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THE TUBEROUS EPIPHYTES OF THE RUBIACEAE 2: THE NEW GENUS ANTHORRHIZA

C.R. HUXLEY[1] & M.H.P. JEBB[1 2]

SUMMARY

Anthorrhiza Huxley & Jebb, Psychotrieae–Hydnophytinae, is described. The eight species, all of which are new to science and endemic to Papua New Guinea, are fully described, and a key to the species and an enumeration of specimens are given.

INTRODUCTION

While studying the tuberous genera of the Psychotrieae, *Hydnophytum* Jack, *Myrmecodia* Jack, *Myrmephytum* Becc., *Myrmedoma* Becc. and *Squamellaria* Becc., now designated as the Hydnophytinae (Huxley & Jebb, 1990), it became apparent that many unidentified sheets did not fall readily into any of these genera (Huxley, 1981; Jebb, 1985). These specimens all share the character of a single inflorescence in one axil at each node ('pseudo-axillary') though this may be obscured by dense spines. In this they resemble *Myrmephytum* and *Myrmedoma* but lack the 6-merous flowers of these genera. *Hydnophytum* and *Myrmecodia* normally have paired inflorescences. The solitary inflorescence of *Anthorrhiza* differs from the rare solitary inflorescence of *Hydnophytum* in being divided by sterile, often spine-bearing ridges into separate flower-bearing areas. Moreover branches arise from among these flower-bearing areas. While some species resemble *Hydnophytum* in their glabrous tubers and narrow, freely branched stems, others have spiny tubers and single unbranched stems as *Myrmecodia* does. This new genus of epiphytic ant-plants was first mentioned by Huxley (1981), and was expanded by Jebb (1985), and the generic name and the type species has been published (Huxley & Jebb, 1990). The other seven species described here have not been published before. All specimens are cited and have been seen, unless marked 'n.v.' The figure in square brackets after *'Flowers'* in the descriptions is the number of flowers dissected.

ANTHORRHIZA

Anthorrhiza Huxley & Jebb, Bull. Jard. Bot. Nat. Belg. 60 (1990) 420.

Anthorrhiza propter tuber cavernosum et florum fructuumque fabricam nullo dubio ad *Hydnophytinis* pertine, tubi, inflorescentiis solitariis, sessilibus, quas componunt areae florigerae disjunctae jugis substantiae vascularis saepe spinigeris et ramis caulinis inter areas florigeras abeuntibus, bene dignoscenda. — Typus generis: *Anthorrhiza echinella* Huxley & Jebb.

1) Department of Plant Sciences, Oxford University, South Parks Road, Oxford, OX1 3RB, U.K.
2) Now at Christensen Research Institute, P.O. Box 305, Madang, Papua New Guinea.

Tuber spherical, conical, or oblate, occasionally lobed, not ridged, to 35 × 25 cm, grey or pale to dark brown. Spines absent or present, simple to stellate, yellow to black. Holes 0.2–3.0 cm across, scattered over the surface or confined to the base of the tuber, and then occasionally also at the apex of the tuber. Cavities within tuber often large; the first one warted and continuing to grow throughout the life of the plant, and not connecting to other cavities. Tuber tissue drying reddish, brown, or yellowish. The later cavities whitish, added peripherally, generally smooth-walled, and largely interconnected. *Stems* one to several, sometimes branched. Internodes condensed or not. Spines absent, confined to inflorescence or clothing stem and tuber densely, then longer and branching to a greater degree on the stem than on the tuber. *Leaves* clustered to remote, spreading to erect. Lamina broadly elliptic to narrowly lanceolate, 4.5 × 2 – 29 × 10 cm, thick, sometimes hard or leathery. Petiole absent to 6(–8) cm. Stipules remaining united between petioles, triangular to orbicular, 0.4–1.0 cm in length, occasionally with a central ridge, persistent to caducous. *Inflorescence* a single mass of flower-bearing areas, sessile to sunken, more or less central to the leaf axil; a dense pulvinate cushion of bract hairs surrounded by a ridge of stem tissue, or a mass of triangular leathery bracts, or densely spined, the spines sessile or mounted on fleshy walls of stem tissue between the individual flower-bearing areas. Flowers produced successively over a long period, and separated by the compacted remains of bracts or spine-capped stem tissue. Each flower enclosed by a single bract which may be chartaceous and inconspicuous or leathery and prominent; bracts splitting along one side and boat-shaped towards the apex. Bracts sometimes enclosing numerous hairs, attached at its lower inner edge, these hairs are conspicuous in some species. *Flowers* 4-merous, heterostylous (or homostylous).

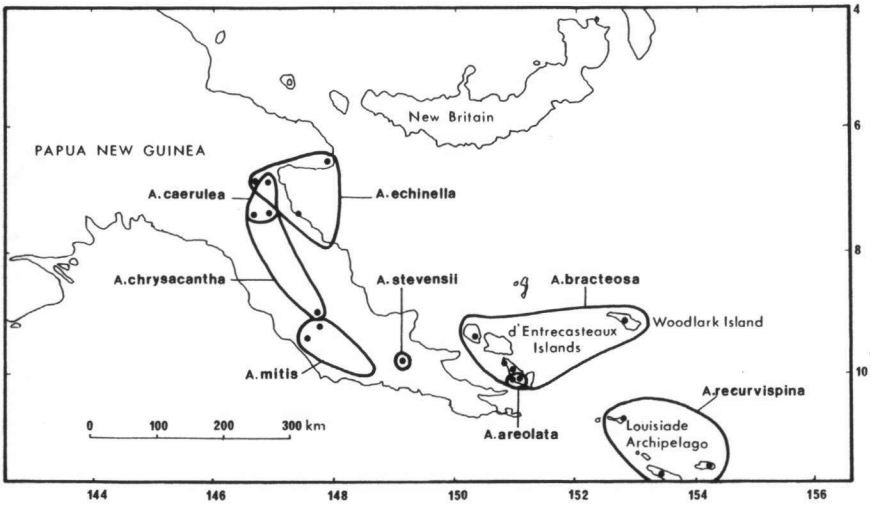

Fig. 1. Distribution of the species of *Anthorrhiza* Huxley & Jebb.

Calyx 1–4 mm. Corolla white, greenish white, rarely turquoise, 11–20 mm; lobes 2–5 mm; ring of hairs in the corolla tube present (or absent). Anthers 1–5 mm, cream, yellow, pale or dark blue. Pollen 3-porate with or without 3 vesicles, 60–100(–150) µm; apertures bordered or not; reticulation fine to coarse. Stigma 2–8-lobed. *Drupe* to 12 mm, orange to red. Pyrenes 2–8.

Distribution – South-eastern Papua New Guinea: Owen Stanley Mountains, the Sattelbergs, Huon Peninsula, d'Entrecasteaux Islands, Woodlark Island, Louisiade Archipelago (fig. 1).

Ecology – All epiphytic, from sea level to 3000 m. Found in undisturbed or disturbed forest, on agricultural trees, or in stunted forest on poor soil. Often growing with *Hydnophytum* or *Myrmecodia,* several of the species are sympatric. Two species are regularly inhabited by ants (*Iridomyrmex*); the others may contain centipedes, beetles, cockroaches or lizards. In one species rainwater is generally present, sometimes with cockroaches.

Historical note

The first specimen of *Anthorrhiza* to be collected was by Carr in 1935, at Boridi in the Central Province, who noted in his diary: "an interesting find was a simple plant, to which I gave no number, of a small very spiny *Myrmecophilum* [sic] with large snow white flowers." (MS in Natural History Museum, London). Unfortunately, this collection was not given a number; however, a specimen of *A. chrysacantha* fitting this description does comprise part of the mixed collection *Carr 14659* (A).

Just two months later Mary Clemens collected *Anthorrhiza echinella* near Finschhafen, Morobe Province. It was this species that CRH recognised as a distinct genus when she collected specimens near Lae in 1975. The 4th and 5th Archbold expeditions yielded 3 species from the d'Entrecasteaux Islands: *Anthorrhiza bracteosa, A. areolata,* and *A. recurvispina.* Streimann and Kairo discovered *A. mitis* in 1967. The Mount Suckling expedition of 1972 produced *A. stevensii.* In 1974 CRH collected *A. caerulea* on Mt Kaindi, a surprisingly ignored species on a well visited mountain. MHPJ recollected all species except *A. stevensii* in 1983 and 1984, enabling a thorough morphological study to be made.

Discussion

The genus is characterised by its large and centrally positioned inflorescences, in which branches and ridges bearing spines occur between the flower-bearing areas. However the vascularization of these inflorescences requires further study to elucidate their morphology.

The tuber and general morphology of the genus show a remarkable range from *Hydnophytum*-like to *Myrmecodia*-like. This variation makes instant recognition of the genera difficult. Previously the gross morphology of *Hydnophytum* with its smooth tuber and slender branched stems, versus the densely spined tuber and thick little-branched stems of *Myrmecodia,* made field identification of the Papua New Guinean genera of tuberous Rubiaceae a simple task.

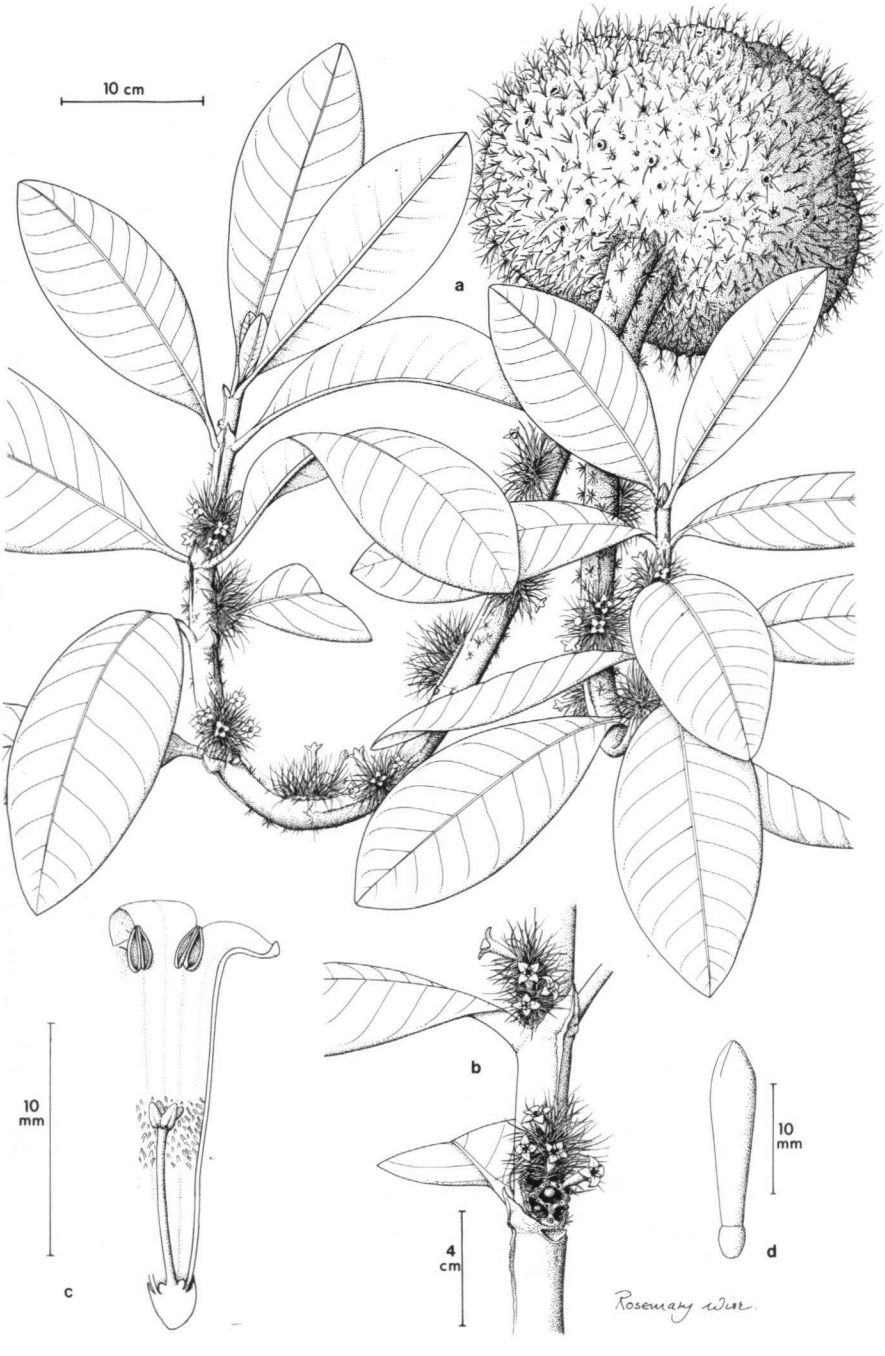

Fig. 2. *Anthorrhiza echinella* Huxley & Jebb. a. Habit; b. stem and inflorescences showing interpetiolar stipules; c. half flower; d. bud (a, b: *UPNG 3463*; c, d: *Jebb 341*).

KEY TO THE SPECIES OF ANTHORRHIZA

1a. Spines present on stem 2
b. Stem spines absent or very few 6
2a. Spines largely, but not exclusively, confined to the inflorescence forming a cushion in the leaf axil. Leaves 4–10 cm wide 3
b. Spines scattered on stem. Leaves usually less than 4 cm wide 4
3a. Inflorescence with fleshy ridges separating flower producing tissue. Spines straight, usually dense on tuber. Corolla lobes greenish-white. Anthers cream **1. A. echinella**
b. Inflorescence without ridges of tissue. Spines gently curved, usually sparse on tuber. Corolla white. Anthers blue ..... **2. A. recurvispina**
4a. Lamina less than 8 cm long ..... **6. A. stevensii**
b. Lamina more than 10 cm long. 5
5a. Stem dorsi-ventral, more spines on upper side. Spines light brown to blackish. Leaf margin crinkled.Corolla blue ..... **8. A. caerulea**
b. Stem radially symmetrical. Spines golden brown. Leaf margin flat. Corolla white ..... **7. A. chrysacantha**
6a. Inflorescence covered by leathery and papery bracts. Fruit with 4–8 pyrenes **4. A. bracteosa**
b. Inflorescence sunken or covered by a dense cushion of bract hairs. Fruit with 2 pyrenes 7
7a. Tuber surface smooth. Leaves to 17 × 7 cm. Inflorescence narrowly cordate in outline ..... **3. A. mitis**
b. Tuber surface areolate. Leaves to 11 × 4 cm. Inflorescence arch-shaped in outline ..... **5. A. areolata**

Anthorrhiza mitis

Anthorrhiza areolata

1. **Anthorrhiza echinella** Huxley & Jebb – Fig. 2.

Anthorrhiza echinella Huxley & Jebb, Bull. Jard. Bot. Nat. Belg. 60 (1990) 420.

Tuber globosum, spinis ramosis armatum. Caules pauci, spinis plerumque ad inflorescentias limitatis. Folia lanceolata usque obovata, usque ad 29 × 10 cm. Stipulae triangulares, satis persistentes. Inflorescentia dense spinosa, spinis in parietibus angustis inter areas florigeras impositis. Corollae tubus albus, lobi viridi-albi. Antherae cremeae. Pyrenae 4–6. — Typus: Papua New Guinea, *Huxley & Worthing UPNG 3463* (holo UPNG; iso A, FHO, K, L, LAE).

Tuber suborbicular, slightly flattened, to 18 cm tall, 25 cm diameter, smooth, grey. Spines numerous, irregularly stellate, 1.0–1.8 cm long, side branches c. 6, 0.3–0.6 cm, sharp, yellow to blackish. Holes scattered over tuber surface, 0.2–5

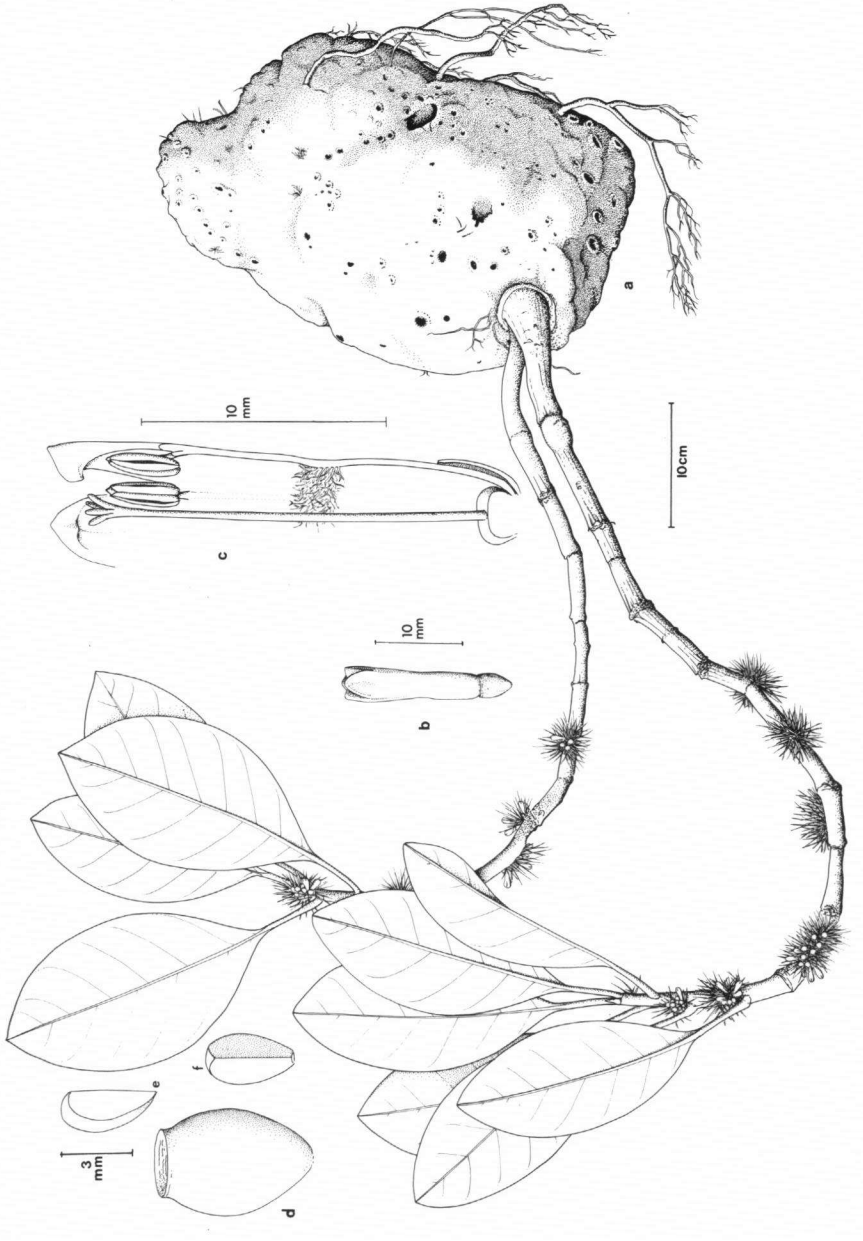

Fig. 3. *Anthorrhiza recurvispina* Huxley & Jebb. a. Habit; b. bud; c. mature flower; d. fruit; e. & f. pyrenes (all from *Jebb 399*).

cm in diameter, with raised rims, often surrounded or occluded by spines. Tuber tissue drying pinkish. *Stems* few, rarely branched, to 100 × 2.5 cm, semi-pendulous, upcurving, with 2 rounded ridges descending from stipules (fig. 2b), grey green; internodes 5–8 cm long. Spines largely restricted to inflorescences, but also a few, 0.4(–1.4) cm long, in lines along stem ridges, or rarely scattered. *Leaves* spreading. Lamina 15 × 6 – 29 × 10 cm, lanceolate to obovate, apex acute, base tapered, leathery to brittle, dark glossy green above, pale below. Midrib prominent below, caniculate above, yellow-white. Veins 12–17, almost perpendicular to midrib, with alternate, very faint veins. Petiole 0–2(–3.5) cm, rounded below, yellowish. Stipules triangular, to 1 cm long, fairly persistent, brown. *Inflorescence* oval to oblong, often raised in the centre, to 4 × 1.5 cm, densely covered and surrounded by branched spines. Up to 15–20 flowering-bearing areas, groups of 1–3 being surrounded by a narrow wall of tissue 0.2–0.5 cm high and 0.1–0.2 cm thick, surmounted by spines; spines to 2 cm long, and irregularly or stellately branched. Bracts inconspicuous, papery, to 2 mm. *Flowers* [7] heterostylous. Calyx 2–3 mm, level with or slightly above disc, membraneous at margin, with flaky scales. Corolla 15–18 mm, white; lobes greenish white, c. 4 mm. A ring of hairs below the middle of the tube. Longistyle flowers with anthers at level of hairs, stigma exserted. Brevistyle flowers with anthers at mouth of tube, stigma at level of hairs. Anthers cream. Pollen with 3 small vesicles; 60–72 µm large irregular pores, reticulation medium to coarse. *Fruit* unknown. Pyrenes 4 to 6, 3 × 1.3 mm.

Ecology – In coastal, riparian or disturbed forest at sea level to 1000 m. Commonly found on *Casuarina* and other open-canopied trees. Low to middle level epiphyte. Always ant-inhabited, but not with any great specificity. Found with *Myrmecodia tuberosa* Jack. Generally found in some numbers, but individual trees usually only contain a few scattered individuals.

Notes – The spiny inflorescence and otherwise smooth stem of this species is similar to that of *A. recurvispina,* see there. This species was *A. clemensii* in Huxley (1981).

The specific epithet describes the spine-covered inflorescences, which look like small sea-urchins or pin-cushions.

Collections – PAPUA NEW GUINEA. Morobe Province: SE 06° 33' 147° 47' Qwembung, Finschhafen Subprovince, *Clemens 1266* (A, G, L); 07° 25' 147° 10' Buso, Lae Subprovince, *Kairo & Emos NGF 39094* (A, CANB, K, L, LAE), *Streimann NGF 45103* (BRI, CANB, K, L, LAE); 07° 25' 147° 15' Lasanga Island, Lae Subprovince, *Streimann NGF 44188* (A, BRI, CANB, K, L); 06° 53' 146° 37' growing beside Patep Creek, 1 km NW of Perakles Pass on Lae–Bulolo road, *Jebb 341* (A, L, LAE), *342* (K, L, LAE), *343* (LAE) and *605* (LAE); 06° 53' 146° 37' Lae–Bulolo road just N of Perakles Pass, *Huxley & Worthing UPNG 3463* (type). Fly Island, c. 80 km S of Salamoa, *UPNG 5950* (UPNG).

2. **Anthorrhiza recurvispina** Huxley & Jebb, *spec. nov.* – **Fig. 3.**

Tuber globosum, spinis sparsis simplicibus vel pauce ramosis armatum. Caules pauci, spinis praeter inflorescentiam paucis. Folia ovata usque obovata, usque ad 22 × 10 cm. Stipulae triangulares, caducae. Inflorescentia spinifera, spinis sensim curvatis, inter areas florigeras abeuntibus. Corolla alba. Antherae caeruleae. Pyrenae 4. — Typus: Louisiade Archipelago, *Brass 28346* (holo A; iso BO, K, L).

Fig. 4. *Anthorrhiza miitis* Huxley & Jebb. a. Habit; b. flower and bud; c. fruit; d. pyrene (all from *Jebb 558*).

Tuber irregular, oblong-ovoid or oblate, to 35 cm across, semi-pendent, smooth, green brown, with scurfy layer of brown epidermal cells. Sparse, short to long root-like spines scattered on surface, 0.3–2.0 cm, sometimes branched, often pendulous, more numerous near host tree, becoming stiffer and more spine-like on more exposed surfaces. Holes numerous, scattered to clustered, 0.2–0.4 cm diameter, with prominent rims. Tuber tissue drying reddish. *Stems* few, rarely branching, weakly upcurving to 50 × 1.5 cm; internodes 3–8 cm, often sterile near tuber and longer there. Two ridges descending from between the leaves. Spines largely restricted to inflorescences, rarely elsewhere, branched, root-like, especially near junction with tuber, grey green. *Leaves* lax, spreading. Lamina 10 × 4 – 22 × 10 cm, ovate to obovate, apex broadly acute, base acute, glossy dark green above, pale below. Midrib prominent above and below, whitish; veins c. 7–9, with alternate faint veins. Petiole triangular, 2.5–6 (–8) cm, white. Stipules triangular, acute to acuminate, to 1.0 cm long, brown, tearing from stem, often giving the impression of intrapetiolar stipules opposite fertile axils, caducous. *Inflorescence* sessile, circular to cordate, to 4 × 1.5 cm, regularly spined. Spines to 2 cm, irregularly branched, flexible, curved, yellow to brown. Flower-bearing areas separated by compacted bracts, the spines appearing amongst these. *Flowers* [7] heterostylous. Calyx narrowed towards margin, c. 1–2 mm, thin membraneous with minute brown scales, at or above level of disc. Bud strongly 4-angled. Corolla white, to 20 mm, lobes to 4 mm; a ring of hairs, 2 mm broad, slightly more than ½ way up the tube. Anthers c. 3 mm, partly exserted, blue. Pollen with slight vesicles, to 75 µm, unbordered; reticulation fine. Stigma exserted to 4 mm from corolla mouth, 4-lobed; lobes long, papillose. *Fruit* subglobose, to 6 mm long, with prominent disc and calyx remains. Pyrenes 4, obovoid, triangular in section, to 4 mm long.

Ecology – In rain forest or more open ridge top forest, from sea level to 300 m. Epiphyte at low to middle level of the forest. Often found in some abundance, but usually as solitary specimens or in small groups growing with *Hydnophytum*. Regularly inhabited by the ant *Iridomyrmex scrutator*.

Notes – The stems of this species are similar to *A. echinella* from which it is distinguished by its less regular and more sparsely spined tuber with a far greater number of entrance holes; its rounded leaves with longer petioles; its smaller inflorescences with fewer, often slightly recurved, thicker spines which are not mounted on thin walls; and its white corolla with blue anthers.

The name *recurvispina* draws attention to the curved spines.

Collections – PAPUA NEW GUINEA. Louisiade Archipelago, Milne Bay Prov. SE 10° 39' 152° 48' S slopes of Mt Sisa, Missima Is., *Jebb 399* (CANB), *400* (LAE), *401* (LAE, UPNG), *402* (LAE), *403* (BRI, LAE). 11° 22' 154° 12' Rossel Is., *Brass 28346* (type). 11° 30' 153° 24' W slopes of Mt Riu, Sudest Is., *Brass 27967* (A, K, L).

3. **Anthorrhiza mitis** Huxley & Jebb, *spec. nov.* – **Fig. 4.**

Tuber subglobosum, laeve. Caules plures, laeves. Folia ovata usque obovata, usque ad 17 × 7 cm. Stipulae rotundatae, persistentes. Inflorescentia elongato-cordata, pulvinus pilorum in caule infossa. Corolla alba. Antherae caeruleae. Pyrenae 2. — Typus: Papua New Guinea, *Streimann & Kairo NGF 30756* (holo LAE; iso BULOLO).

Tuber subglobose, slightly flattened to conical, 30 × 26 cm, horizontal. Surface smooth, without spines, silvery-grey to brown. Holes scattered, occasionally clustered, 0.2–1.0 cm diameter. Tuber tissue drying whitish. *Stems* several, unbranched, horizontal to upcurving, arising from boss-like base, to 100 cm by 1.0–1.7 cm thick, thickest in fertile internodes. Internodes 2.5–6.0 cm in length, with 2 rounded ridges running from below the stipules; surface rough, with corky scales of bark, silvery grey. *Leaves:* lamina 10 × 3.5 – 17 × 7 (15 × 8) cm, ovate to obovate, apex blunt to acute, base shortly attenuate, leathery, brittle, dark glossy green above, pale and dull below. Midrib rounded, translucent below, prominent above and below; veins c. 10–12 with alternate less distinct veins, obscure below. Petiole 1.0–3.5 cm, rounded, white. Stipules semi-circular, to 0.7 cm long, with a central hooked or irregular process to 0.3 cm, persistent, sometimes falling after leaves, drying dark brown. *Inflorescence* sunken, narrowly cordate, to 4 × 2.5 cm, at first a compact cushion of brown bract hairs 0.5–0.8 cm long and papery bract remains, becoming smooth or hollow with age. Soft spines also sometimes arising from within the inflorescence. *Flowers* [3] heterostylous (?). Calyx to 2 mm, margin 4-dentate, translucent, with small brown scales, at or above level of disc. Corolla waxy white, to 11 mm long; lobes c. 2.5 mm. A ring of hairs more than $^1/_2$ way up inside the tube, or absent. Anthers c. 1.5 mm, immediately above ring of hairs, pale blue. Filaments 0.2 mm. Pollen 62–74 µm; pores bordered, reticulation fine. Stigma immediately above anthers or exserted, 2-lobed, lobes to 1.5 mm. *Fruit* obovoid, with prominent disc and calyx remains, to 7 mm long, orange-red, glossy. Pyrenes 2, semi-circular in section, obovoid, with a slight ridge on the inner surface, to 3.5 mm long, brownish yellow.

Ecology – In disturbed or open forest, sometimes in agricultural areas, 600–800 (–2000) m altitude. Middle to high level epiphyte, nearly always solitary. Growing with *Hydnophytum,* usually ant occupied, but not always by *Iridomyrmex* species.

Notes – *Anthorrhiza mitis* is similar to *A. areolata,* particularly in its pulvinate inflorescences. The tuber is smooth and quite regular, however, and the cavities are warted and smooth-walled, do not open by large funnel-like entrance holes, and are more compact in size compared to the large bulbous chambers of *A. areolata* which are not occupied by ants. In addition the internodes are longer, the inflorescence differs in shape, and the leaves are larger.

The single specimen from Milne Bay Province has unusually small leaves and was collected at high altitude. The flowers of *Jebb 155* are somewhat anomalous, lacking a ring of hairs, and with the anthers mounted on filaments c. 1 mm long. The style also appears to be far longer than the corolla tube, being twisted in the unopened bud. It is not clear whether this species is heterostylous.

The name refers to the smooth, defenceless surface of the tuber.

Collections – PAPUA NEW GUINEA. Sogeri Plateau and Owen Stanley foothills, Central and Milne Bay Provinces. SE 09° 15' 147° 37' Central, Naoro, on tree by airstrip, *Jebb 155* (LAE). 09° 22' 147° 28' Sogeri Subdistrict, 1 km before Ower's Corner on road from Ilolo, *Jebb 152* (A, K, L, LAE), *558* (LAE, UPNG). 09° 25' 147° 25' end of road past Eilolo, Sogeri Subdistrict, *Streimann & Kairo NGF 30756* (type). Milne Bay, near Bonenau village, upper slopes of Mt Mon, Daga Subprov., *Gay 902* (LAE).

4. Anthorrhiza bracteosa Huxley & Jebb, *spec. nov.* – **Fig. 5.**

Tuber subglobosum, foraminibus multis asperum. Caules pauci, quadrangulares, inermes vel spinis raris prope basin. Folia lanceolata usque obovata, usque ad 24 × 5.5 cm. Stipulae triangulares, persistentes. Inflorescentia bracteis grandibus, triangularibus, acuminatis, chartaceis usque coriaceis dense vestita. Corolla alba. Antherae caeruleae. Pyrenae 4–8. — Typus: Papua New Guinea, *Jebb 370* (holo LAE; iso BRI, L).

Tuber flattened, spherical or irregularly cylindrical, to 20 × 25(–35) cm, horizontal and clasping, smooth, without spines, silvery to light brown. Holes numerous, circular, 0.2–0.5 cm in diameter, with raised rims; also occasional slit-like openings arranged in semi-circular arrays. Tuber tissue drying reddish, granular. *Stems* several, occasionally branching, to 100 × 1.4 cm, subpendent, sinuous or erect, smooth near apex, 4-angled, slightly ridged, becoming more rounded, and with a few short spines near the tuber; internodes 0.5–6.0 cm, pale green to grey-brown. *Leaves* erect to spreading. Lamina 7 × 2 – 17 × 7 (24 × 5.5) cm, lanceolate to obovate; apex acute to acuminate; base tapering to petiole; thin to leathery, mid green above, pale below; margin inrolled when dry. Midrib sharply triangular, whitish; veins c. 6–10. Petioles 3–5 cm, triangular, white. Stipules triangular, to 0.7 cm long, persistent, silvery grey to brownish grey. *Inflorescence* sessile, to 2 cm in length, circular to elliptic, covered by triangular, acuminate, papery to leathery bracts to 1.3 cm long, grey to dark brown, with fine bract hairs. *Flowers* [21] heterostylous, distinctly quadrangular; bud winged. Calyx 2–3 mm, membraneous towards margin, with numerous small dark brown flakes, margin entire with 4 slight dentations. Corolla white, waxy, to 16 mm; lobes 3 mm. A narrow ring of hairs $^1/_3$ to $^1/_2$ way up inside the tube. Anthers 2–3 mm, pale blue; filaments 1–2 mm. Pollen 3-vesiculate, 58–89(–150) µm in diameter; apertures irregular, with a slight border; reticulation fine to medium. In longistyle flowers, anthers at the ring of hairs, $^1/_2$ way up tube, stigma at tube apex. In brevistyle flowers, anthers at tube apex, stigma immediately above ring of hairs. Stigma 4 or 6-fid, generally larger in brevistyle flowers. (In 2 collections the anthers and stigma both at the tube mouth.) *Fruit* oblong-ovate, to 1.0 cm long, with prominent calyx and disc remains, red. Pyrenes 4, 6, or 8, elliptic, triangular in section, to 3 mm long.

Ecology – In rain forest from sea level to 1600 m. On Normanby Island it grows in stunted vegetation on poor-soil sites, with *Anthorrhiza areolata* and *Hydnophytum* spp. A frequent high level epiphyte, often found in some abundance, particularly at lower altitudes where individual trees may contain large numbers of these plants. Only occasionally inhabited by ants, more usually by cockroaches, beetles and other invertebrates.

Notes – The large bracts covering the inflorescence in this species are a feature to a lesser degree of *Anthorrhiza chrysacantha*; however, the dense spines of the latter species readily distinguish it. *Anthorrhiza bracteosa* is variable on Normanby Island, where a more compact form is found in the very stunted and open forests on the nutrient poor soils of Mt Bwebwesu and Mt Pabinama. This differs from the more usual rain forest form in having erect stems with highly condensed internodes, smaller and thicker leaves, and a less regular tuber. Inflorescence, flower, and pollen characters maintain the integrity of the species.

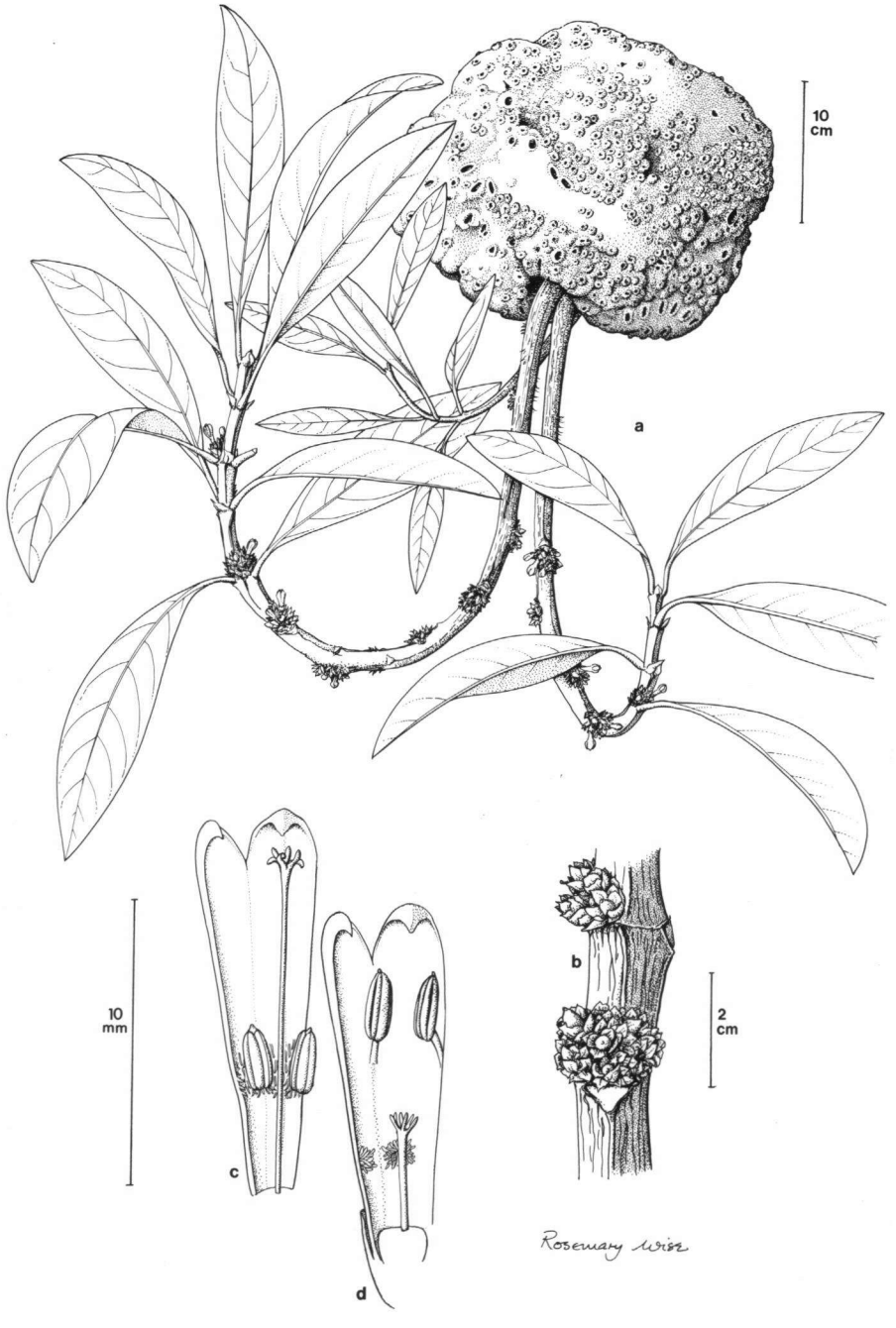

Fig. 5. *Anthorrhiza bracteosa* Huxley & Jebb. a. Habit; b. stem detail; c. longistyle flower; d. brevistyle flower (a–c: *Jebb 372*; d: *Jebb 370*).

On Goodenough Island the two collections have 4-fid stigmas, while in the rest of its range 6 lobes are usual. In two other collections [one from Woodlark (*Brass 28814*), the other from Normanby (*Jebb 366*)] heterostyly appears to have broken down, both anthers and stigma being found at the corolla mouth.

Collections – PAPUA NEW GUINEA. D'Entrecasteaux and Woodlark Is., Milne Bay Prov. SE 09° 05' 152° 46' Woodlark Is., Kulumadau, *Brass 28814* (A, L). Ledau logging area, Guasopa Subprov., Woodlark Is., *Gay 1033* (FHO, K). 09° 22' 150° 15' E slopes of Goodenough Is., *Brass 24798, 24736* (A, L). Fergusson Is., Mts between Agamoia and Ailuluai, *Brass 27122* (A, K, L). Near Bosalewa village, Fergusson Is., *Gay 1105* (LAE). 09° 45' 150° 47' NE slopes of Mt Solomonai, above Esa-ala, Normanby Is., *Jebb 366* (LAE), *367* (LAE). 09° 53' 150° 58' Esa-ala airport, *Dennis & Menzies UPNG 3497* (UPNG). 09° 54' 150° 57' 2 km from Esa-ala airport along track to Sewa Bay, Normanby Is., *Jebb 370* (type), *371* (CANB, K, LAE), *372* (LAE, UPNG), *373* (A, LAE), *374* (FHO, LAE). 10° 02' 151° 00' NW slopes of Mt Bwebwesu, above Sewa Bay, Normanby Is., *Jebb 381* (K, LAE), *384* (L), *385* (LAE). 10° 03' 150° 58' Lebudowa river, Normanby Is., *Brass 25536* (A, L).

5. **Anthorrhiza areolata** Huxley & Jebb, *spec. nov.* – **Fig. 6.**

Tuber omnino inerme, asperum areolatum. Caules plures, inermes. Folia anguste obovata, usque ad 11 × 4 cm. Stipulae rotundatae, persistentes. Inflorescentia oblonga, basi complanata, densus pulvinus pilorum in caule infossus. Corolla alba. Antherae percaeruleae. Pyrenae 2. — T y p u s: Normanby Is., *Brass 25710* (holo LAE; iso A, K, L).

Tuber subglobose, to 35 × 25 cm, decumbent on host; surface without spines, rough, areolate, with irregular polygons 0.3–1.0 cm across, slightly raised at edges and separated by narrow fissures, dull brown in colour. Holes few, 0.2–3.0 cm in diameter, funnel-shaped. Tuber tissue drying pinkish brown. *Stems* several, occasionally branching, to 100 cm or more, 1.0–1.5 cm in diameter, upcurving. Nodes prominent, internodes barely to strongly zigzagged, 0.9–2.5 cm when fertile with a single raised ridge on side opposite to inflorescence, to 6 cm when sterile and then with two ridges decurrent from stipules, smooth, glossy, reddish-brown. *Leaves* erect (spreading), clustered at stem apex. Lamina 6 × 2 – 11 × 4 cm, narrowly obovate, apex blunt to acute, base tapering to petiole, stiff, leathery, not brittle, dark glossy green above, pale below. Midrib rounded, prominent below, white; veins c. 7–9, obscure. Petiole 1–2 cm, rounded, white. Stipules semi-circular, to 0.4 cm long, with a blunt central process to 0.15 cm long, persistent, becoming worn. *Inflorescence* sunken, basally axillary, but becoming less central towards next node, oblong, to 2.0 × 1.3 cm, surrounded by a ridge of stem tissue to 0.3 cm high; filled with a dense papillose cushion of bract hairs to 0.5 cm long, and papery bract remains, becoming hollow with age; hairs reddish when dry, dark brown when wet. *Flowers* [3] heterostylous. Calyx to 2 mm, with a membraneous, darkly flecked margin, infundibular, rarely cylindrical, at same level as disc. Corolla white, to 12 mm long; lobes c. 4 mm. A ring of hairs $^2/_3$ way up the tube. Anthers 2 mm long, deep blue, in longistyle flowers at apex of tube, exserted in brevistyle flowers. Pollen with small vesicles, 63–73 µm, reticulation fine to medium. Stigma with 2 lobes c. 1 mm or more in length. *Fruit* ovoid-oblong, orange-red. Pyrenes 2.

Ecology – Only known from a very small area of unusual vegetation: open, very stunted *Dacrydium* forest, 3–5 m high, on red, apparently nutrient-poor soil, cap-

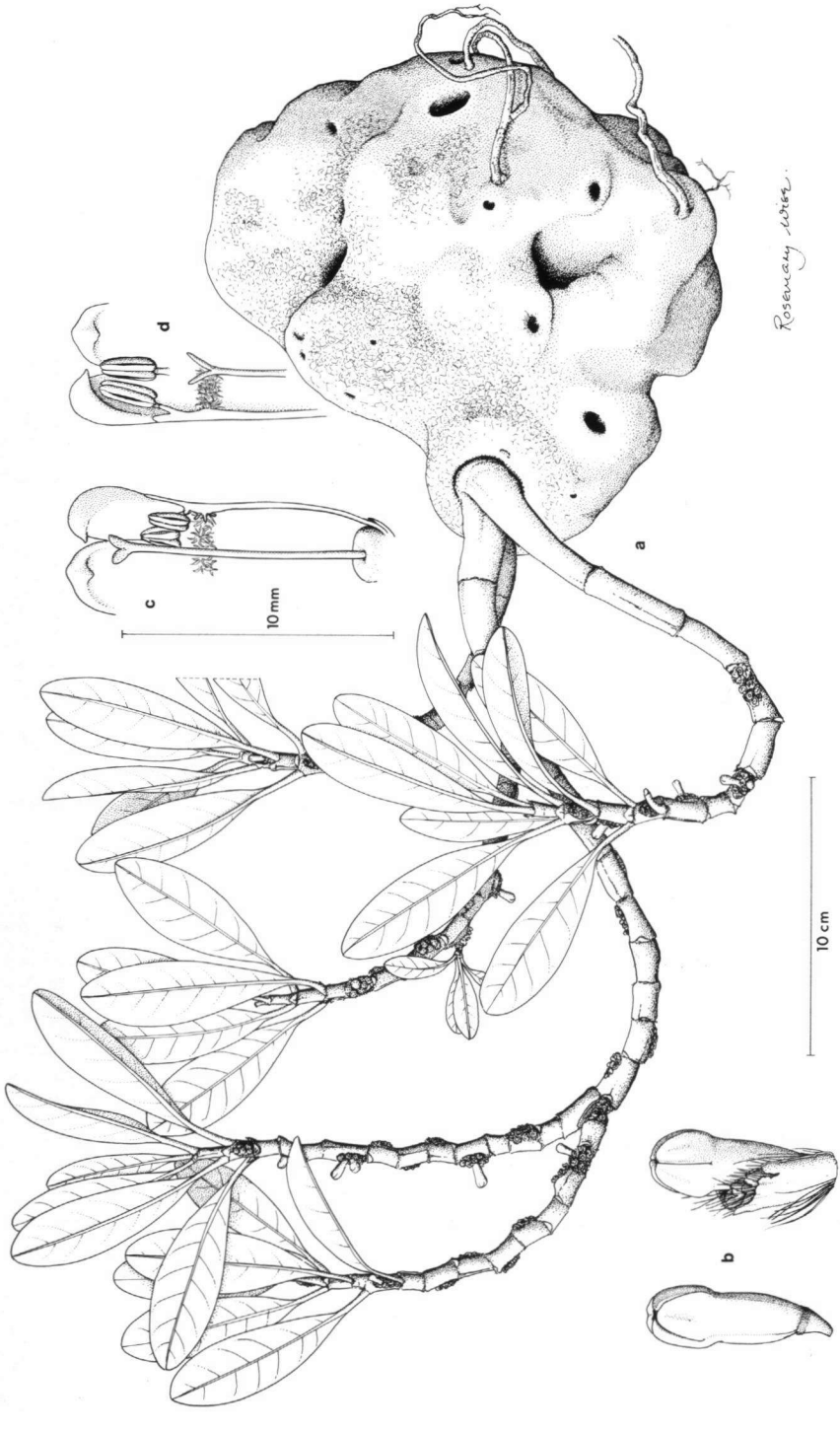

Fig. 6. *Anthorrhiza areolata* Huxley & Jebb. a. Habit; b. buds (to same scale as flowers); c. longistyle flower; d. brevistyle flower (a–c: *Jebb 382*; d: *Brass 25710*).

ping Mt Pabinama and Mt Bwebwesu, an area of about 50 km^2 at 600–750 m. A low epiphyte, up to 1.5 m above the ground, generally solitary, growing with *Hydnophytum* and *A. bracteosa*. Not ant occupied; tuber cavities contain rainwater, cockroach egg cases, and occasionally geckos.

Notes – The tuber of *A. areolata* has large cavities which open by funnel-shaped entrance holes to the upper surface. The inflorescence is similar to that found in *A. mitis*, being a pulvinate cushion of bract hairs. *Anthorrhiza areolata* is distinguished by its rough surfaced tuber, shorter zigzagged internodes, and smaller inflorescence.

The specific epithet describes the roughened, areolate surface of the tuber, which readily distinguishes this species.

Collections – PAPUA NEW GUINEA. D'Entrecasteaux archipelago, Normanby Is., Milne Bay Prov. SE 10° 02' 151° 00' slopes of Mt Bwebwesu, above Sewa Bay, Normanby Is., *Jebb 382* (BRI, L, LAE, UPNG), *383* (FHO), *386* (K, LAE). 10° 04' 150° 59' Mt Pabinama, Normanby Is., *Brass 25710* (type).

6. **Anthorrhiza stevensii** Huxley & Jebb, *spec. nov.* – **Fig. 7.**

Tuber complanatum, spinis simplicibus et ramosis. Caules plures, sparse usque dense spinosi. Folia elliptica usque obovata, usque ad 7,5 × 3 cm. Stipulae orbiculares, persistentes. Inflorescentia infossa, pilis bractearum et aliquot spinis repleta. Corolla alba, lobis interdum pallidis viridibus. Antherae caeruleae. Pyrenae 3 vel 4. —Typus: Papua New Guinea, *Stevens LAE 55709* (holo LAE; iso BRI, CANB, K, L).

Tuber flat, clasping, 5 × 20 cm, smooth, blackish. Holes unknown. Spines variable: sparse, flexuous and rarely branched, or dense, stout, and irregularly branched (2 or 3 side branches), to 0.8 cm, drying dark brown with pale tips. *Stems* several, branching, to 40 × 1 cm (excluding spines), spreading to erect. Internodes 1–3 cm; spines as on tuber, either sparse rarely branched, to 0.6 cm, or dense, irregularly branched (3–6 side branches) to 1.2 cm. *Leaves* erect. Lamina 4.5 × 2 to 7.5 × 3 cm, elliptic to obovate, apex blunt to acute, base tapering to petiole; leathery, drying thick, dark green above, paler below. Midrib triangular, prominent below; veins obscure, c. 4–6. Petiole 0.5–1.5 cm. Stipules persistent, large, 0.5–0.7 × 0.6 cm, nearly orbicular, with a blunt, slightly hooked, central process, contiguous with stem ridge; persistent. *Inflorescence* cordate to oval, to 1.5 × 0.7 cm, sunken and surrounded by a rim of tissue which may bear spines, sparsely to densely filled with bract hairs and papery bract remains, these to 0.6 cm. Spines root-like to stiffly branching, arising within the inflorescence. *Flowers* [4] heterostylous. Calyx to 1 mm, chartaceous. Corolla white, to 14 mm; lobes sometimes pale green, 2 mm; uncus c. 1 mm. A ring of hairs ½ way up inside the corolla tube. Anthers at mouth of tube, c. 1.5 mm long, the walls with numerous black flecks (probably blue *in vivo*); filaments to 2 mm. Pollen 75–100 µm, with very small vesicles; pores unbordered; reticulation fine. Stigma 4-fid, above or below the anthers, longistyle flower stigma lobes to 1.5 mm, brevistyle stigma lobes to 0.5 mm. *Fruit* globose, to 8 mm long, with prominent disc and calyx remains, orange. Pyrenes 3 or 4, obovoid, to 3 mm long.

Ecology – On ridge top or river side trees in montane forest, 1600–2000 m. Growing with *Myrmecodia pendens* Merr. & Perry and *Hydnophytum*. Ant inhabited or not.

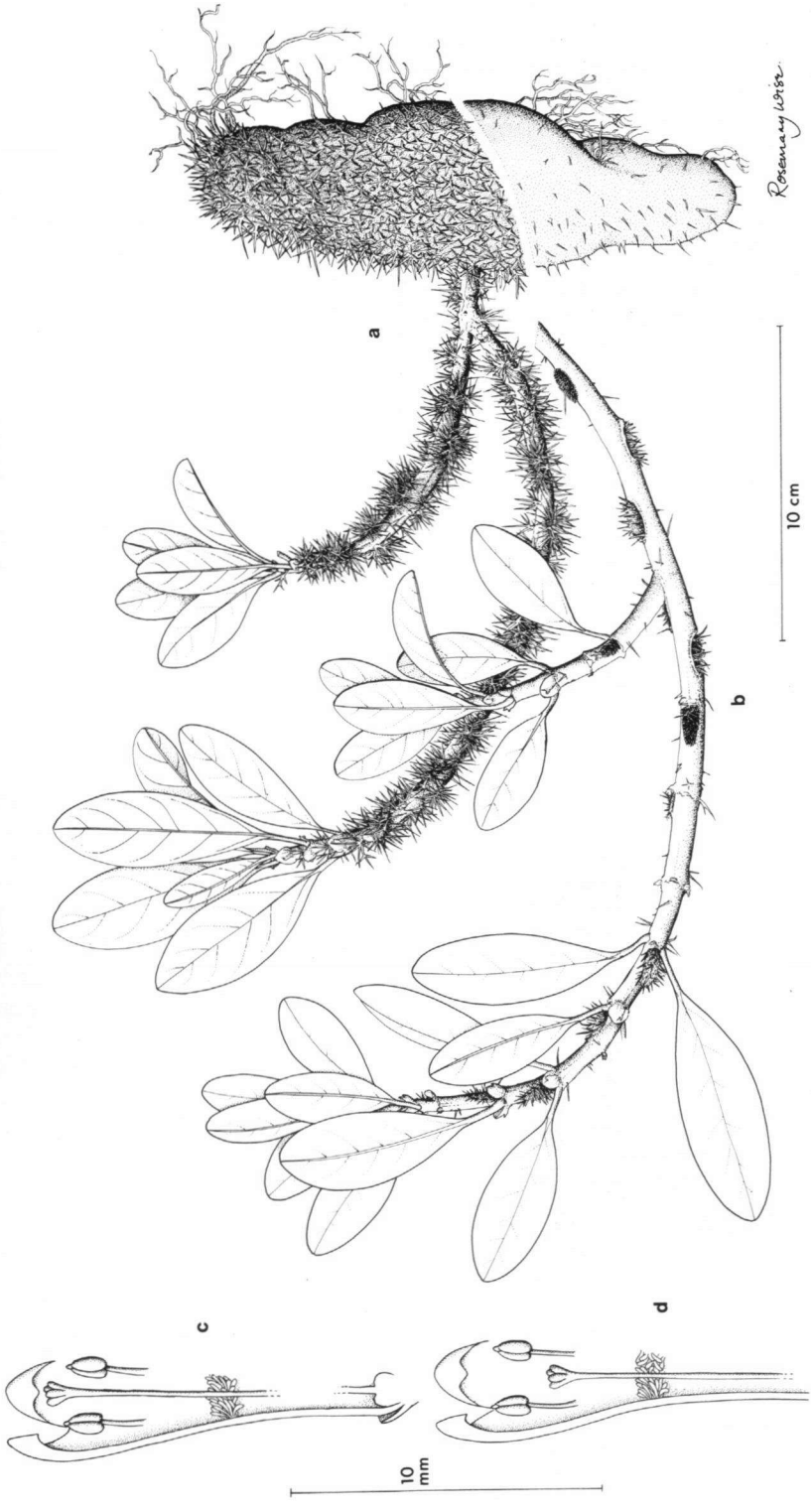

Fig. 7. *Anthorrhiza stevensii* Huxley & Jebb. a. & b. Habit; c. longistyle flower; d. brevistyle flower (a, d: *Stevens LAE 55690*; b, c: *Stevens LAE 55709*).

Notes – The least known species of *Anthorrhiza,* this taxon has only been collected on the 1972 Mt Suckling expedition. The two collections are morphologically dissimilar, *Stevens LAE 55690* having a more densely spined tuber and stem, with shorter internodes and larger, less fleshy leaves. Stem, flower, and pollen characters, in addition to the tuber and leaf shape, confirm their conspecificity; figure 7 is a composite to show the variation. The large orbicular stipules are characteristic of this species which was described as *Myrmecodia hydnostipula* in Huxley (1981).

The specific epithet honours Peter Stevens who gathered the only known collections.

Collections – PAPUA NEW GUINEA. Milne Bay Province. SE 09° 45' 149° 04' Side of Mayu River, below Mayu 2, Mt Suckling, Raba Raba Subprovince, *Stevens LAE 55709* (type). 09° 45' 149° 05' Scarp of Tantam plateau overlooking Mayu river, Raba Raba Subprovince, *Stevens LAE 55690* (L, LAE).

7. **Anthorrhiza chrysacantha** Huxley & Jebb, *spec. nov.* – **Fig. 8.**

Tuber latius quam altius, spinis dense ramosis, aureofulvis. Caules unus usque pauci, densissime spinosi. Folia lanceolata usque obovata, usque ad 19 × 5 cm. Stipulae triangulares, caducae. Inflorescentia muro spinifero cincta. Corolla alba. Antherae flavae. Pyrenae 4. — Typus: Papua New Guinea, *Jebb 110* (holo LAE; iso A, L).

Tuber broader than tall, clasping, lobed, axis usually horizontal, on erect branches or main trunk of host tree, to 12 × 30 cm, black-brown. Spines very dense, stiff, irregularly stellate, golden-brown; central branch 1.5–3.0 cm, side branches 0.9–2.0 cm, sometimes rebranched. Holes restricted to base of tuber and the apex, near the base of the stem. Roots with numerous erect, spine-like branches, occasionally stellate; spreading on host and forming a carpet of spines. Tuber tissue drying pinkish brown. *Stems* 1–3, upcurved, rarely branched, to 40 × 3 cm [7 cm including spines], internodes 0.5–1.5 cm long, green. Spines dense, as on tuber but larger, to 3.5 cm in length, side branches 2.5 cm, 10–17 in number, often rebranched; central branch also branching irregularly above; base of spine 0.2–0.6 cm to first branch, thickened, to 0.3 cm in diameter; spines golden brown, green towards stem apex. *Leaves* erect, somewhat clustered at apex. Lamina 11 × 2 – 19 × 5 cm, lanceolate to obovate, leathery; apex acuminate, base gradually tapered; margin entire, inrolled when dry; dark glossy green above, pale below. Midrib whitish, prominent, rounded below. Lateral veins 8–10, often obscure, less so when dry. Petiole winged, 2–4 cm, white. Stipules triangular, to 0.4 cm long, caducous. *Inflorescence* sessile, oval, 1.5–2.5 cm, the whole surrounded by a narrow rim of stem tissue surmounted by spines. Individual parts of flowering areas separated by spines and compacted bract remains. Bracts leathery, with prominent ridges and a filiform appendage at the apex. Bract hairs to 5 mm long. *Flowers* [8] homostylous, produced all along stem, also near the tuber. Calyx cylindrical, to 4 mm, margin irregular, membraneous, translucent, and flecked with small brown scales. Corolla white, glabrous, to 17 mm long; lobes 5 mm; lobe tips 2 mm, narrow, tapering, and separated in bud, reflexed in mature flower. Ring of hairs absent. Anthers at mouth of tube, yellow. Pollen with 3 small vesicles, 77 µm; apertures irregular, not bordered; reticulation medium. Stigma above anthers (or ½ way up tube), indistinctly 4- or 8-lobed. *Fruit* globose,

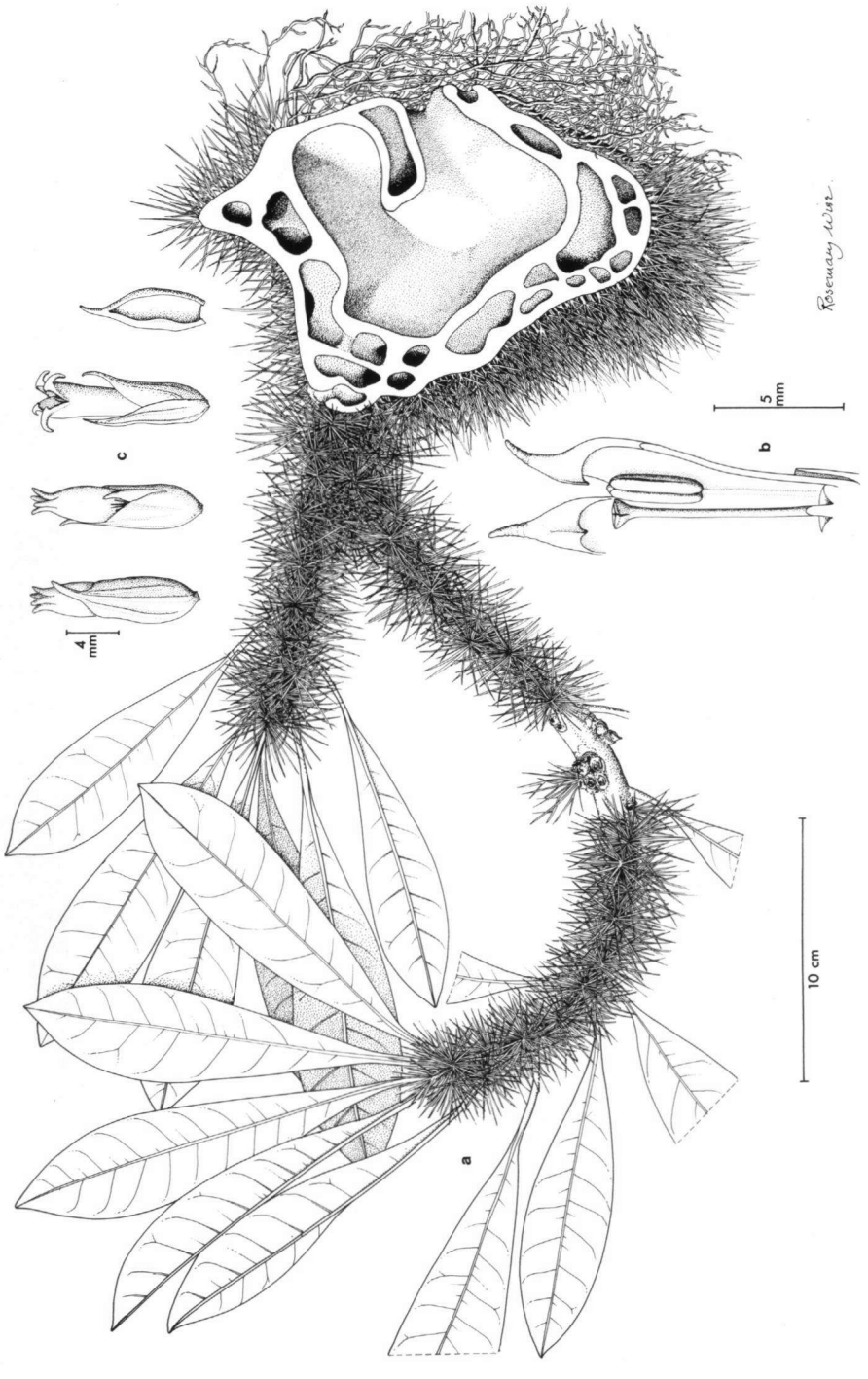

Fig. 8. *Anthorrhiza chrysacantha* Huxley & Jebb. a. Habit; b. flower; c. bracts enclosing buds (all from *Jebb 605*).

baccate, surmounted by calyx remains, yellow-orange. Pyrenes 4 or 8, elliptic to oblong, 4 mm long, triangular in section.

Ecology – In disturbed *Nothofagus* forest, 1200–2200 m. High in the canopy this epiphyte is usually solitary, or few in a given tree. It is commonly sympatric with *A. caerulea* and regularly inhabited by the ant *Iridomyrmex scrutator*.

Notes – This species resembles *A. caerulea* in its highly condensed and relatively thick stem, with dense spines obscuring the stem and tuber. It is distinguished by its flatter clasping tuber; larger, more highly branched, golden spines; its smaller leaves with less prominent venation and flat margins, and its white corolla with large slender lobe tips. *Carr 14659* (A) has somewhat thicker leaves than the Jebb collections from Mt Kaindi. Of the remaining duplicates of *Carr 14659*, those at K, L, and LAE, are specimens of *Myrmecodia albertisii* Merr. & Perry, the second duplicate at K also comprises a tuber fragment belonging to *M. pendens* Merr. & Perry.

The specific epithet draws attention to the large golden spines which readily distinguish this species from *A. caerulea* in the field, which tends to be more blackish brown.

Collections – PAPUA NEW GUINEA. Central and Morobe Provinces. SE 06° 51' 146° 43' Morobe, on path from Bugwev to the summit of Mt Shungol, *Jebb 605* (LAE). 07° 20' 146° 40' 1 km down road to Eddie Creek, from the Mt Kaindi summit road, *Jebb 172* (K, L, LAE), *173* (CANB, LAE), *174* (LAE), *176* (BRI), *177, 179* (UPNG), *181* (BULOLO). 07° 21' 146° 39' near turn to Eddie Creek on summit road to Mt Kaindi, Wau Subprovince *Jebb 108* (LAE), *110* (type). 09° 05' 147° 38' Central, Mt Koiari, Boridi, *Carr 14659* (A; non K, L, and LAE).

8. **Anthorrhiza caerulea** Huxley & Jebb, *spec. nov.* – **Fig. 9.**

Tuber conoideum, spinis densis, ramosis, atrofuscis vestutum. Caules unus usque pauci, supra dense spinosi, sic dorsi-ventrales. Folia lanceolata usque obovata, usque ad 28 × 6 cm. Stipulae triangulares, caducae. Inflorescentia muro spinifero cincta. Corolla pallide turcoisina. Antherae cremeae. Pyrenae 6–8. — Typus: Papua New Guinea, *Huxley UPNG 3408* (holo UPNG; iso LAE).

Tuber conical, to 35 × 15 cm, horizontal, smooth, black brown; densely clothed in stellately branched spines which are 1.0–1.5 cm long, finely tapered, stiff, straight, occasionally branched again, light brown to blackish. Holes on tuber base and at the apex adjacent to the stem. Tuber tissue drying yellowish brown. *Stems* one (two), unbranched, to 40 × 4 cm (excluding spines), upcurved; internodes 0.5–1.2 cm. Spines dense, stellate, larger and more branched than on tuber, 1.5–2.5 cm long, branches 5–18 in number, to 1.7 cm, arising from a short fleshy foot to 0.3 cm high, branches rebranching up to 3 times; scattered, especially dense on the inflorescence. Stems dorsi-ventral, with inflorescences and spines largely confined to the upper surface, the lower surface with few scattered spines, and the nodes clearly visible as raised lines 0.5–1.2 cm apart. *Leaves* clustered at apex, spreading. Lamina 12 × 3 – 28 × 6 (21 × 8.5) cm, lanceolate to obovate, apex acuminate, base finely tapered to petiole, margin slightly recurved, strongly waved to crinkled, dark glossy green above, pale below. Midrib white, prominent below; veins c. 8–13, very distinct. Petiole 3–7 cm, creamy white. Stipules triangular, to 0.8 cm long, caducous, drying grey to black. *Inflorescence* sessile, circular to oval, 3 × 2 cm, surrounded by a narrow spine-topped wall of stem tissue to 0.4 cm high and 0.1–0.2 cm thick.

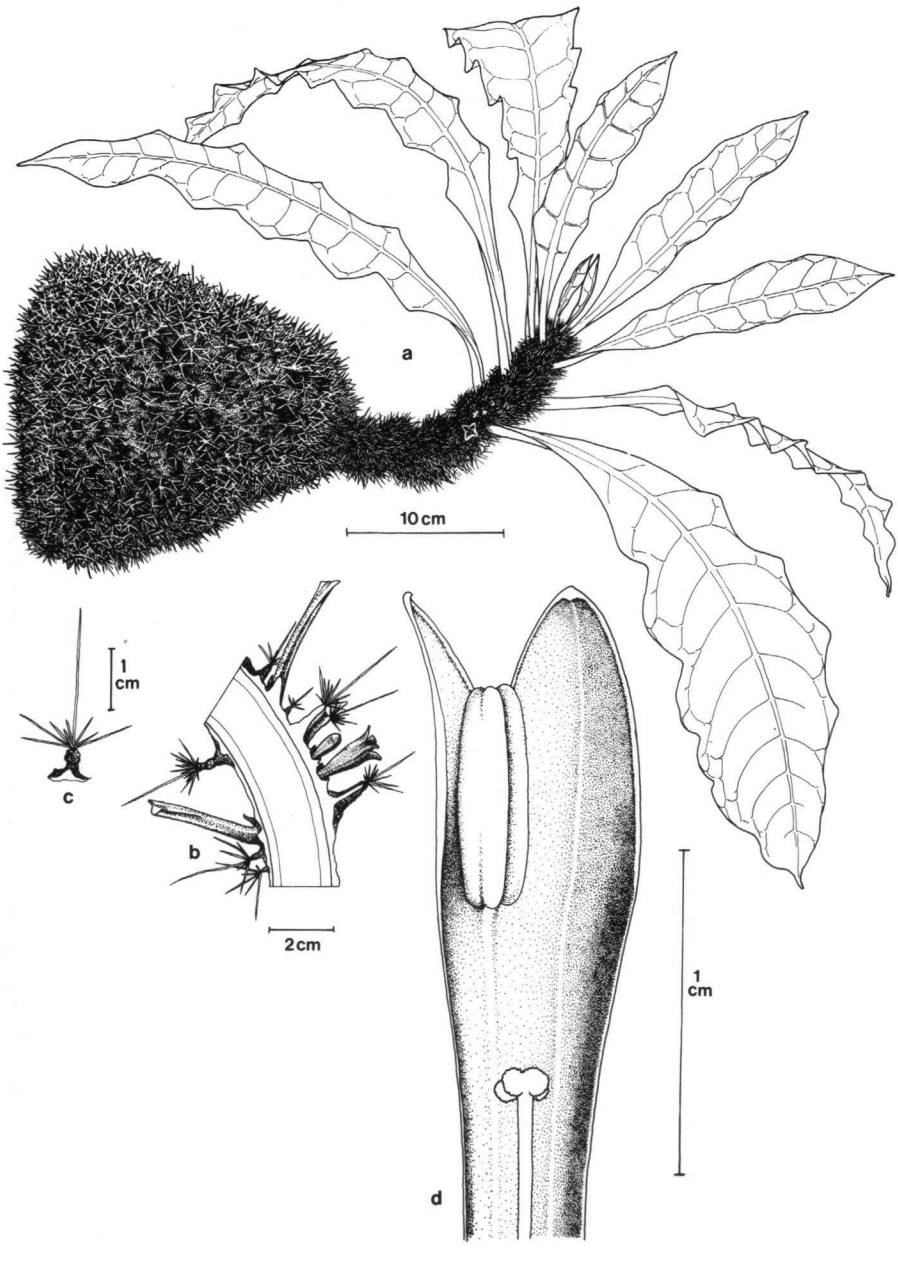

Fig. 9. *Anthorrhiza caerulea* Huxley & Jebb. a. Habit; b. stem section; c. spine; d. flower (all from *UPNG 3408*).

Spines also arising from between the individual flower-bearing areas, amongst the compacted bract remains. Bracts papery, to 7 mm, bract hairs to 7 mm. *Flowers* [5] heterostylous. Calyx c. 2 mm, margin entire, membraneous. Corolla to 20 mm long, pale turquoise; tube widening towards apex, lobes c. 5 mm, glabrous. Anthers c. 5 mm, cream in colour. Pollen 61–90 μm, with large vesicles, pores strongly bordered; reticulation fine. In longistyle flowers the anthers below tube mouth, the stigma 8-lobed, exserted; in brevistyle flowers the anthers at tube mouth, the stigma near base of tube, 4-lobed. *Fruit* to 1.2 cm, oblong-ovoid, calyx and disc remains prominent, to 5 mm across, orange. Pyrenes 6–8, 5 × 1 mm, triangular in section, dark grey.

Ecology – Lower montane forest, 2000 - 3000 m. Low to high in canopy conspicuous on large *Nothofagus*, occasionally growing low on trees, often abundant in a given tree. Always occupied by *Iridomyrmex scrutator*.

Note – The epithet *caerulea* refers to the blue flowers which are unique in the genus.

Collections – PAPUA NEW GUINEA. Morobe Province. SE 06° 51' 146° 43' N side of the summit of Mt Shungol, *Jebb 353* (K), *354* (BRI), *355* (LAE), *356* (UPNG), *357* (CANB), *358* (FHO), *359* (L, LAE), *360*. 07° 20' 146° 40' 1 km down road to Eddie Creek, from Mt Kaindi summit road, *Jebb 169* (LAE), *170* (L), *171* (A), *180* (FHO), *182, 183, 184, 185* (LAE). 07° 21' 146° 39' summit road to Mt Kaindi, *Jebb 27* (BULOLO), *28* (LAE), *29* (LAE), *109* (A), *111* (LAE), *112* (K). Mt Kaindi, on roadside 200 m below Eddie Creek turning, *Huxley UPNG 3408* (type). Mt Kaindi, *Dodd UPNG 3498* (UPNG). 07° 20' 146° 45' Kaisenik logging road, *Katik NGF 62284* (LAE). 19 km beyond Kaisenik village on logging road, Wau Subprovince, *Huxley UPNG 3410* (UPNG, L).

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