

CLYMENTIA AND BURKILLANTHUS, NEW GENERA  
ALSO THREE NEW SPECIES OF PLEIOSPERMIUM  
(RUTACEAE—AURANTIOIDEAE)

WALTER T. SWINGLE

*With three plates*

IN CONNECTION with the preparation of a synopsis of the genera and species of the Orange Subfamily, AURANTIOIDEAE, that I have had under way for the past few years, a number of new species and a few new genera have come to light.

The striking new genera and new species here described show several new types of pulp-vesicles that throw much light on the origin and development of these remarkable organs peculiar to the subtribe CITRINAE to which belong *Citrus* and the genera most closely related to it.

Attention has recently been directed to a very peculiar *Citrus* species commonly cultivated in New Ireland, an island about 360 miles north-east of New Guinea in the Bismarck Archipelago. It is called "a mulis" by the natives who eat the sweet fruits. Prof. T. Tanaka studied a herbarium specimen of this plant in the herbarium of the Botanical Museum at Berlin-Dahlem which was collected by Peekel, no. 408<sup>1</sup> at Nukonuko, Namatanai, in New Ireland in 1910. In 1928, Tanaka published a new species, *Citrus polyandra* Tanaka, based on this specimen. He considered his new species as probably being a hybrid of the citron, *C. medica*, with the native bitter orange, *C. macroptera*, common in New Guinea and the western Polynesian Islands.

Upon examining a photograph of the type specimen, furnished me by Prof. Tanaka, I was struck by the fact that the leaves of *C. polyandra* are very unlike those of either of the supposed parent species in having very short wingless petioles, not articulated with the leafblades. Inasmuch as *C. macroptera* has very long, broadly winged petioles, sometimes nearly equalling the leafblade in area, it seems improbable that this species could be one parent of *C. polyandra*, especially since hybrids often found in the Philippines, between the commonly cultivated species of *Citrus* and *C. macroptera*, or related species belonging to the same group of *Citrus* (the subgenus *Papeda* with broadly winged petioles), always have petioles with wings intermediate in width between those of

<sup>1</sup>Tanaka, Tyozaburo, On certain new species of *Citrus* (in *Studia Citrologia*, Kankitsu Kenkyu, 2: 158-159 [Japanese], 163-164 [English and Latin]. Nov. 1928).

the two parental species. I was also impressed with the fact that the leaves of *C. polyandra* show a remarkable resemblance to those of *Monanthocitrus cornuta* (Lauterbach) Tanaka, a *Citrus* relative native to New Guinea, but differing widely in other respects from *C. polyandra*. Thanks to the kindness of Dr. L. Diels, Director of the Botanisches Museum at Berlin-Dahlem, I have been able to make a critical examination of the leaves, flowers and fruits of *C. polyandra*. In the course of this study the only remaining flower bud on the unique type specimen was restored by a modification of Juel's method<sup>1</sup>, then imbedded and cut into serial sections. The bud, after imbedding, was first cut into longitudinal serial sections as far as the axis, then turned at right-angles and cut completely into numerous transverse serial sections. (Plate 1, figure 2.) These two sets of serial sections revealed characters very unlike those of *Citrus*, particularly in the androecium.

A section of dried fruit from the type specimen was also restored and cut into serial sections which showed that the pulp-vesicles, highly specialized structures found only in the subtribe CITRINAE, differ decidedly in structure and still more strikingly in their mode of attachment, from those of any other plants of this tribe. Convinced by the study of this material that the plant from New Ireland was a striking new type of Citrus Fruit Trees, I wrote to Prof. Cyril T. White, F. L. S., Government Botanist of Queensland, Brisbane, Australia, requesting him to secure, if possible, more material for me. Through his good offices, the hearty cooperation of the Agricultural officers of the Mandate of New Guinea (of which New Ireland is a part) was secured and in May, 1937, Mr. G. S. Gee, with the help of Brother Peekel, who collected the type specimen of *Citrus polyandra* Tanaka, secured for me excellent material preserved in formaldehyde solution, showing flowering and fruiting twigs, mature leaves and ripe fruits. (Plate 1, figures 3, 4, 5.) A thorough study of this material proves that this plant constitutes a new genus closely allied to *Citrus* yet differing in many very important characters; for this genus I propose the name *Clymenia*.

### **Clymenia**<sup>2</sup> gen. nov.

*Clymenia*, genus *Citro* affine sed differt vesiculis pulpiferis pyriformi-

<sup>1</sup>See Swingle, Walter T., New methods of restoring material in a study of Citrus and related genera. (in Jour. Wash. Acad. Sci. 29: 218, 1939). In this work I have had the skilled assistance of Dr. Albert H. Tillson.

<sup>2</sup>From the Greek κλυμένη, a mythological Greek character, sometimes said to be the mother of Atalanta (for whom Correa da Serra named the genus *Atalantia*, a rather close relative of *Citrus*), but more often held to be either the daughter of the Titan, Oceanus, and mother of Atlas or else a consort of Jupiter and mother of the ill-fated Phaeton (see Bulfinch, Thos., Age of Fable, ed. E. E. Hale, pp. 49, 457, 467, 1881.)

bus, sessilibus, non solum ad parietes dorsales loculorum fructus sed etiam numerosissimis ad parietes laterales ( $\frac{2}{3}$ – $\frac{3}{4}$  distantibus a centro) colligatis; staminibus numerosissimis (quindecies vel viginties quam petalis), liberis, in androphoro truncato-conico latiore quam ovario dispositis; stylo crasso, brevissimo, haud tam longo quam dimidio ovario; foliis simplicibus, petiolis brevissimis cum lamina non articulatis; nervis lateralibus numerosissimis, subparallelis.

Arbor parva, ramis inermibus, ramulis subangularibus; foliis simplicibus, nervis lateralibus numerosissimis (utrinque 20–30), petiolis brevissimis (quindecies vel decies brevioribus quam lamina folii); floribus solitariis in axillis foliorum nascentibus; pedicellis crassioribus et paulo longioribus quam petiolis foliorum subtendentium; disco parvo; filamentis liberis, filiformibus; ovario ovoideo, loculis 14–16, ovulis 4, uniseriatim in quoque loculo, stigmatibus depresso-capitato; fructibus ovoideis, fructu *Citri* similibus, cortice glandulis oleiferis punctato; seminibus numerosis, magnitudine seminis *C. Limon*, embryo unico.

TYPE SPECIES: *Citrus polyandra*, Tanaka in *Studia Citrologica*, 2: 163 (1928).

DISTRIBUTION: Known only from the type locality at Namatanai, New Ireland, Bismarck Archipelago.

This genus strongly resembles *Citrus* in its general aspect, but differs very strikingly in having simple leaves with more numerous, subparallel lateral veins (20–30 pairs, but not all equally prominent); completely wingless, very short petioles (less than  $\frac{1}{10}$  as long as the leaf-blade); very numerous stamens (15–20 times as many as petals) borne in many rows on a truncate-conical androphore broader than the ovary; hypermerous ovary (14–16 locules), short style (about  $\frac{1}{2}$  as long as the ovary), depressed capitate stigma; ovoid fruit, with very numerous short, broad, pyriform, sessile pulp-vesicles having the apex broadly rounded, attached both to the dorsal locule walls and to the radial walls for  $\frac{2}{3}$ – $\frac{3}{4}$  of the distance from dorsal wall to the axile angle of the locule.

The most striking character exhibited by this genus is its huge, broad, cork-shaped androphore that subtends the ovary and obviously exceeds it in diameter (Plate 1, figure 3). This androphore is not the disk, as Tanaka supposed, but the greatly swollen, truncate-conical, stamen-bearing portion of the floral axis.

Although *Clymenia* is obviously closely related to *Citrus* and the other genera of the True Citrous Fruit Tree Group (*Microcitrus*, *Poncirus*, *Fortunella* and *Eremocitrus*) it is clearly distinct from any of them. Its nearest analogue in the genus *Citrus* is found among the bitter oranges belonging to the subgenus *Papeda* which also often has fruits with pulp-vesicles

attached to the outer portions of the radial walls of the locules. However, the bitter oranges have very long, very broadly winged, clearly articulated petioles and the leafblades do not show numerous subparallel lateral veins.

Possibly the nearest relative of *Clymenia* is the anomalous *Microcitrus inodora* (Bail.) Swingle, indigenous to northern Queensland, which also has rather large, simple leaves with very numerous parallel lateral veins and very short, wingless petioles and very numerous (over 30) free stamens. However, *M. inodora* has slender-stalked pulp-vesicles like all the other species of *Microcitrus*, an ovary with only 8 locules and abundant spines, often paired. The leaves of *Clymenia* show a number of remarkably close resemblances to those of *Monanthocitrus* and *Wenzelia*, two genera of the Minor Citroid Fruit Trees (subtribe TRIPHASIINAE), usually considered rather distantly related to *Citrus*.

*Clymenia* may prove on close study of living material to represent a side-line of evolutionary development parallel to, but not in, the main line of descent of the True Citrous Fruit Tree Group. Only one species is known:

***Clymenia polyandra* (Tanaka) Swingle, comb. nov. PLATE 1**

*Citrus polyandra* Tanaka in *Studia Citrolog.* 2: 163, [Japanese] pp. 160-162. 1928.

*Citrus medica* subsp. *Limoum* var. *Limetta* sensu Lauterbach in *Bot. Jahrb.* 55: 264. 1918, non (Risso) Engl.

Twigs angular when young, glabrous, fruiting branches spineless (young plants possibly spiny); leaves simple, large, 12-18 × 4-6.5 cm., oblong-elliptical, more or less caudate-acuminate at the tip (acumen narrow, abruptly rounded), cuneate-attenuate at the base, subcoriaceous, glabrous, lateral veins subparallel, numerous (20-30 pairs), varying in visibility, about half of them easily seen and felt (only these stronger veins visible on upper surface), arising at an angle of 55-65° with the midrib, margins minutely crenulate-serrate; petioles slender, wingless, very short, 6-12 × 2-2.5 mm., flattened on upper side and narrowly margined for a short distance at the tip where the leaf margins are slightly decurrent; flowers borne singly or in few-flowered cymose fascicles in the leaf axils; pedicels more or less angled, usually slightly longer than the petioles on mature flowers, 10-12 mm. long, merging into the calyx and 3.5-4 mm. wide at the top, tapering to 2-2.5 mm. diam. at base; calyx 5-lobed, lobes very thick, rugose without, subtriangular; corolla imbricate (not seen except in the bud); disk inconspicuous, stamens very numerous, in several series, borne on a large truncate-conical androphore wider than the ovary; ovary truncate-conoidal, 3 mm. wide at

base, 2.5 mm. at top, 3 mm. high with 14-16 locules, each with 4 uniseriate ovules; style short (2 mm. long with stigma) 1.3-1.5 mm. wide, not merging into the ovary; stigma depressed-capitate, slightly broader than the style; fruits pyriform or subglobose, slightly mamillate at attached end, 6-8 × 5-6 cm.; pulp-vesicles attached as described above under the genus, ovoid, pyriform, 3-4 mm. high, 2-3 mm. wide, narrowed below to only  $\frac{1}{3}$  or  $\frac{1}{2}$  of the maximum diam. where attached, but not slender-stalked; peel 3-4 mm. thick, dotted with numerous slightly-depressed oil-glands, yellow when ripe; stipe of fruit rigid, 5 mm. diam. sometimes swelling to 7-8 mm. just below the attachment which is about 6-7 mm. diam.

BISMARCK ARCHIPELAGO. New Ireland: Nukonuko, Namatanai, *Peckel no. 408*. Type in Herb. Bot. Mus. Berlin-Dahlem; fragment of type, Herb. Nat. Arboretum, Washington, sheet no. 46011; serial microtome sections, S. and T., slides 222 B, 1-6 (longitud. sect. ovary), 227 A, 1-17 (cross sect. of same bud), 300 A, 1-2 (pulp vesicles and locule walls), filed in type collection, Nat. Arboretum, Washington. Topotype: Buratamtawai, Namatanai, *G. S. Gee, 5 6, 37* (Herb. Nat. Arboretum, sheet no. 46010).

Possible Uses: The fact that *Clymenia* bears a sweet fruit the size of a large lime, and is already cultivated by the Melanesian natives of New Ireland, makes it of unusual interest for trial as a new Citrus fruit tree. It will be very interesting to test *Clymenia* as a root-stock and make hybrids if possible, between it and the five other genera of the True Citrus Fruit Trees (*Citrus*, *Microcitrus*, *Fortunella*, *Eremocitrus* and *Poncirus*) both in the hope of securing new types of edible Citrus fruits and also new root-stocks for experimental tests.

#### BURKILLANTHUS, A NEW GENUS REMOTELY ALLIED TO PLEIOSPERMIUM

In 1893 a remarkable tree was discovered in the Territory of Malacca, Malay Peninsula; thirty years later it was named *Citrus malaccensis* by Ridley who expressed doubts, however, about its being a species of *Citrus*.

Attention was again called to the anomalous nature of this plant by I. H. Burkill (*Gardens' Bull., Straits Settlem.* 5: 218, 1931) but he did not have any additional material, and so was unable to determine its proper taxonomic position.

Through the courtesy of R. E. Holtum, Director of the Botanic Garden of Singapore, I have been able to study the type specimen and the cotype specimen from Malacca, the only collections of this plant made up to now in the Malay Peninsula. A pistil from the type specimen was

restored as nearly as possible to its original condition by a modification of Juel's system, then imbedded, cut into serial microtome sections that were double-stained and mounted permanently. An examination of these serial sections showed clearly that the gynaeceum was very different from that of *Citrus* (Plate 3, figures 1, 2).

The fruits of the cotype from Malacca were in such a decayed condition that it was impossible to make out the nature of the tissues found in the locules around the seeds.

Fortunately, at this juncture, Dr. E. D. Merrill called my attention to material of what he considered to be a probable new genus of the *Rutaceae*, that had been collected in northern Sumatra by B. A. Krukoff, and asked me to study it, generously waiving his claim to it. Fruiting specimens of Krukoff's collection, no. 4233 from Asahan, loaned to me by the New York Botanical Garden and by the Arnold Arboretum, showed at once that this Sumatran plant was the same, or very nearly the same, as the one from Malacca Territory, some 400 kilometers to the eastward across the Malacca Strait. This Sumatran material showed well-preserved ripe fruits (Plate 2) that were found to have pulp-vesicles of a new type attached to the locule walls. It was now clearly evident that this plant must be made the type of a new genus.

**Burkillanthus**,<sup>1</sup> gen. nov.

*Pleiospermio* remote affinis, sed differt (1) loculis ovarii multiovulatis (22-24), (2) fructu multo majore, mesocarpio eximie sclerotico sub cortice tenui, (3) parietibus dorsalibus loculorum vesiculis pulpiferis magnis, sessilibus, liquido gelatinoso impletis, (4) seminibus numerosis, magnis, glabris.

Arbor ad 14 m. alta; ramis teretibus, spinis rigidis, rectis, singulis, vel binis axillaribus instructis vel inermibus; foliis 1-2-3-foliolatis, acutis, plus minusve acuminatis; nervis primariis numerosis, utrinque 12-18, prominentibus; petiolis longitudine variabilibus, supra anguste alatis vel marginato, basi pulvinatis; floribus magnis (5-6 cm. expansis), in fasciculis paucifloribus axillaribus dispositis, 5-meris; petalis lineari-spatulatis; staminibus 10; pistillo longo; ovario 5-loculari, ovulis in quoque loculo numerosissimis (22-24), in duobus seriebus dispositis; fructu grandi, ovoideo, cortice glanduloso, mesocarpio eximie sclerotico; loculis 5, pulpa vesiculari seminibus magnis, embryone unico.

<sup>1</sup>I am naming it *Burkillanthus* in honor of I. H. Burkill, former Director of the Singapore Botanical Garden, whose Dictionary of the Economic Products of the Malay Peninsula is an invaluable work of reference filled with the result of painstaking research on the plants of the Malayan region and their products. He has also published valuable notes on this plant.

Twigs terete, glabrous, armed with stout, straight, paired or single axillary spines, or spineless (especially older fruiting twigs); leaves 3- 2- or 1-foliolate; leaflets thin, with numerous (12-18 pairs), strongly marked, subparallel, lateral veins; petioles narrowly winged or sometimes merely margined, with pulvinoid bases, variable in length, articulated with the leaflets; petiolules very short, pulvinoid; inflorescences forming few-flowered clusters in the leaf axils; flowers large, 5-merous, with 10 stamens; pedicels short, about the length of the styles; calyx deeply 5-lobed; petals 5, spatulate; gynophore cylindrical,  $\frac{1}{8}$  as long as the ovary; ovary obclavate, merging abruptly into the much narrower style which is nearly as long as the ovary, with 5 locules, each with 22-24 ovules arranged in 2 rows; fruits large, ovoid, more than twice as long as the longest petioles, with a thin peel dotted with numerous oil-glands covering a thin, hard woody mesocarp; pulp-vesicles numerous, broad-based and sessile (not deeply countersunk) on the dorsal locule wall, cylindrical (or subclavate?), bluntly conical at the apex, hollow (and filled with mucilage?), with rather thick, semitranslucent walls, somewhat roughened on the outside; seeds very numerous, very large, immersed in mucilaginous gum; seeds large with a thin, glabrous slightly wrinkled testa, mono-embryonic.

*Burkillanthus* is so distinct from any other genus of the Orange subfamily, that it must be considered as representing a rapid evolutionary development of some much simpler ancestral form that probably was somewhat like a 1-3-foliolate species of *Pleiospermium*, such as *P. dubium*. However, *Burkillanthus* has evolved into something very different from any species of *Pleiospermium*. Its large and very hard-shelled fruits resemble in some ways those of the subtribe BALSAMOCITRINAE, but the internal structure of these fruits is strikingly different and precludes close relationship.

There are several other instances of genera in the Orange subfamily that have acquired large, more or less hard-shelled fruits, very different from those of their nearest related genera, for example *Swinglea* of the Philippines, *Merrillia* of the Malay Archipelago and Sumatra. These two genera undoubtedly are not related to each other or to *Burkillanthus*, but seem to represent rapid divergent evolution culminating not in a group of species or genera but, in each case, in a single aberrant monotypic genus.

Robert A. Cockrell (in Papers Mich. Acad. Sci. 20: 33-36, pl. 9, 1935) finds the wood of *Burkillanthus* as it grows near Asahan, Sumatra, almost exactly like that of *Micromelum pubescens*, but differing decidedly from the wood of all the other genera of the Orange subfamily that

he studied, viz.: *Glycosmis*, *Clausena*, *Murraya*, *Merrillia*, *Feronia*, *Aegle*, *Atalantia* and *Citrus*. He did not, however, have wood of *Pleiospermium* nor of *Swinglea* to compare with that of *Burkillanthus*.

**Burkillanthus malaccensis** (Ridley) Swingle, comb. nov.

PLATES 2 & 3, FIGURES 1 & 2.

*Citrus malaccensis* Ridley in Fl. Mal. Penin. 1: 359. 1922.

A tree up to 14 meters high, some branches with stout, straight, usually paired spines, others spineless, with leaves mostly 1- or 2-foliolate, rarely 3-foliolate, leaflets subcoriaceous but thin, broadly lanceolate or elliptic-lanceolate, acute or more or less acuminate at the tips which are blunt at the very apex; terminal leaflets and 1-foliolate leaves variable in size, often large, 12.5-27 × 4.5-11.5 cm., lateral leaflets much smaller, 6.5-8 × 3-4 cm. with short, pulvinoid petiolules 2-2.5 mm. long; lateral veins (of terminal leaflets) about 12-18 on each side arising at a very wide angle (70°-85°) with the midrib, running subparallel and only slightly curved for  $\frac{2}{3}$  or  $\frac{3}{4}$  of the distance from the midrib to the margin, then branching dichotomously; base broadly cuneate, articulated with the petiole by means of a pulvinoid petiolule; margin subentire, very slightly coarse-crenate; petioles of the 2- or 3-foliolate leaves 4-5 cm. long, often narrowly winged (3-6 mm. in total width) at apex, narrowing toward the base, often merely margined even at the apex, petioles of 1-foliolate leaves sometimes shorter, 1-3, rarely 4 cm. long, sometimes almost wingless when short; inflorescences forming few- (usually 1-4-) flowered, axillary clusters; flowers large, 5-6 cm. in diam., borne on pedicels 5-7 mm. long; calyx of 5 lanceolate-acuminate, acute sepals with large oil glands, free nearly to the base; petals 5, subspathulate, with oil-glands in the broadened upper part, 20-25 mm. long, 3.5-4.5 mm. wide, tapering into a long slender base 1-1.5 mm. wide; stamens 10, filaments free, long, slender, anthers rather small, oblong; ovary obclavate, 6.5-7 mm. long, 2.5 mm. in diameter at the broadest part (about  $\frac{2}{3}$  of the distance from the top of the disk to the base of the style, at a point shortly below the tips of the locules) and 1.8-2 mm. in diameter at the base, with 5 locules, each with 22-24 ovules in 2 rows in the upper three-fourths of the locular cavity (Plate 3, figure 2), the entire ovary covered with short sparse pubescence and with a few small oil-glands dotted over the upper half only; style slender, 5.5-6 mm. × 0.5-0.7 mm., with small oil-glands, glabrous, merging abruptly into the tip of the ovary without any definite demarcation, swelling gradually at the tip and surmounted by a depressed globose stigma without oil-glands; disk short, cylindrical, 1.4-1.5 mm. wide, 0.6-0.7 mm. high; fruits large, ovoid, 10-11 × 8-9 cm., outer peel



thin (2-3 mm.), roughened with numerous slightly depressed oil-glands, fitting closely on a woody mesocarp 2-3 mm. thick, very hard in dried fruits, that shows on its outer surface numerous slightly depressed areas 1.5-3 mm. diameter; pulp vesicles 5-12 (or more ?) mm. long and about 1.5-3 mm. wide, sac-like, cylindrical, broad-based and sessile but apparently only very slightly imbedded in the locule wall. These pulp-vesicles are not stalked, near the tip they taper abruptly into a blunt conical apex. They seem to have a semitranslucent, rather thick wall, rough on the outside and are perhaps hollow and full of mucilage. No similar pulp-vesicles are known in any other genus of citrous fruit yet studied. The locules of the ripe fruit are almost filled with large seeds, apparently imbedded in mucilaginous gum, perhaps secreted by the rudimentary pulp-vesicles; the seeds are large, broadly obovate, tapering to an acute point at the base where the seed is attached, 22-27  $\times$  16  $\times$  7-10 mm., mono-embryonic with pale buff (not green) cotyledons, testa thin, papery, irregularly wrinkled when dried.

TYPE: Malay Peninsula, Malacca, Nyalas, *Goodenough no. 1273* (Herb. Bot. Gard. Singapore); Serial microtome sections, S. and T., slides 223 A, 1-10 (cross section of pistil), 244 A, -1, 0, 1-4 (longitud. sect. of pistil), filed in type collection, Herb. Nat. Arboretum, Washington. PARATYPE: Malacca, Bukit Sadanan *Derry no. 1106* (Herb. Bot. Gard. Singapore); Asahan, North Sumatra, *Krukoff no. 4233* (Herb. N. Y. Bot. Gard. and Herb. Arnold Arboretum). Common name: Malay Ghost-lime (*limau hantu*), Sumatran *djeroek octan*.

POSSIBLE USES: This striking tree is without doubt a member of the subtribe *Citrinac* and very possibly is nearly enough related to *Citrus* to be used as a root-stock for it. *Burkillanthus* has numerous seeds which, because of their large size, should provide the young seedling with abundant nourishment. Very vigorous seedlings should be produced and tested as root-stocks. Now that *Burkillanthus* has been rediscovered in northern Sumatra, it is to be hoped that it can be introduced into culture.

**Pleiospermium** (Engl.) Swingle, in Jour. Wash. Acad. Sci., 6: 426. 1916.

*Limonia* Sect. *Pleiospermium* Engl. Nat. Pflanzenfam. III. 4: 189. 1896.

This genus, when I established it in 1916, included *P. alata* (Wight & Arn.) Swingle of India and Ceylon, the type species with 3-foliolate leaves and the polymorphic *P. dubium* (Blume) Swingle of Java with 1-2- or 3-foliolate leaves with petioles varying decidedly in length, with single or paired spines in the axils of the leaves or spineless.

The three new species here described all have 1-foliolate leaves with more or less broadly winged petioles and in their leaf characters resemble somewhat the 1-foliolate forms of *P. dubium*.

The well developed winged petioles of *Pleiospermium* that are always articulated with the leaf-blade, resemble those of *Burkillanthus* (which has, however, very different flowers and fruits), and are also not unlike those of *Citrus* and *Poncirus*. The pulp-vesicles of *Pleiospermium* are of a primitive type, varying decidedly in form, size and structure in the different species. They show a more or less well-differentiated outer cortical layer surrounding a central portion that seems to disintegrate on maturity much like the cellular contents of the oil-glands found in all the superficial tissues of the *Rutaceae*. None of the species of *Pleiospermium* have broad-based conical pulp-vesicles like *Atalantia* and *Citropsis*, nor slender-stalked juicy pulp-vesicles like *Citrus*.

Nevertheless, these latter genera having more specialized pulp-vesicles may well have developed from remote ancestral *Pleiospermium*-like forms.

***Pleiospermium longisepalum*, sp. nov.** PLATE 3, FIGURE 5.

*Pleiospermio dubio* affine, sed differt (1) foliis semper 1-foliolatis, (2) lobis sepalorum gracilibus, longissimis (9–12 mm.), reflexis.

Arbor parva vel arbuscula, ramulis gracilibus (2–3 mm. diam.), junioribus angularibus, inermibus (in ramulis fructiferis); foliis 1-foliolatis, lamina 75–115 × 30–45 mm., ellipticis, integris, apice acuminatis, nervis lateralibus obscuris, utrinque 8–10; petioli 10–12 mm., anguste alatis (ala  $\frac{1}{2}$ – $\frac{2}{3}$  mm. lata); floribus singulis in axillis foliorum, ramulis florentibus apice in inflorescentiam racemosam sine foliis vel cum foliis reductis transientibus; pedicellis 20–25 × 1.5–2 mm., bracteis minutis instructis (pedicellis florum sterilibus persistentibus, gracilibus, 15–20 × 0.75–1 mm.); sepalis persistentibus, griseo-viridibus, liguliformibus, 9–12 mm. longis, basi 2 mm. latis, apice 0.5–0.8 mm. latis et obtuse rotundatis vel paulo emarginatis, rectis et valde reflexis sub fructu maturante, intus unum nervum medium exhibentibus, integris; fructibus ovoideis, glabris, griseo-viridibus, 20 × 15 mm., 3-locularibus cum 1–2 ovulis in quoque loculo, vesiculis pulpiferis rudimentariis, corticatis, ellipticis, 4–6 mm. longis, e parietibus dorsalibus loculorum nascentibus, apice obtusis; fructus cortice tenui (1–1.5 mm.), numerosis glandulis oleiferis minutis instructo; seminibus 1–2, circiter 11 × 6 × 4 mm., embryo unico.

BORNEO: Banguey Island, about 11 km. off the extreme northeast point of Borneo and about 50 km. south of Palawan, the westernmost large island of the Philippines, *Castro and Melegrito 1348*. (Type in Herb. Nat. Arboretum, no. 45800; isotype in Herb. Arnold Arboretum; paratype *Castro and Melegrito, 1713*, in Herb. Univ. Calif.)

Dr. E. D. Merrill in a paper "The Flora of Banguay Island" (Phil. Jour. Sci. 29: 377, 1926) lists it as "*Atalantia* sp.?" but says: "The sepals are linear or strap-shaped, free, persistent, 1 cm. long and about 1.5 mm. wide, in this character differing from both *Citrus* and *Atalantia*." After mentioning that I had found in the fruits pulp-vesicles differing essentially from those of *Citrus*, he says: "Perhaps an undescribed genus is represented here."

Recently in making a close study of *Pleiospermium*, it became evident that this plant was an aberrant species of this genus with 1-foliolate leaves very like *Citrus* and fruits very like those of *P. dubium*, containing similar primitive corticate pulp-vesicles. The extraordinary elongate strap-shaped sepals which become reflexed after anthesis and persist until after the ripe fruits fall off, are a new and very striking character not found on such a grand scale in any other species of the 200 and more belonging to the Orange subfamily. Shorter persistent sepals are found in *P. latialatum*.

*Pleiospermium dubium* of Java often has unifoliolate leaves on old trees that are much like those of *P. longiscpalum*, even to showing frequently a narrow wing on the upper portion of the petiole.

***Pleiospermium sumatranum*, sp. nov.** PLATE 3, FIGURES 3, 4.

*Pleiospermio dubio* affine, sed differt (1) foliis semper 1-foliolatis, (2) foliolis majoribus, acuminato-caudatis, (3) petiolis distincte alatis, (4) vesiculis pulpiferis minutis (1-2 mm. longis).

Arbor vel arbuscula, ramulis fructiferis inermibus, gracilibus, 1-2 mm. diam.; foliis 1-foliolatis, laminis magnis, 1.7 × 5-6.5 cm., rotundate lanceolatis, acuminato-caudatis, acumine 9-13 mm. longo, deorsum 3-4.5 mm. lato, sursum 1-2 mm. lato, apice abrupte minute emarginato; nervis primariis utrinque 10-12; petiolis 18-20 mm. longis, alatis, apice 3.5-6.5 mm. latis, basi apteris, 4-5 mm. latis; floribus ignotis; calycibus persistentibus, 5-lobis, lobis 2-2.2 mm. longis, 1-2 mm. latis; fructu subgloboso, 18-20 diam., 3-loculari, loculo quoque vesiculis pulpiferis numerosissimis minutis, 1-2 mm. longis et 0.4-0.7 mm. latis, apice rotundatis mucilagine translucente impletis instructo.

SUMATRA: *Korthals* no. S 960 (Type in Rijksherbarium, Leiden, sheet no. "908,204- . . . 137"); Sumatra, Paanus, *Korthals* no. S 960 (paratype in Rijksherbarium, Leiden, sheet no. "908,204- . . . 132"). Probably a Sumatran specimen labeled "Herb. Korthals?" in Rijksherbarium, Leiden, sheet no. "908,203- . . . 210" is also this species. Known only from this collection.

This species of *Pleiospermium* has the dorsal walls of the three locules of the fruit lined with remarkably small pulp-vesicles which are very numerous, ovoid, bluntly rounded at the tips, 1-2 mm. long, 0.4-0.7 mm. wide, slightly narrowed at the base but not imbedded in the locule wall, cortex very thin, composed of indistinct cells, contents sharply delimited from the cortical layer, decomposing into a spongy (?) mass of oily or mucilaginous matter looking almost exactly like the contents of the oil-glands in the peel of immature fruit (Plate 3, figure 4). Apparently these very small pulp-vesicles secrete a translucent liquid that completely fills the locules of the fruit. In dried herbarium specimens this liquid hardens to a dark reddish brown mass that splinters when struck a sharp blow.

*Pleiospermium sumatranum* resembles *P. dubium* in having small pulp-vesicles but differs in having only 1-foliolate, larger, more acuminate-caudate leaves that are much like those of *P. longisepalum* and *P. latialatum* and not unlike those of *Citrus* except in being acuminate-caudate.

***Pleiospermium latialatum*, sp. nov.**

PLATE 3, FIGURE 6.

*Pleiospermio longisepalo* affine, sed differt (1) foliis majoribus, acuminato-caudatis, (2) petiolis late alatis, alis cordatis (1.6-2.4 × 1-2 cm.), (3) lobis calycis angustis, triangularibus 4-6 × 2-3 mm., cuneatis, persistentibus, reflexis usque 90° ad pedicellum.

Arbor parva vel arbuscula, ramulis inermibus, ultimis gracilibus (1-2 mm. diam.), primo paulo angulatis, demum teretibus; foliis 1-foliolatis, laminis 9-15 × 3.5-7 cm., glabris, oblongo-ellipticis vel lanceolatis, apice acuminato-caudatis, acumine lineari 4-6 mm. longo, 1.5-2 mm. lato, emarginato, nervis lateralibus utrinque 10-13; petiolis late alatis, cordatis, 1.6-2.4 × 1-2 cm., basi angustatis, pulvinoideis, minute striatis, supra canaliculatis; floribus ignotis; calycis extus puberulentis lobis anguste triangularibus vel apice plus minusve rotundatis, 2-4 mm. longis, 2.5 mm. latis, sub fructu juniore persistentibus reflexis usque 90° ad pedicellum; fructu globoso, 10-14 mm. diam., glabro, cortice viridi, rugoso, glandulis oleiferis crateriformibus numerosis instructo; loculis 3, ad parietes dorsales vesiculis pulpiferis gracillimis 3-4.5 mm. longis acutis indistincte corticatis instructis; seminibus 2 vel 3, magnis, crassis.

Pulp-vesicles slender, conical often ending in a blunt point at the apex 3-4.5 mm. long. The cortical tissue is much thinner than in *P. dubium* and the contents do not break up as completely. The bases of the pulp-vesicles are not so deeply sunken into the dorsal locule walls as in *Atalantia* or *Citropsis*.

BORNEO: Elphinstone Province, Tawao. British North Borneo, *Elmer no. 21542* (Herb. Arnold Arboretum). Known only from the type collection.

This species is clearly related to *P. longispalum* but differs in so many characters that it appears to be a good species. The leaves look surprisingly like *Citrus*, but the twigs (at least the fruiting ones) are spineless. It is of especial interest as it looks as if it might be a remote ancestor of *Citrus* although its fruits show only rudimentary pulp-vesicles.

This species with *P. longispalum*, *P. dubium* and *P. alatum*, constitute a remarkable series: *P. alatum* with always 3-foliolate, *P. dubium* with 1- or 2-foliolate, but occasionally 3-foliolate leaves, *P. longispalum* with 1-foliolate leaves with narrowly winged petioles, and finally *P. latialatum* with 1-foliolate leaves with broadly winged petioles much like some forms of *Citrus Aurantium*. The pulp-vesicles in this series progress from the short, thickly corticated ones of *P. dubium* to the slender-conical, acute-pointed ones of *P. latialatum*. Much light will doubtless be thrown on the origin and development of pulp-vesicles by a critical study of living material of these and other species of *Pleiospermium*.

## EXPLANATION OF PLATES

### PLATE 1

*Clymenia polyandra* (Tanaka) Swingle. Figures 1, 2, 3, type specimen in Herb. Berlin-Dahlem. Figures 4, 5, 6, topotype, Coll. Gee, 5/6/37, preserved in formaldehyde solution.

Figure 1. 1/5 nat. size.

Figure 2. Sections of flower bud.  $\times 5$ .

Figure 3. Flower buds and pistil.  $\times 1\frac{1}{2}$ .

Figure 4. Section of ripe fruit. Nat. size.

Figure 5. Ripe fruit. Nat. size.

### PLATE 2

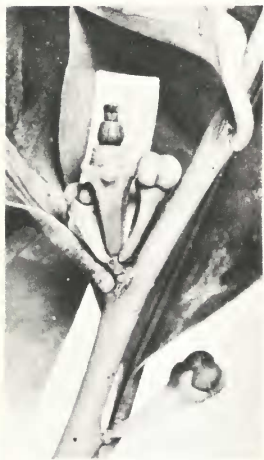
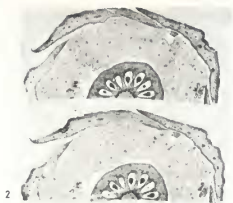
*Burkillanthus malaccensis* (Ridl.) Swingle. Leafy twig, spines and fruit sections, Coll. Krukoff, Asahan, Sumatra. Nat. size.

### PLATE 3

#### *Burkillanthus malaccensis*

Figure 1. Type specimen from Malacca Territory. Two axillary flowers. Nat. size.

Figure 2. Nine serial sections of the pistil in Figure 1.  $\times 2$ .



*CLYMENIA POLYANDRA* (Tanaka) Swingle