calyx* very sparsely pubescent; tube short; lobes straight, lanceolate, 3.8–5.2 mm long; colleters a few, light-coloured, alternate with the calyx lobes. *Corolla* tubiform with spreading lobes; tube c. 5 mm, outside glabrous, inside with a

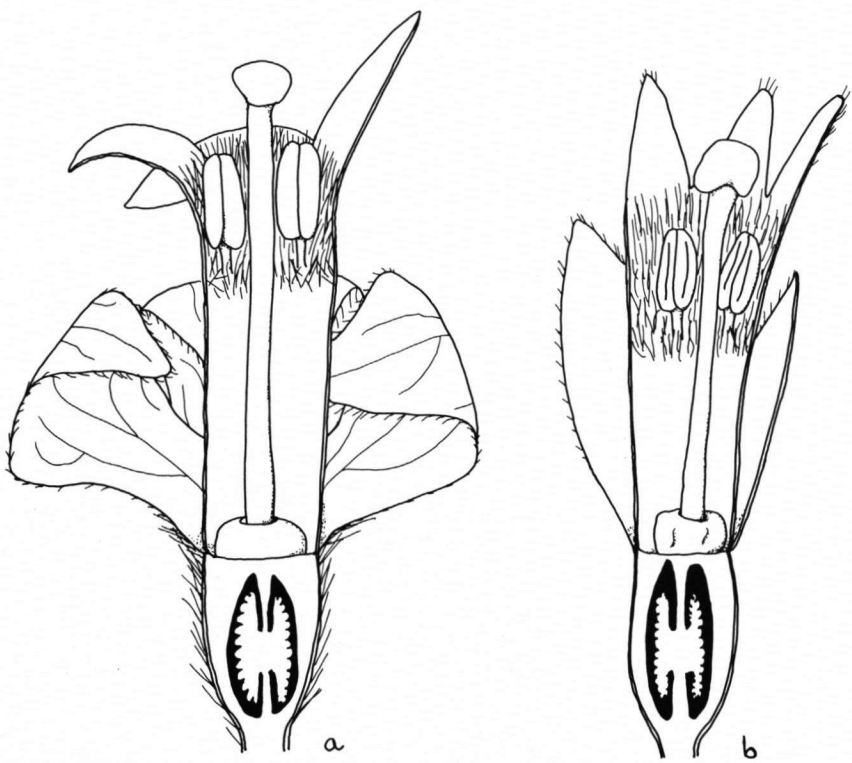

Fig. 38. a. *Xanthophytum grandiflorum* Axelius, flower × 9 (*Brass 27946*); b. *X. magnisepalum* Axelius, flower × 9 (*Brass 28481*).

dense ring of hairs in the upper half; lobes c. 2.2 mm, outside with a few hairs along the vein. *Stamens* adnate to the corolla for most of their length; anthers c. 1.3 mm. Style c. 6.3 mm, glabrous. *Fruits* on herbarium sheets found more or less split into two with the calyx still present, or older and totally split and up-rolled without calyx but with the thickened veins of the hypanthium visible as a network; height of endocarp c. 4.8 mm; c. 3.1 times as long as wide; outline of flat side of mericarp oblong to obovate.

N o t e. All the measurements are from one collection only and are therefore tentative. The flowers show the same characters as *X. calycinum* and the rest of the New Guinea taxa and I regard the species as homostylous. The seeds are few in each locus but all seem well developed.

C o l l e c t i o n. New Guinea, the Louisiades, Sudest Isl: Mt Rui, *Brass 27946* (CANB, K, L, LAE).

29. Xanthophytum magnisepalum Axelius, *spec. nov.* – Figs. 36, 37b, 38b.

Frutex vel arbor parva, 1,5–3 m alta. Partes juvenes vegetativae indumento cupreo pallido vel aureo vestitae. Lamina lanceolata vel oblonga, tenua, 9,5–20 × 2,5–6 cm, basi cuneata vel attenuata et in petiolum ad 3 cm longum angustata, apice cuneata vel acuminata, subtus leviter pallentior; nervis primariis 14–22 paribus; stipulae ovatae, membranaceae non nisi venis marginibusque indumenta, omnio 1,5 × 0,7 cm; apice acuminata, usque ad 0.8 cm longa; colleteres praesentes. Inflorescentia sub anthesis, laxe capitulata brevipedunculata, in statu fructifero paniculata pedunculo usque 3,5 cm longo. Calyx cupulatus, tubo et basi loborum parum pubescens; tubus brevis; lobi magni, rotundati vel spathulati, venis manifestis, imbricati, 4–6 × 2,5–3,5 mm; colleteres atrati . Corolla tubiformis lobis recurvatis; tubus c. 5 mm longus, extra glaber, intra annulo pilorum denso in dimido superiore ornatus; lobi c. 3 mm longi, extra pilis paucis. Stamina pro parte majore corollam adnata; antherae ad orificium tubi locatae, c. 1,4 mm. Stylus c. 7 mm. Fructus in speciminibus exsiccatis plus minusve in duobus partibus fissus calyce persistenti, vel veterior omnino fissus, volutus et sine calyce sed venis hypanthii crassis quasi reticulatim persistentibus; endocarpus c. 6,3 mm altus; c. 3,5 plo longior quam latior; circumferentia plana mericarpi oblongus. — T y p u s: *Brass 28481*, Mt Rossel, Rossel I., Papua New Guinea (L, holo; K, LAE, iso).

Shrub or small tree, 1.5–3 m, younger vegetative parts with a light copper-coloured to golden indumentum. *Blade* lanceolate to oblong, thin, 9.5–20 by 2.5–6 cm, cuneate to attenuate at base, narrowing into an up to 3 cm long petiole, cuneate to acuminate at apex, lower side just slightly paler than upper; lateral veins 14–22 pairs; stipules ovate, membranaceous with hairs only along the veins and margins, totally 1.5 by 0.7 cm; apex acuminate, up to 0.8 cm long; colleters present. *Inflorescence* a short-peduncled lax head, in fruit becoming a panicle with a peduncle up to 3.5 cm long. *Calyx* cup-shaped, sparsely hairy on tube and base of lobes; tube short; lobes large, rounded or short-stalked spatulate, with visible veins, overlapping, 4–6 by 2.5–3.5 mm; colleters dark. *Corolla* tubiform with recurved lobes; tube c. 5 mm long, outside glabrous, inside with a dense ring of hairs in the upper half; lobes c. 3 mm long, outside with a few hairs. *Stamens* adnate to the corolla for nearly all their length; anthers placed just at the opening of the tube, c. 1.4 mm. Style c. 7 mm, glabrous. *Fruit* on herbarium sheets found more or less split into two with calyx still present, or older totally split and up-rolled, without calyx but with the

thickened veins of the hypanthium left as a network; height of the endocarp c. 6.3 mm; c. 3.5 times as long as wide; outline of split fruit oblong.

N o t e. The flowers show the same characters as *X. calycinum* and the rest of the New Guinea taxa and I regard the species as homostylous. The calyx lobes are so large and special that no problems will arise in identifying this new species. The seeds are few in each loculus but all seem well developed.

C o l l e c t i o n s. New Guinea, Louisiades, Rossel I.: Mt Rossel, *Brass 28481* (K, L, LAE, S); Mt Kwa, Abilete, *Henty 27088* (K, L, LAE).

30. Xanthophytum capitellatum Ridley – Figs. 24a, 39.

Xanthophytum capitellatum Ridley, Fl. Mal. Penin. 5 (1925) 316. — *Xanthophytum capitatum* Ridley, J. Fed. Mal. Stat. Mus. 10 (1920) 139, nom. illeg., non Valeton (1910). — T y p e: *Ridley s.n.*, 3 Feb. 1917, Pehi River, Kelantan, Malaysia (K, holo).

Fig. 39. *Xanthophytum capitellatum* Ridley, × 0.35 (*Ridley s.n.*).

Monocaul dwarf (?), c. 30 cm tall, slender. All vegetative parts with a ferrugineous indumentum. *Leaves* pseudo-alternate, i.e. one leaf at each node suppressed, ovate to oblong; blade 15–21.5 by 6–9 cm, cuneate to attenuate at base, narrowing into an up to 2.5 cm long petiole, acute to acuminate at apex, lower side slightly paler than upper; lateral veins 16–19 pairs; stipules broadly ovate, acuminate at apex, c. 0.9 by 0.6 mm, hairy especially at the margins. *Inflorescence* of short peduncled dense heads. *Calyx* pubescent outside; tube none; lobes unequal in size, 0.5–1 mm long; colleters five, alternate with the calyx-lobes. *Corolla* white, not seen. *Fruit* indehiscent, c. 2 mm.

N o t e. Ridley described this species from Kelantan. Its diagnostic characters are the pseudo-alternate leaves and the head-like inflorescence. Except the type specimen no other *Xanthophytum* with alternate leaves exists. I suspect that Ridley's type is just a divergent specimen. I have seen a second sheet with head-like inflorescence from Malaya, *Moysey & Kiah 33734,* but this has opposite leaves. The two specimens from Malaya differ slightly from each other, but both lack flowers and could be interpreted as atypical *X. ferrugineum.* They differ, however, from that species in having larger leaves, smaller fruits and no hairs on the inside of the calyx lobes. Without any flowering specimens from Malaya I refrain from reducing this species into a synonym.

C o l l e c t i o n s. Malaysia: Pehi River, Kelantan, *Ridley s.n.* (K); Ulu Brang, Terengganu, *Moysey & Kiah 33734* (K).

EXCLUDED TAXON

Xanthophytum biceps Ridley, Fl. Mal. Penin. 5 (1925) 316. — In the description of this species Ridley stated that the diagnostic character is the absence of ferrugineous hairs. This shows that it does not belong to *Xanthophytum.* Unfortunately, I have not found the type, *Burkill 17463.* It ought to have been in SING where Burkill left most of his material. My guess is that it became reidentified at an early stage and relocated in the herbarium without any cross reference.

SPECIES VARIATION

In this treatise I present thirty species. I have found no need for infraspecific taxa. The species of *Xanthophytum* have generally not been problematic to recognize. I have used the morphological species concept and with a few exceptions, the specimens have been easily classified. The problems and questions raised are presented in the note(s) under each species.

Often tropical genera comprise many more or less endemic species and one or two very widespread 'weeds'. This is not the case in *Xanthophytum,* where no species could be regarded as widespread. Besides the local endemic, with small variation and limited distribution, and the homogeneous, moderately widely distributed species, there are in *Xanthophytum* also some species with small gaps either in the character variation, i.e. *X. semiorbiculare, X. attopevense,* or in the distribution, i.e. *X. olivaceum, X. pubistylosum,* and *X. ferrugineum.* These species could be examples of speciation in progress but, perhaps more likely, of under-collecting.

PHYLOGENETIC ANALYSIS

The interrelationships of *Xanthophytum* and related genera, *Lerchea* and *Pomazota* (*Coptophyllum* Korthals), were discussed in an earlier article (Axelius, 1987). Here I have studied the relationships within *Xanthophytum* itself.

The natural choice of an outgroup for character polarization is *Lerchea* or perhaps *Pomazota*. Both of these were tried but with very uninformative results. Because of the variability of the characters a lot of them were found in many states or in a different state in the outgroup. This resulted in a vast amount of trees giving a consensus tree with highly unresolved lower nodes. The favourable situation found in *Lerchea* (Axelius, 1987), with one divergent taxon, displaying a majority of plesiomorphic character states and thus usable as a functional outgroup, did not occur in *Xanthophytum*. In the analyses with either *Lerchea* or *Pomazota* as outgroup, *X. involucratum* often came out as sister species to the rest of the genus but sometimes it was nested well inside the cladogram. Hence I did not want to use *X. involucratum* as a functional outgroup. The next try was to use only one species in *Lerchea* or *Pomazota* as an outgroup. *Lerchea corymbosa* was the natural choice since it is so surely moored at the bottom of the *Lerchea* cladogram (Axelius, 1987: fig. 15). Still, two characters could not be polarized since the relevant states were not found in the outgroup *L. corymbosa*.

The characters used, their states, and the resulting matrix over the character distribution are presented in table 1 and figure 40.

The two characters that could not be polarized, nrs 7 and 8, are both of the inflorescence. Unlike *Xanthophytum, Lerchea* has terminal inflorescences and, moreover, very special ones. They are neither paniculate nor head-like and consequently have no panicle branches.

Xanthophytum capitellatum was excluded from the analysis since it is too vaguely known. With no corolla characters and with the majority of the remaining characters in the plesiomorphic state its unclear relationships obscure the patterns in the analysis.

The computerized parsimony analysis resulted in one cladogram presented in figure 41. Despite the single solution the cladogram is rather susceptible. Many nodes are supported by a parallelism or a reversion only and very few nodes by more than one synapomorphy. The consistency index is 0.62 and the length 56 steps.

Xanthophytum involucratum comes out as the sister species to the rest of the genus. It is worth noticing that this species closely resembles the genus *Pomazota* in habit. *Pomazota* is the proposed sister genus to *Xanthophytum* and *Lerchea*. The rest of the species, except *X. sessile* with a solitary position, are divided among three main branches, at node A, B, and C (fig. 41).

Branch A is fairly well defined. The species occur in W and E Borneo and are recognized by their partly adnate filaments and tubiform flowers. The form of the flowers are due to the combination of relativly long corolla tube and short corolla lobes. Only the filament character, nr 20, is found as a synapomorphy at node A. The other, nr 17, is found one node above; this is due to the reduction of size in *X. minus*. Narrow, often crescent-formed anthers are also typical of this branch, though

Table 1. Character states used in the analysis of *Xanthophytum*.

Leaves		
1.	With ferrugineous hairs.	(1)
	Without ferrugineous hairs.	(0)
2.	With setose hairs (fig. 1b).	(1)
	Without setose hairs.	(0)
3.	Light greyish green, thin.	(1)
	Darker, thicker.	(0)
Stipules		
4.	Triangular to narrowly ovate, not foliaceous.	(1)
	Obovate to ovate, foliaceous.	(0)
5.	Apex caudate.	(1)
	Acute to rounded.	(0)
Inflorescence		
6.	Prolonged between anthesis and fruit.	(1)
	Not prolonged.	(0)
7.	Peduncle at anthesis long, maximum length > 7 cm.	(1)
	Short, maximum length < 7 cm.	(0)
8.	A panicle, at least in fruit.	(1)
	Head-like.	(0)
9.	Side-branches long (c. 5 cm), flowers lax.	(1)
	Side-branches short, flowers clustered.	(0)
Calyx		
10.	Lobes ovate to spatulate, not broadest at base.	(1)
	Triangular, broadest at base.	(0)
11.	Lobes thin, often with visible veins	(1)
	Thick	(0)
12.	Tube present, combined with long lobes.	(2)
	Tube present, no lobes.	(1)
	No tube.	(0)
13.	Outside with short stiff hairs (fig. 1c).	(1)
	Outside without short stiff hairs.	(0)
14.	Inside of lobes densely hairy.	(2)
	Hairy.	(1)
	Glabrous.	(0)

(Table 1 continued)

Corolla

15. Calyx and corolla densely hairy. (1)
Slightly hairy to glabrous. (0)

16. Outside with broad sturdy hairs (fig. 1d). (1)
Outside without broad sturdy hairs. (0)

17. Medium, i.e. > 5.5 mm; tube > 4 mm and lobes > 1.5 mm. (2)
Small, i.e. 4.5–5.5 mm; tube > 3.5 mm but lobes < 1.5 mm. (1)
Minute, i.e. < 4.4 mm; tube < 3.5 mm and lobes < 1.5 mm. (0)

18. Hair-ring on inside narrow. (1)
Broad. (0)

19. Homostylous flowers with the anthers at the opening of the tube and a stigma well above the tube. (3)
Homostylous with the anthers at the hair-ring and the stigma just above. (2)
Homostylous with a style prolonged during anthesis. (1)
Heterostylous. (0)

Stamens

20. Filaments completely free from corolla or fused only at lower margin. (2)
Adnate for 1/3 to 2/3 of their length. (1)
Adnate for most of their length. (0)

21. Filaments hairy. (1)
Glabrous. (0)

Gynoecium

22. Style very hairy, especially at upper part. (2)
Hairy at lower part. (1)
Glabrous. (0)

23. Disc divided. (1)
Entire. (0)

24. Fruits dehiscent into two loculi. (1)
Indehiscent. (0)

25. Fruits big, > 3.3 mm. (2)
Medium, c. 3 mm. (1)
Small, ≤ 2.5 mm. (0)

26. Fruit ovate in outline. (1)
Round in outline. (0)

27. Distinct network of veins visible on the dry hypanthium. (1)
No or very obscure veins. (0)

this character has proved hard to define and is hence not used in the analysis. The weakness of this branch is perhaps to be found in the inclusion of the species-pair *X. grandifolium* and *X. cylindricum*. They have characters in common with species of branch B, for example *X. brookei*, with the same small stiff hairs on the outside of the calyx (character nr 13). Note also that *X. semiorbiculare* has three autapomorphies as parallelisms in common with branch C.

Character no	12345 67etc ...
Outgroup	00000 0--00 00000 00000 00000 00
X. alopecurum	10010 01100 00000 00102 00000 00
X. attopevense	10010 00001 10000 10-02 00000 00
X. balansae	10110 00111 10000 ----- ---10 00
X. borneense	10010 01100 00011 00102 00001 00
X. brookei	10010 01110 00100 00102 00000 00
X. calycinum	10110 10101 10000 00030 00110 00
X. capitatum	11010 00000 00021 00102 00000 00
X. cylindricum	10010 00100 00100 01001 12000 00
X. ferrugineum	10010 00000 00011 00122 00001 00
X. foliaceum	10000 00000 00000 01001 0000- 00
X. fruticulosum	10010 00100 00011 00122 00001 00
X. glabrum	10010 01110 00000 00102 00000 00
X. glomeratum	10000 00000 02010 01001 00000 00
X. grandiflorum	10111 10101 10000 02030 00112 11
X. grandifolium	10010 01100 00100 01001 12000 00
X. involucratum	10000 00000 00000 00102 00000 00
X. johannis-winkleri	10010 00100 00000 00102 00000 00
X. kwangtungense	10010 00001 10000 10002 00010 00
X. longipedunculatum	10010 01100 01000 00102 00000 00
X. magnisepalum	10111 10101 10000 02030 00112 11
X. minus	10010 00000 00010 00001 00000 00
X. nitens	10110 10101 10000 00030 00112 10
X. olivaceum	10010 00100 00011 00102 00001 00
X. papuanum	10-11 00001 10001 02030 00112 10
X. polyanthum	10010 00101 10000 10002 00001 00
X. pubistylosum	10010 00100 00000 00102 01000 00
X. semiorbiculare	10000 00001 12010 0100- 00010 00
X. sessile	10010 00000 00000 00012 00000 00
X. setosum	11010 00100 00021 00102 00000 00

Fig. 40. Character state distribution matrix. The numbers correspond to the numbers in table 1 and in the cladogram in figure 41. (– = no relevant state present).

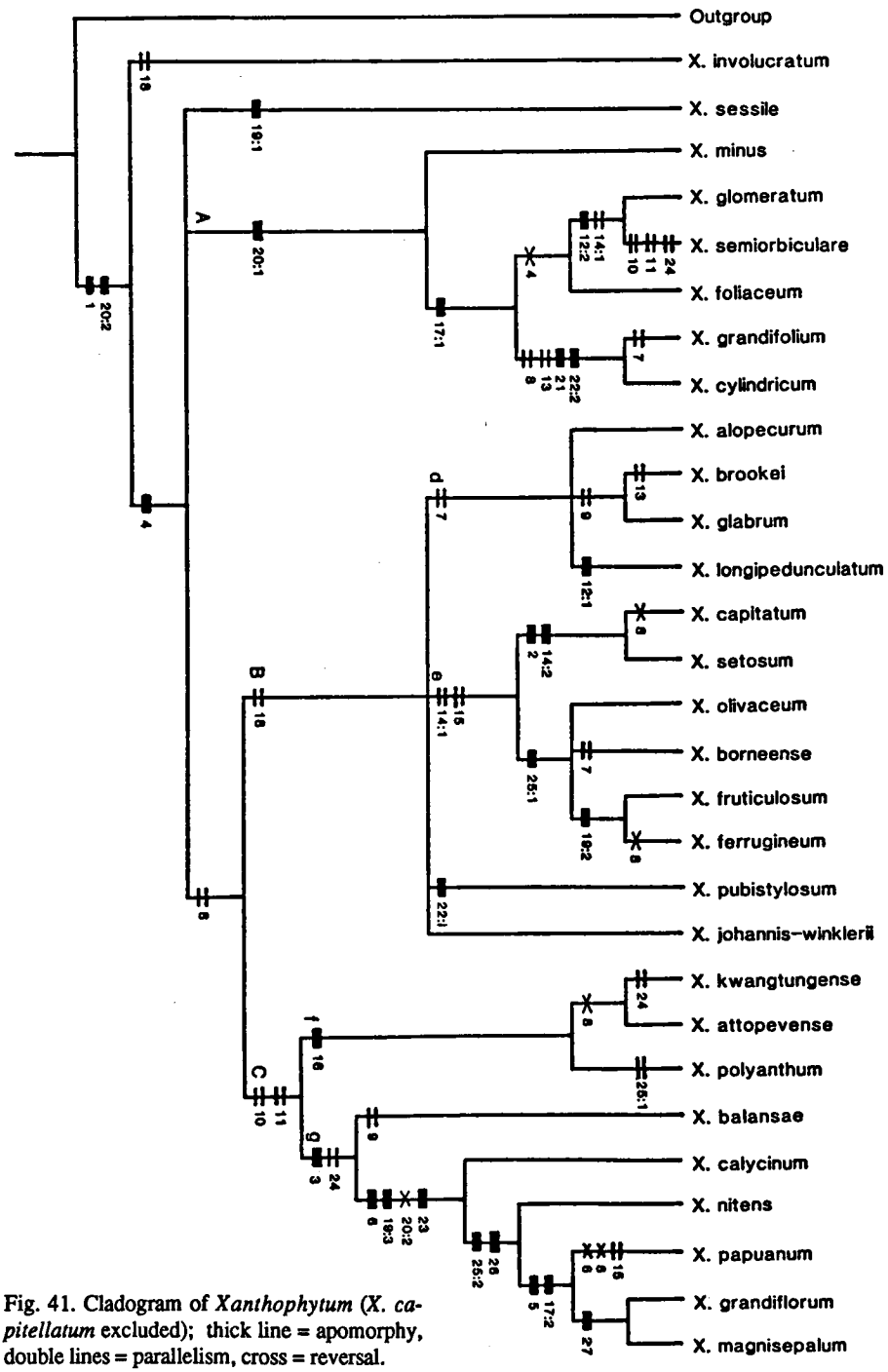

Fig. 41. Cladogram of *Xanthophytum* (*X. capitellatum* excluded); thick line = apomorphy, double lines = parallelism, cross = reversal.

Branch B is the most weakly supported group. Although it is easily recognized by its small flowers and free stamens, these characters are plesiomorphic. The only synapomorphy, nr 18, a narrow hair-ring at the inside of the corolla, is weakened by its occurrence as a parallelism in *X. involucratum*. The species united at node d occur in W and N Borneo, the species at node e in W and E. The species group united at node e seems fairly well supported, even though the hairiness at the inside of the calyx also occurs as a parallelism in branch A. The two species-pairs *X. fruticulosum–X. ferrugineum* and *X. capitatum–X. setosum* are among the strongest groupings in the cladogram, supported by stable synapomorphies. Note also that in each of these species pairs the panicle is reduced into a head-like inflorescence. The placement of the two ungrouped species *X. pubistylosum* and *X. johannis-winkleri* in branch B, appears to me to be likely, since their inflorescences, viz. small delicate panicles, connect well with those of, for example, *X. olivaceum* and *X. fruticulosum*.

Branch C, finally, is well defined. The two synapomorphies, nrs 10 and 11, concern the form and type of calyx lobes. Strangely enough *X. semiorbiculare* of branch A also shows these two characters. Perhaps they are connected in some way with character nr 24, dehiscent fruits, which also occurs in *X. semiorbiculare*. The species at node g are easily recognized by their light greyish-green leaves (character nr 2), type of homostylous flowers (nr 19) and dehiscent fruits (nr 24). They occur in New Guinea and the Louisiades. Since the flower of *X. balansae* is unknown, the position of this species could be either outside or inside this group. The detailed sequencing above node g is also supported by good synapomorphies. The remaining group at node f, from China and Indo-China, is defined by a very special type of hairs (character nr 16). The more detailed arrangement above node f is based on the changeable inflorescence states and hence weak.

BIOGEOGRAPHY AND AREA INTERRELATIONSHIPS

Theories of biogeography

The area of Malaya and the Indonesian Archipelago has always been in the focus of interest for systematists and biogeographers. To the zoologists Wallace's Line, which goes right through the area, has been a striking borderline and to the botanists Malaya, with its abundance of primitive angiosperm families, has been presented as the cradle of the angiosperms (Takhtajan, 1969). One aim of my study has been to produce an area cladogram based on the cladistic analysis of the species included, thereby hopefully contributing to the understanding of the interrelationships within the area.

Biogeography of today has developed a long way since the time when present-day distribution patterns were explained by long-distance dispersal or by land-bridges. Even if some authors (Darlington, 1965; Raven & Axelrod, 1974) merely seem to adjust Darwinian dispersal hypotheses to more modern geological theories, most biogeographers of today have a theoretical background based on generalized tracks and vicariance events as explored by Croizat (1964; Croizat et al., 1974). A further development, cladistic biogeography, where both the identification of areas and their

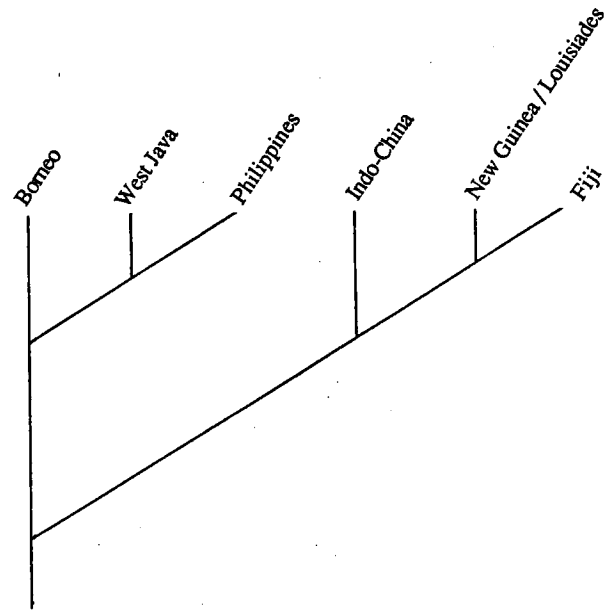

Fig. 42. Area cladogram derived from the *Xanthophytum* cladogram in figure 41.

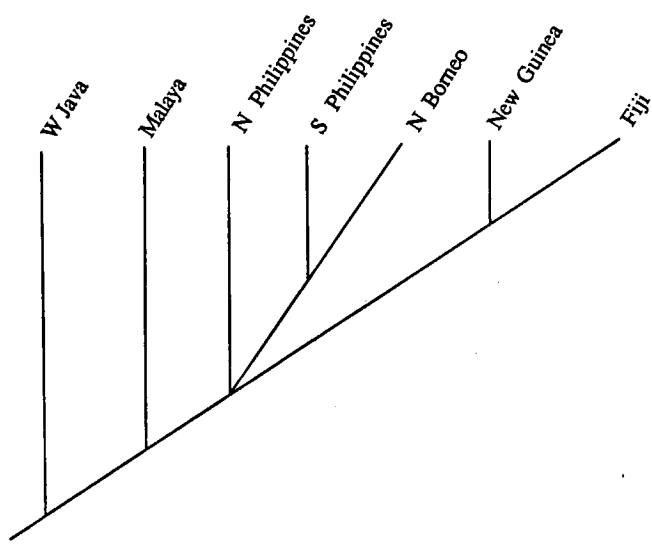

Fig. 43. General area cladogram after Schuh & Stonedahl 1986: fig. 11. Not discussed areas are excluded.

interrelationships are based on falsifiable statements, was introduced by Platnick & Nelson (1978). Individual taxonomic cladograms are substituted with their area cladograms and added to form a general area cladogram (Nelson & Platnick, 1981; Humphries & Parenti, 1986).

Note that a lot of dendrograms of the affinities of the floras and faunas of the different islands in the Malay Archipelago have been constructed in attempts to solve their interrelationships. These dendrograms are not discussed here. They are not comparable to the area cladograms since they must be regarded as phenograms. Furthermore, they are based mainly on wide-spread species and exclude the endemics which contain most information about possible vicariance events.

Results of area analysis

When the species of *Xanthophytum* in figure 41 are substituted with their areas and redundant branches are deleted we obtain the area cladogram as shown in figure 42. The Indo-China area includes the island Hainan and the mountains on the Tonkin/Kwangsi border.

How does this fit into the general area cladogram of the area? The one presented so far is by Schuh & Stonedahl (1986: fig. 11). Figure 43 shows their cladogram redrawn and reduced to the areas of interest here. If we compare the two, there is an incongruence in the placement of West Java. Furthermore, the cladogram in figure 43 differs in having North Borneo as an area of endemism by itself and in having the Philippines divided into a north and a south part. Indo-China does not occur in the general area cladogram of Schuh & Stonedahl.

If we want to add the knowledge of the area interrelationships of figure 42 to the general area cladogram, we have to look into these differences. The Indo-China area represents no problem, it is easily addible. Albeit Schuh & Stonedahl did not explicitly define their areas, I feel rather certain that their South Philippines is south central Mindanao and that their North Philippines is the rest of the Philippines, i.e. an area that corresponds to the Philippines of figure 42. Regarding North Borneo of figure 43 it has to be sunk into Borneo since the *Xanthophytum* distributions do not satisfactory support any subdivision of the island. Last we have the real problem, the incongruence of West Java. In the area cladogram for *Xanthophytum,* West Java is placed closest to the Philippines and is not regarded as sister area to all the other areas as in figure 43. If a single taxon-area cladogram fails to fit a general pattern, based on many different groups, this is perhaps best explained by a divergent history. This is not the case here though, since Schuh & Stonedahl's hypothesis for West Java is based on one area cladogram only, from an analysis of the genus *Myiocapsus* (Miridae, Heteroptera, Insecta). Generally, incongruence problems could be solved either by forming a consensus solution (Nelson & Platnick, 1981; Page, 1989) or by using the Wagner parsimony criterion (Miyamoto, 1987). The latter approach is, though correct, difficult to handle since it needs appropriate coding methods. The first is the one usually used, though it has the disadvantage of all consensus solutions: hidden information.

In cases like this, with only two incongruent placements of an area, I think it is better to display both positions until new information could solve the discrepancy.

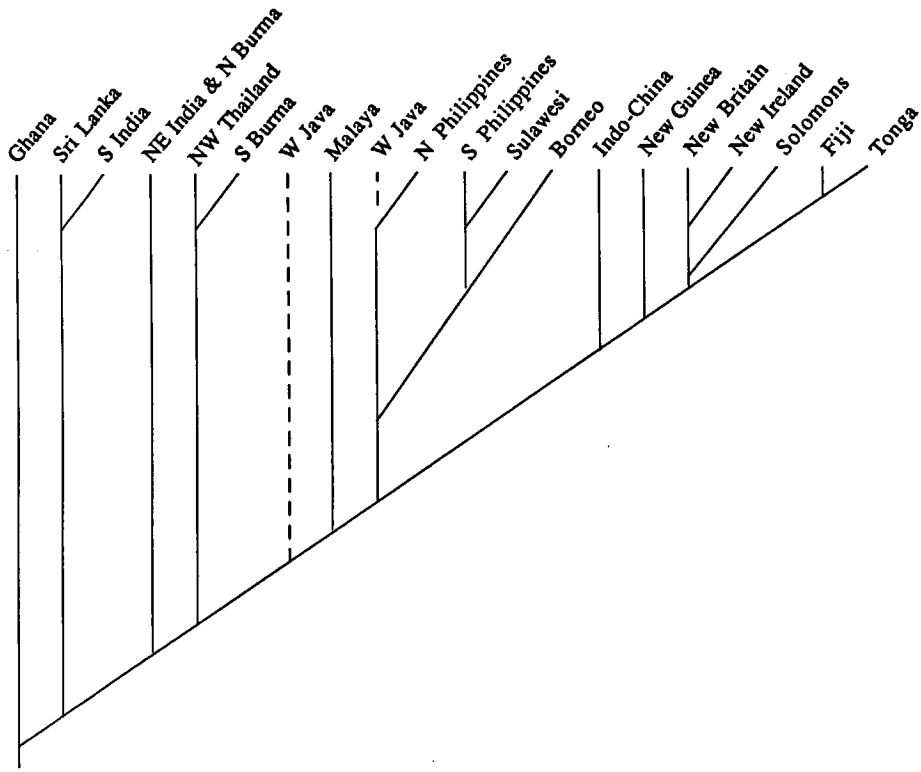

Fig. 44. New extended general area cladogram for the Indo-Pacific area.

Hence a new area cladogram for the Indo-Pacific is presented in figure 44. The uncertain positions of South India and Sulawesi in the general area cladogram presented by Schuh & Stonedahl (1986: fig. 11) are a bit more fixed here. The position of South India as a sister area to Sri Lanka is based on information derived from the cladistic analysis of the genus *Exacum* (Gentianaceae) by Klackenberg (1985). The position of Sulawesi as sister area to the S Philippines is based on the somewhat vague information presented by Holloway (1987).

DISCUSSION

In cladistic biogeography it is the patterns of general area cladograms that need general explanations, as historical geological hypotheses. Even so, it may be interesting to discuss the congruence of the patterns found in the individual area cladogram obtained by *Xanthophytum* (fig. 42) with two theories of the geological history of the area and to see what additional explanations of different history are needed.

One theory is a Gondwana– Laurasia collision in Miocene preceded by the collision of islands rifted from the northeast coast of Gondwanaland (Audley-Charles, 1978, 1983, 1984, 1987; Smith et al., 1981). These islands formed a sort of archipelago in the Tethys Ocean during the late Jurassic and Cretaceous and are today identified as S Tibet, Burma, the Thai-Malay Peninsula, as well as parts of today's Malay Archipelago. The island chain moved faster in its western part where S Tibet, Burma and the Thai-Malay Peninsula reached Laurasia early, while fragments of the Malay islands remained near Australia–New Guinea. China and Indo-China, including E Thailand, are regarded as two blocks separated by the Red River (Song Hong) suture. China is part of Laurasia while the Indo-China block was attached to Laurasia as early as the early Mesozoic. For a short survey see Barron et al. (1981) and Whitmore (1987).

The area cladogram (fig. 42) does not fit well into this theory. *Xanthophytum* would in that case have its origin in the vicinity of Borneo (Sunda), later advancing south and east through New Guinea to Fiji. However, the placement of Indo-China is totally incompatible with this model. Besides the possibility that the cladogram is false, two explanations exist. Either *Xanthophytum* reached Indo-China by long-distance dispersal or the cladogram is rooted with the wrong outgroup. Rerooting the cladogram to get Indo-China at a bottom position using e.g. *X. polyanthum* from Indo-China as outgroup produces an area cladogram with Indo-China as sister area to Borneo/Java/Philippines and Fiji/New Guinea/Louisiades. This cladogram is compatible with this geological model but only in combination with a traditional dispersal explanation. *Xanthophytum* is then interpreted as a genus of Laurasian origin, expanding east on the proposed islands.

The placement of the Philippines as sister area to Java (fig. 42) is also incompatible with this geological model. The Philippines are regarded as part of Laurasia, located somewhere outside China; they probably attached and rifted off several times (A.G. Smith, Cambridge, pers. comm.). The Philippines were never close to Java. To overcome this incompatibility rerooting does not help, nor is this branch in the cladogram likely to be falsified. Long-distance dispersal could be the explanation, since the distribution of *X. ferrugineum* is very wide and puzzling.

The second main geological model is the theory of an expanding earth (Carey, 1988; Owen, 1976). In this model, at the time of the late Triassic-early Jurassic, Pangaea was a continent on an earth with a diameter 80% of today's. The Pacific Ocean opened in early Jurassic and in the Cretaceous the parts of southeast Asia lay close to each other in a way presented by Carey (1988: fig. 94). Later, by spreading of the ocean floors the blocks rifted in different arcs. Note that in this model both the Philippines and New Guinea comprise many blocks.

In this model the Java–Philippine relationship is more understandable, since Java and most of the numerous blocks of the Philippines belong to the same arc. But the disribution gap on interjacent W Sulawesi is unexpected.

The placement of Indo-China in the area-cladogram is still incompatible with the geological model. In Carey's figure, Indo-China is placed parallel to Malaysia at nearly right angles to SW Borneo. Also in this case long-distance dispersal could be an explanation. If, as in the first model, we reroot the area cladogram using *X. poly-*

anthum as outgroup, dispersal need not be invoked. Instead *Xanthophytum* may be regarded as a rather widely spread genus split by the growth of the ocean floors, i.e. real vicariance events, but with numerous gaps in the distribution.

Carey's scenario for southeast Asia is appealing in that it determines very clearly the existing geological borderlines. It is astonishing how well these borderlines fit with biological distributions, even in detail (see, e.g., George, 1987: figs. 10.2–10.8).

However, I must conclude that none of the models can explain the area cladogram obtained by *Xanthophytum* (fig. 42) and that the placement of Indo-China is the main obstacle.

Hopefully, geologists will adopt the cladistic approach to grouping and start to construct geological area cladograms. They must be constructed without influence of any historical models and based not on overall similarity, but on geological synapomorphies only. The possibility of comparing area cladograms would enrich both biogeography and geology in their search for the history of the earth.

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