

THE WINTERACEAE OF THE OLD WORLD IV.  
THE AUSTRALIAN SPECIES OF *BUBBIA*

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SUMMARY

The Australian species of *Bubbia* are revised. The *leaf anatomy* provides good diagnostic characters. There are three species. *Bubbia whiteana* is given varietal rank under *B. semecarpoides*, and a new species *B. queenslandiana* with two subspecies is described.

INTRODUCTION

In 1869 Von Mueller described from Lord Howe Island the first one of a group of *Drimys* species which were accommodated in the new genus *Bubbia* by Van Tieghem in 1900. The second Australian species was in 1891 also described by Von Mueller in *Drimys*. In 1943 A.C. Smith added a third Australian species of *Bubbia*. The latter is presently reduced to varietal rank, but a new species from Queensland is described.

Although flowering material of the Queensland species is still very scarce, it was thought of interest to publish a revision of the Australian species pending the revision of the genus as a whole, because the differentiation in leaf anatomy proved to be unexpectedly diagnostic. Especially the distribution of sclerified cells in the leaf lamina provided useful characters, like in *Zygogynum*; in the New Caledonian species of *Bubbia* these characters are less specific.

ACKNOWLEDGEMENTS

Thanks are due to the Directors of the Herbaria at A, B, BM, BO, BRI, CANB, FI, GH, K, L, MEL, NSW, RSA, and S for loan of material and of QRS for providing duplicate material. Dr. P. Baas kindly assisted in the preparation of the photographs. Mr. J. van Os is thanked for the drawing of fig. 3 and assistance in the preparation of the diagrams. Dr. R.D. Hoogland gave valuable hints on nomenclature.

## BUBBIA

*Bubbia* van Tieghem, Journ. de Bot. 14 (1900) 277, 278, 293; Lemée, Dict. 6 (1935) 1073; A.C. Smith, J. Arn. Arb. 24 (1943) 141; Hutchinson, Gen. Fl. Pl. 1 (1964) 61; Bongers, Blumea 21 (1973) 388. – *Bubbia* sect. *Diploclada* van Tieghem, o.c. 294. – Type species: *Bubbia howeana* (F. Muell.) van Tieghem.

(Description based on Australian taxa only)

Shrubs or trees; entirely glabrous. Terminal buds with cataphylls in the same spiral as the leaves. Elongation of vegetative twigs monopodial, after flowering sympodial. *Leaves* with greatest width at or usually above the middle of the blade, entire, pinninerved; veins reticulate but often obscure. On lower leaf surface stomata white, occluded by both alveolar and waxy material; unspecialised cells with or without white to grey waxy layer. *Inflorescences* terminal, composed of a terminal florescence and 0–14 florescences in the axils of the closely aggregate, fugacious cataphylls. Florescences 1–23-flowered, flowering centrifugally, all axes anthotelic, more-flowered florescences approaching (compound) dichasia. *Flowers* bisexual, pedicellate. *Calyx* calyptrate, enclosing bud in very young stages only, soon rupturing; thin, persistent. *Petals* 4–14, all free, 1–3-seriate. *Stamens* 8–32; filaments obovoid and slightly flattened to rod-shaped, rarely laterally widened; thecae apical at an angle of 75°–180° to each other, well-separated to, rarely, with their slits continuous over apex of stamen. Pollen grains in tetrahedral tetrads. *Carpels* 1–8, free; stigma sessile, elongated, on ventral side of the broad, convex apex of carpel; placentas 2, parallel, apical-ventrally with ovules in one or sometimes seemingly in more than one row; ovules 6–22 per carpel. *Fruitlets* with pulpa not completely separating the seeds; seeds with straight axis or slightly curved, dull, epidermis cells with internal apical constriction.

*Distribution.* *Bubbia* occurs from the Moluccas to New Caledonia; in Australia 1 species on Lord Howe I. and 2 species in NE. Queensland.

## NOTES ON MORPHOLOGY

*Inflorescences.* – In *Bubbia* the inflorescence (fig. 1) is terminal and elongation of the twig is thus sympodial, from a vegetative bud in the axil of one of the lower cataphylls of the inflorescence. The inflorescence consists of *florescences*, one terminal and the others – if present – inserted in the axils of the fugacious cataphylls closely aggregate around the terminal florescence. Below the florescences there can be up to 10 cataphylls with empty axils or with a vegetative bud. Within a florescence all lateral axes (peduncles, pedicels) are subtended by fugacious bract(eole)s. Triads are pedunculate; the pedicel of their terminal flower is usually shorter than those of their lateral flowers.

In the Australian species the most elaborate inflorescences are found in *B. howeana*; the other extreme is found in *B. queenslandiana* and *B. semecarpoides* var. *whiteana*, where often a solitary flower is representing a florescence.

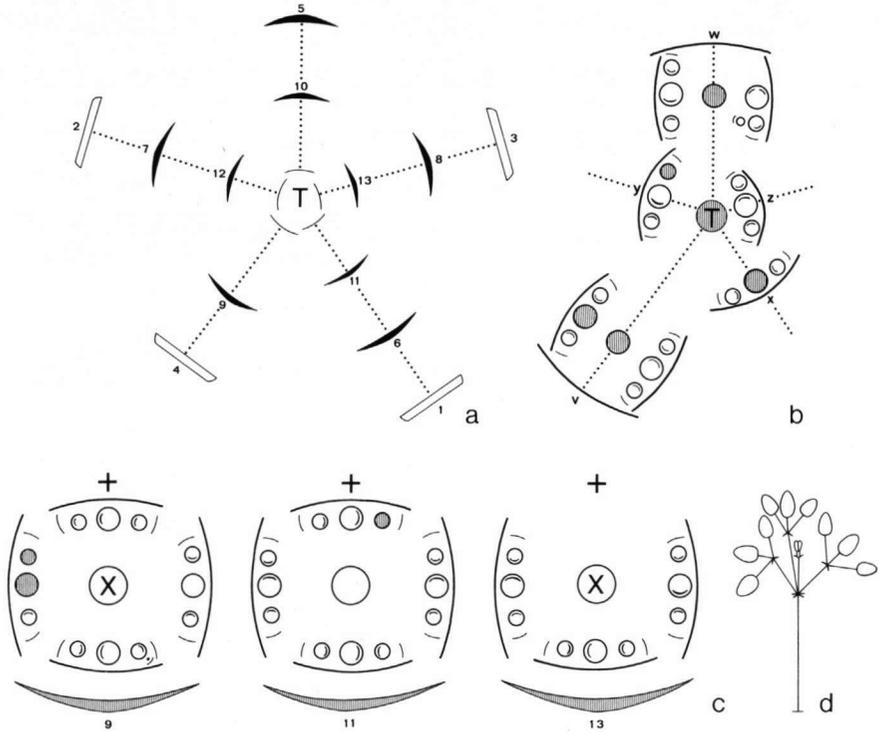


Fig. 1. An inflorescence of *Bubbia howeana* (van Balgooy 1111). – a. General diagram; straight symbols: leaves (1–4); curved symbols: cataphylls (bracts) on twig (6 & 7 empty axils, 8 with vegetative bud, 9–13 subtending florescences); T: terminal florescence with bracts on its axis. – b. Terminal florescence; terminal flower T and bracts w–z in one tier on top of its axis, bract v inserted much lower. – c. Diagrams of three other florescences; circles: open flowers; in buds insertion of outer petal indicated; circles with cross: old flowers; hatched: scars. – d. Florescence, schematic, x ½.

Although the inflorescences of *Bubbia* are rather flexible in construction, with differences even within one plant, there can be found some tendencies:

1. Florescences decrease in size acropetally (fig. 1 c) from compound dichasia with e.g. four triads decussate in one tier around the terminal flower, through loss of the highest (median) pair of triads (the adaxial one first) to small dichasia and eventually to triads.

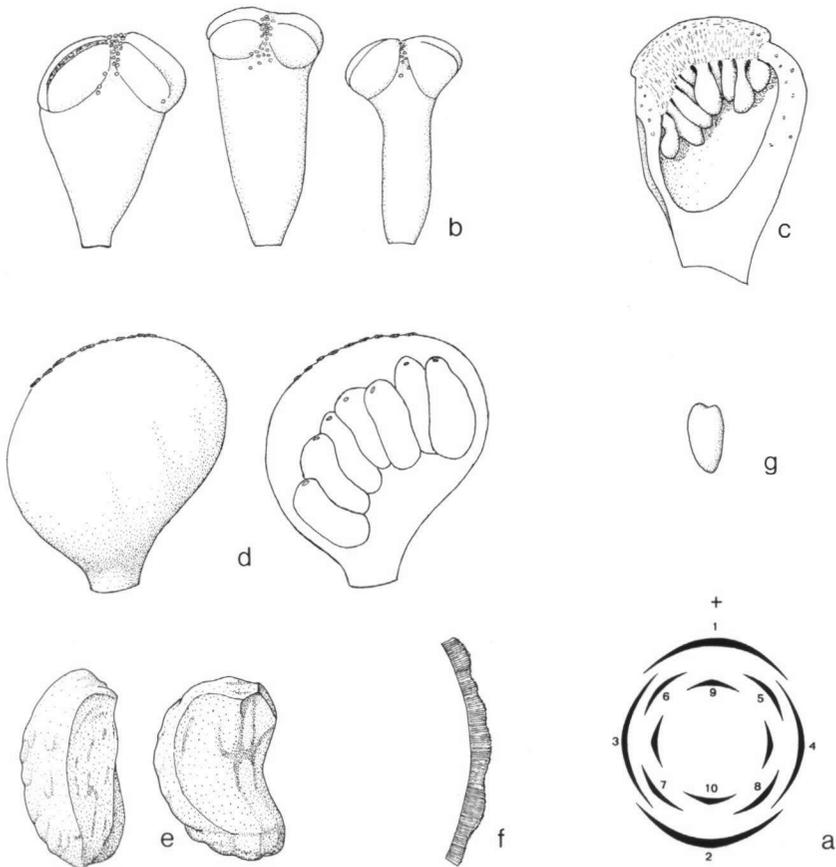


Fig. 2. *Bubbia howeana*. – a. Typical arrangement of petals (in this specimen 11–14 petals), numbered according to apical overlap; innermost ones do not touch. – b. Stamens from one flower, apically glandular (x 12½). – c. Halved carpel with crowded ovules and wide slit to stigma (x 12½). – d. Fruitlet, also showing arrangement of seeds of one half (x 3). – e. Two seeds (x 6). – f. Schematic section through testa; pusticulate surface caused by differences in length of epidermal cells (x 12½). – g. Embryo (x 25). – (a–c: *van Balgooy 1111*; d–g: *Green 1598*).

2. The terminal florescence can be similar to the lower ones, or (fig. 1 a, b) behave as an elongation of the twig (but with its axis similar to the other florescence axes) with, spirally arranged and often not in one tier, the lateral partial florescences decreasing acropetally from dichasia, comparable to florescences, to solitary flowers just below the terminal one.
3. Flowering tends to be centrifugal for flowers of the same order, but especially in the higher orders or in the lower florescences irregularities are common.

**Calyx.** — In *Bubbia* the calyx is calyptrate; usually it is initiated with two or three primordia which are soon connected by a cylinder. This cylinder forms the main body of the calyptra; the positions of the primordia are mostly still recognizable by the tiny lips closing the terminal opening of the calyptra, but already in an early stage the calyptra is ruptured irregularly into 'lobes' with withered margins (fig. 4a).

The young stages are always very scarce in herbarium material; of *B. queenslandiana* two collections and of each of the other two species only one collection provided some information on the position of the 'sepals' composing the calyptra. In these four cases the sepals are orientated perpendicular to the bract subtending the flower or, in terminal flowers of triads, subtending the lateral flowers. If one of the lateral flowers of a triad is absent, the terminal flower had three sepals. As in *Bubbia* as a whole the outer pair of petals is usually inserted perpendicular to the sepals, the trend in the Australian species to have the outer pair of petals parallel to the bracts just mentioned corroborates the few observations on the orientation of the sepals (fig. 4c).

**Petals.** — In the Australian species of *Bubbia* the petals are all free; in some non-Australian species of *Bubbia* as well as in species of *Zygogynum* and *Exospermum* the outer series of petals is connate. Usually the outer series of petals consists of two decussate pairs; if the calyx is composed of three sepals, the outer petals can be arranged in series of three each. Rarely one outer series of five petals is found. If more than four (to six) petals occur, the higher ones alternate with the lower ones and with each other (fig. 2a), like in simple forms of stamen arrangement.

**Stamens.** — Some stamens of some flowers of some specimens of *B. howeana* and *B. semecarpoides* have (uni-)laterally widened filaments (fig. 5). In herbarium specimens these lateral widenings are flattened between adjoining stamens and/or petals, so living or liquid-preserved material is needed to determine their true form.

**Floral apex.** — In two young buds of a specimen of *B. semecarpoides* the carpels were already well developed; in one the entire floral apex was used up in the formation of the carpels, in the other a distinct vestigial floral apex was present (fig. 5e). Apparently the presence of such a vestigial floral apex is not a fixed character.

#### DIFFERENCE WITH OTHER WINTERACEAE

The Winteraceae are represented in Australia by three species of *Bubbia* and five species of *Drimys* sect. *Tasmannia*; the latter have been treated in Blumea 18 (1970) 303–351. As far as the Australian taxa are concerned, the main differences are:

***Bubbia*:** After flowering twig elongating sympodially. Flowers bisexual. Calyx enclosing other flowerparts in very early stages only, soon rupturing; persistent under fruit. Seed-axis straight or slightly curved. — Pedicels usually inserted on distinct inflorescence-axes. — Lord Howe I., NE. Queensland.

***Drimys* sect. *Tasmannia*:** After flowering twig elongating monopodially. Plants dioecious (staminate flowers with sterile carpels). Calyx enclosing other flowerparts until anthesis, then rupturing and dropping. Seed-axis curved. — Pedicels inserted directly on the twig. — NE. Queensland to Tasmania.

## KEYS TO THE AUSTRALIAN SPECIES

*a. Based on external characters*

- 1a. On lower leaf surface only stomata white or stomata grouped in white patches. Lord Howe I. . . . . 1. *B. howeana*
- b. Except for margin and midrib the whole lower leaf surface white (to grey). Queensland . . . . . 2
- 2a. Dry leaf surfaces rough to the touch by numerous minute bumps. (Stamens 14–32) . . . . . 3. *B. semecarpoides*
- b. Dry leaf surfaces smooth. (Stamens 8–13) . . . . . 2. *B. queenslandiana*

*b. Based on leaf anatomy*

- 1a. Mesophyll without noticeable sclerification. Alveolar material over stomata only, sometimes also over part of cells between stomata . . . . . 1. *B. howeana*
- b. Mesophyll with distinct sclerification. Alveolar material also over cells between stomata . . . . . 2
- 2a. Brachysclereids solitary and in clusters, but not united into layers . . . . . 3. *B. semecarpoides*
- b. Adaxial subepidermal layer strongly sclerified, continuous, 1 or 2 cells thick . . . . . 2. *B. queenslandiana*

1. *Bubbia howeana* (F. Muell.) van Tieghem. – Fig. 1, 2, 6, 7.

*B. howeana* (F. Muell.) van Tieghem, Journ. de Bot. 14 (1900) 293; Pilger in E. & P., Nat. Pfl., Nachtr. 3 (1908) 109; Vickery, Proc. Linn. Soc. N.S.W. 62 (1937) 84; A.C. Smith, J. Arn. Arb. 24 (1943) 141; Recher & Clark, Environmental Survey of Lord Howe Island (1974) 22, photo. – *Drimys howeana* F. Muell., Fragm. 7 (1869) 17; Parmentier, Bull. Sc. France & Belg. 27 (1895) 230, 307. – Type: *C. Moore 23* (MEL 5610).

*Drimys insularis* Baill. ex F. Muell., Fragm. 9 (1875) 76, *nomen*.

*B. muelleri* van Tieghem, Journ. de Bot. 14 (1900) 293; Pilger, l.c. – Type: prob. *MEL 5604* (MEL), see note on Typification.

Shrub or treelet 2–6 m high, with relatively stout trunk and with erect branches. Branchlets slender to rather stout; dry epidermis longitudinally wrinkled. *Petioles* 0.6–2(–3) cm, rounded to triangular below, narrowly winged by descending leaf base. *Blade* obovate-oblong to (linear-)oblanceolate, 5–27 × 1–8.5 cm, chartaceous to coriaceous, smooth, apex (broadly) rounded to obtuse, base narrowly cuneate, descending along petiole; midrib narrow to rather broad, above almost flat to raised, often with a groove, below rounded to triangular; nerves at the middle of the blade at an angle of 45°–70° to the midrib, thin and prominulous to almost indistinct on either side; veins prominulous to inconspicuous on either side. On lower leaf surface stomata white, sometimes part of unspecialised cells grey and combining groups of stomata into irregular greyish white islets. *Inflorescences* with (1–)3–10 bract scars below lowest florescence; florescences 2–9, these 4–12 cm long, 3–23-flowered,

with pedicels inserted on main axis or on branches 1st or 2nd order; all axes and pedicels smooth. *Pedicels* 3–10 mm long. *Calyx* 1–1.5(–2) mm wide; shallowly ruptured, irregularly or into 2–4 lobes. *Torus* 1–1.5(–2) mm high. *Petals* 8–14, usually rounded, without brachysclereids; outer petals usually shortest and broadest, elliptic to ovate, 6.5–12 × (3.5–)4–6 mm; petals of second series usually longest, obovate to oblanceolate, 7–11.5 × 2–4(–5) mm; if more petals present these the narrowest, oblong or obovate-oblong to -spathulate, 7–11.5 × 2–3.5 mm. *Stamens* 10–30, length 1.5–2.8 mm; filaments inflated, sometimes near apex somewhat (wing-like) widened; thecae apically at an angle of 75°–155° to each other, slits never continuous, apex of stamen between thecae often densely glandular. *Carpels* 3–6, these 2–3 × 1.5–2 × 1–1.8 mm; stigma 0.6–0.8 of length of carpel apex; ovules 13–22, often crowded and seemingly in more than one row. *Fruitlets* obliquely ellipsoid to obovoid, up to 13 × 10 × 8 mm, stipe 0–1 mm, stigma 5–7 mm and distinct or indistinct; brachysclereids thin-walled, in clusters, rather dense in middle layer of fruit wall. *Seeds* 5–17, obovoid to subreniform, almost smooth to slightly pusticulate, up to 5 × 3 × 2.5 mm, brownish to greyish black; axis straight to slightly curved.

Leaf anatomy. Lamina 220–310 µm. Adaxial epidermis 23–42 µm; adaxial cuticle rather smooth, (2–)4–10 µm, underlying cell wall 1.5–5 µm. Abaxial epidermis 10–30 µm; abaxial cuticle 1.5–4.5 µm, *alveolar material* only over stomata, sometimes also over part of unspecialised cells and there 0.2–0.5 of thickness of cuticle, homogeneous (sensu Bongers, 1973), underlying cell wall 1–3 µm. Stomatal plugs 0–6 µm below surface of epidermis. *Epidermal oil cells* 40–45 µm in diam. occasionally (*van Balgooy 1063, 1064*) in abaxial epidermis, with external opening, surrounded by more or less distinctly radiating unspecialised cells. *Palisade* parenchyma not differentiated; cell walls of mesophyll at most slightly birefringent especially in abaxial part of lamina. *Brachysclereids* absent. *Druses* 5–12 µm in diam. (very) frequent in mesophyll; globose to rod-shaped crystals 1–2(–3) µm long rare to rather common throughout lamina. *Oil cells* (45–)60–75 µm in diam. (very) frequent in mesophyll.

Field notes. Bark reddish to dark greyish brown, finely flaking. Leaves glossy above, glaucous below. Flowerbuds tinged with reddish brown. Petals white. Stamens yellow or white, or filaments green and anthers creamy white. Carpels green, stigma purplish. Fruitlets ripening from green through brown and dark purple to black; pulpa green.

Distribution. Lord Howe Island: Goat House (Cave), Mt Lidgbird, Erskine Valley, Mt Gower.

LORD HOWE I. *Van Balgooy 1063\** (L), *1064\** (L), *1111* (L). *Boorman s.n.* dd. 17.5.1920 (NSW). *Camara 8* (MEL), *18* (MEL), *34* (MEL). *Darnell Smith s.n.* Oct. 1928 (NSW). *Fullager 30* (MEL), *s.n.* (BM, BRI, MEL, P). *Fullager & Lind s.n.* (MEL). *P.S. Green 1594\** (A, K), *1598\** (A, K). *Hale 6* (MEL). *Hedley & Dunn s.n.* Sept. 1908\* (L, NSW). *Johnston & Rodd 1352* (L, RSA). *E. King s.n.*, 1898 (NSW). *Maiden s.n.*, Apr. 1898 (NSW). *McCornish 82* (NSW). *C. Moore 23* (type) (MEL), *43* (MEL). *F. von Mueller s.n.* (BO, FI, L, MEL, P). *Rodd 1858\** (L). *Takhtajan & Rodd 1849\** (L).

\* Material indicated with an asterisk was used for the description of the leaf anatomy.

**Ecology.** In undergrowth of forests and in scrub, 80–860 m alt. Both flowers and fruits (often from the same tree) collected from July to November, but no collections seen outside this period.

Many labels do not indicate the altitude. From the available data there appears no strict correlation between leaf size and altitude; perhaps such a trend is reversed in exposed situations at lower altitudes.

**Typification.** The Melbourne sheet *MEL 5610* does not mention the collector (*C. Moore*), but has a number (23) not mentioned by Von Mueller. Nevertheless, this sheet is the holotype of *Drimys howeana* because: a. the specimen matches the description exactly; b. the description was based on one specimen only; c. the bag containing the remnants of the analysed flower is folded from the draft of the description of which whole sentences are identical to those of the published one.

Von Mueller described a second, fruiting specimen. This is probably sheet *MEL 5604*, labelled with number 43; in that case the collector is *C. Moore* and this specimen is the type of *Bubbia muelleri* van Tieghem.

**Notes.** Although Von Mueller describes the tree as 'acri-aromatica' and some labels give the name 'Peppertree' or 'Hot-bark', none of the labels refers to aromatic leaves or bark.

In the above general description the differences in petal size in individual flowers are blurred by the large number of measurements taken. Therefore, as an illustration, the means of the sizes of the petals from each series are given for three individual flowers from *Takhtajan & Rodd 1849* (in mm):

outer petals	7.2 × 4.4	7.5 × 4.2	7.5 × 4.0
middle petals	8.2 × 2.9	10.5 × 3.0	9.7 × 3.0
inner petals	7.8 × 2.7	8.5 × 3.0	8.7 × 2.2

The peculiar almost wing-like widening of some of the lower filaments in some flowers is shared with *B. semecarpoides* (fig. 5). It is possible that *in vivo* this widening is not flat, but I have no liquid-preserved material available.

## 2. *Bubbia queenslandiana* Vink, *spec. nov.* – Fig. 3, 4, 6–8.

Frutex vel arbuscula ad 8 m alta. Laminae foliorum obovatae vel oblanceolatae, 5–16 × 1.5–5 cm, subcoriaceae, laeves, subtus praeter costam strato albo obtectae, apice late rotundatae ad obtusae rarius acutae vel emarginatae, basi cuneatae vel attenuatae; costa supra leviter impressa; nervi inconspicui vel gracillimi; venae inconspicuae. Axes inflorescentiae glabri, laeves; florescentiae 4–10, floribus 1–3(–6). Calyx tenuis, 1–1.5 mm latus, in lobos 2–4 rumpens. Petala 4–8, discreta, 5.5–8 × 2.3–5 mm. Stamina 8–13; loculi apicibus contigui. Carpella (1 vel) 2–5; stigmata brevia; ovula 6–11. Carpodia usque ad 11.5 × 11.5 × 9 mm, stipitibus 0.6–1 mm. Semina 4–9 laevia vel pusticulata, usque ad 6 × 4 × 3.5 mm. – Typus: *B. Gray 484* (L), Queensland, Australia.

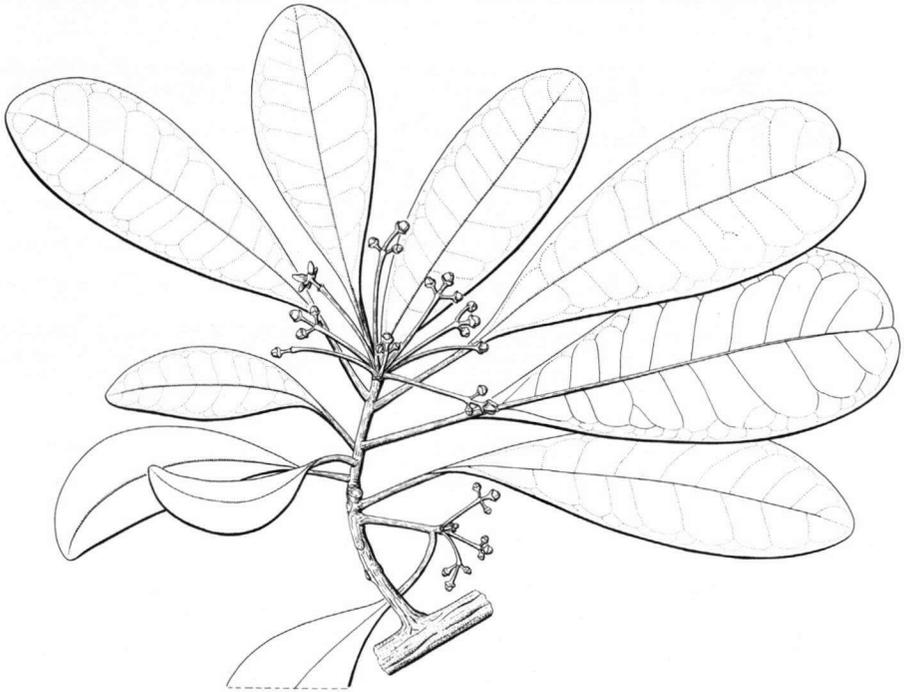


Fig. 3. *Bubbia queenslandiana* ssp. *queenslandiana*. Habit,  $\times \frac{1}{2}$  (Gray 484, type).

Shrub or treelet 2–8 m high. Branchlets slender; dry epidermis longitudinally wrinkled. *Petioles* 1–4 cm, rounded to triangular below. *Blade* ovate to oblanceolate, 5–16  $\times$  1.5–5.5 cm, subcoriaceous, smooth, apex broadly rounded to obtuse, rarely acute or emarginate, base cuneate to attenuate; midrib rather narrow, slightly impressed above, rounded below; nerves at the middle of the blade at an angle of 50°–75° to the midrib, indistinct to thin and prominulous on either side; veins inconspicuous on either side. On lower leaf surface both stomata and unspecialised cells white. *Inflorescences* with up to 7 bract scars below lowest florescence; florescences 4–10, these 1.5–5 cm long, 1–3(–6)-flowered, with pedicels all inserted on main axis of florescence, very rarely on branches 1st order; all axes and pedicels smooth. *Pedicels* 3–13 mm long, of solitary flowers 21–31 mm long. *Calyx* 1–1.5 mm wide, margin ruptured into 2–4 lobes. *Torus* 0.5–0.7 mm high. *Petals* 4–8, ovate or elliptic to oblong, rounded, 5.5–8  $\times$  2.3–5 mm; brachysclereids thin-walled, solitary and in small clusters, very sparse to fairly dense in central or lower part of petals. *Stamens* 8–13, length 1–2 mm, filaments inflated; thecae apically at an angle of 90°–145° to each other, slits not continuous. *Carpels* (1 or) 2–5, these 1.5–2  $\times$  1–2  $\times$  1.2–1.5 mm; stigma short; ovules 6–11. *Fruitlets* globose, up to 11.5  $\times$  11.5  $\times$  9 mm, stipe

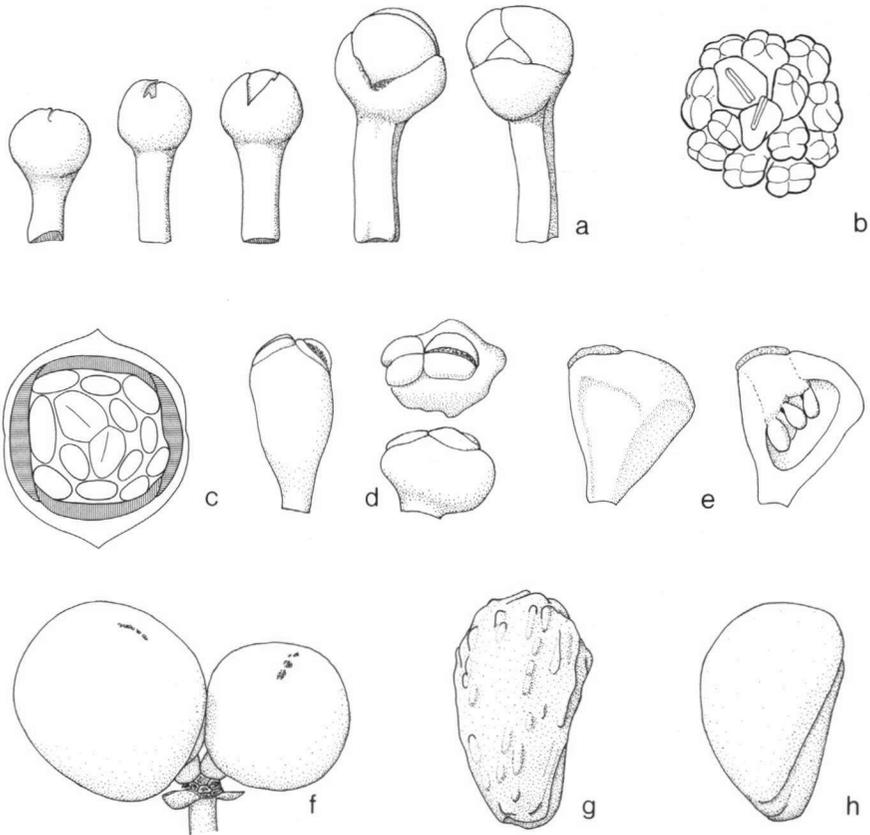


Fig. 4. *Bubbia queenslandiana*. – a–e, h: *ssp. queenslandiana*; f & g: *ssp. australis*. – a. Four flowerbuds, the largest from two sides, showing rupturing of calyprate calyx (x 6). – b. Stamens and carpels from young bud (x 12½). – c. The same, semi-diagrammatic; irregular arrangement and sizes of stamens. – d. Two stamens from one flower, smallest one also apically (x 12½). – e. Carpel, also halved; ovules crowded; slit to stigma rather narrow (x 12½). – f. Fruitlets (x 3). – g & h. Seeds (x 6). – (a–c: *Irvine 1152*; d & e: *Gray 484*; f & g: *Johnson s.n.*; h: *C.T. White 10644*).

0.6–1 mm, stigma 2–4 mm and indistinct; brachysclereids rather thin- to rather thick-walled, solitary and in small clusters, rather dense (but not compact) throughout fruit wall outside vasculature. *Seeds* 4–9, obovoid, smooth to slightly pusticulate, up to 6 × 4 × 3.5 mm, greyish black; axis straight.

*Leaf anatomy.* Lamina 240–320 μm, Adaxial epidermis 17–25 μm; adaxial cuticle (rather) smooth, 3–7.5 μm, underlying cell wall 0.5–1.5 μm. Abaxial epider-

mis 13–21  $\mu\text{m}$ ; abaxial cuticle 3–6(–8)  $\mu\text{m}$ , *alveolar material* (almost) homogeneous over guard cells and subsidiary cells, irregularly heterogeneous (in surface view densely finely granular and widely spaced coarsely granular) over unspecialised cells and there 0.4–0.9 of thickness of cuticle, underlying cell wall 1–2  $\mu\text{m}$ . Stomatal plugs (0–)2–6  $\mu\text{m}$  below surface of epidermis. *Adaxial subepidermal layer* consisting of 1 or 2 layers of strongly sclerified squarish cells; throughout mesophyll part of cell walls rather strongly sclerified, more so in abaxial subepidermal layer(s). *Brachysclereids* absent. *Druses* (3–)5–15  $\mu\text{m}$  in diam. very few to very frequent in mesophyll; globose to rod-shaped or ellipsoid crystals 1–3  $\mu\text{m}$  long rare to rather common throughout lamina. *Oil cells* 35–65  $\mu\text{m}$  in diam. very few to rather many in mesophyll.

Field notes. Flowers white or cream; pedicels and florescence axes bright red.

Distribution. NE. Queensland, from 15°50' to 17°25' SL.

Ecology. Rainforest understorey; mixed notophyll vine forest; windswept microphyll mossy thickets; 680–1300 m alt. Fl.: April–June; fr.: Aug.–Dec.

Note. In *B. semecarpoides* nests of brachysclereids cause a rugulose surface on both sides of the dry leaves. In the present species the continuous subepidermal layer of sclerified cells results in smooth surfaces of the dry leaves. Differences in this subepidermal layer appeared to separate the available specimens in a northern and a southern group; the few data available on petal number corroborate this division, but further data are certainly necessary.

#### KEY TO THE SUBSPECIES

- a. In the leaves 2 (sometimes in a leaf locally 1 or 3) adaxial subepidermal layers of rather small, squarish, strongly sclerified cells. – Petals (always?) 4 or 5 (1-seriate) ssp. *queenslandiana*
- b. In the leaves 1 adaxial subepidermal layer of rather large, squarish, strongly sclerified cells. – Petals (always?) 7 or 8 (2-seriate) . . . . . ssp. *australis*

#### a. ssp. *queenslandiana*

Petals 4 or 5 (1-seriate). – Adaxial cuticle 3–4.5  $\mu\text{m}$ . Under adaxial epidermis 2 (sometimes locally 1 or 3) layers of rather small, squarish, strongly sclerified cells together 45–60  $\mu\text{m}$  (c. 30  $\mu\text{m}$  in case of 1 layer) thick; sometimes of these the subepidermal layer less sclerified than the inner one.

Distribution. Between Cooktown and Cairns from Mt Finnigan to Mt Lewis.

QUEENSLAND. V.C.L. Noah, *Hyland 8295\** (L). Mt Finnigan, *Webb & Tracy 10840* (K). Carbine Tableland, Mt Miscry, *Webb & Tracy 10818* (K, L). T.R. 140, Cow L.A., *Hyland 7970\** (L). Mt Spurgeon, C.T. *White 10644\** (BRI). T.R. 142, Zarda L.A., Platypus Creek track, *Irvine 650* (L). Mt Lewis, S.F.R. 143, North Mary L.A., *B. Gray 484\** (type, L), *Hyland 6735\** (L), *Irvine 1152\** (K, L), *Stocker 1153B\** (L). Mt Lewis area, *G. Gillett 2607* (L).

**b. ssp. australis** Vink, *subsp. nov.*

Differt a subspecie typica strato adaxiali subepidermali foliari ex cellulis majoribus uniseriatis plerumque scleroideis unilateraliter et petalis 7 vel 8. — Typus: *K.J. White QF 52/235* (BRI).

Petals 7 or 8 (2-seriate). — Adaxial cuticle 4–7.5  $\mu\text{m}$ . Under adaxial epidermis one layer of rather large, squarish, strongly sclerified cells 30–55  $\mu\text{m}$  thick; often inner periclinal walls of these cells less or not sclerified.

Distribution. Between Cairns and Innisfail: Mt Bartle Frere and surroundings.

QUEENSLAND. Boonjie area, S.F.R. 755, *Dockrill 170\** (L), *324\** (L); S.F.R. 310, W. side Mt Bartle Frere, *K.J. White QF 52/235\** (type, BRI); on Gurka Pocket road at foot of Mt Bartle Frere, *Thorne 27621\** (RSA). Upper Russell R., *Steph. Johnson s.n.\** (MEL). Towalla, Russell R., *Steph. Johnson s.n.\** (MEL). Mt Bartle Frere, *Steph. Johnson s.n.\** (MEL).

**3. *Bubbia semecarpoides*** (F. Muell.) Burt. — Fig. 5, 6, 8.

(for synonymy see under the varieties)

Shrub or tree up to 20 m high and 20 cm d.b.h. Branchlets rather slender; dry epidermis longitudinally or irregularly wrinkled. *Petioles* 0.7–4 cm long, rounded to triangular below, flat to canaliculate and with ridges descending from leaf base above. *Blade* obovate to oblanceolate, 3–36  $\times$  1–8.5 cm, chartaceous to coriaceous, *in sicco* pusticulate, scabrous, apex (broadly) rounded or acute to obtuse, base narrowly cuneate; midrib (rather) broad, above sunken to flat, below rounded; nerves at the middle of the blade at an angle of 45°–65° to the midrib, thin and prominulous to inconspicuous on either side; veins inconspicuous on either side. On lower leaf side both stomata and unspecialised cells white. *Inflorescences* with up to 10 bract scars below lowest florescence; florescences 1–14, these 1.2–10 cm long, 1–8-flowered, with pedicels inserted on main axis or on branches 1st order; all axes and pedicels smooth to pusticular. *Pedicels* 2–13 mm long, of solitary flowers 4–19 mm long. *Calyx* 2–3 mm wide, ruptured into 2–4 lobes. *Torus* 0.5–1.3 mm high. *Petals* 5–12, elliptic to obovate, rounded to truncate, outer ones 5–7  $\times$  2.5–4 mm, other ones 3–7  $\times$  1.5–3 mm; brachysclereids rather thin-walled, solitary and in small clusters, very dense throughout petals, or in apical parts of petals sparse or in inner petals rather dense. *Stamens* 14–32, length 1–2 mm; filaments inflated, sometimes laterally wing-like widened; thecae apically at an angle of 80°–180° to each other, slits sometimes continuous over apex of stamen. *Carpels* 1–8, these 1.5–2  $\times$  1.0–1.3  $\times$  1.0–1.2 mm; stigma 0.4–0.6 of length of carpel apex; ovules 7–20. *Fruitlets* obliquely ellipsoid to obovoid, up to 15  $\times$  15  $\times$  13 mm, stipe 0.3–2 mm, stigma 2.5–3.5 mm and distinct to indistinct; brachysclereids solitary or in clusters, rather dense in middle layer of fruit wall. *Seeds* 2–13, obovoid, almost smooth to slightly pusticulate, up to 6.5  $\times$  3.5  $\times$  3.5 mm, black; axis straight.

Leaf anatomy. Lamina 185–380  $\mu\text{m}$ . Adaxial epidermis 20–38  $\mu\text{m}$ ; adaxial cuticle rather smooth, 3–17  $\mu\text{m}$ , underlying cell wall 1–2  $\mu\text{m}$ . Abaxial epidermis 13–25  $\mu\text{m}$ ; abaxial cuticle 4–8  $\mu\text{m}$ , *alveolar material* over all cells, homogeneous or

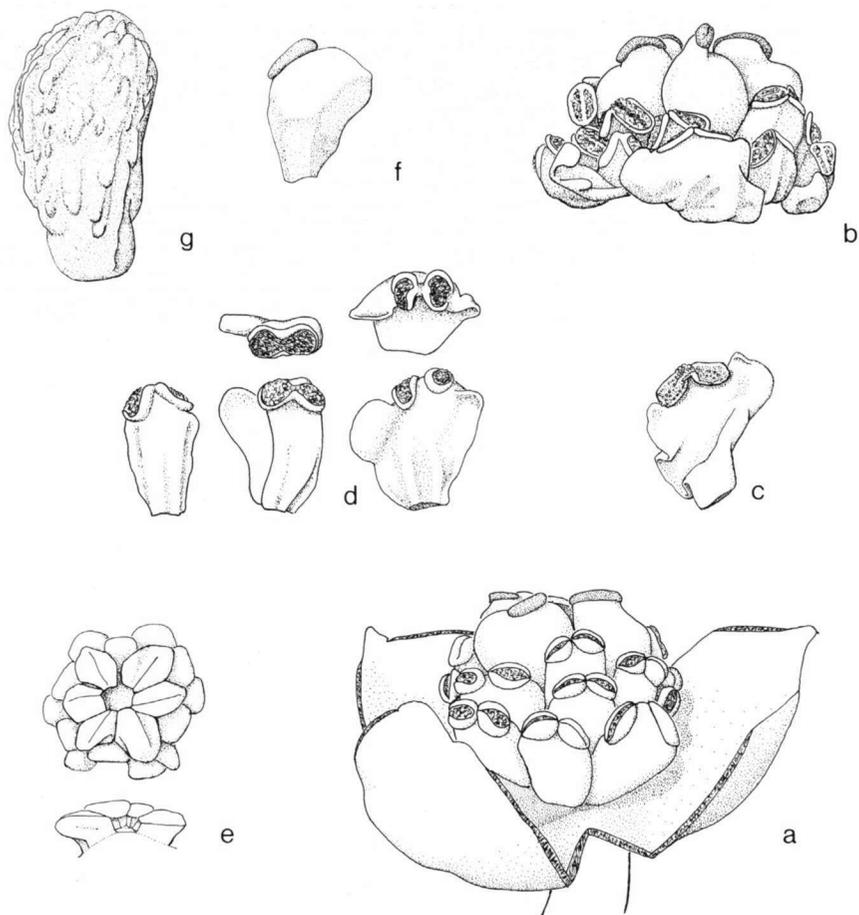


Fig. 5. *Bubbia semecarpoides*. — a–d: var. *whiteana*; e–g: var. *semecarpoides*. — a. Just opening flower, petals removed; ruptured calyx and normal stamens (x 12½). — b. Open flower, calyx and petals removed; lower stamens with lateral expansions (x 12½). — c. Same stamen as in middle of fig. b, adaxially (x 12½). — d. Three stamens from another flower, adaxially, two also apically (x 12½). — e. Young carpels and in the apical view also some stamens, showing vestigial floral apex (x 25). — f. Carpel from old flower (x 12½). — g. Seed (x 6). — (a: *Kajewski 1495*; b–d: *Brass 2278*; e: *Webb & Tracy 5567*; f: *Hill s.n.*; g: *Fraser 54*).

heterogeneous, over unspecialised cells 0.5–0.9 of thickness of cuticle, underlying cell wall 1–2  $\mu\text{m}$ . Stomatal plugs 0–6  $\mu\text{m}$  below surface of epidermis. *Palisade* parenchyma not to distinctly differentiated and then in one or two layers and not to slightly or locally sclerified; in abaxial half of lamina (part of) cell walls often slightly to strongly birefringent. *Brachysclereids* rather to very frequent, solitary and in small to large clusters, most of these touching adaxial or both epidermides. *Druses* 5–22

$\mu\text{m}$  in diam. (very) frequent in mesophyll; globose to rod-shaped crystals 1–2(–3)  $\mu\text{m}$  long rare to rather common throughout lamina. *Oil cells* 30–60  $\mu\text{m}$  in diam. very few to rather many in mesophyll.

Distribution. Australia: NE. Queensland.

Note. *Bubbia whiteana*, described by A.C. Smith to accommodate the material from Thornton Peak, is characterised by smaller leaves and inflorescences and smaller numbers of petals, stamens, carpels, and ovules, and a thicker upper epidermis with a thicker cuticle in its leaves. Compared with what is known about *Bubbia semecarpoides* (not very much more than at the time of Smith's studies) these smaller sizes and numbers could be caused by ecological factors as *B. whiteana* occurs at elevations of 1250–1300 m, whereas *B. semecarpoides* is known from 300–1200 m altitude. Such a correlation with the more adverse conditions of higher altitudes occurs also in *Drimys piperita*. Forms ('entities') from the alpine regions in New Guinea usually have smaller leaves, shorter internodes, and florescences consisting of a single flower, whereas the entities from the mid-mountain areas have larger leaves, longer internodes, and florescences with several flowers.

As flowering material of the present species is still extremely scarce, the full range of variability is certainly not yet known and more material always gives more overlap. However, *B. whiteana* has two characters in which it differs constantly, namely the flat upper side of the midrib (which is sunken in *B. semecarpoides*) and the absence of heterogeneous alveolar material on the lower cuticle of the leaves. As these differences strengthen those mentioned above I cannot, without much more material, decide on a continuous or discontinuous variation. As this variation is not regional, but local, I have accepted two varieties.

#### KEY TO THE VARIETIES

- a. Midrib sunken (*in sicco*) . . . . . var. *semecarpoides*  
 b. Midrib flat (*in sicco*) . . . . . var. *whiteana*

#### a. var. *semecarpoides*

*Bubbia semecarpoides* (F. Muell.) Burtt, Hook. Ic. Pl. V, 4 (1936) ad. t. 3315, p. 3; A.C. Smith, J. Arn. Arb. 24 (1943) 144. – *Drimys semecarpoides* F. Muell., Vict. Nat. 8 (1891) 15; Bot. Centralbl. 46 (1891) 204; F.M. Bailey, Queensl. Fl. 1 (1899) 19; Compr. Cat. Queensl. Pl. (1913) 21; Domin, Bibl. Bot. 22 (Heft 89) (1925) 115 = 669; C.T. White, Contr. Arn. Arb. 4 (1933) 28, p.p. – Type: *W. Sayer 293* (MEL; unnumbered dupl. in K).

Petioles 1–4 cm long; blade 6–36 × 2.3–8.5 cm; midrib sunken above. Florescences 4–14, these 2.5–10 cm long, (2–)3–8-flowered. Petals 8–12; stamens 19–32; carpels 3–8; ovules 10–20.

Leaf anatomy. Adaxial epidermis 21–30  $\mu\text{m}$ ; adaxial cuticle 3–8  $\mu\text{m}$ . Alveolar material homogenous over guard cells and subsidiary cells, heterogeneous over unspecialised cells (in surface view finely granular over all cells, also coarsely granular over unspecialised cells).

Field notes. Bark grey, smooth, with vertically elongated lenticels; blaze cream to light yellow, with conspicuous odour, bitter. Leaves glaucous beneath.

Distribution. NE. Queensland from 15°40' to 18°50' SL.

QUEENSLAND. Gap Crk, c. 24 miles S. by E. of Cooktown, *L.S. Smith 11217\** (BRI). 20 miles NNW of Daintree, *Boylard 433* (K). Black Mtn, N. of Cairns, *D. Anderson s.n.\** (L). Saddle Hill, Macalister Ra., *Wrigley & Telford 19* (CBG). Trinity Bay, *sine coll. MEL 5619 = NSW 68513* (MEL, NSW). Davies Crk, *Webb & Tracy 5567* (CANB, L). Tinaroo Ra., *H. Hecken s.n.* (BRI, N.Q. Nat. Herb. 12897); Robson's Camp, *L.S. Smith 4178\** (BRI, K, L). Atherton Tableland, Jan. 1918, *C.T. White s.n.\** (BRI). S.F.R. 194, W. of Atherton, Moonim, *Dockrill 110\** (L); bank of Walsh R., *Stocker 1028\** (L, RSA). West Line 4, F.R., W. of Atherton, *Carlquist 15209* (RSA). Six miles W. of Atherton, *Thorne & Dansee 20767* (RSA). F.R. 99, Herberton Ra., *Schodde 4178\** (A, L). East Malanda, *Kajewski 1216\** (A, BRI, P, S). Lamins Hill, 4 km NW of Boonjie, *Vink 17710, 17711* (L). Boonjie, *W.T. Jones 1486\** (CANB), *C.T. White s.n.\**, Jan. 1923 (A, B, BO, BRI, NSW), *Webb 998\** (CANB). Parish of Bartle Frere, near headwaters of Russell R., *D. Fraser 54\** (BRI). Harveys Crk, Russell R., *Sayer 293* (MEL, no 5616, type; K, unnumbered). Rockingham Bay, *Dallachy s.n.\** (K, MEL). Between Cleveland Bay and Rockingham Bay, *Hill s.n.* (K). Seaview Ra., *sine coll. 25\**, dd. 1864 (MEL), *sine coll.*, dd. 30-5-1865 (MEL). Mt Fox, *Clemens s.n.* (GH, K), *Webb SN5459\** (CANB).

Ecology. Montane rainforest(-margins), mesophyll vine forest; 300–1200 m alt. Fl. prob. about January; fr. July to January.

Note. In some branches of *C.T. White s.n.* and of *Webb & Tracy 5567* the empty bracts below the florescences are replaced by young leaves.

**b. var. whiteana** (A.C. Smith) Vink, *nov. stat.*

*Bubbia whiteana* A.C. Smith, J. Arn. Arb. 24 (1943) 145, fig. a–f. — Type: *Brass 2278* (A, holo, n.v.; B, BRI, K, P).

*Drimys semecarpoides auct. non* F. Muell.: C.T. White, Contr. Arn. Arb. 4 (1933) 28, p.p.

Petioles 0.7–1.5 cm long; blade 3–12 × 1–3.5 cm; midrib flat above. Florescences 1–7, these 1.2–2.5 cm long, 1- or 2-flowered, if 1-flowered pedicels 0.4–1.9 cm long. Petals 5–9; stamens 14–19; carpels 1–4; ovules 7–10.

Leaf anatomy. Adaxial epidermis 30–38 μm; adaxial cuticle 10–17 μm. Alveolar material homogeneous over all cells of abaxial epidermis (finely granular in surface view).

Field notes. Leaves glaucous beneath; margins mostly recurved. Petals cream or cream-green. Ripe fruits black.

Distribution. NE. Queensland: Thornton Peak (Mt Alexander).

QUEENSLAND. Thornton Peak, *Brass 2278\** (type; A, n.v.; B, BRI, K, P); *Hyland 7051\** (L); *Kajewski 1495\** (A, BRI, K, MEL, NSW, S); *Hartley 14066a\** (L).

Ecology. Montane (stunted) rain forest; poor or low scrub; 1250–1300 m alt. Fl. March; fr. March and Dec.

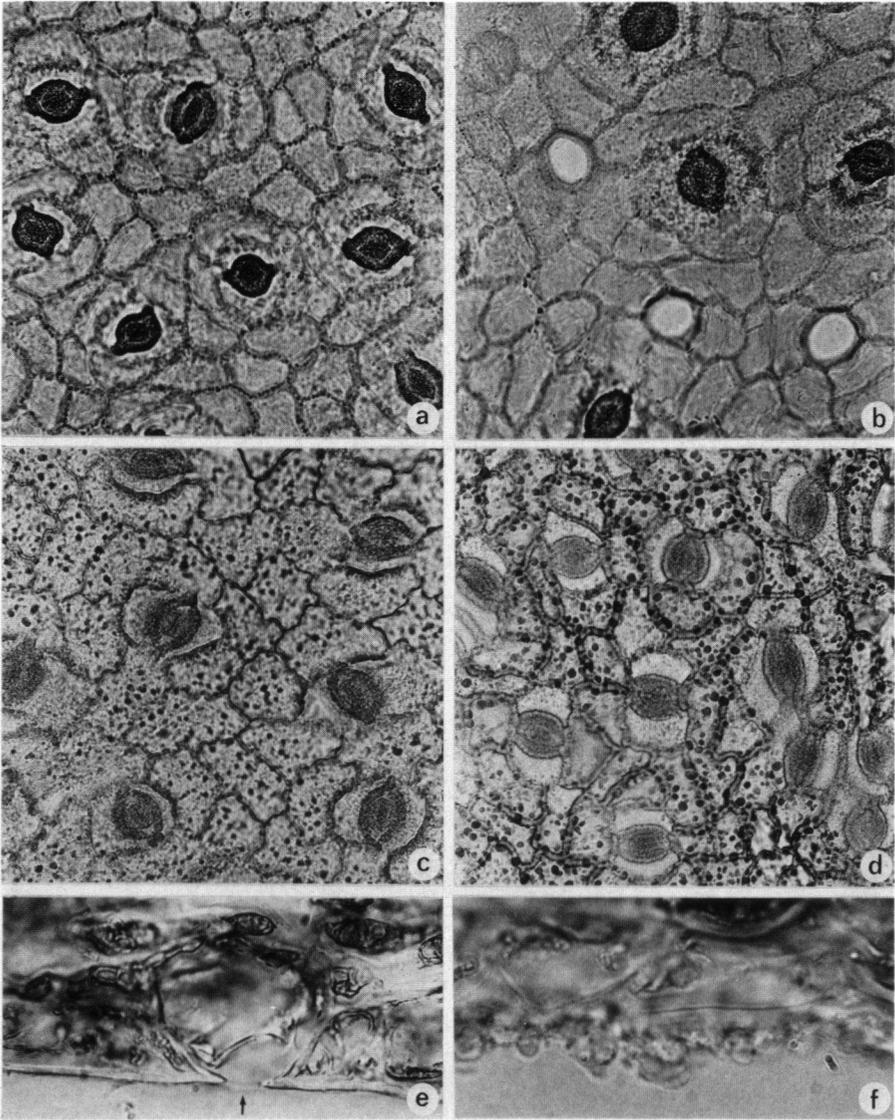


Fig. 6. Leaf anatomy. a–d: cuticular macerations (x 260), e & f: transverse sections. – a. *Bubbia howeana*, alveolar material only over stomata (Takhtajan & Rodd 1849). – b. *ibidem*, with openings of epidermal oil cells (van Balgooy 1063). – c. *B. queenslandiana* ssp. *australis*, heterogeneous alveolar material over unspecialised cells (White QF 52/235). – d. *B. semecarpoides* var. *semecarpoides*, *ibidem* (Dockrill 110). – e. *B. howeana*, oil cell with external opening in abaxial epidermis (arrow), cuticle without alveolar material, x 420 (van Balgooy 1063). – f. *B. semecarpoides* var. *semecarpoides*, strongly heterogeneous alveolar material on abaxial cuticle, x 1000 (Dallachy s.n.).

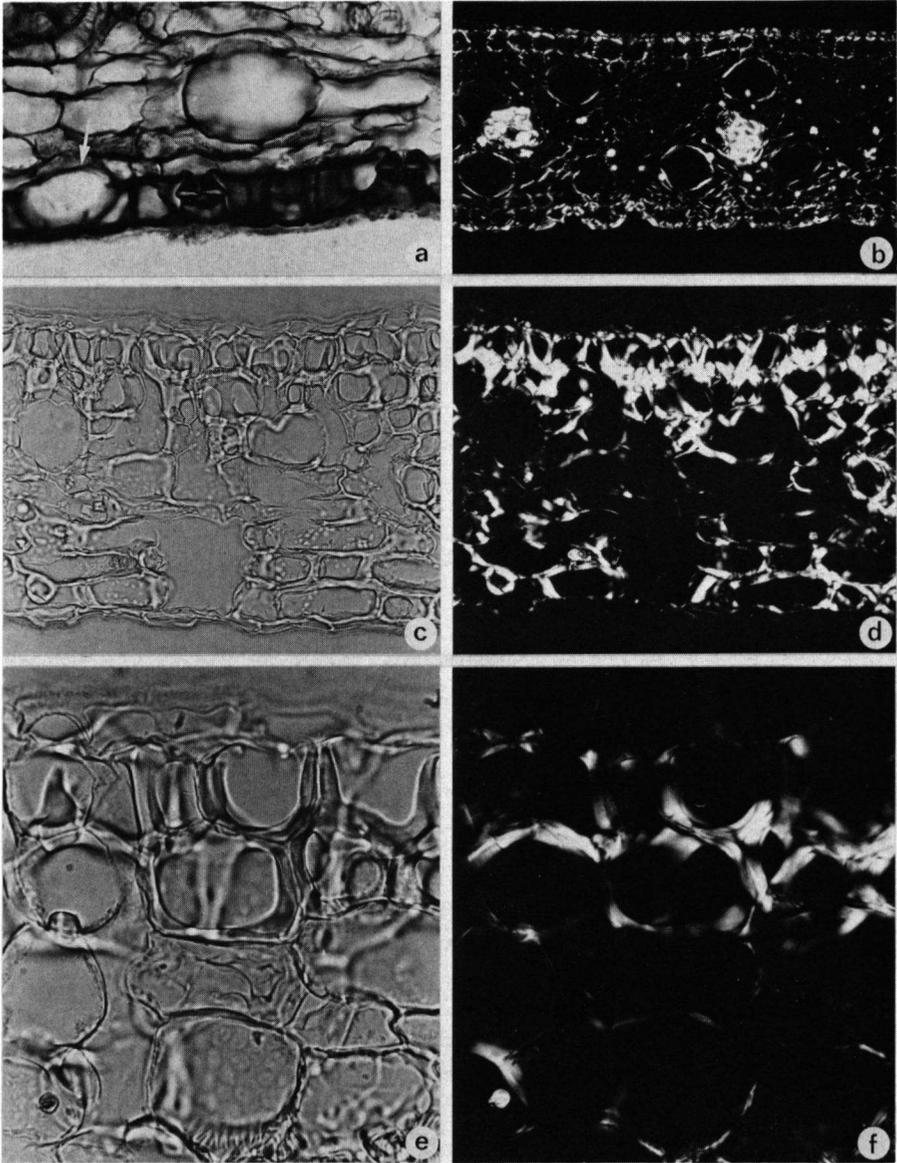


Fig. 7. Leaf anatomy. Bleached transverse sections; b–f unstained; b, d & f with polarized light. — a. *Bubbia howeana*, front cavity of stomata plugged with alveolar material, oil cell in mesophyll and in epidermis (arrow); safranin-haematoxylin, x 260. — b. *ibidem*, walls of epidermis thickened, x 170 (a & b: *Takhtajan & Rodd 1849*). — c–f. *B. queenslandiana* ssp. *queenslandiana*, walls of epidermis thin, mesophyll partly sclerified, adaxial sclerified subepidermal layer about two cells thick; c & d x 170, e & f x 425 (*C.T. White 10644*).

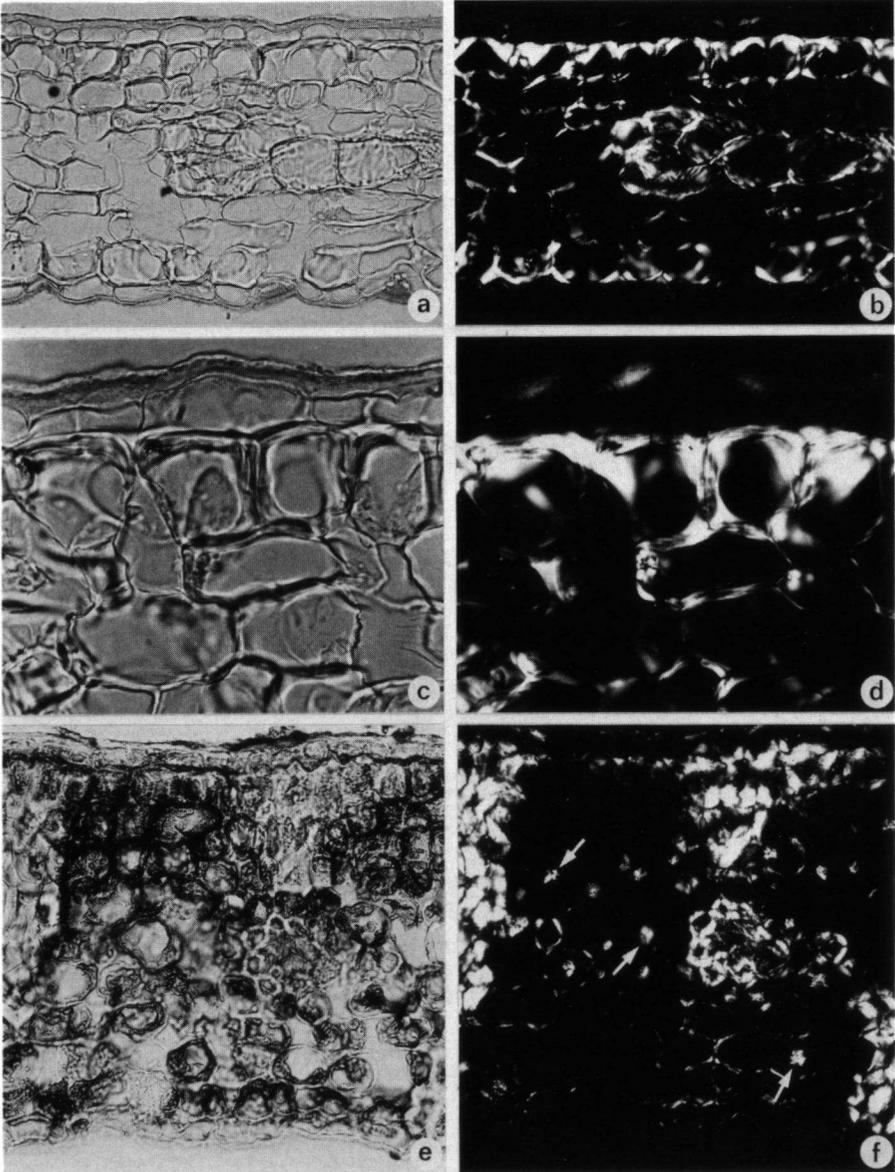


Fig. 8. Leaf anatomy. Transverse sections, unstained, a–d bleached; b, d & f with polarized light. — a–d. *Bubbia queenslandiana* ssp. *australis*; walls of epidermis thin, mesophyll partly sclerified, adaxial sclerified subepidermal layer one cell thick, a & b x 170, c & d x 425 (Dockrill 324). — e & f. *B. semecarpoides* var. *semecarpoides*; walls of epidermis thin; in mesophyll clusters of brachysclereids; druses distinct (arrows); x 170 (Dockrill 110).