Flora Malesiana

Series I – Seed Plants

Volume 15 – 2001

Nepenthaceae

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ISBN 90-71236-49-8

ABSTRACT

Flora Malesiana. Series I, Volume 15 (2001) iv + 1–157, published by the Nationaal Herbarium Nederland, Universiteit Leiden branch, The Netherlands, under the auspices of Foundation Flora Malesiana.

ISBN 90-71236-49-8

Contains the taxonomic revision of one family, *Nepenthaceae*, for Malesia, i.e. the area covering the countries Indonesia, Malaysia, Brunei Darussalam, Singapore, the Philippines, and Papua New Guinea.

Martin Cheek & Matthew Jebb, **Nepenthaceae**, pp. 1–157*.

A palaeotropical family of lianas, shrubs and herbs, with a single genus, *Nepenthes*. There are 83 species of the family in the Malesian area, including three nothospecies and one little known species. Most of the species are cultivated and traded across the world as ornamental plants with curiosity value. Locally in Malesia, some species are used for cooking specialist rice dishes, for medicinal uses or for making rope.

The introductory part consists of chapters on distribution, fossils, habitat and ecology, reproductive biology, morphology and anatomy, pitcher function, cytotaxonomy, conservation, taxonomy, uses, collecting notes, and spot characters.

Regional keys to the species are given. These are based largely on vegetative characters.

For each species full references, synonymy, descriptions, ecology, distribution, notes on diagnostic characters and relationships with other species are presented. Species are arranged alphabetically.

This treatment is illustrated with 19 full-page line drawings.

Index to scientific plant names of taxa treated in this volume (accepted names and synonyms) on pp. 159–161.

Lists of revised families in Flora Malesiana on pp. 163–164.

* Desk-editing: C.G.G. Baak; Digital imaging: B.N. Kieft.

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NEPENTHACEAE

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Nepenthaceae Dumort., Anal. fam. pl. (1829) 16; Hook.f. in A.DC., Prodr. 17 (1873) 90; Benth. & Hook.f., Gen. Pl. 3 (1880) 1; Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 2; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 251; Jebb & Cheek, Blumea 42 (1997) 5.

A single genus of c. 87 species. The description below does not include characters seen outside Malesia.

NEPENTHES

Nepenthes L., Sp. Pl. (1753) 955; Jebb & Cheek, Blumea 42 (1997) 5. — Type species: *Nepenthes distillatoria* L.

Bandura Adans., Fam. 2 (1763) 75. — Type species: *Nepenthes distillatoria* L.

Phyllamphora Lour., Fl. Cochin. 2 (1790) 606. — Type species: *Nepenthes mirabilis* (Lour.) Druce.

Anurosperma (Hook.f.) Hallier f., Bot. Centralbl. 39, Abt. 2, 1 (1921) 162. — Type species: *Nepenthes pervillei* Blume.

Carnivorous, dioecious, woody or subwoody climbers or subshrubs, terrestrial or epiphytic. Stems terete or 2–4-angled, or winged. Buds naked, lacking scales. Phyllotaxy spiral, 2/5 or 1/2. *Leaves* exstipulate; involute or convolute, marcescent, simple, chartaceous or coriaceous, petiolate or sessile; midrib extended into an unbranched tendril, the distal part of which expands into an elaborate, animal trapping receptacle (pitcher) containing digestive fluid. Pitchers dimorphic. *Lower pitchers* produced from rosettes or short stems, often resting on the ground, usually ovoid or globular, the mouth facing towards the stem, with two ventral fringed wings running from the base to the pitcher rim and with the tendril straight, not coiled. *Upper pitchers* (usually absent in *N. argentii, N. ampullaria*, and *N. pectinata*) usually more elongated and infundibuliform (funnel-shaped) than the lower pitchers, the mouth facing away from the stem, the wings reduced to ridges and not fimbriate, or absent, and the tendril coiled. Pitcher mouth apical or subapical, rimmed with a ribbed peristome (except *N. inermis*), the inner edge often toothed and bearing nectar glands, at the rear sometimes raised to form a column, supporting the lid; lid usually held over the mouth (reflexed e.g. in *N. dubia*), lower surface with a laterally flattened basal appendage, rarely an apical filiform appendage, or appendages absent; nectar glands usually abundant; spur inserted on dorsal surface at junction with lid, entire or variously divided, flattened or terete. *Inflorescence* terminal, appearing lateral by subsequent growth, a paniculoid thyrse or raceme, of 6–300 flowers, the main axis with indeterminate growth, the partial inflorescences 1-flowered (racemose) or 2-flowered, less usually 3–40-flowered, bracteate or ebracteate. Perianth imbricate, a single whorl of 4 (also interpreted as two whorls of 2) free or basally united, patent, nectariferous tepals. Female flowers with androecium lacking, ovary superior, 4-carpellate, incompletely 4-locular locules antitepalous, placentation lamellar, ovules erect, anatropous, bitegmic, crassinucellate, 200–500, stigmas sessile, as many as locules. *Male inflorescence* usually larger and more floriferous,

perianth as in female; stamens 4–?12, filaments united into an androphore, anthers tetrasporangiate, in 1–3 dense whorls, united into a subspherical anther head, locules opening by longitudinal slits, extrorse; gynoecium lacking. Fruit sometimes stipitate, a loculicidally dehiscent capsule with 4 valves containing 50–500 seeds. Seeds filiform, 3–25 mm long, slender due to long basal and apical appendages. Testa reduced to an outer epidermis with thick outer walls to the cells and irregular thickenings on the radial and inner walls. Tegmen produced only around the embryonic cavity, crushed. Endosperm starchy or absent. Embryo minute, central, straight or U-shaped in a subellipsoid cavity, cotyledons and hypocotyl well-developed, though minute. *Indumentum* of simple, bifid, fasciculate, stellate, dendritic non-glandular and sunken, sessile or shortly stipitate glandular hairs. *Colour* of pitchers entirely green, or yellow or orange or white or purple or red, often marked with red streaks or blotches; peristome often glossy red; inflorescence with green, brown or red tepals. 2n = 80. — **Fig. 1–19.**

DISTRIBUTION

Genus of c. 87 species, mostly in Malesia, but with c. 8 outlying species in: Madagascar (2), Seychelles (1), Sri Lanka (1), NE India (1), Indochina (6–9), Solomon Islands (1), New Caledonia (1) and Australia (1). Most species are found in Borneo and Sumatra. No species are known from the Lesser Sunda Islands east of Java, nor from the northern tip of Sumatra.

FOSSILS

Krutzsch (1985) identified as *Nepenthes* fossil pollen types known since the 1930s from the European Tertiary as the *Droseridites echinosporus* group. This group had previously been referred to the Droseraceae which also have spinuliferous pollen predominantly in tetrahedral tetrads. Three species are involved. They occur in the Palaeocene from France to Ukraine: *Nepenthes echinatus* (Hunger) Krutzsch, *N. echinosporus* (R. Potonié) Krutzsch and *N. major* (Krutzsch) Krutzsch. However, Krutzsch's identifications seem not to be without ambiguity since the tetrads of *N. major* are over 40 microns in diameter, falling outside of the range of those in present-day *Nepenthes* (24–35 microns after acetolysis according to Basak & Subramanyam (1966)) and inside the lower range of that seen in modern *Drosera*. We know of no non-pollen fossil *Nepenthes*.

References: Basak, R.K. & K. Subramanyam, Pollen grains of some species of Nepenthes. Phytomorphology 16, 3 (1966) 334–338. — Krutzsch, W., Über Nepenthes-pollen (alias Droseridites p.p.) in europäischen Tertiär. Gleditschia 13 (1985) 1, 89–93.

HABITAT AND ECOLOGY

Nepenthes are most commonly encountered in disturbed secondary forest, swamp, kerangas or heath forest from sea level to c. 700 m altitude. In such habitats however, only a few species occur, although they can be locally common. *Nepenthes ampullaria, N. rafflesiana*, and *N. gracilis* can be found in these habitats in Peninsular Malaysia,

Sumatra, and Borneo, while in New Guinea *N. neoguineensis* and *N. ampullaria* occupy these niches. More locally distributed in such habitats are *N. bicalcarata* (Borneo), *N. treubiana* (W New Guinea), and *N. sumatrana* (WC Sumatra). *Nepenthes mirabilis* occurs from Indochina to N Australia, sometimes in such habitats, though it also occurs in *Eucalyptus* savannah and open fresh-water or brackish swamps.

The shade of undisturbed high forest is anathema to most *Nepenthes*. The majority of *Nepenthes* species are confined to montane habitats between 1500–2500 m altitude, usually in open mossy, stunted, ridge-top forest as climbers or epiphytes. A few species reach montane or subalpine grassland, for example *N. lamii* which reaches 3520 m altitude in Irian Jaya – the highest altitude known for the genus.

Some species can occur in both lowland and montane habitats, for example *N. alata*, *N. albomarginata*, *N. eustachya*, *N. maxima*, *N. merrilliana*, *N. neoguineensis*, and *N. reinwardtiana*, although most species occur in one or the other.

Limestone and ultramafic substrates often support open scrub or woodland and are habitats for some *Nepenthes*.

Obligate limestone species are known only from Borneo: *N. boschiana, N. campanulata, N. faizaliana, N. mapuluensis*, and *N. northiana*.

Facultative limestone species (Borneo only) are: *N. albomarginata, N. reinwardtiana*.

It is strange that no *Nepenthes* are reported from the limestone outcrops of Philippines, Sumatra, or New Guinea. This may be due to undercollecting.

Obligate ultramafic species are known only from N Borneo, Philippines, Sulawesi, and Waigeo Island: *N. argentii, N. burbidgeae, N. danseri, N. edwardsiana, N. macrovulgaris, N. philippinensis, N. rajah, N. sibuyanensis, N. tomoriana*, and *N. villosa*.

Suspected ultramafic obligate species (all from Mindanao) are: *N. bellii, N. merrilliana, N. petiolata*, and *N. truncata*.

Facultative ultramafic species are: *N. alata, N. gracilis, N. maxima, N. mirabilis, N. rafflesiana, N. stenophylla*, and *N. tentaculata*.

According to Brookes (1987), plant species that grow on ultramafic substrates adopt one of three physiological strategies to cope with the metal-rich conditions that are toxic to many plant species. Ultramafic dwelling plants are either metal excluders, tolerators or hyperaccumulators. Metal concentrations have been examined in only three species of *Nepenthes*: *N. maxima, N. mirabilis*, and *N. reinwardtiana* in a study on an ultramafic site on Obi Island, Moluccas by De Vogel reported in Brookes (1987). However, the last species is not known from the Moluccas. No vouchers are recorded. The concentrations of nickel, cobalt, and manganese present in the leaf samples taken from these species in the study show them to be metal tolerators rather than excluders or hyperaccumulators (Brookes 1987).

Reference: Brookes, R.R., Serpentine & its Vegetation (1987).

REPRODUCTIVE BIOLOGY

What research has been done on the floral biology of *Nepenthes* has been focused on montane species (Lian 1995; Adam 1998). These studies suggest that *Nepenthes* flow-

ers are entomophilous and are probably most often pollinated during the day by a range of generalist Diptera and Hymenoptera. In *N. macfarlanei* (montane Peninsular Malaysia), pollen is released between 0600–1400(–1700) hrs, and visitors are infrequent, arriving in only 9 of the 15 days of the study period, when syrphid, especially muscid flies, followed by halictid bees were observed as the most likely pollinators (Lian 1995). In five montane taxa in Borneo, visit frequency per species varied from 2.5 visits per day in a study period of 2 days (*N. reinwardtiana*) to 22 visits in a period of 1 day (*N. rajah*). Dipterans were the main visitors in all five species (Adam 1998). Both Lian and Adam observed pollen transport on insect flower visitors. They also report that on cold rainy and cloudy days, common in montane habitats, all insect activity virtually ceases.

In *N. gracilis*, a lowland species, Kato (1993) found that nectar secretion takes place in the early evening and that night-flying moths, followed by evening-flying *Diptera*, are the main pollen vectors. Moran (1993) reported that day-flying chrysomelid beetles were the main visitors to flowers of the lowland *N. rafflesiana*.

Wind pollination has been suggested as possible in the genus but we consider it unlikely in view of facts such as the production of floral odour and nectar. Adam (1998) conducted a pollen trapping experiment with *N. villosa* to evaluate wind pollination. He placed slides smeared with vaseline in holders facing male inflorescences and facing away from females at a distance of about 2 m, and examined them at the end of each day under a microscope. Over a study period of 13 days, no *Nepenthes* pollen was trapped, suggesting that wind pollination is rare or absent.

Flower odour is recorded as slightly musky or foetid for *N. macfarlanei* (Lian 1995), *N. rajah, N. villosa, N. reinwardtiana, N. curtisii* subsp. *zakriana* (= *N. fusca*), and *N.* × *kinabaluensis* (Adam 1998), as faintly sweet for *N. hirsuta* or of mice droppings or acetamide for *N. mirabilis* (Cheek, pers. obs.). Tepals and stigmas are usually green or greenish yellow, sometimes becoming red with age. The sessile glands that occupy at least half of the adaxial surface area of the tepal secrete nectar which covers the entire surface. The stigmatic surface is wet. Anther heads are yellow with the mass of released pollen.

Inflorescences are cylindrical and often held erect, above the plant bearing them and above neighbouring vegetation (species studied by Lian 1995 and Adam 1998), but in other species such as *N. tentaculata* and *N. northiana* they may be held beneath a sparse tree canopy (Cheek, pers. obs.). Flowers open acropetally in the inflorescence. Adam (1998) reports that in *N. rajah, N. villosa*, and *N.* × *kinabaluensis* inflorescences may last up to 3 months, bearing up to 700 flowers, with 0–6 flowers opening per day. Inflorescences of *N. macfarlanei* (Peninsular Malaysia) are borne between May and December, each flower-bearing plant bearing on average c. 1.5 inflorescences during this period, though less than 10% of the individuals in the study population produced inflorescences (Lian 1995).

Being dioecious, all *Nepenthes* are obligate outbreeders. In *N. macfarlanei* some 60% of open pollinated female flowers produced fruits, each containing an average of 92.5 fertile and 44.2 infertile seeds (Lian 1995). Female flowers take about 6 months to develop to maturity in this species (Lian 1995), but Kaul (1982) and Adam (1998) cite 3 months as normal for fruit maturation in the Bornean species of Mt Kinabalu that they studied.

Interspecific hybrids occur sporadically in the wild and are frequent in collections. Some cultivars have multiple species parentage. Physiological barriers to interspecific hybridisation seem weak.

Seeds of all Malesian species are light, long (8–30 mm) and slender and clearly adapted for wind dispersal. No elaiosomes, hooks or other structures associated with animal dispersal are known from *Nepenthes* seed. At maturity the capsule valves open slightly allowing the ripe seeds to disperse slowly in gusts of wind: the 'censer' mechanism. We are aware of no studies of distances travelled by seeds of *Nepenthes*.

References: Adam, J.H., Reproductive biology of Bornean Nepenthes (Nepenthaceae). J. Trop. Forest Sci. 10, 4 (1998) 456–471. — Kato, M., Floral biology of Nepenthes gracilis (Nepenthaceae) in Sumatra. Am. J. Bot. 80 (1993) 924–927. — Kaul, E. B., Floral & fruit morphology of Nepenthes lowii and N. villosa, montane carnivores of Borneo. Am. J. Bot. 69 (1982) 793–803. — Lian, L.C., Conservation studies with Nepenthes macfarlanei Hemsl. in Peninsular Malaysia. Univ. Bath. Unpubl. PhD thesis, 235 pp (1995). — Moran, J.A., Visitors to the flowers of the pitcher plant Nepenthes rafflesiana. Brunei Mus. J. 8 (1993) 77–80.

MORPHOLOGY AND ANATOMY

Seedlings — Germination is phanerocotylar, light-dependent and takes place 4–6 weeks after sowing. The cotyledons are narrowly oblong to elliptic, c. 5 by 2 mm. The first true leaves are sessile, bear minute pitchers 2–3 mm long which lack tendrils and show spiral phyllotaxy on congested stems.

Architecture — Most *Nepenthes* begin life as a low 'rosette' stage with an extremely short, erect stem and short internodes, they then become shrubby by the production of 'short-stems' up to 2 m tall with longer internodes, which in turn can become lianas, the internodes of these 'climbing stems' lengthening further and the stems being supported by the coiling leaf tendrils. The inflorescence is terminal, appearing lateral by subsequent vegetative growth from the axil of the subtending leaf. Not all species show all three stages. *Nepenthes argentii* flowers in the rosette stage without producing short or climbing stems. *Nepenthes rajah* flowers from short stems and does not produce climbing stems. *Nepenthes maxima* and *N. ampullaria* may proceed from the rosette to the climbing stage with a negligible 'short stem' stage. Stem, leaf blade and pitcher generally exhibit stage-dependent heteromorphy. For example, in *N. spathulata* the short stems are terete, with large spathulate, subpetiolate leaves and ovoid lower pitchers. Climbing stems are sharply 4-angular, with smaller, more oblong-elliptic leaves and with infundibuliform upper pitchers. In *N. maxima* and related species, a change in phyllotaxy accompanies the change from rosette (phyllotaxy 2/5) to the climbing phase (phyllotaxy 1/2) which is also correlated with the change from lower to upper pitchers. Aerial branching of stems is usually rare in the genus, branches only occurring from the rootstock or near the ground. However, *N. ampullaria* is unusual in having short axillary rosette stems from the lower 1–2 m of its climbing stems.

Leaf morphology — The leaves of *Nepenthes* species are highly specialised. The 'leaf blade' bears at its tip a tendril from which arises a sharply upturned and hollow pitcher, with a more or less oblique mouth overhung by a lid, from the base of which arises a

short spur. Venation suggests that this spur is the true leaf apex. The lid, being the only organ to lack a midrib, may be derived from a modified pair of leaflets (Hooker 1859; Macfarlane 1908; Lloyd 1942). Whatever the derivations of the leaf blade, tendril, pitcher and lid, here the blade is referred to as the leaf blade, and a well-defined narrowing at its base as the petiole. The blade of the leaf may be sessile or petiolate. Leaf bases are often decurrent down the sides of the stems as ridges, angles or wings.

The leaves of both short stems and climbing stems tend to be more markedly petiolate than those of the rosette stems in all species. At fertile nodes, however, the leaves can be quite aberrant, often being sessile or basally more abruptly truncate than the norm. In some species the leaf blade shows great variation in size on one plant; in *N. ampullaria* the blades of the rosette leaves are far smaller than those of the climbing or short stems, while in *N. maxima* the converse is true, and the leaves of climbing stems often have smaller blades than the rosette ones. Blade margins are entire, except in *N. mirabilis* and in the seedlings of several species where the margins of the seedling or rosette leaves are finely fimbriate (the fimbriae are extensions of the leaf margin). Other species may have a dense band of indumentum below the margin, but none are fimbriate. Venation is camptodromous. The longitudinal nerves are largely marginal. Unusually the pennate nerves, which arise more or less perpendicularly from the length of the midrib, form a reticulum with the longitudinal nerves. The relative numbers, distribution and dominance of the longitudinal and pennate nerves provide important characters and in some geographical areas can be diagnostic (Jebb 1991).

Pitcher morphology — Pitchers range from almost globose, or urceolate, to cylindrical or infundibulate. The edge of the pitcher mouth bears an unusual, finely ribbed structure – the peristome. In section the peristome is more or less T-shaped, with the arms of the T curving downwards and inwards. On the inner edge of the peristome the ribs often end in teeth, and between each of these teeth or at their apex lies the aperture of a nectar gland. The peristome of the upper pitchers of some species is much reduced. In others the ribs of the peristome have become vastly enlarged and widely spaced, giving the appearance of flat plates or claws.

The upper one third or so of the inner pitcher wall we refer to as the waxy zone (or pruinose zone of some authors) and below this lies the glandular zone. Whilst the waxy zone has a white 'bloom', the glandular zone is glossy. Under the electron microscope the waxy appearance is seen to be due to a dense coating of minute (> 1 μm diam.), readily detachable wax scales (Juniper et al. 1989). These scales become attached to the suction pads or tarsi of insects, temporarily destroying their ability to grip any surface, even after removal from the pitcher (Lloyd 1942). Upper pitchers in many species have a far larger glandular zone than those of the lower pitchers, and in some species may be wholly glandular, whilst the lower pitchers have a larger waxy zone (Danser 1928). The size of the lowermost pitcher glands shows significant variation, and can be diagnostic in a limited geographical area (Kurata 1976).

The shape and venation of the lid are of some taxonomic importance. Some species have one or more appendages on the lower surface of the lid. These appendages are particularly characteristic of the Regiae group. In these species an appendage arises from the base of the midline of the lid, and is usually laterally flattened, with numerous

large nectar glands. The second appendage, if developed, also lies on the midline, but at the apex of the lid. The apical appendage is more filiform, and may not always be glandular. In most species, the size, nature and distribution of the nectar glands on the lower surface of the lid is an important character. The tendril connecting the blade and the pitcher is in all species but one, cylindrical, constant in diameter, and is straight in the lower pitchers, but coils in upper pitchers. In *N. bicalcarata* the tendril is densely covered by glands, and at its centre is much swollen and has a cavity occupied by ants, which chew a small entrance hole (Clarke 1997).

References: Clarke, C., Nepenthes of Borneo. Natural History Publications, Kota Kinabalu (1997). — Danser, B.H., The Nepenthaceae of the Netherlands Indies. Bull. Jard. Bot. Buitenzorg III, 9 (1928) 249–438. — Hooker, J.D., On the origin and development of the pitchers of Nepenthes. Trans. Linn. Soc. 22 (1859) 415–424, t. 69–74. — Jebb, M., An account of Nepenthes in New Guinea. Science in New Guinea 17 (1991) 7–54. — Juniper, B.J., et al., The carnivorous plants. Academic Press, London (1989). — Kurata, S., Nepenthes of Mt Kinabalu. Sabah National Parks Trustees, Kota Kinabalu (1976). — Lloyd, F.E., The carnivorous plants. Chronica Botanica Co., Massachusetts (1942). — Macfarlane, J.M., Nepenthaceae, in A. Engler, Das Pflanzenreich 4, 3 (1908) 1–92.

Vegetative anatomy — Metcalfe & Chalk (1950) provide a report on the vegetative anatomy based on their examination of two horticultural hybrid taxa, *Nepenthes* 'Hainaniana' and *N.* 'Ratcliffeana' as well as summarising data from previous work. Much of what follows is based on their work.

Leaf blade with distinct palisade in some taxa, indistinct in others. Stomata on lower surface only, ranunculaceous. Hypoderm usually present, especially at the upper surface, of 1–3 cell layers. Mesophyll including up to 5 layers of palisade cells and cells with spiral bands of cellulose thickening. Midrib similar to petiole.

Petiole with vascular cylinder adaxially flattened, of widely spaced collateral bundles supported by fibres and connected by a zone of sclerotic cells. Larger adaxial bundles with xylem uppermost, smaller adaxial bundles inverted. Abaxial bundles variously orientated. One medullary bundle in one taxon, two in another; xylem adaxial. Small bundles present in petiole wings. Tanniniferous deposits and occasional cluster crystals in mesophyll cells.

Tendril with vascular cylinder of collateral bundles embedded in sclerenchyma. Adaxial bundles sometimes inverted, that is, with xylem internal. Medullary bundle(s) well developed or absent.

Pitcher with epidermis of thick-walled cells. Stomata present on outer surface, and both surfaces of the lid. Spirally thickened cells embedded, walls supplied by numerous vascular bundles with very well-developed phloem. Larger bundles sheathed in fibres (Metcalfe & Chalk 1950).

References: Metcalfe, C.R. & L. Chalk, Nepenthaceae, in Anatomy of the Dicotyledons, Vol. 2 (1950) 1105–1111. Oxford.

Non-glandular trichomes — In his survey of 58 taxa of *Nepenthes*, Schmid-Hollinger (1971) recognises five main types of non-glandular multicellular trichome: multicellular simple hairs, hairs with teeth, tufted, rosette and arachnoid hairs. Tufted hairs are referred to by other authors, such as Metcalfe & Chalk (1950) and ourselves in the species descriptions that follow, as branched or dendritic. The rosette we term stellate

in our descriptions. Schmid-Hollinger groups each of the 58 species under one of seven trichome-complement types. These are not congruent with Danser's or any other classification of the genus. Non-glandular trichomes are usually found on the inflorescences and often on the outer surface of the pitcher and lid, on the tendril and stem, and on the lower surface of the leaf. Variants of the 'tufted', that is branched or dendritic hairs, are numerous and are the most frequently encountered trichomes. One particularly common branched hair variant has a single large branch, the other branches being short, basal and inconspicuous and so the hair appears 'simple' when viewed by a hand-lens. Unicellular, simple hairs are rare, according to Metcalfe & Chalk (1950).

References: Metcalfe, C.R. & L. Chalk, Nepenthaceae, in Anatomy of the Dicotyledons, Vol. 2 (1950) 1105–1111. Oxford. — Schmid-Hollinger, R., Nepenthes-Studien II. Die Haare der Nepenthaceen und ihre phylogenetische Bedeutung. Bot. Jahrb. Syst. 91 (1971) 61–90.

Secretory structures — Metcalfe & Chalk (1950) categorise the glandular structures of *Nepenthes* as follows:

1) Hydathodes. These are present on the stem, leaf blade, and pitcher. They have a circular or stellate head of 4–16 cells and a foot of 1–several cells. According to Stern (1917) they are wholly epidermal in origin. Metcalfe & Chalk describe these glands as usually sunk in depressions, but sometimes level with or raised above the surface. It is believed that they may absorb as well as secrete water. We have found these structures (which we refer to as sessile glands in the descriptions that follow) to occur in many, perhaps most species and to be relatively abundant when present but, where non-glandular trichomes occur, they are difficult to detect, being concealed. They are usually coloured red.
2) Nectar- or honey glands are widely but thinly distributed on leaves and stems. They are also entirely epidermal in origin (Stern 1917) and are situated at the end of a vascular bundle and sunk in depressions linked with the surface by a narrow orifice. The nectar glands of *N. mirabilis* are provided with 3 layers of secretory tissue, the outermost layer being of columnar cells. The glands of *N. bicalcarata* are branched, those of *N. lowii* are particularly deeply embedded whilst *N. ampullaria* is reported to lack glands. Most species remain unsurveyed for these glands. They are not included in our species descriptions.
3) Digestive glands. These are distributed densely and regularly throughout the glossy 'digestive' zone (see morphology) on the inside of pitchers below the 'waxy zone', if it is developed. They are situated at the end of vascular bundles in depressions and are partly enclosed above by an extension of the epidermis. They consist of small multicellular masses of tissue, the outermost layer being columnar and secreting the digestive enzymes into the pitcher fluid responsible for breaking down prey.
4) Marginal glands are situated on the inner portion of the peristome of the pitcher. Each consists of a deeply embedded ovoid or cylindrical mass of secretory tissue linked by a narrow canal to the inner edge of the peristome, the portal being located below, or more usually, between the ends of two peristome ribs (Cheek & Jebb, pers. obs.). The outermost layer of the gland is of columnar cells, the remainder is parenchyma with a central prosenchyma element and a peripheral enveloping layer of flattened cells with the radial wall cutinised. Only the columnar layer is of epidermal origin (Stern 1917).

A fifth type of secretory structure common in the genus is not discussed by Metcalfe & Chalk (1950). The lower surface of the pitcher lid of almost all species bears several to numerous nectar glands. Their morphology, size, density, and distribution vary greatly between species. They produce the sweet-tasting nectar that helps attract prospective prey. They appear quite unlike the nectar glands of the leaf blade and stem and may have more in common with the digestive glands and the nectar and scent glands of the adaxial tepal surface, also undescribed by Metcalfe and Chalk.

References: Metcalfe, C.R. & L. Chalk, Nepenthaceae, in Anatomy of the Dicotyledons, Vol. 2 (1950) 1105–1111. Oxford. — Stern, K., Beiträge zur Kenntnis der Nepenthaceen. Flora 109 (1917) 213–283.

Floral anatomy — Floral anatomy is reported upon by Kaul (1982) based on his observations of *N. villosa* and *N. lowii*. He also summarises previous work. Kaul reports that no receptacular vascular plexus occurs. Perigonal nectar glands of the adaxial tepal surfaces are probably protodermal in origin. Each gland is served by a strand of phloem and comprises multiseriate hypodermal cells, the outermost layer of which is columnar and secretory. Below the palisade is an irregular endodermis-like layer connected with the cuticle and with radial and tangential walls thickened. The androphore has 4 bundles which branch only at the anther head. The fused partial walls which almost separate the 4 ovary loculae project towards the axis and act as placentae, giving lamellar placentation. The ovules are served by fine bundles arising at the base of the ovary and are not connected with the large bundles of the carpel outer walls. The bitegmic ovules show the inner integument projecting beyond the outer at the micropyle before anthesis, projecting further at anthesis. Before anthesis the chalazal end elongates into a lobe as long as the rest of the ovule and continues to elongate, into a filiform appendage after pollination, whilst the outer integument extends to about the same degree at the micropylar end, producing a matching filiform appendage.

Reference: Kaul, R.B., Am. J. Bot. 69 (1982) 793–803.

Primary stem anatomy — The primary cortex is differentiated into an outer zone of fibrous cells with scattered vascular bundles and an inner zone of larger cells, both zones bearing elements with spiral bands of cellulose thickening. A well-defined endodermis is present. The pericycle consists of spirally thickened cells, the thickenings filling the lumina when old. Cork arises in the pericyclic region.

The vascular cylinder is composed of 20–30 bundles, separated by narrow rays. Primary xylem with vessels 70–90 μm diam., sometimes much larger, the perforations simple; fibres with bordered pits.

Pith with scattered spiral cells. Outer part of prosenchyma with thin transverse partitions accompanied by shorter cylindrical cells. Inner part of large, thin-walled parenchyma. Medullary bundles are present in some taxa, but absent in others. Clustered and sphaerocrystals occasional. Suspected tanniniferous material is abundant in the cortex, pericyclic region and pith.

Literature: Metcalfe, C.R. & L. Chalk, Nepenthaceae, in Anatomy of the Dicotyledons, Vol. 2 (1950) 1105–1111. Oxford.

Wood anatomy — The only report on the secondary xylem of *Nepenthes* is that of Carlquist (1981) from which the following is entirely derived. Carlquist examined material from three taxa: *N. ampullaria, N.* × *kinabaluensis*, and *N. lowii,* and reported the secondary xylem anatomy relatively uniform in the species he examined. The main features of interest are the dimorphic vessels and the rarity of multiseriate rays, the latter unusual in lianas.

Secondary xylem cylinder 4–6 mm diam., in stems 18–22 mm diam. Growth rings absent. Vessels dimorphic. Wider vessels solitary, scattered, averaging 332–348 μm long, 83–190 μm diam. (sometimes subisodiametric) and 16–49 per mm^2 in transverse section. Fusiform vessels inconspicuous, but about as many as wider vessels, c. 300 by 20 μm. Perforation plates of both vessel types simple, sometimes (c. 20% of elements) double or triple in fusiform vessels, often markedly subterminal. Pits circular, bordered, alternate. Vessel-ray pits elongated, parallel. Contents gummy. Ground tissue of tracheids (non-vascular), 1.21–1.75 times as long as the fusiform vessels, pits fully-bordered. Axial parenchyma in short, unicellular tangential bands, sometimes diffuse, mostly in strands of two, pits bordered. Rays biseriate or uniseriate. Multiseriate rays, more than two cells wide, rare. Ray cell walls moderately thick, pits bordered. Crystals, silica bodies or other idioblasts not detected.

Reference: Carlquist, S., Wood anatomy of Nepenthaceae. Bull. Torrey Bot. Club 108 (1981) 324–330.

PALYNOLOGY

The only survey of *Nepenthes* pollen is that by Basak & Subramanyam (1966) who looked at 13 species using the light microscope and concluded that "the pollen grains of (the) 13 species investigated are more or less identical". Other authors have examined one to four species, usually peripherally as part of wider pollen Floras or other surveys (Rao & Ong 1972; Rao & Tian 1974; Takahashi & Sohma 1982; Adam 1998). The pollen grains of *Nepenthes* are released in tetrads. The tetrads are tetrahedral (rarely isobilateral in *N. ampullaria:* Rao & Tian 1974, or decussate: Rao & Ong 1972) and spinuliferous, measuring 24–35 microns wide (excluding the spines) according to Basak & Subramanyam (1966). A diameter of up to 40 microns has been mentioned by Adam (1998), but it is not clear whether this measurement included the spinules, nor which species was concerned. Dimorphic pollen grains are reported by Rao & Tian (1974) for *N. ampullaria*, 3.8% of the pollen grains lacking spinules but not otherwise differing from normal pollen grains. The constituent grains of the tetrad are inaperturate, subelliptic to spheroidal in surface view, 17–25 by 16.5–23 μm. Each component grain has one distal convex face and three proximal flattened ones with their fusion extending nearly to the equatorial plane. Exine is 1–1.5 μm thick and provided with spinules on the exposed dorsal surface, the other surfaces having much thinner exine and lacking spinules. The sexine is as thick or slightly thicker than the exine. The spinules are pointed, 0.5–3 μm in length, 0.5–1.5 μm in width at the base and 1–3.5 μm apart (Basak & Subramanyam 1966). The distal surface of the pollen grain appears smooth using LM, but under the SEM is densely papillose, the papillae covered with a lipidic layer in

section. Sections of the proximal wall show cohesion of the exine and that the intine of adjoining grains is connected through gaps in the exine. No stratification, e.g. a columellal layer, occurs in the exine (Takahashi & Sohma 1982). Putative fossil *Nepenthes* pollen (see 'Fossils', p. 2) is dealt with by Krutzsch (1985).

References: Adam, J.H., Reproductive biology of Bornean Nepenthes (Nepenthaceae). J. Trop. Forest Sci. 10, 4 (1998) 456–471. — Basak, R.K. & K. Subramanyam, Pollen grains of some species of Nepenthes. Phytomorphology 16, 3 (1966) 334–338. — Krutzsch, W., Über Nepenthes-pollen (alias Droseridites p.p.) in europäischen Tertiär. Gleditschia 13 (1985) 1, 89–93. — Rao, A.N. & E.T. Ong, Germination of compound pollen grains. Grana 12 (1972) 113–120. — Rao, A.N. & Tian, Pollen morphology of certain tropical plants. J. Palyn. 10 (1974) 1–37. — Takahashi, H. & K. Sohma, Pollen morphology of the Droseraceae and its related taxa. The Science Reports of the Tohoku Univ. 38, 2 (1982) 81–156.

PITCHER FUNCTION

The pitcher of *Nepenthes* acts as a pitfall trap for a wide range of invertebrates and, less commonly, vertebrates. The wall of the pitcher is thin but in general of great strength, attributable chiefly to the thick-walled epidermis both within and without, supported by the veins which have a generous supply of sclerenchyma (Lloyd 1942).

During development the mouth of the pitcher is hermetically sealed by the lid which only opens when the final size of the pitcher has been approached. Unopened pitchers contain several ml of fluid. The lid is not fused to the pitcher mouth, but is tightly applied, and has a dense growth of branching hairs which clothe the outer face of the pitcher mouth and the edge of the lid (Lloyd 1942). Once open, the lid is usually held a little above the mouth, and it is probably an efficient bar to the entry of rain. There are exceptions to this, such as *N. ampullaria, N. campanulata, N. dubia, N. eymae, N. fusca, N. inermis,* and *N. lowii,* in which the lid is far smaller than the mouth, and/or is reflexed.

Trapping of prey — Prey is probably attracted to the pitcher by a combination of its coloration and the presence of nectar secreted by glands on the underside of the pitcher lid, the inner edge of the peristome, and on the outer surface of the pitcher. The prey drops into the fluid at the base of the pitcher, which contains a wetting agent, making escape more difficult. The combination of proteolytic enzymes secreted by the glands in the lower part of the pitcher, and bacteria living in the pitcher fluid, leads to the breakdown of the prey followed by absorption of the products by these same glands (Lloyd 1942; Juniper et al. 1989).

In all the species of *Nepenthes* of which we have been able to examine pitchers in the field the catch is predominantly of ants, which appear to be the single most important prey item (e.g. Jebb 1991). Observations have also shown that ants use *Nepenthes* nectaries as a food source, and only a small proportion of ant visitors are captured. Joel (1988) sees this as a mutualistic interaction. However, a wide range of other invertebrates are also caught, for example, cockroaches, Lepidoptera, centipedes, Hymenoptera, Orthoptera, Diptera, and Coleoptera were found trapped in pitchers of *N. mirabilis* in New Guinea (Jebb 1991).

Research on trapping spectra in other locations and species of *Nepenthes* suggests that the above pattern is common (Clarke 1997). However, few species of the genus have been studied in detail in this respect. So far the only species known to show high prey specificity is *N. albomarginata*. Two independent studies of this species, one in Sumatra, the other in Brunei, show that for lengthy periods pitchers of this species trap little or nothing until termites become available, when they trap little else but these animals. Pitchers of neighbouring species of *Nepenthes* in contrast, catch very few termites (Clarke 1997).

Rat trapping by *N. rajah* has been reliably reported on three occasions (Phillipps & Lamb 1996).

The effect on prey composition of differences in shape and position between upper and lower pitchers in one species have been investigated by Jebb (1991). Upper pitchers of *N. mirabilis* trap a significantly higher proportion of flying, as opposed to crawling insects, than do lower pitchers.

The pitchers of some species of *Nepenthes* may have a primary function not as animal traps, but as water and/or litter trapping devices. This has been suggested for *N. ampullaria* and *N. lowii*, amongst other species (e.g. Clarke 1997).

The Pitcher as a Community — Apart from dead animals in the process of being digested, pitchers may also contain organisms which are capable of living above or within the fluid without being killed and digested. These include spiders and water mites, mosquito larvae (Tripteroides and Toxorhynchites), and the larvae of many other dipterans (Phoridae, Chironomidae) and crustaceans (copepods and ostracods, decapods). Protists, desmids, diatoms, bacteria, and fungi may also be present (Lloyd 1942; Beaver 1983, 1985; Clarke & Kitching 1993). Clarke (1997) gives an excellent review of this topic, and shows how the complexity of the ecological foodwebs that comprise the community within a pitcher can be correlated with longevity and size of the pitcher. Larger, long-lived pitchers can have numerous species of organisms living inside them, whilst *Nepenthes* species with small and transient pitchers may have few supernumerary organisms present. These organisms improve the function of the trap by breaking down trapped animals more speedily and so reducing the chances of putrefaction and early pitcher death (Clarke 1997).

Several animals are known only from *Nepenthes* pitchers. An extreme, but well-known example is the ant *Camponotus schmitzii* which inhabits the hollow tendrils of *N. bicalcarata*, chewing away a thin part of the epidermis to gain access to the cavity inside. These ants drag large prey from the pitcher to the peristome and cut it up, taking fragments to their nest. In the absence of large prey, groups of these ants swim in the pitcher fluid and herd mosquito larvae to the wall, where they are slaughtered and consumed in the usual manner (Clarke & Kitching 1995; Clarke 1997).

References: Beaver, R.A., The communities living in Nepenthes pitcher plants: fauna and food webs; in: H. Frank & P. Lounibos (eds.), Phytotelmata: terrestrial plants as hosts for aquatic insect communities. Plexus, New Jersey (1983). — Beaver, R.A., Geographical variation in food web structure in Nepenthes pitcher plants. Ecological Entomology 10 (1985) 241–248. — Clarke, C., Nepenthes of Borneo. Natural History Publications, Kota Kinabalu (1997). — Clarke, C. & R.L. Kitching, The metazoan foodwebs from six Bornean Nepenthes species. Ecological Entomology 18 (1993) 7–16. —

Clarke, C. & R.L. Kitching, Swimming ants and pitcher plants: a unique ant-plant interaction from Borneo. Journal of Tropical Ecology 11, 4 (1995) 589–602. — Hooker, J.D., On the origin and development of the pitchers of Nepenthes. Trans. Linn. Soc. 22 (1859) 415–424, t. 69–74. — Jebb, M., An account of Nepenthes in New Guinea. Science in New Guinea 17 (1991) 7–54. — Joel, D.M., Mimicry & mutualism in carnivorous plants. Pitcher plants. Biol. J. Linn. Soc. 35 (1988) 185–197. — Juniper, B.J., et al., The carnivorous plants. Academic Press, London (1989). — Lloyd, F.E., The carnivorous plants. Chronica Botanica Co., Massachusetts (1942). — Phillipps, A. & A.L. Lamb, Pitcher Plants of Borneo. Natural History Publications, Kota Kinabalu (1996) 131.

CYTOTAXONOMY

Lowrey (1991) reviewed previous work on the chromosomes of *Nepenthes*. This had been based on two cultivated species (*N. rafflesiana* and *N. thorelii)* and one horticultural hybrid. The family had been considered notable for very high chromosome numbers (n = 39 and 40) and possible aneuploidy. Lowrey discounted previous reports of 2n = 78 (based in part on *N. rafflesiana*) and possible aneuploidy in *Nepenthes* and reported 2n = 80 from *N. rafflesiana* and six other species (unspecified) from Malaysia and Singapore. Thirteen enzyme systems were examined for isozyme number. All enzymes exhibited isozyme numbers within the ranges typical of diploid seed plants. Lowrey interpreted the lack of duplicated loci as lack of evidence for a polyploid origin for the family despite the high chromosome number.

Heubl & Wistuba (1997) confirmed 2n = 80 in their investigation of 15 species: *N. albomarginata, N. clipeata, N. distillatoria, N. eymae, N. gracilis, N. khasiana, N. madagascariensis, N. pervillei, N. rafflesiana, N. reinwardtiana, N. stenophylla, N. tentaculata, N. thorelii, N. truncata*, and *N. veitchii*. They reported the chromosomes of all these species to be similar to each other in shape and very small, from 0.5–2 microns in length in metaphasic karyotypes. The chromosomes are metacentric to submetacentric. Centromeres are only visible at mid-metaphase. Chromosome groupings within the karyotype were not detected by Heubl & Wistuba.

This remarkable chromosomal uniformity is consistent with the ease with which fertile interspecific hybrids are produced in the wild and in horticulture. It provides little taxonomic insight into the genus. However, several major species-groupings in the genus have not yet been sampled. Cytological investigation of the *Montanae* and *Insignes* groups together with the Malesian 'paniculate' species is desirable.

References: Heubl, G. & A. Wistuba, A cytological study of the genus Nepenthes (Nepenthaceae). Sendtnera 4 (1997) 169–174. — Lowrey, T., Chromosome & isozyme number in the Nepenthaceae. Am. J. Bot. 78, 6 (1991) 200–201.

CONSERVATION

Walters & Gillett (1997) in the IUCN Red list of threatened plant species treat 25% of the species of *Nepenthes* they recognise as 'threatened', and give IUCN ratings for 14 Malesian taxa as follows:

- Indeterminate 3 (*N. burbidgeae, N. deaniana, N. philippinensis*)
- Vulnerable 3 (*N. edwardsiana, N. rajah, N. villosa*)

- Rare 4 (*N. burkei, N. lowii, N. paniculata, N. veitchii*)
- Endangered 4 (*N. gracillima, N. muluensis, N. northiana, N. neglecta*)

However, apart from these species, there are several others which are probably more highly threatened. *Nepenthes clipeata* is believed to be reduced to only 2–6 plants in the wild owing to collection of plants for horticultural purposes at its only known wild locality. The type locality of *N. campanulata* was destroyed by fire and the species considered possibly extinct until it was rediscovered at a hitherto unknown, second locality in the last two years.

The species of *Nepenthes* are particularly vulnerable to threats because so many of them have highly restricted distributions. Many are known from a single locality or small area, such as a mountain.

There are two main threats to *Nepenthes*: horticultural trade and habitat destruction.

The Horticultural Trade — The horticultural trade in *Nepenthes* is mostly international. The main markets are Western Europe, Japan, and the United States of America. Increasingly the supply of tissue-cultured plants is growing to meet the demand of purchasers. However, collection of plants from the wild for horticultural purposes continues.

All species of the genus *Nepenthes* are listed on CITES Appendix II, apart from *N. khasiana* (India) and *N. rajah* which appear on Appendix I (CITES is the Convention on International Trade in Endangered Species) (Knees & Cheek 1988; Cheek 1990). The average number of plants traded internationally in the period 1983–1989 (for which records were kept) was 1,168,000 plants per year (World Conservation Monitoring Centre 1991). Prices are generally highest in Japan, where a price of USD 304 per plant has been reported (World Conservation Monitoring Centre 1991). In Germany the highest price recorded has been USD 215 per plant, but plants can be bought for as little as USD 10, depending on rarity (Jenkins 1993).

Habitat Destruction — The species most threatened by habitat destruction are lowland species, particularly those of restricted distribution such as *N. sumatrana* and *N. bicalcarata,* and obligate ultramafic species, such as *N. philippinensis* and *N. argentii* (see 'Habitat and Ecology', p. 2).

Lowland rain forest species are vulnerable to loss of habitat from non-sustainable logging, and the clearance of forest and scrub for agriculture, habitation, tourism, and associated house-building.

Ultramafic-obligate species, and to a lesser extent species of limestone, are especially vulnerable to open-cast mining operations since ultramafic substrates have a super abundance of metals, such as manganese, nickel, and cobalt. *Nepenthes danseri* in particular, may be threatened by mining for nickel (Jebb, pers. obs.). Reference to mine-workings often appear on the collecting labels of such species. Underground workings are likely to have less impact than open-cast mining. Limestone-specific species may be under threat from mining if there are associated metal deposits (e.g. *N. northiana:* gold and antimony at Bau) or if the limestone itself is mined for cement production or other uses (*N. northiana*).

Montane species of *Nepenthes*, constituting most of the genus, are, generally, less threatened with habitat destruction than lowland species, although generally, of more interest to horticulturists. Lian (1995) sampled many of the montane localities in Peninsular Malaysia from which *N. macfarlanei* has been known historically, and found that it was still present at all the sites that she surveyed. However, there is concern that the expansion in number of touristic and leisure complexes situated in the mountains of Peninsular Malaysia has destroyed some populations of the endemic *Nepenthes* species there.

References: Cheek, M., Conserving carnivorous plants. Species (Newsletter of the Species Survival Commission IUCN) No. 13–14 (1990) 30–31. — Jenkins, M. (ed.), The wild plant trade in Europe, results of a TRAFFIC Europe survey of European nurseries. TRAFFIC Europe, Switzerland (1993). — Knees, S. & M. Cheek, Changes in regulations effecting international trade in Carnivorous Plants. Carnivorous Plant Newsl. 17, 2 (1988) 45–46, 61. — Lian, L.C., Conservation studies with Nepenthes macfarlanei Hemsl. in Peninsular Malaysia. Univ. Bath. Unpubl. PhD thesis, 235 pp. (1995). — Walter, K.S. & H.J. Gillett, The 1997 IUCN Red List of threatened plants. IUCN Species Survival Commission, Gland, Switzerland (1997). — WCMC. Review of significant trade in species of plants listed on Appendix II of CITES 1983–1989. WCMC, Cambridge, UK. (1991).

TAXONOMY

Historical — The taxonomic history is summarised by Jebb & Cheek (1997). For Malesia, the work of Danser (1928) has dominated all subsequent work on the genus, although he did not cover either the Philippines or extra-Malesia.

Present arrangement — No infrageneric classification has been proposed to replace that of Danser (1928). Danser recognised six groups which can be summarised in his terms as follows:

Urceolatae Danser

Two species with coarse stems, showing 2/5 phyllotaxy when climbing; urceolate lower pitchers; peristome flattened on the inner side and 'paniculate' inflorescences. Malesia wide.

Insignes Danser

Ten species with coarse stems, showing 2/5 phyllotaxy when climbing; leaves large, sessile or petiolate; large campanulate-infundibuliform pitchers; peristome flattened or expanded, pitcher lids lacking appendages, inflorescence 'racemose' and indumentum fine or absent. Malesia wide.

Regiae Danser

Fifteen species with coarse stems showing 1/2 phyllotaxy when climbing; petiolate leaves with large infundibuliform pitchers; peristome flattened or expanded, pitcher lids with appendages, inflorescence 'racemose' and indumentum coarse, red-brown. Borneo to New Guinea.

Montanae Danser

Ten ill-defined species drying black, fine stems showing 2/5 phyllotaxy when climbing; sessile, but subpetiolate leaves; pitcher lids lacking appendages; inflorescence 'racemose' and indumentum fine and sparing. Peninsular Malaysia, Sumatra, and Java.

Nobiles Danser

Four species intermediate between *Montanae* and *Regiae*; coarse stems showing 2/5 phyllotaxy when climbing; lids lacking appendages, indumentum coarse and red-brown. Sumatra to Palawan.

Vulgatae Danser

Approximately 20 species with fine stems showing 2/5 phyllotaxy when climbing; leaves usually small and narrow, mostly lanceolate; peristome narrow, pitchers small, rarely infundibuliform; inflorescence 'racemose' or 'paniculate', and indumentum usually fine, not red-brown, or absent. Malesia wide.

These groups are not entirely satisfactory. Although *Montanae* and *Regiae* are well delimited, the remaining groups, particularly *Vulgatae,* seem to be heterogeneous. Danser himself admitted that, for example, *Nobiles* was "no phylogenetic unit". For this reason we do not provide a key to Danser's groups (neither did he), nor do we cluster the species descriptions that follow according to his groups. Instead, we arrange species in alphabetical order, as he did.

Like Danser, we do not recognise infra-specific taxa, contending that our knowledge of most species is still too poor to distinguish these reliably, although within such widespread species as *N. mirabilis* and *N. rafflesiana*, there are well-marked varieties. The species that we recognise are delimited from each other by disjunction in two or more morphological characters. If an intermediate specimen occurs between two well-known species well-represented by herbarium specimens, we still maintain these species. However if two taxa are each known by a single specimen and an intermediate comes to light, we unite them.

Infrageneric phylogeny — Mullins (pers. comm.) is near to completion of a molecular phylogeny for the genus using nuclear and chloroplast genes. Danser (1928) saw a Western Indian ocean origin for the genus, with an eastward extension still in progress. Schmid-Hollinger (1971, 1979), concentrating on the Indian Ocean species, largely concurred, but concluded that amongst these species *N. pervillei* is highly advanced.

Relationships of Nepenthaceae — In the 19th century, *Nepenthes* were usually allied with Rafflesiaceae on the basis of floral morphology. More recently, authors such as Cronquist placed several disparate families of carnivorous plants together, simply because they were carnivorous (Cheek 1991) and so *Nepenthes* have been considered allied to Sarraceniaceae, the New World pitcher plants.

In describing Dioncophyllaceae, Airy Shaw (1951) allied his new family to *Drosera*, *Drosophyllum*, *Ancistrocladus*, and *Nepenthes*. Unfortunately, he also considered the possibility of a link with *Hugonia*, apart from which his grouping is supported by the latest molecular evidence (Lledo et al. 1998). However, the topology of the molecular-derived trees in which *Nepenthes* has appeared in the last few years has varied almost from year-to-year (Albert et al. 1992; Williams et al. 1994; Fay et al. 1997; Lledo et al. 1998). Currently (Lledo et al. 1998), *Nepenthes* is sister, at the base of the clade, to the above mentioned taxa. Previous publications show it in a different position, at the base of an adjoining clade, where it is sister to Polygonaceae and Plumbaginaceae. It will be

interesting to see whether the current topology is maintained when further taxa have been sampled and when genes other than rbcL have been sequenced for the taxa concerned.

References: Airy Shaw, H.K., On the Dioncophyllaceae, a remarkable new family of flowering plants. Kew Bull. 1951 (1951) 327–368. — Albert, V.A., et al., Carnivorous plants: phylogeny and structural evolution. Science 257 (1992) 1491–1495. — Cheek, M., Review of: A. Cronquist, The Evolution and Classification of Flowering Plants, 2nd edition (1988). Kew Bull. 46, 2 (1991) 364–366. — Danser, B.H., The Nepenthaceae of the Netherlands Indies. Bull. Jard. Bot. Buitenzorg III, 9 (1928) 249–438. — Fay, M.F., et al., Familial relationships of Rhabdodendron. Kew Bull. 52 (1997) 923–932. — Jebb, M. & M. Cheek, A skeletal revision of Nepenthes. Blumea 42 (1997) 1–106. — Lledo, M.D., et al., Systematics of Plumbaginaceae based upon cladistic analysis of rbcL sequence data. Syst. Bot. 23, 1 (1998) 21–29. — Schmid-Hollinger, R., Nepenthes-Studien II. Die Haare der Nepenthaceen und ihre phylogenetische Bedeutung. Bot. Jahrb. Syst. 91 (1971) 61–90. — Schmid-Hollinger, R., Die Kannenformen der westlichen Nepenthes-Arten. Bot. Jahrb. Syst. 100 (1979) 379–405. — Williams, E.S., et al., Relationships of Droseraceae. Am. J. Bot. 81 (1994) 1027–1037.

USES

The main value of *Nepenthes* in international commerce is in the horticultural trade, where it probably far exceeds 15 million dollars *per annum* in our estimation (see 'Conservation', p. 13).

In SE Asia, the use of *N. mirabilis* as toy phallocrypts in New Guinea is probably the most obscure. Stems of several species are used for making rope, that of *N. ampullaria* being considered of particularly good quality, being very durable when used in, for example, tying fences. Fluid from unopened pitchers is potable (pers. obs.) and used to treat inflammation of the eyes and both indigestion and other stomach problems. Boiled roots of *N. ampullaria* and *N. gracilis* have both been used to treat stomachache. *Nepenthes reinwardtiana* has been used to facilitate healing of skin and as an astringent. Opened pitchers of the larger pitchers are used to cook rice in, imparting an interesting flavour. The last use is reflected in one of the common names of many species in various languages, which translates as 'monkeys' rice pots'. Other common names which may reflect uses translate as 'monkeys' goblet' and 'monkeys' water-scooper'. A detailed compilation of common names based on those recorded on herbarium specimens is given by Danser (1928) from which most of the above uses have been obtained.

Reference: Danser, B.H., The Nepenthaceae of the Netherlands Indies. Bull. Jard. Bot. Buitenzorg III, 9 (1928) 249–438.

COLLECTING NOTES

1) What to collect. — It is important to be aware of the dimorphy of the pitchers when collecting *Nepenthes*; collections of both upper and lower pitchers are of importance (although not essential to identification). For many species the lower pitchers (less usually the upper) are unknown to science. Furthermore, as in the case of any dioecious taxon, collections of male and female plants from the same locality are desirable. Female inflorescences are unknown from many species.

2) What to be aware of while collecting. — Several species may grow together at the same locality. It is important not to overlook this possibility, to look out for and collect potential second species, and to avoid making mixed collections.
Photographs and field notes on population size, colour and flower scent are valuable supplements to herbarium specimens.
3) How to press your specimen. — Particular care should be taken when pressing and mounting the pitcher so that the wings on the ventral surface, the peristome and, most important of all, the underside of the lid, are clearly visible. There is not much point in stuffing pitchers with cotton wool etc. In fact, the flatter they are pressed the better specimens they make.
4) How to mount your pressed specimen. — The same considerations apply when mounting *Nepenthes* collections. Specimens are often mounted with the surface of the lid or the mouth obscured, making identification difficult.

SPOT CHARACTERS

I. Habit

Plant epiphytic:
N. burkei, N. dubia, N. edwardsiana, N. ephippiata, N. fusca, N. inermis, N. insignis, N. lowii, N. macfarlanei, N. maxima, N. merrilliana, N. ovata, N. pilosa, N. reinwardtiana, N. spathulata, N. stenophylla, N. veitchii, N. ventricosa.

II. Stem

Stem wings uniting above node in saddle-shaped structure:
N. ephippiata, N. northiana.

III. Leaf

Tendril with ant-inhabited hollows:
N. bicalcarata.
Leaf suborbicular:
N. clipeata.
Leaf base subperfoliate-adnate:
N. adnata, N. hamata, N. lamii, N. muluensis, N. murudensis, N. tentaculata.
Leaf apex peltate, tendril inserted 10 mm or more from apex:
N. clipeata, N. rajah.
Leaf apex peltate, tendril inserted 2–9 mm from apex:
N. bongso, N. campanulata, N. mapuluensis, N. northiana.
Leaf apex conspicuously truncate/emarginate:
N. truncata, N. villosa.
Leaf blades over 40 cm long:
N. bicalcarata, N. burbidgeae, N. merrilliana, N. mira, N. northiana, N. rajah, N. sumatrana, N. truncata.
Margin of rosette leaves fimbriate (but not hairy):
N. mirabilis.

Longitudinal veins at least 7 on each side of midrib:
N. bicalcarata, N. danseri, N. merrilliana, N. sumatrana, N. treubiana.

IV. Pitcher

The majority of species have lower pitchers with fringed wings, and upper pitchers with wings lacking. Notable exceptions are:
Upper pitchers almost always lacking:
N. ampullaria, N. pectinata, N. rhombicaulis.
Peristome entirely lacking:
N. inermis.
Peristome with teeth inconspicuous (but visible with a ×10 lens), widely separated:
N. campanulata, N. ephippiata, N. lowii.
Peristome inner edge with holes, teeth absent:
N. reinwardtiana.
Peristome with teeth papery, plate-like:
N. edwardsiana, N. hamata, N. macrophylla, N. mira, N. villosa.
Peristome with a prominent white rim below:
N. albo-marginata.
Pitcher mouth with two conspicuous eye-spots on the inner surface of the back wall below the lid:
N. reinwardtiana (rarely also in *N. sanguinea, N. tobaica*).
Peristome teeth united and prolonged into two large descending thorns at the apex of the lid column:
N. bicalcarata.
Pitcher lid lower surface with single, basal appendage:
N. alata, N. boschiana, N. burbidgeae, N. clipeata, N. faizaliana, N. fusca, N. ovata, N. pilosa, N. stenophylla, N. truncata.
Lid with two appendages, one basal, the other apical:
N. eymae, N. fusca, N. klossii (apical appendage sometimes lacking), *N. maxima.*
Lid with apical appendage only:
N. bongso (some collections), *N. rhombicaulis.*
Lid with hairs or bristles below:
N. ephippiata, N. lowii, N. macfarlanei.
Lid with 'tentacles' above:
N. adnata (intermediate pitchers), *N. hamata, N. muluensis* (lower pitchers), *N. tentaculata.*
Lid with glands absent or very sparse:
N. ampullaria, N. hamata, N. tentaculata.
Lid at least 3 times longer than broad:
N. ampullaria, N. dubia, N. eymae, N. fusca, N. inermis.
Lid reniform, at least 1.5 times broader than long:
N. bicalcarata.
Lid greater than 10 cm wide in at least one dimension:
N. ephippiata, N. lowii, N. macrophylla, N. merriliana, N. northiana, N. rajah, N. villosa.

Lid glands absent from centre, near margin only:
N. rafflesiana, N. treubiana (sometimes).
Lid glands to 2 mm wide:
N. sibuyanensis.
Spur fasciculate in upper pitchers:
N. adnata, N. hamata, N. mikei, N. ramispina, N. tentaculata.
Spur over 1 cm long:
N. burbidgeae, N. ephippiata, N. hirsuta, N. lowii. N. macfarlanei, N. merrilliana, N. pilosa, N. rafflesiana, N. sanguinea, N. spectabilis, N. stenophylla, N. truncata, N. veitchii.
Spur bifid:
N. adnata, N. ampullaria, N. aristolochioides, N. burbidgeae, N. eustachya, N. eymae, N. lavicola, N. macfarlanei, N. maxima, N. mira, N. ovata, N. rafflesiana, N. sanguinea, N. singalana, N. treubiana.
Spur branched at base, or with multiple branches, these sometimes hair-like:
N. eustachya, N. hamata, N. macrovulgaris, N. mikei, N. murudensis, N. papuana, N. ramispina, N. rhombicaulis, N. spathulata, N. tentaculata.

V. Inflorescence

Partial peduncles 1-flowered:
Partial peduncles without a bract:
N. adnata, N. alata, N. bellii, N. burkei, N. edwardsiana, N. glabrata, N. gracilis, N. hamata, N. lamii, N. mapuluensis, N. mikei, N. mirabilis, N. muluensis, N. murudensis, N. papuana, N. sibuyanensis, N. tentaculata, N. ventricosa, N. villosa.
Partial peduncles with a bract:
N. densiflora, N. diatas, N. faizaliana, (N. gracilis), N. inermis, N. macrophylla N. ovata, N. rafflesiana, N. ramispina, (N. sibuyanensis), N. singalana, N. spathulata.
Partial peduncles 2-flowered, at least at base of inflorescence:
Partial peduncles without a bract:
N. benstonei, N. boschiana, N. burbidgeae, N. eustachya, N. eymae, N. fusca, N. hispida, N. insignis, N. klossii, N. lowii, N. merrilliana, N. mira, N. mollis, N. philippinensis, N. pilosa, N. rajah, N. reinwardtiana, N. rhombicaulis, N. stenophylla, N. truncata.
Partial peduncles with a bract:
N. bongso, N. gracillima, N. hirsuta, N. lavicola, N. macfarlanei, N. macrovulgaris, N. maxima, N. northiana, N. pectinata, N. rafflesiana, N. sanguinea, N. spectabilis, N. sumatrana, N. treubiana.
Partial peduncles 3- or more-flowered:
Partial peduncles without a bract:
N. bicalcarata, N. danseri, N. paniculata.
Partial peduncles with a bract:
N. ampullaria, N. neoguineensis, N. tomoriana.

MATERIALS AND METHODS

The descriptions of species that follow are based on field observations by the authors in Peninsular Malaysia, Borneo, and New Guinea and on the measurements of specimens principally at K, L, and BO, and to a lesser extent those of B, BK, BM, DBN, KEP, KLU, LAE, OXF, P, SAR, SING, SINU, TCD, U, UPNG, US, and W. Some descriptions are partly taken from protologues, usually where we have not been able to consult adequate herbarium material. For example, for *N. rhombicaulis* and *N. sibuyanensis* we have only seen sterile herbarium sheets bearing fragmentary material, and so data on the inflorescence and the range of variation in vegetative parts has been taken from the protologue. Where this has occurred it is indicated in the notes following the description. Many species are inadequately collected, even though they may be well known from popular illustrated books on *Nepenthes*. For example, the lower pitcher of *N. burbeae* is represented by only a single specimen. For many species, lower pitchers and their leaves or inflorescences or infructescences are entirely unknown. *Nepenthes mollis*, known only from the type specimen, is unusual in that no pitchers, either upper or lower, are known!

The format of the descriptions is unusual in the botanical world, principally in that indumentum and colour are placed at the end of the description. This standard for *Nepenthes* descriptions was set by Danser (1928) and has been followed by *Nepenthes* workers since, e.g. Jebb & Cheek (1997) and Clarke (1997). In order to be consistent, we maintain this standard here.

In order to reduce the length of descriptions, we have omitted characters of the inner pitcher surface and have cut out description of female inflorescences since they are similar to those of the male and much more rarely collected. It should be noted that our descriptions and measurements of nectar glands and indumentum are based on observation made by a Leitz monocular ×10 lens fitted with a graticule measuring to 0.1 mm. No microscope or dissections were used, and so our descriptions of hair types should not be taken as definitive.

Ranges of measurements are based on those of all the specimens that we have seen at K, L, and BO. These are cited in the exsiccatae list of Jebb & Cheek (1997). Exceptional measurements, whether small or large are placed in brackets at the upper or lower end of the range, as appropriate. Such exceptional measurements represent a single specimen that falls outside the main range of measurements. Naturally, ranges are likely to change in future descriptions if more specimens become available, particularly in the case of the many poorly collected species. Of the 83 taxa (80 species) that we recognise in Flora Malesiana, 23 are known by three or fewer collections and it is to be expected that each extra specimen collected of any of these 23 species will necessitate a modification to the ranges given here.

Please note that ranges of measurements given for lower pitchers do not include those of seedlings.

References: Clarke, C., Nepenthes of Borneo. Natural History Publications, Kota Kinabalu (1997). — Danser, B.H., The Nepenthaceae of the Netherlands Indies. Bull. Jard. Bot. Buitenzorg III, 9 (1928) 249–438. — Jebb, M. & M. Cheek, A skeletal revision of Nepenthes. Blumea 42 (1997) 1–106.

GEOGRAPHICAL KEYS TO THE SPECIES OF NEPENTHES

KEY TO THE SUMATRAN AND JAVAN SPECIES

1a. Lid with a curved, hook-like process near the base ..... **55. N. ovata**
b. Lid without a curved, hook-like process near the base, at most a swollen lump 2
2a. Pitcher mouth lateral, pitchers urceolate ..... **6. N. aristolochioides**
b. Pitcher mouth apical, pitchers urceolate, tubular or infundibuliform 3
3a. Pitcher with a prominent rim of white hairs immediately below the peristome ..... **3. N. albomarginata**
b. Pitcher without a rim of white hairs below the peristome 4
4a. Lid narrow, at least four times as long as broad 5
b. Lid broad, less than three times as long as broad 7
5a. Pitcher globose; lid with 0–12 glands on lower surface ..... **4. N. ampullaria**
b. Pitcher strikingly infundibulate, widening greatly to the mouth; lid with 30 or more glands 6
6a. Peristome lacking ..... **34. N. inermis**
b. Peristome present ..... **19. N. dubia**
7a. Stem triangular and leaf bases decurrent 8
b. Stem rounded, or angular but then leaf bases not decurrent 9
8a. Peristome inner margin without teeth; lid with numerous minute glands ..... **65. N. reinwardtiana**
b. Peristome inner margin with teeth; lid with < 50 large-rimmed glands ..... **27. N. gracilis**
9a. Margin of lower leaves fimbriate ..... **49. N. mirabilis**
b. Margin of lower leaves entire 10
10a. Leaf base decurrent or adnate 11
b. Leaf base amplexicaul or sessile, if decurrent, then only as a ridge 18
11a. Leaf base not narrowed to a distinct petiole 12
b. Leaf base narrowed to a distinct petiole 14
12a. Lid glands minute (< 0.15 mm), numerous, throughout underside of lid ..... **1. N. adnata**
b. Lid glands large (0.3–0.5 mm), few (< 50), near base and midline, or throughout underside of lid 13
13a. Lid ovate; glands near base and along midline only ..... **58. N. pectinata**
b. Lid elliptic; glands throughout ..... **78. N. × trichocarpa**
14a. Lid oblong-elliptic, apex notched ..... **33. N. × hookeriana**
b. Lid rounded or ovate, apex rounded 15
15a. Leaf base long decurrent into 2 ridges running almost to next axil ..... **73. N. sumatrana**
b. Leaf base shortly decurrent, attenuate wings to at most 2 cm long 16
16a. Lid glands few, large (0.3–0.5 mm), near midline and base only ..... **58. N. pectinata**
b. Lid glands numerous, small (< 0.3 mm), throughout centre of lid 17

17a. Pitcher spur at least 10 mm or more long and covered by reddish hairs ..... **71. N. spectabilis**
b. Pitcher spur not greater than 6 mm in length, sparsely hairy ... **39. N. lavicola**
18a. Peristome extended into a flattened neck; lid glands absent from centre of lid . **62. N. rafflesiana**
b. Peristome not extended into a neck; glands less numerous towards margin . 19
19a. Stems rounded, < 3 mm diam.; leaves less than 13 by 2 cm 20
b. Stems rounded or angular, > 3 mm diam.; leaves larger than 13 by 2 cm ... 21
20a. Axils with conspicuous downy indumentum ..... **75. N. tobaica**
b. Axils glabrous ..... **47. N. mikei**
21a. Lid oblong-elliptic; apex truncate or notched ..... **33. N. × hookeriana**
b. Lid rounded to ovate; apex not notched 22
22a. Inner margin of peristome entire or with short teeth < 0.3 mm long 23
b. Inner margin of peristome with prominent teeth, 0.4–10 mm long 26
23a. Stem angular ..... **66. N. rhombicaulis**
b. Stem rounded 24
24a. Leaf sessile ..... **47. N. mikei**
b. Leaf petiolate 25
25a. Longitudinal veins arising both from base and along the length of the midrib; inner margin of peristome lacking teeth ..... **22. N. eustachya**
b. Longitudinal veins all arising from base of midrib; inner margin of peristome with teeth ..... **29. N. gymnamphora**
26a. Stem angular 27
b. Stem rounded 28
27a. Peristome flattened towards neck and much broader there ... **70. N. spathulata**
b. Peristome more or less even width throughout ..... **69. N. singalana**
28a. Leaves of lower pitchers often very small (< 8 by 2 cm); upper leaves usually much larger (20–25 by 5 cm), lanceolate; base tapering 29
b. Leaves of lower pitchers (> 10 by 2 cm); upper leaves similar in size (16 by 4 cm), obovate; base parallel-sided 30
29a. Petioles of upper leaves decurrent to stem; margin often densely pubescent .. **58. N. pectinata**
b. Petioles of upper leaves not decurrent to stem; margin not pubescent ..... **29. N. gymnamphora**
30a. Upper pitchers distinctly ventricose below, tubular above 31
b. Upper pitchers infundibuliform or ellipsoid throughout 32
31a. Peristome rigid, somewhat woody ..... **18. N. diatas**
b. Peristome papery in texture ..... **69. N. singalana**
32a. Leaf blade apex not peltate ..... **17. N. densiflora**
b. Leaf blade apex peltate ..... **10. N. bongso**

KEY TO THE PENINSULAR MALAYSIAN SPECIES

(See key to highland species under *N. gracillima*)

1a. Leaf base distinctly petiolate 2
b. Leaf base tapering, decurrent or amplexicaul, at most sub-petiolate 5

2a. Lid narrow; nectar glands 0–12 on lower surface ..... **4. N. ampullaria**
b. Lid elliptic; nectar glands 30–100+ 3
3a. Lower leaf margins fimbriate ..... **49. N. mirabilis**
b. Lower leaf margins not fimbriate 4
4a. Lid with many glands confined to edges ..... **62. N. rafflesiana**
b. Lid with few, scattered, prominently rimmed glands .... **78. N. × trichocarpa**
5a. Leaf base decurrent to stem 6
b. Leaf base amplexicaul, but not decurrent 8
6a. Peristome with a white collar below ..... **3. N. albomarginata**
b. Peristome without a white collar below 7
7a. Stem angular, leaf base sessile; lid flat below with scattered large glands .... **27. N. gracilis**
b. Stem rounded, leaf base sub-petiolate; lid with a basal ridge with large glands ..... **8. N. benstonei**
8a. Lid rounded, cordate at base; peristome narrow, rounded, stem rounded 9
b. Lid ovate, truncate at base; peristome broader, irregular, stem angular 10
9a. Pitcher spur branched; lid glands numerous, small (0.2–0.3 mm) .... **64. N. ramispina**
b. Pitcher spur simple; lid glands few, large (0.4–0.5 mm) .... **28. N. gracillima**
10a. Stem sharply 3-angled; peristome scarcely toothed within; lid without hairs .. .. **67. N. sanguinea**
b. Stem perceptibly 3-angled; peristome teeth large near lid; lid with hairs .... **41. N. macfarlanei**

KEY TO THE JAVAN SPECIES

1a. Lower leaves with fimbriate margin; lid with evenly spread, small (0.1–0.2 mm) glands ..... **49. N. mirabilis**
b. Lower leaves without fimbriate margin; lid with large glands (0.2–0.4 mm) most numerous near midline ..... **29. N. gymnamphora**

KEY TO THE MOLUCCAN AND SULAWESI ISLAND SPECIES

1a. Lower leaves with fimbriate margin ..... **49. N. mirabilis**
b. Lower leaves without fimbriate margin 2
2a. Inflorescence a panicle; at least some partial peduncles 3- or more-flowered . 3
b. Inflorescence a raceme; partial peduncles 1- or 2-flowered 5
3a. Lower pitchers urceolate; lid narrow, without glands ..... **4. N. ampullaria**
b. Lower pitchers globose-cylindrical; lid round, with glands 4
4a. Partial peduncles with a bract, lid glands small, numerous .. **76. N. tomoriana**
b. Partial peduncles without a bract, lid glands large, few ..... **16. N. danseri**
5a. Stems triangular, leaf bases decurrent to 2 angles 6
b. Stems rounded, leaf bases decurrent or not 9
6a. Peristome lacking teeth; pitcher with 2 'eye-spots' .... **65. N. reinwardtiana**
b. Peristome with teeth on inner margin; pitcher without 'eye-spots' 7

7a. Peristome of upper pitchers with large flattened plates and large teeth ..... **30. N. hamata**
b. Peristome ribs as high as wide, lacking large plates 8
8a. Lid with filiform, hair-like processes, especially near margin **74. N. tentaculata**
b. Lid without such filiform processes ..... **27. N. gracilis**
9a. Lid with no appendages on lower surface ..... **26. N. glabrata**
b. Lid with 1 or 2 appendages on lower surface 10
10a. Upper pitchers narrow tubular below, abruptly bowl-shaped above ..... **23. N. eymae**
b. Upper pitchers infundibuliform throughout, never abruptly bowl-shaped ..... **45. N. maxima**

KEY TO THE BORNEAN SPECIES

Whole plant with a short dense indumentum of reddish hairs; the leaves lanceolate, sessile with a broad base, and decurrent into 2 gradually attenuate wings, with 0–2 longitudinal veins on each side (pitchers unknown) ..... **50. N. mollis**

1a. Pitcher with a dense ring of white hairs below the peristome ..... **3. N. albomarginata**
b. Pitcher without a white ring of hairs below the peristome 2
2a. Peristome developing 2 large thorns at apex of peristome; lid reniform ..... **9. N. bicalcarata**
b. Peristome not so; lid orbicular, or narrower than long 3
3a. Lid more than 3 times as long as wide; lacking glands ..... **4. N. ampullaria**
b. Lid less than 3 times as long as wide; with glands 4
4a. Underside of lid with long bristles or thick tubercles to several mm long 5
b. Underside of lid lacking bristles, rarely with a slight indumentum 6
5a. Lid bristles fine, tapering; peristome ribs of upper pitchers scarcely developed ..... **40. N. lowii**
b. Lid bristles thick (1 mm), blunt-tipped; peristome ribs always apparent ..... **21. N. ephippiata**
6a. Peristome ribs like flattened plates, 3 or more mm tall 7
b. Peristome ribs not like flattened plates, scarcely 1.5 mm tall 10
7a. Pitcher ventricose-tubular ..... **20. N. edwardsiana**
b. Pitcher globose, narrowed near mouth 8
8a. Lid less than 6 cm wide ..... **82. N. villosa**
b. Lid more than 6 cm wide 9
9a. Leaf tip acute to acuminate ..... **42. N. macrophylla**
b. Leaf tip peltate ..... **36. N. × kinabaluensis**
10a. Peristome very reduced, only just discernible with a lens as a row of small teeth ..... **14. N. campanulata**
b. Peristome not so reduced, always visible without a lens 11
11a. Inner margin of peristome lacking teeth; with 2 'eye-spots' conspicuous on inner wall of pitcher ..... **65. N. reinwardtiana**
b. Inner margin of peristome with teeth; 'eye-spots' absent 12

12a. Leaf apex peltate, the tendril departing 1 cm or more before the apex of the blade 13
b. Leaf apex scarcely to not peltate, the tendril departing 1 cm or less before the apex of the blade 16
13a. Leaf orbicular; tendril arising in the proximal third ..... **15. N. clipeata**
b. Leaf elliptic; tendril arising in the distal third 14
14a. Lid with an appendage below, at base ..... **63. N. rajah**
b. Lid lacking appendage below 15
15a. Leaf tapering to base, decurrent or forming saddles on stem . **54. N. northiana**
b. Leaf petiolate, amplexicaul to scarcely decurrent ..... **44. N. mapuluensis**
16a. Lid with a basal appendage below 17
b. Lid without a basal appendage 22
17a. Leaf base shortly decurrent or amplexicaul; lid ovate to triangular **25. N. fusca**
b. Leaf base sheathing or long decurrent; lid round 18
18a. Upper pitcher ventricose at base, tubular above ..... **11. N. boschiana**
b. Upper pitcher infundibuliform or tubular 19
19a. Stems triangular; pitchers almost glabrous ..... **12. N. burbidgeae**
b. Stems rounded; pitchers with sparse hairs to 1 mm or more long 20
20a. Upper pitcher infundibuliform throughout, pale green or yellow .. **61. N. pilosa**
b. Upper pitcher tubular; green with red marking 21
21a. Partial peduncles 1-flowered with a bract; not growing on limestone substrate ..... **72. N. stenophylla**
b. Partial peduncles 2-flowered without a bract; always growing on limestone substrate ..... **24. N. faizaliana**
22a. Stem triangular 23
b. Stem rounded 25
23a. Lid with tentacle-like appendages above, especially near margin ..... **74. N. tentaculata**
b. Lid without tentacle-like appendages above 24
24a. Lid with few (< 50) large (> 0.5 mm) glands below ..... **27. N. gracilis**
b. Lid with many (> 200) small (< 0.3 mm) glands below ... **52. N. murudensis**
25a. Stems covered by hairs 1–2 mm long 26
b. Stems more or less glabrous 28
26a. Leaf base sheathing (concealing part of the stem where they enfold it) ..... **80. N. veitchii**
b. Leaf base amplexicaul (not concealing the stem where they enfold it) or sessile 27
27a. Leaf petiolate ..... **31. N. hirsuta**
b. Leaf sessile, broadly amplexicaul ..... **32. N. hispida**
28a. Leaf base decurrent 29
b. Leaf base sessile to amplexicaul 30
29a. Leaf petiolate ..... **11. N. boschiana**
b. Leaf tapering to base ..... **78. N. × trichocarpa**
30a. Leaf sessile, base clasping stem ..... **51. N. muluensis**
b. Leaf petiolate, base at most slightly amplexicaul 31

31a. Margin of lower leaves fimbriate ..... **49. N. mirabilis**
b. Margin of lower leaves entire 32
32a. Peristome elongated into a long flattened neck ..... **62. N. rafflesiana**
b. Peristome not elongated into a long flattened neck 33
33a. Lid slightly notched at apex, glands large (0.5 mm) few . **33. N. × hookeriana**
b. Lid rounded at apex, glands small (0.1–0.2 mm) numerous .....
..... **43. N. macrovulgaris**

KEY TO THE PHILIPPINE SPECIES

1a. Lower leaves with fimbriate margin ..... **49. N. mirabilis**
b. Lower leaves with an entire margin 2
2a. Pitchers markedly constricted at their middle 3
b. Pitchers not constricted at their middle 4
3a. Pitcher hour-glass-shaped, alabaster-white ..... **81. N. ventricosa**
b. Pitcher slightly constricted at middle, green with red streaks ... **13. N. burkei**
4a. Largest pitchers small, globose or subglobose, 4–9 cm tall 5
b. Largest pitchers large and ellipsoid to subcylindrical or narrowly cylindrical, at least 10 cm tall 6
5a. Non-climber 30 cm tall; aerial stem inconspicuous ..... **5. N. argentii**
b. Climber or scrambler, 1 m tall or more; aerial stem at least 40 cm long .....
..... **7. N. bellii**
6a. Lid with a basal appendage below 7
b. Lid lacking a basal appendage 8
7a. Leaf apex truncate ..... **79. N. truncata**
b. Leaf apex acute ..... **2. N. alata**
8a. Lower pitcher length: breadth 1.5 : 2 9
b. Lower pitcher length: breadth 3–4 : 1 11
9a. Lower surface of lid with nectar glands mostly transversely elliptic, absent from midline ..... **68. N. sibuyanensis**
b. Lower surface of lid with nectar glands either not transversely elliptic or absent from midline, or both 10
10a. Peristome ribs 1–5 mm high; lid half as long as mouth ..... **48. N. mira**
b. Peristome ribs 0.5 mm high; lid about as long as mouth ... **46. N. merrilliana**
11a. Lid retuse; nectar glands absent from midline of lower surface .....
..... **60. N. philippinensis**
b. Lid rounded; nectar glands present on midline of lower surface **59. N. petiolata**

KEY TO THE SPECIES OF NEW GUINEA AND NEIGHBOURING ISLANDS

1a. Lower pitchers urceolate; lid narrow, lacking glands ..... **4. N. ampullaria**
b. Lower pitchers tubular to ovoid; lid orbicular, always with glands 2
2a. Lid with 1 or 2 appendages on lower surface; axillary buds spike-like 3
b. Lid without appendages on lower surface; axillary buds never spike-like 4

3a. Mouth of pitcher oblique, dorsal pitcher surface vertical ..... **45. N. maxima**
b. Mouth of pitcher hooded, dorsal pitcher surface curving forwards **37. N. klossii**
4a. Leaves decurrent to at least 1/2 way down internode 5
b. Leaves distinctly petiolate, never decurrent 6
5a. Stem triangular; peristome more than 0.8 cm in width ..... **35. N. insignis**
b. Stem rounded; peristome less than 0.6 cm in width ..... **38. N. lamii**
6a. Margin of lower leaf blades fimbriate; upper pitchers not winged ..... **49. N. mirabilis**
b. Margin of lower leaves never fimbriate; upper pitchers winged or not 7
7a. Longitudinal nerves confined to outer 1/3 of leaf blade 8
b. Longitudinal nerves throughout blade 9
8a. Upper pitchers widest at mouth; partial peduncles not corymbose ..... **56. N. paniculata**
b. Upper pitchers narrowing to mouth; partial peduncles corymbose ..... **53. N. neoguineensis**
9a. Leaves with 2–4 pairs of longitudinal nerves, some arising from midrib ..... **77. N. treubiana**
b. Leaves with 5–7 pairs of longitudinal nerves, all arising from base 10
10a. Lid glands numerous, small (0.1–0.2 mm) ..... **57. N. papuana**
b. Lid glands very few, large (0.3–0.6 mm) ..... **16. N. danseri**

1. **Nepenthes adnata** Tamin & M. Hotta ex Schlauer

Nepenthes adnata Tamin & M. Hotta ex Schlauer in Schlauer & Nerz, Blumea 39 (1994) 141; Clarke, Carnivorous Plant Newsl. 26 (1997) 7, fig. front cover; Jebb & Cheek, Blumea 42 (1997) 14. — *Nepenthes adnata* Tamin & M. Hotta in M. Hotta, Diversity and Dynamics of Plant Life in Sumatra (1986) 76, f. 1, nom. nud. — Type: *Meijer 6941* (holo L), W Sumatra, Taram E of Payakumbuh, river Tjampo, 1000 m, 24 Aug. 1957.

Terrestrial climber to 3 m tall. Rosette reported as 8 cm diam., short stems unknown, climbing stems rounded, internodes 3–10 cm long, 0.2–0.25 cm diam., with a conical axillary bud c. 0.5 by 1 mm, 5 mm above the axil. *Leaves* coriaceous, sessile, subperfoliate-adnate, those of climbing stems narrowly oblanceolate, (6.8–)9–11 by 2.5–3.1 cm; apex rounded, slightly emarginate and peltate by c. 1 mm; base tapering to c. 1 cm wide, decurrent and perfoliate-adnate for 1–1.5(–2) cm on the stem. Longitudinal nerves 3 or 4 (or 5) on each side of the midrib in the outer 4/5, conspicuous above. Pennate nerves numerous, patent, straight and branching little, running to the margin, conspicuous above but not below. *Lower* and *intermediate pitchers* slightly ventricose below, tubular above, to 6.8–7.5 by 1.7–2.3 cm, with two fringed wings 1(–2) mm broad, fringed elements sometimes paired, 5–6 mm long, 2 mm apart; mouth oblique, highly concave, probably ovate, rising at the apex into a slender column; peristome rounded, 0.6–1.2 mm diam., ribs pronounced, 0.1 mm high, 0.2 mm apart, outer edge entire, inner edge, towards the column, with teeth 0.2 mm long; lid broadly ovate to suborbicular, 1.8–2.1 by 1.5–1.9 cm, apex rounded, base cordate, lower surface lacking appendages, with sparsely scattered conspicuous, round, volcano-like glands 0.1–0.2 mm wide, upper surface with up to 8 inconspicuous tentacles 1–2 mm long on each side near the margin; spur 7–9 mm long, filamentous, forked 4–6.5 mm from the apex.

Upper pitchers unknown. *Inflorescence* reported as a short, lax raceme; peduncle 3–10 cm long; partial peduncles 1-flowered, 4–8; pedicels 5–10 mm long. *Indumentum* of sessile red glands on stems, lower surface of the leaves and outer pitchers; leaf blade margin thickly red-brown hairy with fasciculate erect hairs 0.7–1 mm long; pitcher outer surface, including lid and spur sparsely puberulent with scattered simple erect hairs 0.1–0.3 mm long; indumentum of inflorescence unknown. *Colour* of outside of dried pitchers white, about 3/4 overlaid with red stripes and blotches, veined dark violet; peristome dark violet; inside of pitcher blue-green; inflorescence unknown.

Distribution — C Sumatra.

Ecology — Sandstone ridges; 700–1000 m.

Notes — 1. In its adnate-perfoliate leaves, slender glabrous stems, tentaculate lid, and diminutive, few-flowered, ebracteate raceme, seen in no other Sumatran species, *N. adnata* is clearly one of the *N. tentaculata* group, having many similarities especially with the most widespread and common of that group, *N. tentaculata* of Borneo and Sulawesi. Nonetheless, *N. adnata* has several features that distinguish it from *N. tentaculata* and most of the rest of the group. The leaves are 3- or 4-nerved with a brown hairy margin (not 1- or 2-nerved with a glabrous margin) and the pitchers have distinct peristome ribs with teeth on the inner edge near the column, conspicuous glands on the lower surface of the broadly ovate-round, cordate lid and a filiform, once-forked spur 7–9 mm long. In *N. tentaculata*, the peristome ribs are indistinct and teeth are absent, the glands are inconspicuous on a narrowly ovate to elliptic, truncate or round-based lid, and the spur is fasciculate, with up to 5 branches at the base, each themselves repeatedly branched.

2. The description above is based only on the holotype, supplemented with data from the protologue. The holotype is sterile, and lacks fully developed upper pitchers, e.g. those with a coiled tendril. Consequently our knowledge of this species is poor and fragmentary.

2. **Nepenthes alata** Blanco

Nepenthes alata Blanco, Fl. Filip., ed. 1 (1837) 805; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 258, excl. syn. *Nepenthes eustachya* Miq.; Jebb & Cheek, Blumea 42 (1997) 15, excl. syn. *Nepenthes philippinensis* Macfarl. — Type: *Blanco s. n.* (not located, PNH†?), Philippines, Luzon, Ilocos, Vintar.

Nepenthes blancoi Blume, Mus. Bot. Lugd.-Bat. 2 (1852) 10.

Nepenthes alata var. *ecristata* Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 72.

Nepenthes alata var. *biflora* Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 72.

Nepenthes copelandii Merr. ex Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 51.

Nepenthes graciliflora Elmer, Leafl. Philipp. Bot. 4 (1912) 1494.

Nepenthes brachycarpa Merr., Philipp. J. Sci., Bot. 10 (1915) 306.

Nepenthes melamphora auct. non Blume: Fern.-Vill., Fl. Filip. Nov. App. 3 (1880) 173.

Nepenthes alata auct. non Blanco: Sh. Kurata, Nepenthes of Mt Kinabalu, Sabah (1976) 32 (= *Nepenthes stenophylla* Mast.).

Nepenthes alata auct. non Blanco: Shivas, Pitcher Plants of Peninsula Malaysia & Singapore (1984) 23 (= *Nepenthes gracillima* Ridl.).

Nepenthes alata auct. non Blanco: Tamin & M. Hotta in M. Hotta, Diversity and Dynamics of Plant Life in Sumatra (1986) 78 (= *Nepenthes eustachya* Miq.).

Terrestrial climber to 4 m tall. Climbing stems terete or rounded-triangular, 4–8 mm diam., internodes 1.5–4 cm long; axillary buds conical, 1–3 by 0.5–1 mm, acute. *Leaves* coriaceous to chartaceous, petiolate or sessile, blade narrowly elliptic or oblanceolate-spathulate; those of basal rosettes up to 13 by 3 cm, leaves of climbing stems 10.5–25 by 1.6–5.2 cm, apex acute, base either cuneate or with a distinct, winged petiole 2.5–5 by 0.3–1 cm, clasping the stem for 1/2 its circumference, not auriculate or sheathed, but very shortly decurrent by 2–3 mm. Longitudinal nerves 1 or 2 on each side of the midrib, close to the margin, usually obscure. Pennate nerves numerous, ascending at 45° from the midrib or patent, but always sinuous, not reaching the marginal nerves and usually obscure. *Lower pitchers* ± ellipsoid in the basal half, gradually becoming slightly constricted towards the subcylindrical upper half, 9–17 cm long, 2.8–3.5 cm wide in the lower half, 1.9–2.7 cm wide in the upper half, with two fringed wings 0.7–4 mm broad, fringed elements 2–7 mm long, 2–5 mm apart, mouth ovate, acuminate towards the lid, oblique, at 45° to the pitcher axis, straight; peristome flattened, 2–5 mm wide, with fine ribs 0.3–0.5 mm apart, 0.1 mm high, inner edge rarely dentate, the outer margin straight, not sinuate; lid (suborbicular-)elliptic(-ovate), (1.7–)2.2–3.8(–5.5) by (1.6–)2–3(–4) cm, apex rounded to retuse, base rounded (–subcordate), lower surface usually with a fin-like basal appendage 6–8 by 2–4 mm high, rarely absent, the apical appendage a low ridge 7–10 by 1–2.5 mm high or absent; nectar glands crater-like, dense, numerous, evenly spread, small, circular, c. 0.15 mm diam.; spur simple, 6–8 mm long. *Upper pitchers* as the lower, but slightly ventricose, or ellipsoid in the lower 1/3, then abruptly constricted and cylindrical in the upper 2/3, (7.5–)12.5–19.5 cm long, (2–)2.7–4.5 cm wide in the basal part, (1.7–)2–3 cm wide in the upper cylindrical part, with two ridges ± 1 mm wide, lacking fringed elements usually, but sometimes with teeth developed, 1–2 mm long near the peristome, the uppermost wings 4–6.5 mm long, projecting over the peristome. *Male inflorescence* a raceme 28–43 by 3–5 cm; peduncle 10–13 cm long, 2–3 mm diam. at the base; partial peduncles 1-flowered, rarely 2-flowered, bracts absent, pedicels 14–19(–27) mm long; tepals elliptic, 3–4.5 by 1.5–3 mm; androphore (3.5–)4–5 mm long; anther head 1.5–3 mm wide. Fruits with valves 18–28 by 2–3 mm. Seeds filiform, tuberculate at centre, 10–14 mm by 0.3 mm. *Indumentum* generally absent from stem, rarely yellow-brown tomentose; leaves with scattered long white hairs when young, soon glabrous; pitchers densely covered in a mixture of long, mostly unbranched coppery hairs up to 0.7 mm long and minute 4- or 5-armed white stellate hairs sometimes persisting in mature pitchers. Inflorescence thickly, rarely sparsely covered in appressed coppery ± unbranched hairs up to 0.5 mm long, sometimes persisting on young fruit valves, often mixed with small white stellate hairs c. 0.2 mm diam., and long white simple hairs. *Colour* of pitchers usually greenish, sometimes flushed, never splashed red, with contrasting dark purple peristome and mauve bloom to the inner pitcher wall. Inflorescence greenish yellow.

Distribution — Philippines: Luzon to Mindanao.

Ecology — Usually in mossy forest, rarely on ultramafic soils; 400–2400 m.

Notes — 1. *Nepenthes alata* is somewhat polymorphic, and is by far the most commonly collected species in the Philippines. It is one of only two species in Luzon (the other is *N. ventricosa*). The ridge on the lower surface of the lid may be developed into a prominent, even slightly hooked appendage. This lid appendage, together with the

spike-like axillary buds, usually petiolate leaf bases and the sinuous pennate nerves suggest a relationship with the *N. maxima* (Regiae) group. Specimens from Luzon tend to have the smallest, hairiest pitchers, while those from Mindanao have more strikingly ventricose bases to their pitcher and relatively narrow necks.

2. In 1997 we restored the Sumatran *N. eustachya*, which Danser reduced to *N. alata* in his revision (1928). The two species differ in a number of characters: *N. alata* has a lanceolate-ovate leaf blade, with an acute or attenuate apex (unlike the obtuse to subpeltate tip of *N. eustachya*), usually only 2 longitudinal veins (vs. 2 or 3), with sinuous pennate nerves, and the petiole is broadly winged compared to that of *N. eustachya*; the pitchers are very similar in the two, but those of *N. eustachya* have a more angular, woody base. In contrast to *N. alata*, *N. eustachya* has a spur which is usually branched or fasciculate, the partial peduncles are somewhat shorter, and the whole plant is more or less glabrous throughout.

3. In 1999 we restored *N. philippinensis*, a species restricted to ultramafic substrates on Palawan and immediately distinguished from *N. alata* by the lack of an appendage on the lower lid, and the absence of nectar glands from the midline of the lid. *Nepenthes copelandii* may also deserve restoration, but further study is first needed. It seems distinct from *N. alata* on the basis of its 2-flowered partial peduncles, hairy stem and sparse lid glands. It appears restricted to non-ultramafic areas of Mindanao and adjoining islands.

Hybrids — 1. *Nepenthes mirabilis* × *N. alata* Sh. Kurata & Toyosh., Gard. Bull. Sing. 26 (1972) 157. — *Kurata 1111a* (Nippon Dental College n.v.), Philippines, Mindanao, Surigao del Sur, Carrascal bay, 20 m, 9 Aug. 1965.

2. *Nepenthes petiolata* × *N. alata* Sh. Kurata & Toyosh., Gard. Bull. Sing. 26 (1972) 158. — *Kurata 1113a* (Nippon Dental College n.v.), Philippines, Mindanao, Surigao del Sur, E slope Mt Legaspi, 270 m, 19 Aug. 1965.

3. Nepenthes albomarginata T. Lobb ex Lindl.

Nepenthes albomarginata T. Lobb ex Lindl., Gard. Chron. (1849) 580; Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 37, excl. syn. *Nepenthes teysmanniana*; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 262; Shivas, Pitcher Plants of Peninsula Malaysia & Singapore (1984) 25; Tamin & M. Hotta in M. Hotta, Diversity and Dynamics of Plant Life in Sumatra (1986) 80; Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) 65, f. 38; Jebb & Cheek, Blumea 42 (1997) 16; Clarke, Nepenthes of Borneo (1997) 62, f. 38 & 39. — Type: Gard. Chron. 1849, p. 580, t. 3 (lecto).

Nepenthes laevis C. Morren (non *Nepenthes laevis* Lindl. = *Nepenthes gracilis*), Belg. Hort. 2 (1852) 234.

Nepenthes tomentella Miq., Fl. Ned. Ind. 1, 1 (1858) 1075; Sumatra, Seine Pflanzenwelt (1862) 151; Beck, Wiener Ill. Gart.-Zeitung 20 (1895) 191 (as a variety of *Nepenthes albomarginata*).

Nepenthes albomarginata var. *villosa* Hook.f. in A.DC., Prodr. 17 (1873) 103.

Nepenthes albomarginata var. *typica* Beck, Wiener Ill. Gart.-Zeitung 20 (1895) 191, nom. inval.

Nepenthes albomarginata var. *rubra* Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 38. — *Nepenthes albocincta* var. *rubra* Hort. ex Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 38, nomen.

Nepenthes albocincta Hort. ex Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 38, nomen.

Terrestrial climber 2(–10) m tall. Stem cylindrical, 0.3–0.5 cm diam., sometimes slightly flexuose, internodes of climbing stems 3–9 cm long. *Leaves* coriaceous, sessile, narrowly oblanceolate to spathulate, basal rosette leaves 20–36 by 2–3.5 cm, apex

± acute, the basal 4 cm abruptly narrower, ± 1 cm wide; climbing leaves 7–17 by 1.2–2 cm, the basal part often ± abruptly narrower or gradually tapered; apex acute, base not decurrent, clasping half the stem circumference. Longitudinal nerves 1 on each side of the midrib near the margin, inconspicuous. Pennate nerves numerous, held at ± 90° from the midrib, not reaching the marginal vein, inconspicuous. *Lower pitchers* ellipsoid at base, tapering gradually into the cylindrical upper half, 8.5–15 cm long, 3.5–6 cm wide at base, tapering to 2–3 cm wide above, with two fringed wings to 6 mm broad, extending to above the level of the peristome, the fringed elements to 4 mm long; mouth ± ovate, oblique, straight; peristome ± cylindrical in section, 1 mm wide, with fine, closely spaced ribs, 0.1–0.15 mm apart (with a bright white or pale brown band immediately below the peristome composed of densely packed hairs), outer edge entire, inner edge lacking teeth; lid ovate, c. 4 by 3 cm, lower surface without appendages, nectar glands densely packed, elliptic, crater-like, ± 0.3 mm long; spur simple, 1–3(–7) mm. *Upper pitchers* as lower pitchers but cylindrical to infundibulate, 7.5–12 by 1.2–3.2 cm or flaring from 0.8(–1.8) cm at base to 3.2(–6) cm at apex; with two ridges to 1 mm broad, occasionally with short wings towards the pitcher mouth, and then usually extending to above the level of the peristome, lacking fringed elements. *Male inflorescence* 11–45 by 3 cm; peduncle 6–13 cm long, 1.5 mm diam. at base; partial peduncles 20–80, (1- or) 2- (or 3-)flowered, (0–)3(–6) mm long; bracts rarely present; pedicels 14–20 mm long; tepals 1.75–2.5 by 1.2–1.5 mm; androphore 0.7–2 mm long; anther head 0.5–1 by 1 mm. Fruits with valves 25–29 by 2–2.2 mm. Seeds fusiform 10–12 mm long. *Indumentum* a mixture of small, white, 5–8-armed stellate hairs and large patent sparsely branched red, bristle-like hairs 0.3–0.7 mm long; the stem, lower leaf, pitcher and inflorescence subglabrous to tomentellous with dark coppery hairs when young, later inconspicuous or whitish. *Colour* of pitchers green, red or green mottled with red, with a conspicuous glistening white band below the mouth.

Distribution — Sumatra, Peninsular Malaysia (absent from Singapore) and Borneo.

Ecology — Lowland kerangas forest, submontane forest or exposed ridge-tops, on limestone or sandstone; sea level to 1100 m.

Notes — 1. This species is sometimes confused with *N. gracilis*, but is immediately distinguished from this and all other species by the bright white (less usually brown), narrow band of densely packed silky hairs just below the peristome and the dense long coppery red indumentum on young stems and leaves.

2. Herbarium specimens fall largely into two forms, those with upper pitchers infundibulate, with a sub-triangular lid, and those with narrow, pencil-like, tubular pitchers with an orbicular lid. Clarke, Nepenthes of Borneo (1997), has drawn attention to the possibility that this species specialises in trapping termites.

4. Nepenthes ampullaria Jack

Nepenthes ampullaria Jack, Comp. Bot. Mag. (1835) 271; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 265; Sh. Kurata, Gard. Bull. Sing. 26 (1973) 227; Nepenthes of Mt Kinabalu, Sabah (1976) 34; Shivas, Pitcher Plants of Peninsula Malaysia & Singapore (1984) 27; Tamin & M. Hotta in M. Hotta, Diversity and Dynamics of Plant Life in Sumatra (1986) 81; Jebb, Science in New Guinea 17 (1991) 21, f. 4 & 8; Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) 67, f. 40; Jebb & Cheek, Blumea 42 (1997) 18; Clarke, Nepenthes of Borneo (1997) 65, f. 40–43. — Type: *Jack s.n.* (lecto SING), Singapore.

Nepenthes ampullaceae H. Low, Sarawak (1848) 69, nomen.
Nepenthes ampullaria var. *guttata* Moore, Gard. Chron. (1872) 360.
Nepenthes ampullaria var. *vittata major* Mast., Gard. Chron. (1872) 542; André, Ill. Hort. 24 (1877) 45.
Nepenthes ampullaria var. *vittata* André, Ill. Hort. 24 (1877) 272; Beck, Wiener Ill. Gart.-Zeitung 20 (1895) 150.
Nepenthes ampullaria var. *geelvinkiana* Becc., Malesia 3 (1886) 8.
Nepenthes ampullaria var. *longicarpa* Becc., Malesia 3 (1886) 8.
Nepenthes ampullaria var. *microsepala* Macfarl., Nova Guinea 8 (1910) 340.
Nepenthes ampullaria var. *racemosa* J.H. Adam & Wilcock, Mal. Nat. J. 44 (1991) 29.
Nepenthes ampullaria auct. non Jack: Jeann., Nouv. Caléd. Agric. (1894) 92 (= *Nepenthes vieillardii* Hook.f.).

Terrestrial climber to 15 m tall, with many terrestrial and some aerial rosettes. Stem cylindrical, 1–1.5 cm diam., internodes 1.5–7 cm long. *Leaves* sessile or with a short, poorly defined petiole, blade thickly chartaceous, lanceolate to spathulate; rosette leaves 2–5 by 0.5 cm, climbing leaves c. 25 by 6 cm; apex acute, rarely acuminate, base attenuate, clasping the stem by 1/2 its circumference. Longitudinal nerves 3–5 on each side of the midrib, in the outer 1/3 or 1/2. Pennate nerves numerous, oblique, straight, nearly reaching the margin. *Lower pitchers* obliquely urceolate, semi-circular on dorsal side, almost flat ventrally, to 10 by 9 cm, with two fringed wings to 1.5 cm broad, the fringe elements 0.5–1 cm long, 0.2 mm apart; mouth oval, almost horizontal, straight; peristome flattened, to 1.5 cm wide, and sloping steeply inwards; lid narrowly oblanceolate, to 4 by 1.5 cm, apex rounded, base cuneate, lower surface lacking appendages, nectar glands extremely sparse, usually 6–12, sometimes absent, orbicular, broadly bordered, 0.4–0.5 mm diam., central pore c. 0.1 mm diam.; spur simple or branched, up to c. 10 mm long. *Upper pitchers* generally not developed, rudimentary, broadly infundibuliform, c. 2 by 2 cm. *Male inflorescence* a panicle to 40 by 4–5 cm; peduncle 2.5 cm long, 3 mm diam. at base; partial peduncles 8–12(–50) cm long, fasciculate at apex, (1–)3–6(–10)-flowered; bracts foliose, spathulate, 12–14 by 4–5 mm, inserted 0–2 mm from base of partial peduncles; pedicels 7–8 mm long; tepals broadly elliptic, 4–5 by 3–5 mm, androphore 3–5 mm long; anther head 2 by 1.5 mm. *Indumentum* densely velvety in young parts, under leaf blades, especially margins, on young pitchers and on the inflorescence; hairs red or brown, mostly simple, c. 0.3 mm long. *Colour* of pitchers usually green, deeply flecked with maroon, rarely entirely red, sometimes almost whitish yellow, with pale pink flecks, likewise the leaves of these pitchers may be a pale yellow-pink if buried beneath leaf litter; tepals green to yellow; indumentum deep red.

Distribution — Thailand, Sumatra, Peninsular Malaysia, Borneo, New Guinea.

Ecology — Damp shady-forest, in Borneo swamp and kerangas forest, in New Guinea *Araucaria* forest, also in secondary forest, open microphyllous vegetation, or swamp grassland; sea level to 200(–2100) m.

Notes — 1. The globular pitchers of *N. ampullaria* with their reflexed linear-oblong lids are not easily confused with any other species. The habit of this species is characteristic, with numerous rosettes sunken in the leaf litter or moss of the forest floor, and tall climbing stems which lack upper pitchers, though pitchers may be borne in rosettes arising from stems up to 2 m from the ground. Recently a few isolated cases of plants bearing upper pitchers have been reported in Brunei and Peninsular Malaysia. These are small, infundibuliform pitchers no more than 2 cm high, but extremely uncommon.

2. The species is apparently absent from the Moluccas and Sulawesi, but the eastern (New Guinea) and western (Thailand to Borneo) populations are morphologically indistinguishable.

3. Hybrids between this species and *N. gracilis* (*N.* × *trichocarpa*) and *N. rafflesiana* (*N.* × *hookeriana*) are widespread though scarce, and are treated in this account.

5. Nepenthes argentii Jebb & Cheek

Nepenthes argentii Jebb & Cheek, Blumea 42 (1997) 19, f. 1. — Type: *Argent & Reynoso 89119* (holo K; iso PNH), Philippines, Sibuyan Isl., 1400 m, 27 Aug. 1989.

Terrestrial, monopodial shrub c. 30 cm tall. Stem erect, terete, 2–4 mm wide, 22 cm apparently buried in leaf litter, 4 cm above ground, with leaves congested (4 per cm of stem), internodes obscured. *Leaves* thickly coriaceous, more or less petiolate; blade obovate-oblanceolate, 3.5–4 by 1.4–2.2 cm, apex obtuse to truncate, base cuneate-decurrent; petiole 1–1.8 cm long, sheathing, clasping the stem for about half its circumference, not auriculate or decurrent. Longitudinal nerves 1 or 2 on each side of the midrib in the marginal half, mostly inconspicuous. Pennate nerves inconspicuous. *Lower pitchers* infundibuliform-shortly cylindrical, 4–4.7 by 2.2–2.4 cm, with two fringed wings 1.5–2 mm wide, fringed elements 3 mm long, often grouped and webbed together in clusters of 2–4, elements or groups of elements 1–2 mm apart; mouth subcircular, almost flat, abruptly rising in the rear to provide a stout column 5 mm high, 2.5 mm wide, for the lid; peristome subcylindrical, c. 1 mm wide, ribs laterally flattened, highly pronounced, 0.1–2 mm high, 5 mm apart, inner surface with stout, incurved teeth, up to 1 mm long near the column, outer surface never sinuate, adnate to underside of lid, forming a short transverse wall c. 7 by 2–3 mm high, with triangular teeth below; lid suborbicular, to 1.3 by 1.8 cm, apex rounded, base cordate, lower surface lacking appendages, glands very dense, pit-like, near the centre elliptic, 0.2 by 0.3 mm, near the edge orbicular, 0.15 mm wide; spur stout, rounded 1–1.5 mm long. *Upper pitchers* apparently not formed. *Male inflorescence* unknown. Fruit (mature) unknown. Seed unknown. *Indumentum* absent from stem and upper surface of leaves, lower surface of leaf and tendril densely invested with persistent patent red hairs c. 2 mm long, simple or with a short inconspicuous branch, remainder of blade with red sessile glands only. Pitcher outer surface and lid densely invested with minute reddish stellate hairs 0.1–0.2 mm wide, with 3–5 erect arms, and with sparser appressed, twisted, sub-simple hairs 2–3 mm long bearing up to 5 or 6 short branches, giving a slightly matted appearance and felty texture. Inflorescence axis with whitish hairs c. 0.6 mm long, particularly at base and apex; tepals glabrescent; carpels densely hairy with appressed reddish hairs. *Colour* of pitchers buff mottled red, peristome dark purple, lid spotted red underneath, mostly mottled red on top. Young fruit brown. — **Fig. 1.**

Distribution — Philippines: Sibuyan, Romblon Province.

Ecology — Subalpine shrubbery with smooth wind-clipped canopy 30 cm tall on a ridge of ultramafic rock; 1400 m.

Notes — 1. *Nepenthes argentii* is unusual in that it has a long, vertical, subterranean rhizome. It seems that the stem may grow slowly upwards, keeping pace with the accumulation of organic matter on the surface which continually buries the lower portion of

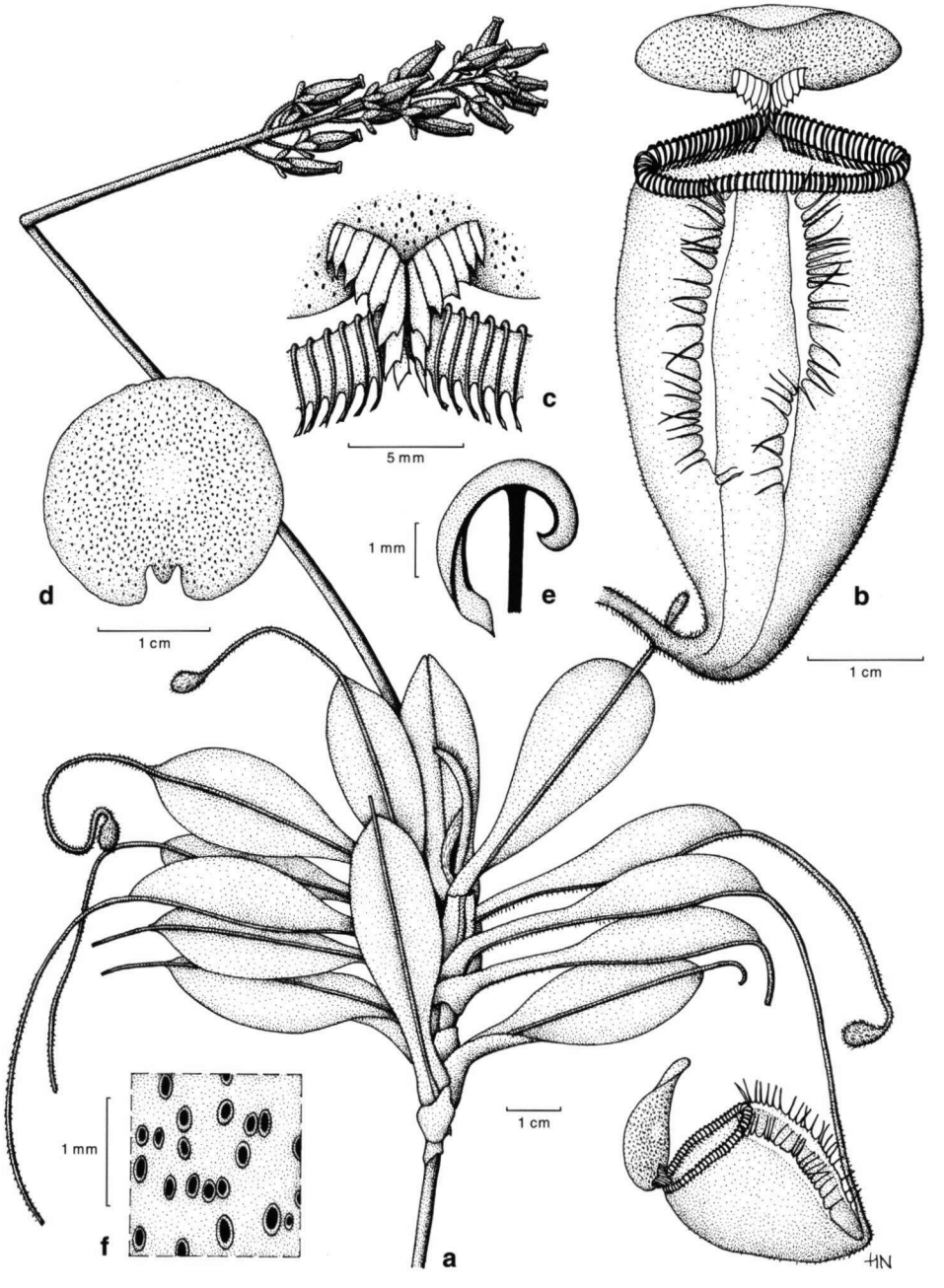

Fig. 1. *Nepenthes argentii* Jebb & Cheek. a. Habit, with female inflorescence; b. pitcher; c. detail of peristome junction with lid; d. underside of lid; e. section through peristome; f. detail of glands on lower lid surface (*Argent & Reynoso 89119*). Drawn by Holly Nixon.

the stem as with *Drosera rotundifolia* in a Sphagnum bog. More field studies are needed to verify this hypothesis. The diminutive stature, lack of upper pitchers and lack of climbing habit are also unusual in the genus and this species must contend as the smallest at maturity of all. Argent (pers. comm.) reports that the plants he collected were completely concealed below the low (c. 30 cm high), wind-clipped shrubbery and that the pitchers were buried in the substrate amongst grasses or sedges. Plants were only detected by the inflorescences emerging above the shrub canopy. Several other species of *Nepenthes* known from ultramafic derived soils (e.g. *N. rajah*, *N. burbidgeae* and *N. macrovulgaris*, all from Sabah and unrelated) are entirely restricted, as far as known, to such soils and this may be the case with *N. argentii*.

2. *Nepenthes bellii* of Surigao Province, Mindanao is the only other Philippine species with subglobose lower pitchers, with upper pitchers absent or rare and with grouped fringed elements of the pitcher wings. *Nepenthes argentii* differs in the lack of climbing habit and the subpetiolate oblanceolate leaves with truncate apices. *Nepenthes argentii* is unique in the peristome being adnate to the underside of the lid.

3. *Nepenthes argentii* commemorates one of the collectors of the only known specimen, George Argent, a botanist of the Royal Botanic Gardens, Edinburgh, well known for his fieldwork in Borneo, Philippines, and New Guinea, and for his research on the species of *Musa* and *Rhododendron*.

6. Nepenthes aristolochioides Jebb & Cheek

Nepenthes aristolochioides Jebb & Cheek, Blumea 42 (1997) 22, f. 2. — Type: *Meijer 6542* (holo L; iso BO), Sumatra, Mt Kerinci, G. Tudjuh, 2000 m, 5 Aug. 1956.

Terrestrial climber, height unknown. Stem terete 0.2–0.4 cm diam., internodes 5.5–13 cm long; axillary buds conspicuous, 0.15–0.7 cm above axil. *Leaves* coriaceous, sessile; leaves of short stems narrowly lanceolate to lanceolate-spathulate, to 15 by 2.5 cm; apex acute, rarely sub-peltate; base more or less parallel-sided, ultimately with rounded auricles; leaves of climbing stems 7.5–15 by 1–3 cm, as the short-stem leaves, but lacking auricles, the base clasping the stem for 1/3–1/2 its circumference, rarely decurrent. Longitudinal nerves indistinct in dried leaves, 2 or 3 on each side of the midrib, in outer 1/3 of blade, arising from base, and sometimes along the midrib. Pennate nerves few, indistinct, arising obliquely and curving towards apex. *Lower pitchers* unknown. *Upper pitchers* utriculate, basally infundibuliform, obovoid above; to 9 by 3.5 cm; wings lacking; mouth almost vertical, lateral, not apical, ovate, to 2 cm wide; peristome externally rounded, to 1.5 mm wide, internally flattened, to 8 mm, broadening within, ribs 0.5–0.8 mm apart, inner margin entire, with large glands between ribs; spur simple, c. 9 mm long, apex with 2–4 acute points; lid orbicular, c. 2.7 by 2.1 cm, apex rounded to emarginate, base slightly cordate, lower surface lacking appendages, nectar glands evenly scattered, thinly bordered, circular or shortly elliptic, c. 0.3 mm diam., somewhat larger and denser on midline, the rims distinctly asymmetric, being highest toward lid apex. *Inflorescence*, fruit and seed unknown. *Indumentum* inconspicuous, of short, irregularly branching or simple, appressed white hairs to 0.2 mm long, in leaf axils, on midrib and on pitcher particularly around the peristome, and on the lid; lower leaf blade with sessile glands. *Colour* of pitchers green with brown-red

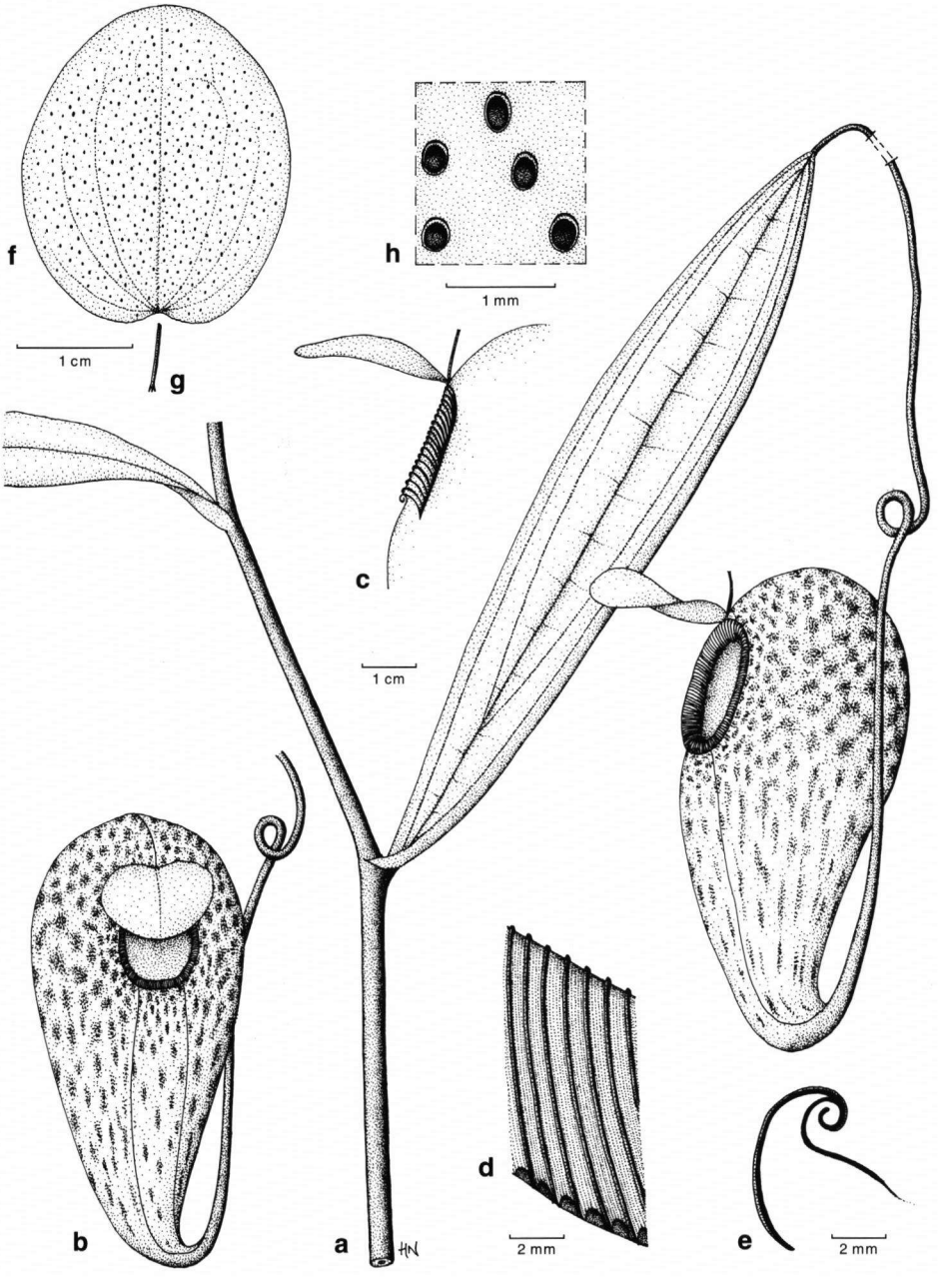

Fig. 2. *Nepenthes aristolochioides* Jebb & Cheek. a. Stem with upper pitcher; b. upper pitcher, frontal view; c. vertical section through mouth of pitcher; d. peristome, internal view; e. section through peristome; f. underside of lid; g. spur; h. detail of glands on lower lid surface (*Meijer 6542*). Drawn by Holly Nixon.

flecks, becoming denser towards mouth, conspicuous in dried specimens; peristome dark red-brown. — **Fig. 2.**

Distribution — Sumatra: Jambi (Mt Kerinci).

Ecology — Mossy forest; 2000–2200 m.

Notes — 1. Resembling *N. bongso* in leaf shape, the pitchers of *N. aristolochioides* however, are unmistakable in their bladder-like shape with a lateral, porthole-like mouth, and the unusual hooded nature of the lid nectar glands.

2. The specific epithet signifies the resemblance of the pitchers, in their shape and coloration, to the flowers of *Aristolochia*.

7. Nepenthes bellii K. Kondo

Nepenthes bellii K. Kondo, Bull. Torr. Bot. Club 96 (1969) 653, f. 1; Jebb & Cheek, Blumea 42 (1997) 24. — Type: *Kondo 11514* (holo NCU; iso KC, Nagoya n.v.), Philippines, Mindanao, Surigao, between Hayangobon & Carrascar, 800 m, 14 April 1968.

Nepenthes globamphora Sh. Kurata & Toyosh., Gard. Bull. Sing. 26 (1972) 155, t. 1, f. 1; J. Insect. Pl. Soc. 36 (1966) 15, nomen. — Type: *Kurata & Toyoshima 1128* (holo Nippon Dental College), Philippines, Mindanao, Surigao del Sur, Mt Legaspi, 270 m, 22 Aug. 1965.

Terrestrial climber 0.3–2.5 m tall. Stems terete, or slightly angular, 3–5 mm diam., internodes 0.8–2 cm long. *Leaves* coriaceous, sessile, narrowly elliptic, 8–15 by 1–1.8 cm, apex acute, base barely attenuate, clasping the stem for 1/2–3/4 its circumference, slightly auriculate, obliquely attached, not or only slightly decurrent. Longitudinal nerves 3 on each side of the midrib, in the outer 1/3. Pennate nerves numerous, running obliquely to the margin. *Lower pitchers* ovoid-ellipsoid to subglobose, 4–9 by 3–5 cm, with two densely fringed wings, wings 6–10 mm broad, fringe elements 5 mm long, often in groups of 3, groups 0.8–1.3 mm apart; mouth suborbicular to broadly ovate, ± straight, slightly oblique; peristome subcylindrical to flattened, 5–8 mm broad, ribs 0.7 mm apart, c. 0.2 mm high, outer margin entire or slightly sinuate, revolute, inner margin finely dentate, teeth c. 1 mm long; lid ovate to broadly ovate, 2–3.5 by 1.5–3.5 cm, apex rounded, base shallowly cordate, lower surface lacking appendages, nectar glands few, only 5 or 6, sparsely scattered, pit-like, deep, unbordered, transversely elliptic or circular, 0.2–0.4 mm long; spur entire, 1–5 mm long. *Upper pitchers* reported as infundibuliform, 7.3–7.5 by 2–2.5 cm, but upper pitchers not formed in flowering specimen seen. *Male inflorescence* 10–15 by 1 cm; peduncle 6–9 cm long, 1 mm diam.; partial peduncles 1-flowered, c. 40; bracts absent; pedicels 3–4 mm long; tepals ovate, 2–2.5 by 1–1.2 mm; staminal column c. 1.5 mm long; anther head diameter unknown. Fruit valves 17–20 mm long. Seed unknown. *Indumentum* absent from stems and leaves; pitchers and inflorescence inconspicuously ferruginous-tomentose, hairs simple, 0.1 mm long, tepals minutely tomentose, staminal column glabrous. *Colour* of pitchers yellowish or reddish with diffuse purple spots; peristome yellow. — **Fig. 3.**

Distribution — Philippines: Mindanao (Surigao Province).

Ecology — Possibly on ultramafic substrate; 250–800 m.

Notes — 1. *Nepenthes bellii* is unusual in the subglobular pitchers, with very densely fringed wings, the fringed elements c. 1 mm apart (cilia trifid) on tendrils up to twice as long as the blades. Not easily confused with any other species besides *N. argentii*, where the specific differences are listed (q.v.). The lower pitchers of *N. tomoriana*, only re-

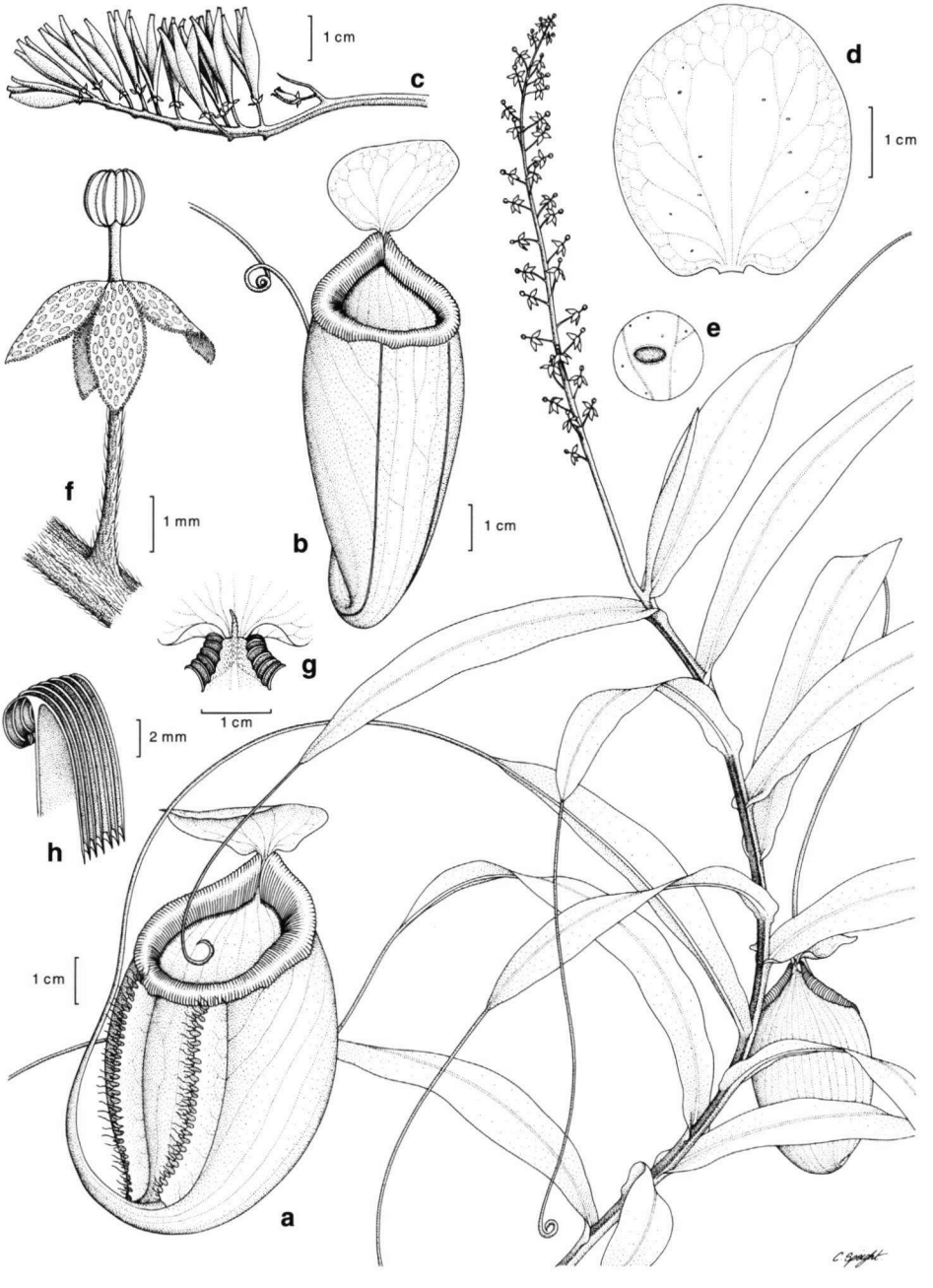

Fig. 3. *Nepenthes bellii* K. Kondo. a. Habit, with lower pitchers and male inflorescence; b. upper pitcher; c. infructescence; d. underside of lid; e. detail of glands on lower surface; f. male flower; g. spur, lower pitcher; h. section through peristome, inner view (a, c–h: *Kurata & Toyoshima 1128*; b: ex photo Wistuba). Drawn by Camilla Speight.

cently collected, also bear a remarkable resemblance to those of *N. bellii*. However, the affinities of *N. bellii* may be with the Insignes group (*N. burkei, N. insignis, N. merrilliana, N. sibuyanensis*, and *N. ventricosa*). Known only from the two type collections cited above.

2. Little ecological information is available on this species. However, the localities known appear to coincide roughly with ultramafic areas in Surigao.

8. Nepenthes benstonei C. Clarke

Nepenthes benstonei C. Clarke, Sandakania 13 (1999) 80, f. 1, 2 & 3. — Type: *Clarke s.n.* (holo KEP n.v.; iso BO n.v., K n.v., L n.v., SAN n.v., SING n.v.), Malaysia, Kelantan, Bukit Bakar, 530 m, 24 July 1998.

Terrestrial climber up to 10 m tall. Stem terete, 0.4–0.8 cm diam., internodes 5–20 cm long on climbing stems, up to 1 cm on rosettes. *Leaves* of the rosettes and short shoots broadly linear-lanceolate to slightly spathulate, sessile to sub-petiolate; lower leaf blades 25–30(–60) by 4–5(–9) cm, upper blades to 20 by 4.5 cm; apex rounded to acute, base gradually tapering throughout, to a broad amplexicaul sheath clasping the stem for 1/2–3/4 of its circumference, the margins decurrent in tapering wings 1–3 cm long; longitudinal veins 3–5 on each side, in outer 1/2 of blade; pennate veins inconspicuous, forming a network with the longitudinal veins. *Lower pitchers* distinctly hipped, ovoid in the lower half, cylindrical in the upper part; to 15 by 5 cm; with two fringed wings to 4 mm wide, fringe elements 4–6 mm long, 4–6 mm apart; mouth round to ovate, oblique; peristome cylindrical, 3–6 mm wide, ribs to 0.1 mm wide, 0.3 mm apart, outer edge entire, inner edge with short, broad teeth to 0.1 mm long, interspersed with circular, deeply sunken glands about 0.2 mm wide; lid broadly ovate, to 4 by 3.5 cm, apex rounded to obtuse, base cordate, underside with a pronounced keel near the base, to 1 cm long, this keel densely covered with larger elliptical glands to 0.3 by 0.1 mm, spur simple or bifurcate, to 12 mm long. *Upper pitchers* as the lower, but narrower, to 15 by 3 cm; the cylindrical upper part abruptly contracted below the peristome; wings reduced to prominent ridges 1 mm broad; peristome somewhat flattened; spur entire, to 5 mm long. *Inflorescences* usually 2 or 3 produced sequentially at the apex of the stem, separated by 1 or 2 very short internodes, the intervening leaves very short, broadly linear and not bearing pitchers. *Male inflorescence* to 50 by 4 cm; peduncle terete, to 9–20 cm long; partial peduncles 2-flowered, without bracts, to 10 mm long, pedicels to 9 mm; tepals ovate, 4 by 3.5 mm, apex rounded to acute; androphore 4 mm long, anther head 1.5 by 1.5 mm. *Female inflorescence* as male, but partial peduncles 1-flowered in upper half; ovary to 16 mm long. *Indumentum* mostly persistent on vegetative parts, caducous on the inflorescence; simple white hairs to 1 mm long; sparse on stem, leaf bases and on upper leaves, denser and longer (2–3 mm) on the surface of lower leaves; short, branched, reddish brown hairs to 1 mm long forming a dense fringe to lower leaf margins, sparser on upper leaves and on the pitcher surface; inflorescence with both hair types. *Colour* of the living specimens variable: leaves and stems dull green with a white-blue waxy sheen; lower pitchers varying from green through yellow to brick red throughout, with red blotches on the inner surface and underside of lid, the peristome usually yellow-white, often with thin red bands; upper

pitchers often light yellow-green throughout, sometimes with red blotches on the inner surface and underside of the lid, and with red bands on the peristome; inflorescence rhachis fuscous, tepals green, androphore maroon, anther head yellow.

Distribution — Thailand, Peninsular Malaysia.

Ecology — Locally common in secondary vegetation; 450–600 m.

Notes — 1. *Nepenthes benstonei* differs from *N. sanguinea* (q.v.) in its cylindrical (vs. angular) stem, the longer, narrower leaves which taper gradually to the base (vs. leaves broad and base parallel-sided) which is sub-petiolate, and the decurrent leaf bases (vs. abruptly amplexicaul), in the absence of bracts, the hairy (not glabrous) stems and in the lower altitudinal range.

2. The existence of this species was first suggested in Jebb & Cheek in Blumea 42 (1997) 80. It is named in honour of Ben Stone, who dedicated his life to South-East Asian botany.

9. **Nepenthes bicalcarata** Hook.f.

Nepenthes bicalcarata Hook.f. in A.DC., Prodr. 17 (1873) 97; Becc., Malesia 2 (1886) 231, t. 55; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 270; Sh. Kurata, Nepenthes of Mt Kinabalu, Sabah (1976) 37, t. 8; Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) 70, f. 41; Jebb & Cheek, Blumea 42 (1997) 24; Clarke, Nepenthes of Borneo (1997) 68, f. 43 & 44. — Type: *Low s.n.* (lecto K; iso K), Borneo, Sarawak, Lawas River.

Nepenthes dyak S. Moore, J. Bot. 18 (1880) 1, t. 206; Burb., Gard. Chron. 1 (1882) 56; Becc., Malesia 3 (1886) 1.

Terrestrial climber up to 15 m tall. Stem terete, c. 1.8 cm diam., sometimes hollow with small circular entrance holes cut by ants, internodes 0.5–8 cm long. *Leaves* thickly chartaceous, petiolate, oblong-lanceolate, 20–65 by 6–14 cm, apex acute to truncate and emarginate, occasionally peltate, base attenuate; petiole narrowly winged, 4–12 cm long, clasping the stem for 3/4 of its circumference, petiole wings sometimes decurrent to next node, usually large rimmed nectaries present on lower surface of petiole immediately adjacent to stem. Longitudinal nerves 10 or more on each side of the midrib. Pennate nerves patent, numerous, distinct almost to leaf margin. Tendril of lower pitcher swollen, to 12 mm thick, and with a thin-walled spot which is usually hollowed and inhabited by an ant colony, entrance hole facing towards pitcher surface; tendril of upper pitcher only once coiled, coil in contact with the dorsal surface of pitcher, and it is at this point that the entrance hole to the hollow tendril lies. *Lower pitchers* globose, to 13 by 6.5 cm; with 2 fringed wings to 2.3 cm broad, fringed elements to 1.2 cm long, 0.5–4 mm apart; nectaries scattered on pitcher surface, especially dorsally, on ventral wings and on tendril; mouth suborbicular, straight and almost horizontal at front, rising abruptly at rear and forming a stout vertical or overarching column; peristome with outer edge cylindrical, c. 0.4 cm wide, inner edge flat, 1–2 cm wide, ribs 0.2–0.5 mm apart, inner margin with teeth c. 0.6 mm long, with a pit between each tooth; the apical most 10–12 ribs of the column drawn out into a pair of long downward curving acute thorns 1–2.5 cm long; lid reniform, much wider than long, 3.5–6 by 4.7–6 cm, glands thinly bordered, circular, c. 0.3 mm diam., densest towards the two sides, ± absent towards centre and near junction with pitcher; spur

simple, flattened, recurved, glandular, 10–20 mm long. *Upper pitchers* ovoid-cylindrical, slightly narrowed towards mouth, to 13 by 6 cm, with 2 prominent ribs, these sometimes minutely winged near peristome; peristome and spur as in lower pitchers, lid often larger still, to 4 by 10 cm. *Male inflorescence* to 1 m long; peduncle 0.6 cm diam. at base; partial peduncles to 10 cm long, fasciculate,(1–)4–15-flowered, sometimes with nectaries near the base; pedicels to 2.5 cm long; occasionally with a bract on the lower half of the basal partial peduncles; tepals suborbicular, 5 by 4 mm; androphore 1.5–2 mm long; anther head 1 by 1.5 mm. Fruit with valves to 3 by 0.5 cm, lanceolate. Seed not seen. *Indumentum* sparse on leaves and stem, dense on pitchers and inflorescence; on the latter of two kinds, a dense short pubescence, and scattered longer hairs of 1–2 mm. *Colour* of pitchers green with orange to red flush from the indumentum, peristome green, rarely red; lid yellowish above, often deeper red or purple below, especially towards margin; tepals deep purple, almost black.

Distribution — Borneo: NW Kalimantan, Sarawak, Brunei, SW Sabah.

Ecology — Locally common in peat-swamp forest dominated by *Shorea albida*, also occasionally in heath forest on white sand soils; sea level to 950 m.

Notes — 1. *Nepenthes bicalcarata* is not easily confused with any other species of the genus: the huge peristome thorns formed from united ribs, the reniform lid which is broader than long, and the ant-hollowed tendrils and stems, are each features unique to this species. The paniculate inflorescence has fasciculate partial peduncles similar to those of the Madagascan species (*N. madagascariensis* and *N. masoalensis*).

2. The tendril of the pitcher is nearly always hollowed out and occupied by small red ants (*Camponotus schmitzii*). The ants are said to recover prey items from the pitcher fluid (see p. 11). Numerous nectar glands are found scattered on the stem, upper midribs and tendrils, and the spur is also often densely glandular. The long lid-column and the recurved thorns may comprise parts of the mechanism of prey capture, rather than the fanciful protective role suggested by Burbidge (Gard. Chron. 28/2/1880).

3. The upper pitchers of this species are often surprisingly small relative to the large leaf blades. This may be an adaptation to the somewhat shady sites that this species favours.

10. Nepenthes bongso Korth.

Nepenthes bongso Korth., Kruidkunde, in Temminck, Verh. Nat. Gesch. (1840) 19, t. 14; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 272; Sh. Kurata, Gard. Bull. Sing. 26 (1973) 227; Jebb & Cheek, Blumea 42 (1997) 25. — Type: *Korthals s.n.* (lecto K; iso B, W), Sumatra, G. Merapi, 2500 m.

Nepenthes carunculata Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 277, f. 1; Sh. Kurata, Gard. Bull. Sing. 26 (1973) 227.

Nepenthes carunculata var. *robusta* Nerz & Wistuba, Carnivorous Plant Newsl. 23 (1995) 111, f. 5.

?*Nepenthes talangensis* Nerz & Wistuba, Carnivorous Plant Newsl. 23 (1995) 101, f. 1.

Nepenthes bongso auct. non Korth.: Ridl., J. Linn. Soc., Bot. 38 (1908) 320 (= *Nepenthes gracillima* Ridl.).

Nepenthes bongso auct. non Korth.: Guill., Ann. Mus. Col. Mars. sér. 2, 9 (1911) 211 (= *Nepenthes vieillardii* Hook.f.).

Nepenthes bongso auct. non Korth.: Tamin & M. Hotta in M. Hotta, Diversity and Dynamics of Plant Life in Sumatra (1986) 83, f. 2 (p.p. = *Nepenthes bongso* Korth., *Nepenthes dubia* Danser & *Nepenthes inermis* Danser).

Terrestrial climber to 2 m tall. Stems terete to slightly angular, 0.3–0.6 cm diam., internodes 1.5–9 cm long. *Leaves* thinly coriaceous, sessile, obovate-spathulate to oblanceolate-spathulate, 6–20 by 1.5–4.5 cm, apex rounded or acute, rarely emarginate, peltate or not, base attenuate to more or less parallel-sided, clasping the stem by 1/2 its circumference, subauriculate, not decurrent. Longitudinal nerves 2–4 on each side of the midrib, scattered throughout blade. Pennate nerves scattered, irregular, arising perpendicular to midrib, or obliquely ascending. *Lower pitchers* ellipsoid or ellipsoid-cylindrical, 10–20 by 2.5–6 cm; with 2 narrow, sparsely fringed wings 1–1.5 mm broad, fringe elements 7 mm long, 1–2 mm apart; mouth oblique, ovate-acuminate; peristome flattened, c. 7 mm wide, ribs c. 1 mm apart, inner edge with teeth, outer edge entire; lid orbicular, apex rounded, base cordate, lower surface lacking appendages, nectar glands circular; spur entire, filiform. *Upper pitchers* infundibulate, narrowed at mouth, often with a broad curve near base; 8–16(–21) by 2.5–4(–6) cm; wings lacking; mouth horizontal at front, oblique and sometimes attenuate to lid; peristome rounded, to 5 mm wide; lid orbicular to subtriangular, 2.5–5 by 2.5–4 cm, apex rounded, base cordate, lower surface with or without a thickened boss near the apex, nectar glands numerous, orbicular, 0.2–0.3 mm wide, most dense towards centre, often with a few, large (0.8–1 mm) glands towards the apex; spur simple, 2–8 mm long. *Male inflorescence* 10–23 by 1.8–3.5 cm; peduncle 4.5–6.5 cm long, 1–1.5 mm diam. at base; partial peduncles 1- or 2-flowered; bract filiform c. 10 mm long; pedicels 4–15 mm long; tepals elliptic, 2–4 by 1–2 mm; androphore 2–4 mm long; anther head c. 1 mm diam. Fruit and seed unknown. *Indumentum* absent from stem and leaves, sparsely puberulent on pitcher, inflorescence puberulent from base of rhachis to lower surface of tepals, hairs white, simple, appressed, 0.2–0.4 mm long, androphore puberulent and pitcher surface, glabrescent. *Colour* of pitchers green, peristome with red lines, and mottled red within; flowers creamy-green to red; indumentum white to rufous brown.

Distribution — Sumatra: Barat & Utara.

Ecology — Forest and forest edges; 1000–2700 m.

Notes — 1. This is one of a Sumatran group of apparently closely related species (the others are: *N. aristolochioides*, *N. diatas*, *N. densiflora*, *N. ovata*, *N. singalana*, and *N. spathulata*). The wholly infundibulate upper pitchers, which are narrowed immediately below the mouth are characteristic of this species, *N. densiflora* and *N. ovata*. *Nepenthes ovata* is distinguished by the appendage on the underside of its lid towards the base, while *N. densiflora* has more gradually attenuate and narrower leaves (not obovate-spathulate) with an acute or acuminate apex (not sub-peltate), and the abrupt (not gradual) origin of the pitcher from the end of the tendril.

2. Danser in Bull. Jard. Bot. Buitenzorg III, 9 (1928) 279 distinguished *N. carunculata* from *N. bongso* by the presence of an apical appendage on the lid, and the 2-flowered partial peduncles. Furthermore, the type specimen of *N. carunculata* at Bogor is a mixed collection, the second sheet bearing a specimen of *N. pectinata*, which can be identified by its larger laminas with more numerous, and evenly spaced longitudinal veins. Recent collections combine one or other of these distinguishing characters with those of *N. bongso* (e.g. *De Vogel 2826* has a lid appendage and 1-flowered partial peduncles). Each mountain peak in C Sumatra appears to support a slight variant of *N. bongso*, and we have adopted a rather broad definition of the species. Specimens

from Mt Talang have been distinguished as *N. talangensis,* which may well merit recognition on the basis of photographs we have seen. However, we have not yet viewed the type specimens and for the meantime are leaving it as a synonym of *N. bongso.*

11. Nepenthes boschiana Korth.

Nepenthes boschiana Korth., Kruidkunde, in Temminck, Verh. Nat. Gesch. (1840) 25, t. 2, 4: 39–54; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 275; Jebb & Cheek, Blumea 42 (1997) 27; Clarke, Nepenthes of Borneo (1997) 71, f. 45 & 46. — Type: *Korthals s.n.* (lecto L; iso B, K, L, W), Borneo, S Kalimantan, G. Sakoembang, 950 m, 1836.

Nepenthes borneensis J.H. Adam & Wilcock, Gard. Bull. Sing. 42 (1990) 26, t. 1, f. 1; Jebb & Cheek, Blumea 42 (1997) 26; syn. nov.

Nepenthes boschiana auct. non Korth.: Hook.f. in A.DC., Prodr. 17 (1873) 98 (p.p. = *Nepenthes stenophylla* Mast.).

Nepenthes maxima auct. non Reinw. ex Nees: Becc., Malesia 1 (1878) 214; 3 (1886) 3 & 9 p.p.

Nepenthes boschiana auct. non Korth.: Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 71 (p.p. = *Nepenthes stenophylla* Mast.).

[*Nepenthes boschiana* var. *sumatrana* Miq., Fl. Ned. Ind., 1, 1 (1858) 1074 = *Nepenthes sumatrana* (Miq.) Beck.].

[*Nepenthes boschiana* var. *lowii* Hook.f. in A.DC., Prodr. 17 (1873) 98 = *Nepenthes stenophylla* Mast.].

Terrestrial shrub or climber to c. 5 m tall. Stems of short shoots terete, 0.9 cm diam., internodes c. 2 cm long; tall shoots with internodes 2–3 cm long, (0.7–)1.1 cm diam., slightly 2-winged or 2-ridged, axillary buds spike-like. *Leaves* chartaceous, petiolate, those of short stems oblong, 18–19(–28) by 10 cm, apex broadly acute, not peltate, base abruptly attenuate; petiole canaliculate, 6.5–10 by 0.5 cm, sheathing and clasping the stem for 5/6 of its circumference; leaves of tall shoots lanceolate or oblong-lanceolate, 16–26 by 3.8–6.5(–7) cm, apex acute, peltate by 1–2 mm or not peltate, base gradually attenuate; petiole 3–7.5(–10) cm long, 0.75–1(–1.7) cm wide at the base, sheathing and clasping the stem for 1/2 its circumference, then decurrent in two appressed or patent wings, each up to 2 mm wide, descending to the node below as an arc, diminishing to ridges. Longitudinal nerves 2(–4) on each side of the midrib in the outer 1/3–1/2. Pennate nerves numerous, oblique, straight, reaching the margin. Longitudinal and pennate nerves fairly conspicuous above and below in short stem leaves, inconspicuous in tall shoot leaves. *Lower pitchers* 17–22 cm long, ellipsoid in the lower half, c. 4 cm broad, contracted to 2 cm at the centre, the upper half cylindrical to slightly infundibulate, c. 3 cm broad at the mouth; with two fringed wings 3 mm wide, fringed elements 5–7 mm long, 1–5 mm apart; mouth ovate, highly concave and oblique, rising abruptly at the rear to form a column; peristome subcylindrical, 5 mm wide, ribs conspicuous, 0.2 mm high, 0.5 mm apart, the outer edge infrequently sinuate-lobed, lobes to 5 mm long, inner edge toothed near the column; lid ovate, 5.5 by 3.5 cm, apex rounded, base truncate to cordate, lower surface with a long keel, 2–3 mm high, along the midrib, but lacking a protruding appendage, nectar glands as in upper pitchers, 0.2 mm diam., sparsely scattered over the entire surface; spur dorsiventrally flattened, 6–8 by 1 mm, apex rounded. *Upper pitchers* entirely cylindrical, narrowly infundibulate, or ellipsoid in the lower 1/4–1/3 and cylindrical above, 15–30 cm tall, 4–6 cm wide, lacking fringed wings, but with two ridges c. 0.5 mm wide; mouth ovate or orbicular,

oblique, slightly to markedly concave, rising at the back to a short column, peristome subcylindrical, the outer part flattened, 9–28 mm wide, ribs conspicuous, c. 0.2 mm high, 0.5–0.75 mm apart, the outer edge deeply or shallowly undulate-sinuate, with up to 7 lobes per side, inner edge slightly toothed at the column; lid orbicular, 3.8–6.2 by 5–6.5 cm, apex rounded, base cordate, lower surface with a keel along the midrib 8–12 by 1–2 mm high, with an appendage up to 3 mm high; nectar glands circular, 0.2–0.4 mm diam., broadly bordered, either evenly scattered, moderately densely, over the surface of the lid, or, the largest glands densely concentrated in two arms diverging from the keel towards the apex, the remainder of the lid with smaller, sparsely scattered glands; spur as in lower pitcher. *Inflorescences* incompletely known, rhachis with 2-flowered partial peduncles at base, 1-flowered above. *Male inflorescence* known only from fragments, partly 1-flowered and partly 2-flowered, partial peduncles 1–2 mm; bracts absent; pedicels 7–9 mm; tepals oblong-elliptic, 4–4.5 by 1.5–2 mm, reflexed; androphore 3.5 mm; anther head 1.5 by 1.5 mm. Infructescence 91 by 7.5 cm; peduncle 51–55 cm long, 1–1.2 cm wide at the base; partial peduncles 4–10 mm long; bracts absent; pedicels 7–14 mm long. Fruit with valves 25 by 2.5 mm. Seed filiform, 24 by 0.5 mm. *Indumentum* of stems obscurely simple, branched and substellate red-brown hairs 0.2 mm long, mixed with sessile glands; midrib above, edges of petiole and wings of stems with pale brown simple and branched hairs 0.5–0.7 mm long; lower surface of leaves with sessile glands only; male inflorescence axis white-puberulent as the stem, androphore glabrous. *Colour* of dried stem and leaf blackish grey; pitchers pale or yellowish green splashed lightly to heavily with red to purple; inflorescence colour unknown.

Distribution — Borneo: S Kalimantan (Meratus Mt Range: G. Sakoembang, G. Sarempaka, G. Besar).

Ecology — Open, stunted forest on limestone hills; 780–1880 m.

Notes — 1. On the evidence of Ch. Clarke (pers. comm. and Nepenthes of Borneo (1997) 72–73) and of specimens that we have seen since our skeletal revision (Jebb & Cheek, Blumea 42 (1997)), we here unite *N. borneensis* J.H. Adam & Wilcock with *N. boschiana*, which we previously maintained as distinct species (op. cit.). Clarke reports that at the type locality of *N. borneensis* (G. Besar), he has seen in one population plants with the pitcher, peristome and lid appendage characteristics of *N. borneensis*, other plants with the characteristics of *N. boschiana*, and intermediates between both. The previously overlooked *De Vogel 1934*, from a third locality in the same mountain range, is also intermediate in several characters between *N. borneensis* and *N. boschiana*. *Nepenthes boschiana* is a polymorphic species and still poorly known: more study is needed to evaluate its variability and habitat.

2. *Nepenthes boschiana* seems closely related to *N. stenophylla* and *N. faizaliana* of Sarawak, but differs in always having arcuate stem wings (if present at all in the latter species they are straight), a less pronounced basal lid appendage (in the latter species it is 3–5 mm long), in the glabrous androphore (pubescent in the latter two species), in the sparse indumentum of white, simple hairs 0.2 mm long on the stem (in the latter the stem indumentum is dense, covering the surface of the stem, and usually brown and longer than 0.2 mm). Neither *N. stenophylla* nor *N. faizaliana* ever have a peristome as broad or as undulating as seen in the type collection of *N. boschiana*, nor a pitcher with

a ventricose basal 1/4–1/3 and a narrowly cylindrical upper part. However, it seems that these characters are just an extreme variant of *N. boschiana* and not characteristic of that species. *Nepenthes boschiana* shares with *N. faizaliana* the affinity for limestone (as Ch. Clarke first pointed out (Nepenthes of Borneo (1997) 73)), and also infructescences/inflorescences reaching over 90 cm long.

3. Danser in Bull. Jard. Bot. Buitenzorg III, 9 (1928) 275 reinstated *N. boschiana* in the sense we use it here, after the name had been applied differently by earlier authors. Miquel included within *N. boschiana* what we now accept as *N. sumatrana* Beck, whilst Beccari included *N. boschiana* within his concept of *N. maxima* Nees. Both Hooker and Macfarlane included *N. stenophylla* Mast. within *N. boschiana*.

12. **Nepenthes burbidgeae** Hook.f. ex Burb.

Nepenthes burbidgeae Hook.f. ex Burb., Gard. Chron. 1 (1882) 56; Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 70; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 276; III, 13 (1935) 467; Sh. Kurata, Nepenthes of Mt Kinabalu, Sabah (1976) 40, t. 9 & 10; Phillipps & A.L. Lamb, Nature Malaysiana 13, 4 (1988) 22 & 23; Pitcher Plants of Borneo (1996) 75, f. 43; Jebb & Cheek, Blumea 42 (1997) 27; Clarke, Nepenthes of Borneo (1997) 73, f. 47–49; J.H. Adam & Wilcock, Sarawak Mus. J. 50 ('1996', 1998) 149, f. XXIIIa. — Type: *Burbidge s.n.* (lecto K, isolecto K), Borneo, Sabah, Mt Kinabalu.

Nepenthes phyllamphora auct. non Willd.: Stapf, Trans. Linn. Soc. London, Bot. II, 4 (1894) 217.

Terrestrial climber to 10 m tall. Stem of short, non-climbing shoots with stem terete, 1.1–1.5 cm diam., internodes c. 2 cm long; climbing stems D-shaped, semi-circular, or subtriangular in cross section, 0.7–1.2 cm wide, with two wings 1–9 mm wide, internodes 7–10 cm long, the wings running the length of the internode, stopping just above the node to 9 mm wide; axillary buds prominent, rarely absent, cylindrical, slender, 2–5.5 mm long, acute, inserted c. 1 cm above the axil. *Leaves* of short stems distinctly long petiolate, oblong, 44–50 by 9–11.5 cm, apex acute, base attenuate; petiole 10–17 by 0.9 cm, canaliculate, the margins sheathing and clasping the stem for 5/6 its circumference; leaves of climbing stems elliptic-lanceolate, 13–25 by 3.8–7.5 cm, apex acute, base acute to rounded; petiole 6–11 cm long, semi-circular in cross section, the upper surface flat, 4–10 mm wide, ± winged, clasping the stem for 1/3–1/2 its diameter and decurrent into two wings. Longitudinal nerves 1 or 2 on each side of the midrib in the outer 1/4 of the blade. Pennate nerves numerous, patent. *Lower pitchers* ellipsoid or ovoid, 19–25 by 8.5–10 cm, wings 5–7 mm wide, with fringe elements 3–6 mm long, 2–3 mm apart; mouth obliquely concave; peristome broad, subcylindrical to slightly flattened, c. 20–30 mm wide, with fine ribs 0.6 mm apart, 0.1–0.2 mm high, outer surface sinuate, inner surface with teeth c. 1 mm long; lid ovate, 7–9.5 by 6.4–9 cm, apex round, base cordate, margin straight, lower surface densely uniformly glandular, excepting the non-glandular marginal 0.9 cm, glands volcano-like, 0.3 mm diam.; lower surface of lid with base keeled, bearing a rounded appendage 3–14 mm high from a ridge up to 18 mm long; spur c. 15 mm long, unbranched. *Upper pitchers* shortly infundibuliform, 7.2–11 by 5–8 cm, arising abruptly from the tendril, dilating to 1 cm and curving for 3–4 cm before expanding, slightly contracted below the peristome, lacking fringed wings but with two prominent ridges 1(–2) mm wide, these rarely, then

in the upper part only, with fimbriae 1.5 mm long, 1–2 mm apart; mouth round, horizontal, abruptly rising at the rear into a neck c. 1 cm long; peristome cylindrical, (1–) 2.5(–4) mm broad, with ribs 0.1 mm high, 0.2–0.3 mm apart, outer edge not sinuate, inner edge lacking teeth; lid ovate, 2.5–6.5 by 2.6–5.2 cm, apex rounded, base cordate, margin slightly sinuate, lower surface uniformly, densely glandular, glands circular to slightly elliptic, rimmed, 0.15–0.2 mm diam., midline keeled at base, the appendage 1.5–10 mm high from a raised ridge 4–15 mm long; spur c. 10 mm long, unbranched or shortly bifurcate. *Inflorescence* (fide Kurata 1976) 25–35 cm long, partial peduncles 2-flowered, pedicels 10–15 mm long. Fruits and seeds unknown. *Indumentum* of sessile red glands 0.1 mm diam. on stem, petiole, lower surface of leaf blade, outer pitcher and upper lid; intermixed with simple red hairs 0.5 mm long on outer pitcher, upper lid and on spur; dark brown 1- or 2-branched hairs 0.6–1 mm long line the edge of the leaf blade and the petiole wing. *Colour* of lower pitchers pale green, streaked and blotched red or purple, peristome with numerous red stripes; upper pitchers translucent white or pale yellow, speckled or blotched with red or purple. Inflorescence colour unknown.

Distribution — Borneo: Sabah (Mt Kinabalu & Mt Tambuyukon).

Ecology — Ridges in open moss forest on ultramafic soils; 1200–2250 m.

Note — *Nepenthes burbidgeae,* on account of its shortly infundibuliform, translucent, porcelain white, lightly red-flecked upper pitchers is unlikely to be confused with any other species on Mt Kinabalu. It is part of the *N. maxima* group, as evidenced by the appendage on the lower surface of the lid, and the distinctly petiolate leaves with prominent axillary buds. Although well-known to nepenthophiles through Kurata, Nepenthes of Mount Kinabalu (1976: 40), this species is represented by only a few incomplete sheets: we have found no fertile material of *N. burbidgeae* and lower pitchers are represented by only two collections.

Hybrids — A hybrid with *N. rajah* has been named: *Nepenthes* × *alisaputrana* J.H. Adam & Wilcock, Reinwardtia 11, 1 (1992) 37 (as *alisaputraiana*). — *Nepenthes burbidgeae* × *N. rajah* Phillipps & A.L. Lamb, Nature Malaysiana 13, 4 (1988) 10; Pitcher Plants of Borneo (1996) 153, f. 81. — Type: *Jumaat Adam et al. 2442–4* (holo UKMS; iso ABD n.v., BO n.v., K, L, SAN n.v., SAR n.v., Sabah National Parks Herbarium n.v., UKMS n.v.), Borneo, Sabah, Mt Kinabalu, 1900 m, 2 Feb. 1988.

Notes — 1. Specimens of this hybrid share the triangular stem, smaller lid with glandular crest, and pitcher coloration of *N. burbidgeae*, while with *N. rajah* they share the peltate leaf tip and the expanded peristome with an undulate outer edge.

2. As with other wild collected hybrids, the parentage is assumed rather than known. *Nepenthes burbidgeae* is an uncommon species, as is *N. rajah* and this hybrid is correspondingly a great deal rarer.

13. Nepenthes burkei Mast.

Nepenthes burkei Mast., Gard. Chron. (1889) 492, f. 69; 566; Sh. Kurata & Toyosh., Gard. Bull. Sing. 26 (1972) 155; Jebb & Cheek, Blumea 42 (1997) 28. — Type: *J. Veitch & Sons s.n.* (lecto K), cultivated from material collected by David Burke from Mindoro, Philippines.

Nepenthes burkei var. *prolifica* Mast., Gard. Chron. III, 8 (1890) 184.

Nepenthes burkei var. *excellens* Veitch, J. Roy. Hort. Soc. 21 (1897) 233.

Terrestrial or epiphytic climber 1–2 m tall. Stem terete, ± 4 mm diam., apparently climbing. *Leaves* subcoriaceous, sessile, those of basal rosettes unknown; leaves of short stems narrowly oblanceolate-oblong, 8.5–26 by 1.2–2.9(–3.5) cm, apex obtuse, inconspicuously peltate, base gradually attenuate, ± 1.1 cm wide at the base, clasping the stem for 1/2 its circumference, decurrent for up to 1.5 cm with wing 2–3 mm wide, not auriculate or sheathed; leaves of climbing stems shorter and more oblong, scarcely decurrent. Longitudinal nerves 4 on each side of the midrib, evenly spread, fairly conspicuous. Pennate nerves held at 90° from midrib, sinuous, scattered, inconspicuous. *Lower pitchers* unknown, not produced? *Upper pitchers* broadly cylindrical, 10–17.5 cm long, 3.7–8 cm wide in the basal half, gradually constricted to 4–4.5(–6.7) cm at the centre, flaring slightly to 4.3–6 cm wide below the peristome; wings not fringed, reduced to ridges < 1 mm wide; mouth elliptic, oblique, straight or slightly concave, peristome flattened, 11–12 mm wide, bearing coarse ribs (0.7–)1 mm apart interspersed with 10–15 striae, outer edge with 4–6 undulations each protruding ± 3 mm, inner edge with coarse teeth; lid elliptic, 3.8–6.3(–8) by 2.9–3.8(–5) cm, apex broadly acute, base rounded, lower surface lacking appendages, nectar glands transversely elliptic 0.5–0.7 mm wide, slightly raised but unbordered; spur stout, cylindrical, 7–10 mm long. *Inflorescences* unknown. Infructescence 26 cm long, peduncle 17 cm long; partial peduncles ± 55, 1-flowered, lacking bracts, 6–8 mm long. Fruit valves up to 15 mm long. Seed unknown. *Indumentum* absent from stems and leaves; pitchers subglabrous, with scattered, inconspicuous, translucent appressed simple hairs 0.5 mm long. *Colour* of pitchers dull green spotted with red-purple, interior of pitcher waxy yellow, rarely violet, overlain with glaucous bloom, peristome deep red.

Distribution — Philippines: Mindoro and Panay Islands.

Ecology — Not recorded; 1300–1600 m.

Note — *Nepenthes burkei* is closely related to *N. ventricosa* of Luzon and even more closely related to *N. sibuyanensis* of Sibuyan. *Nepenthes burkei* can be distinguished from the former by the less strongly waisted, green-blotched purple pitchers with lid as large as mouth. In *N. ventricosa* the pitchers are more narrowly waisted, glossy yellowish white, with lids much smaller than the mouth. *Nepenthes sibuyanensis* has non-waisted, massive pitchers.

14. **Nepenthes campanulata** Sh. Kurata

Nepenthes campanulata Sh. Kurata, Gard. Bull. Sing. 26 (1973) 227, t. 1 & 2; The Heredity 26, 10 (1972) 44 & 50, nomen; Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) 78, f. 44; Jebb & Cheek, Blumea 42 (1997) 29; Clarke, Nepenthes of Borneo (1997) 76, f. 44. — Type: *Kostermans 13764* (holo SING; iso A n.v., BM, BO, CANB n.v., K, KEP, L, NY n.v.), Borneo, E Kalimantan, Sankulirang, Ilas Bungaan, upriver from Sangkulirang, 300 m, 9 Sept. 1957.

Terrestrial shrublet to 30 cm tall. Stems terete, c. 0.4 cm diam., internodes c. 2 mm long. *Leaves* coriaceous, sessile, obovate, 5–9 by 1.2–2.5 cm, apex rounded, peltate by 0.1–0.4 cm, base attenuate, margin regularly undulate and sinuate. Longitudinal nerves 3 on each side of the midrib, scattered throughout lamina and arising from base of midrib. Pennate nerves obscure. *Pitchers* campanulate, i.e. ventricose near base, narrowed at middle, upper half infundibulate, c. 8 by 4 cm; wings absent, but with a pair of

ridges; mouth circular, horizontal, to 4 cm wide; peristome reduced to small but prominent teeth 0.25–0.4 mm apart, these conical, curving inwards, c. 0.2 mm long; the margin scarcely thickened between these teeth, outer edge entire; lid elliptic-oblong to ovate, 1.5–2 by 1.2–1.5 cm, junction with pitcher broad, 3–4 mm wide, lower surface lacking appendages, nectar glands volcano-like, 0.1–0.2 mm wide, dense near base and along midline, becoming sparse towards margin; spur simple, flattened, 1.5–3 mm long. *Inflorescence* unknown. Fruit and seed unknown. *Indumentum* sparse, dense below peristome and around spur, brown, < 0.1 mm long. *Colour:* "pitcher yellowish green; base inside with red brown dots. Lip inside dark green" (*Kostermans 13764*).

Distribution — Borneo: E Kalimantan (Ilas Bungaan) and Malaysian Borneo.

Ecology — On sheer limestone walls; 300 m.

Notes — 1. In other species with strongly infundibuliform pitchers such as *N. dubia*, *N. eymae*, and *N. inermis* the lid is very narrow, and before opening the pitcher is laterally flattened along its length. *Nepenthes campanulata* on the other hand has a relatively small, elliptic lid. Thus after opening, the mouth of these pitchers must expand far more than is the norm in the genus. In this respect they are similar to the pitchers of *N. reinwardtiana* which has a broad infundibuliform pitcher with a wide mouth, but a relatively small lid and a very reduced peristome. The pitchers are not clearly differentiated as either upper or lower pitchers. The pitcher tendrils do not twine, but are short and bent abruptly, as in *N. pervillei* of the Seychelles. No flowering material of this species is known.

2. This species was reported to be absent from the type locality in 1987, the whole area having been burnt over during the drought of 1982. It is possible that the species is now extinct at this location. However, it has recently been discovered at an unspecified second site in Malaysian Borneo (Chi'en Lee: website http://www.malesiana.tropicals.com.my/tropicals/campanulata.html).

15. **Nepenthes clipeata** Danser

Nepenthes clipeata Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 281, f. 2; Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) 80, f. 45; Jebb & Cheek, Blumea 42 (1997) 30; Clarke, Nepenthes of Borneo (1997) 78, f. 51. — Type: *Hallier B 2344* (lecto BO sh. 1711–04; iso BO, K), Borneo, W Kalimantan, G. Kelam, Feb. 1894.

Terrestrial scrambler or prostrate herb c. 30 cm tall. Stem terete or slightly flattened, to 1 m or more in length, 0.6–1.2 cm diam., internodes 2–5(–10) cm long. *Leaves* thickly coriaceous, petiolate, orbicular to ovate, 7–20 by 6–16 cm, apex rounded, peltate 1/2–1/3 way from apex, base obtuse to cordate; petiole stout, 5–10.5 by 0.5–0.8 cm, V-shaped in transverse section, the lower 3 cm clasping the stem for 4/5 or its complete circumference. Longitudinal nerves 3–5 on each side of the margin, spread evenly through the marginal half of the blade. Pennate nerves ± 9 pairs, at 45° from the midrib and branching within the innermost of the longitudinal vein pairs. *Lower pitchers* unknown. *Upper pitchers* 10–30 cm long, lower third globose to obovoid, leathery-woody, 8–11.5 by 6–8.5 cm, abruptly constricted above, the upper 2/3 narrowly infundibuliform, 2.8–5 cm wide at the base, chartaceous, flaring gradually to 5.2–9 cm at the mouth, ridges and wings absent except the smallest pitchers with two thin fringed wings

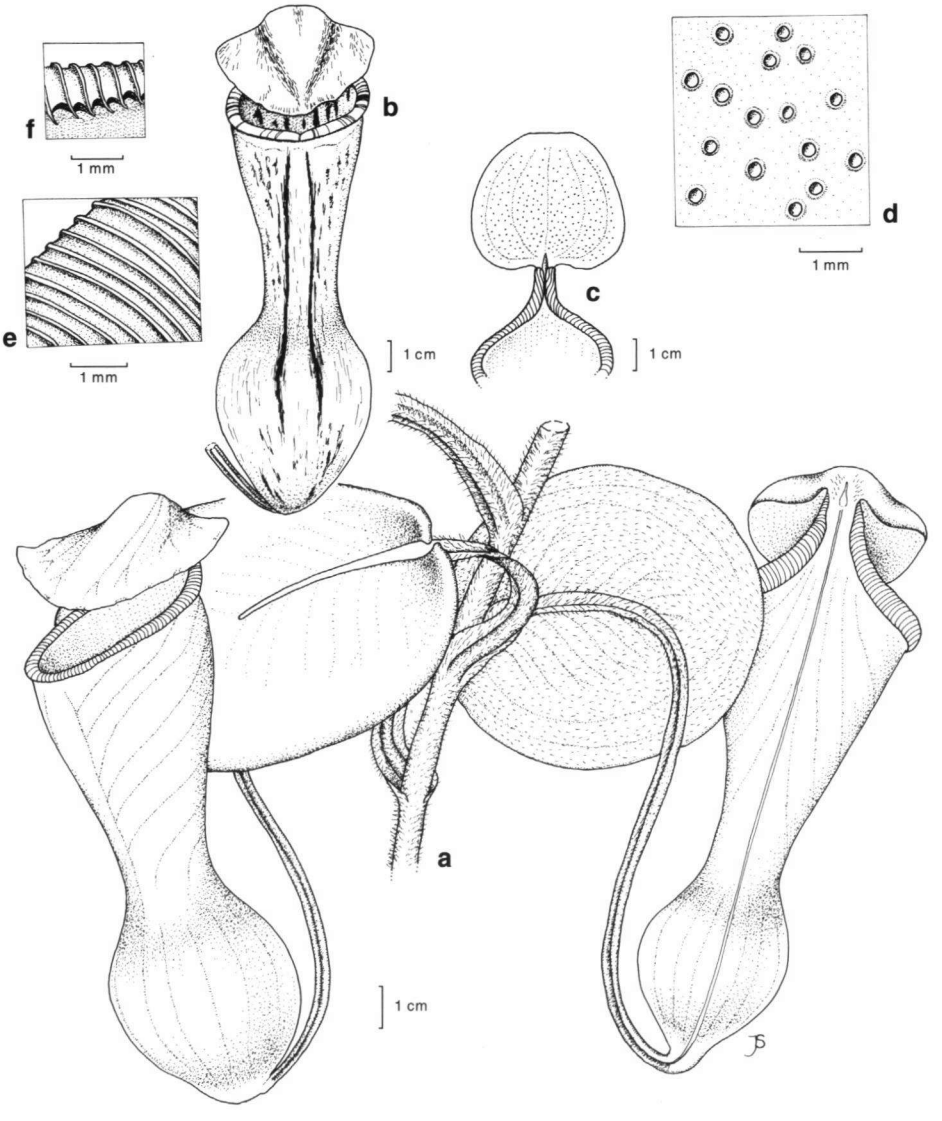

Fig. 4. *Nepenthes clipeata* Danser. a. Habit; b. intermediate/upper pitcher; c. underside of lid; d. detail of glands on lower lid surface; e. detail of peristome; f. peristome, inner view (*Hallier B 2344*). Drawn by Judi Stone.

1.5 mm wide; mouth ± circular, horizontal to slightly oblique; peristome subcylindrical, 1–12 mm wide, ribs 0.3–0.7 mm apart, 0.1–0.2 mm tall, outer edge entire or slightly sinuate, inner edge toothed; lid ovate, vaulted, being markedly concave below, 3–8 by 2–5 cm, apex rounded, base cordate, the lower surface with a laterally flattened basal appendage to 8 mm tall, nectar glands crater-like, slightly longitudinally elliptic, 0.2–0.3 mm long, fairly densely and evenly scattered; spur simple, c. 5 mm long. *Male in-*

florescence unknown. Fruit unknown. Seed unknown. *Indumentum* of coarse, patent, bronze hairs 1–2 mm long, dense on the stem, lower leaf, petiole and tendril, less dense, shorter (0.5–0.6 mm long), less conspicuous and browner on the outer pitcher. *Colour* of stems, petioles and midribs red; pitcher, including lid white, with a few red flecks; peristome white, heavily streaked with red; inflorescence colour unknown. — **Fig. 4.**

Distribution — Borneo: W Kalimantan (Mt Kelam).

Ecology — Crevices in sheer granite walls; 600–800 m.

Notes — 1. *Nepenthes clipeata* is a member of the *N. maxima* group. It is unmistakable, with its orbicular leaf blade from which the tendril arises near the centre of the lower surface. It is known in herbaria only from the type gathering made over 100 years ago, and reports from nepenthophile tourists. Kurata, Nepenthes of Borneo (1976: 23) and Adam et al., J. Trop. For. Sci. (1991) claim that the species is a limestone endemic, but this is not in agreement with either the collection notes or the type locality (granitic). The best data on its habit and habitat is to be found in Clarke, Nepenthes of Borneo (1997: 78).

2. A number of horticultural collectors are reported to have visited the only known locality over the last ten years and the species is now said to be much scarcer than formerly, and in danger of extinction. Clarke (pers. comm.) believes only 2–6 plants may survive in the wild.

16. **Nepenthes danseri** Jebb & Cheek

Nepenthes danseri Jebb & Cheek, Blumea 42 (1997) 30, f. 3; Nepenthes sp. in Jebb, Science in New Guinea 17 (1991) 47, f. 29. — Type: *Jebb 989* (holo K; iso BO, BRI, CANB, L, LAE, MAN), New Guinea, Waigeo Island, Go village, 100 m, 8 Sept. 1992.

Terrestrial shrub or climber 0.3–4 m tall. Stem terete, 0.3–0.9 cm diam., internodes of climbing stems 0.5–2.5 cm long. *Leaves* thinly coriaceous, petiolate, those of climbing stems with leaf blade broadly to narrowly elliptic; 6–11.5 by 2–4.3 cm; rosette leaf blade sometimes very reduced; apex acute to rounded, base tapering to a winged petiole; petiole 1.5–4 cm long, amplexicaul, clasping the stem by half its circumference, or rarely decurrent to 1.5 cm below the node, with the two margins becoming united on the opposite side of the stem. *Leaves* of short stems with blades narrowly lanceolate, 1.5–9.5 by 0.5–2.5 cm; petioles 0.5–2 cm, sheathing at the base. Longitudinal nerves 4–8 on each side of the midrib, mostly arising from base, but sometimes 1 or 2 arising from midrib, spread throughout width of the leaf blade, fairly conspicuous. Pennate nerves numerous, arising obliquely and curving towards the margin, less distinct than the longitudinal nerves. *Lower pitchers* ovoid in lower 2/3, cylindrical towards mouth, and broadening there, 4.5–10 by 1.8–2.7 cm, with 2 fringed wings c. 0.5 cm broad, fringe elements 0.5–1.5 mm long, c. 0.5 mm apart; mouth oblique, straight, ovate-elliptic; peristome cylindrical, 0.5–2 mm wide, ribs c. 0.3 mm apart, barely perceptible, outer edge entire, inner edge with triangular teeth c. 0.5 mm long; lid elliptic to orbicular, 2–3.5 by 2.1–3 cm; apex rounded, base truncate to cordate, lower surface lacking appendages, nectar glands 15–50, thinly bordered, 0.2–0.7 mm wide, most numerous towards midline of lid; spur 1–1.5 mm long, stout, apex rounded. *Upper pitchers* narrowly ovoid in lower half, gradually narrowing towards mouth, but widening again at

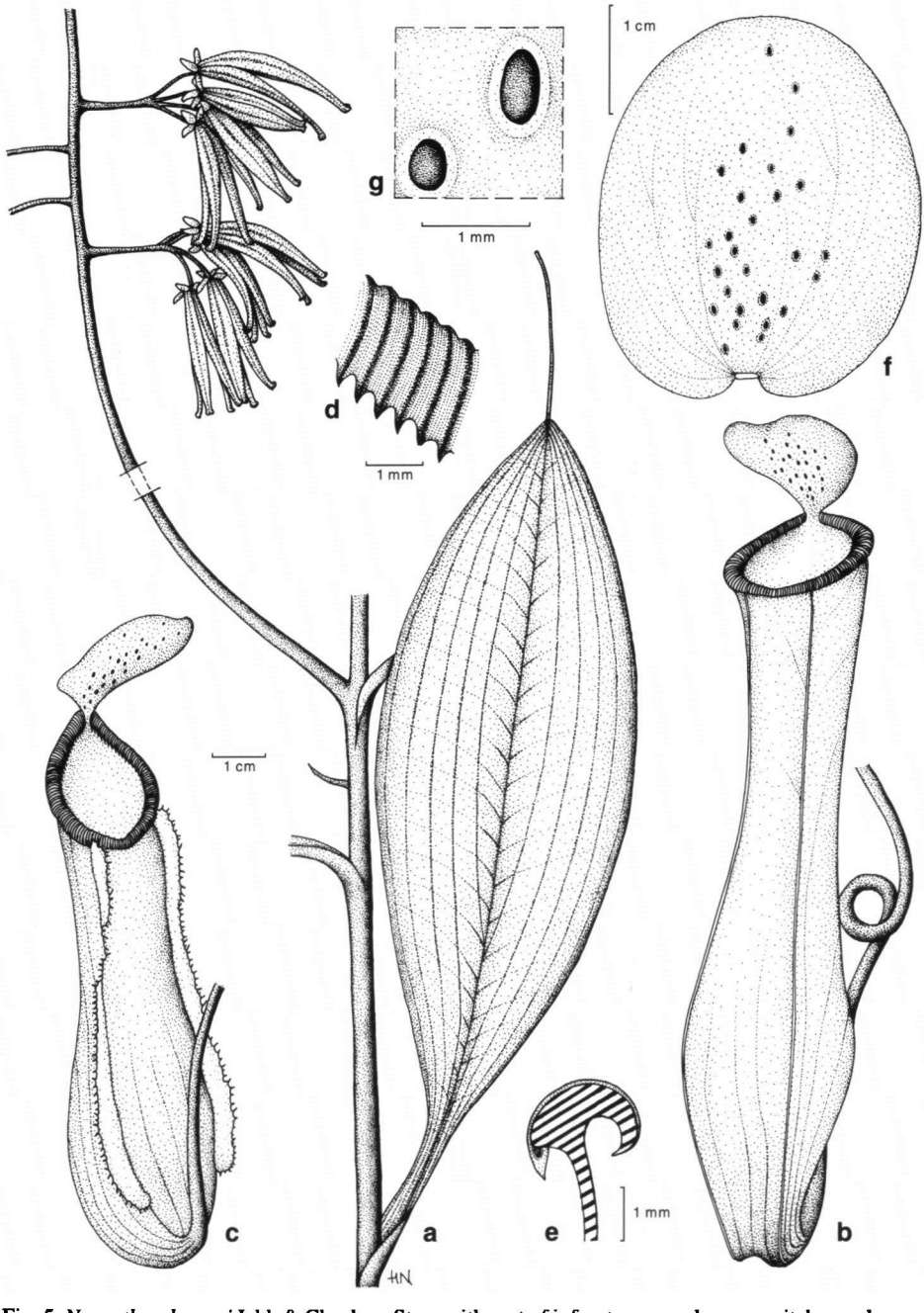

Fig. 5. *Nepenthes danseri* Jebb & Cheek. a. Stem with part of infructescence; b. upper pitcher; c. lower pitcher; d. detail of peristome, internal view; e. section through peristome; f. underside of lid; g. detail of glands on lower lid surface (*Jebb 989*). Drawn by Holly Nixon.

c. 2/3 its length, upper 1/3 narrowly infundibuliform, 9–13.5 by 2.2–3.2 cm, with 2 prominent ventral ridges, lacking fringed elements; mouth as in lower pitcher; peristome subcylindrical, 1–3 mm wide, ribs 0.3–0.5 mm apart, 0.1–0.3 mm high; lid as in lower pitcher; spur stout, c. 2 mm long. *Male inflorescence* 18 cm long; peduncle 10 cm long, 0.2 cm diam. at base; partial peduncles 1–5-flowered, 4–16 mm long; pedicels 3–7 mm long; tepals elliptic, 2 by 1.5 mm; androphore c. 1.5 mm long; anther head subglobular, 0.5 by 1 mm. Fruit with valves 14–28 by 2.5–4 mm. Seeds fusiform, 11.5 by 0.5 mm. *Indumentum* sparse and inconspicuous, of appressed, simple bronze hairs c. 0.4 mm long on new parts, lower pitchers, near spur (only upper pitchers), dense on inflorescences, and midribs of new leaves. *Colour* of stems reddish; leaves yellowish green, occasionally lower leaves maroon; midrib and tendrils red; lower pitchers green with khaki to brown marbling; upper pitchers greenish yellow to pale green; underside of lid with red streaks; tepals green, red in fruit; fruit olive yellow; indumentum golden-orange. — **Fig. 5.**

Distribution — New Guinea (Waigeo Island) and Moluccas (Halmahera).

Ecology — Most commonly in open scrub or on bare soils on ultramafic rock, also in forest; sea level to 300 m.

Notes — 1. *Nepenthes danseri* is slender, with a yellowish coloration overall. Other unusual features of this species are the very small blades of the rosette leaves, and the ability of the plants to grow in shade, though they apparently fail to produce pitchers there.

2. *Nepenthes tomoriana* from Sulawesi is the only paniculate species with which *N. danseri* is likely to be confused. *Nepenthes danseri* is distinguished from it by the lack of a bract on the partial peduncles, and the fewer, larger glands on the lid. The rosette and lower pitchers of *N. tomoriana* are ellipsoid and much more inflated, 3.5–4 cm wide (not 1.8–2.5 cm), the fringe elements 5–10 mm long (not 0.5–1.5 mm) and grouped in clusters (not evenly spaced); the peristome is 4 mm deep on the inner face (not to 2 mm) with teeth to 7 mm long (not 0.5 mm) and has prominent, ridge-like (not barely perceptible) ribs.

3. The species was named in honour of Benedictus Danser (1891–1943), whose taxonomic studies of this genus are without parallel.

17. **Nepenthes densiflora** Danser

Nepenthes densiflora Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1940) 268. — *Nepenthes bongso* × *N. pectinata* Danser, Bull. Jard. Bot. Buitenzorg III, 16 (1928) 274; Steenis, Tijd. Kon. Aardrijksk. Genootsch. 55 (1938) 750, ic. 7; Schlauer & Nerz, Blumea 39 (1994) 140; Jebb & Cheek, Blumea 42 (1997) 33. — Type: *Van Steenis 8331* (lecto BO; iso L, SING), Sumatra, Aceh, Gajo Land, Poetjoek Angasan, biv. I to biv. II, 2400 m, 28 Jan. 1937.

Terrestrial climber, to 2.5 m tall. Stems obtusely triangular to quadrangular, 0.2–0.8 cm diam., internodes 1–9 cm long. *Leaves* thinly coriaceous, sessile, obovate to obovate-lanceolate or slightly spathulate, 3–15 by 1–3.2 cm, apex acute to rounded, base attenuate, clasping the stem for 3/4 of its circumference. Longitudinal nerves 2 or 3 on each side of the midrib in outer 1/2 of blade, innermost arising from base of midrib, fairly conspicuous. Pennate nerves numerous, oblique, ± curving towards margin. *Lower*

pitchers ovoid, c. 10 by 3 cm, fringed wings 3 mm broad, fringe elements c. 5 mm long; mouth oblique, but horizontal in front part; peristome cylindrical at front, 3–5 mm broad, flattened towards lid, and to 18 mm broad, ribs 0.5–1 mm apart, less marked than in upper pitchers, outer edge strongly recurved, entire, inner edge with teeth 3 mm long, increasing to 7 mm long near the lid; lid orbicular, 3–3.5 cm diam., apex rounded, base cordate, lower surface lacking appendages, nectar glands dense over whole surface (rarely absent from the edge), orbicular (rarely transversely elliptic), shallow, pit-like, 0.15–0.4 mm diam., much larger and longitudinally elliptic along the midline, to 1–1.5 mm long; spur simple, ± flattened, to 7 mm long. *Upper pitchers* broadly to narrowly infundibuliform, somewhat contracted at mouth, 9–23 by 3–4.5 cm, lacking fringed wings; mouth horizontal at front, with peristome rising more or less to the vertical towards lid; peristome cylindrical, 2–4 mm diam. at front, to 11 mm broad near lid, ribs 1–2 mm apart, outer edge entire, inner edge with teeth 3 mm long, otherwise as lower pitcher; lid orbicular to 5.5 cm diam., lower surface lacking appendages, nectar glands dense, largest, c. 1 mm diam., near base of lid. *Male inflorescence* to 20 cm long, 1.5 cm wide; peduncle 7 cm long, 1 mm diam. at base; partial peduncles 10–20, 1-flowered, rarely 2-flowered, 3–5(–7) mm long; bract 3–4 mm long, inserted at or near base; tepals elliptic, c. 5.5 by 3 mm; androphore c. 3 mm long; anther head c. 1.75 by 3 mm. Fruit valves 15–20 by 5 mm. Seeds fusiform, c. 8 mm long. *Indumentum* dense on inflorescence, new growth and tendrils, sparse elsewhere. *Colour* of pitchers pale green, peristome streaked with red; midrib red; indumentum reddish brown.

Distribution — Sumatra: Aceh province (G. Leuser National Park).

Ecology — Montane scrub; 1700–3000 m.

Note — Among the Sumatran species, *N. densiflora* can only be confused with *N. bongso* s.l. or *N. ovata,* which share infundibuliform upper pitchers, which are constricted below the mouth. From *N. bongso* it differs by the more abrupt origin of the pitcher from the tendril (in the latter the curve of the lower pitcher is broad, and the pitcher widens gradually), the clasping, non-auriculate leaf bases, and the larger lid glands. From *N. ovata* it differs by its lack of an appendage on the lower surface of the lid. *Nepenthes diatas*, which occurs in the same area as *N. densiflora* and which is probably closely related, is distinguished by its ventricose-tubular pitcher, and stiff, almost woody peristome.

18. Nepenthes diatas Jebb & Cheek

Nepenthes diatas Jebb & Cheek, Blumea 42 (1997) 33, f. 4. — Type: *De Wilde & De Wilde-Duyfjes 14927* (holo L; iso K), Sumatra, Aceh Province, G. Bandahara, 10 km NE of Seldok, 25 km N of Kutacane.

Terrestrial subscandent shrub to 2.5 m tall. Stem base woody; stem quadrangular, angles being most marked below the nodes, 0.4–0.8 cm diam., internodes 1–3.5 cm long. *Leaves* thinly coriaceous, sessile, leaves of climbing stems oblanceolate, 9.5–17 by 2.5–3.5 cm, apex acute, base attenuate, subparallel-sided, to 1.6 cm wide, clasping the stem for 1/2 its circumference, occasionally auriculate. Longitudinal nerves 3 or 4 on each side of the midrib, in outer half of blade, fairly conspicuous. Pennate nerves numerous, oblique and parallel, inconspicuous. *Lower pitchers* not known. *Upper pitch-*

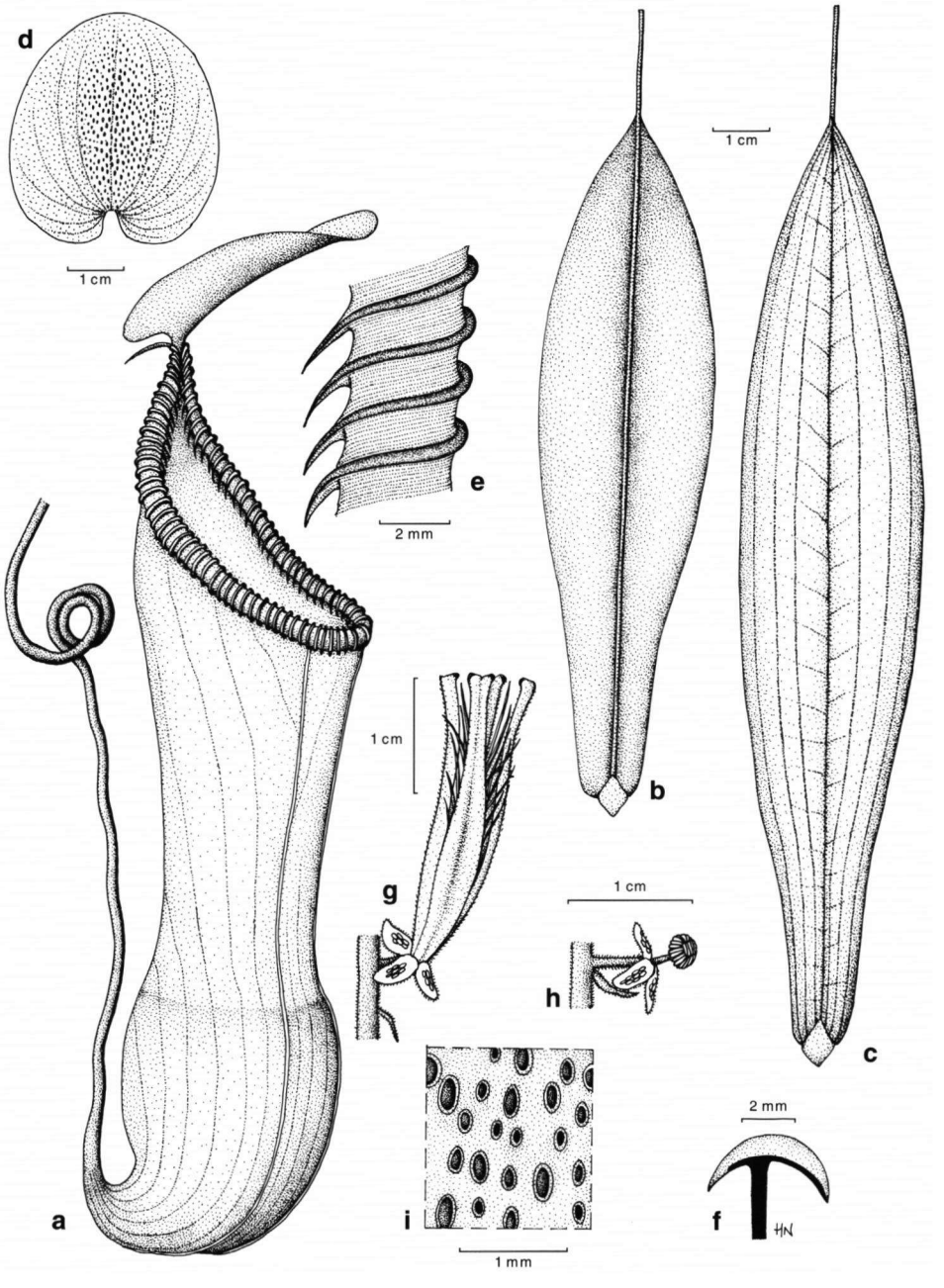

Fig. 6. *Nepenthes diatas* Jebb & Cheek. a. Upper pitcher; b. lower leaf surface; c. upper leaf surface; d. underside of lid; e. detail of peristome, internal view; f. section through peristome; g. fruit; h. male flower with bract; i. detail of glands on lower lid surface (a–g, i: *De Wilde & De Wilde-Duyfjes 13172*; h: *De Wilde & De Wilde-Duyfjes 15285*). Drawn by Holly Nixon.

ers ventricose in lower 1/3, cylindrical to slightly infundibuliform in upper 2/3, and gradually broadening towards mouth, 14–22 by 3–4.5 cm; with prominent ridges, and rarely with very short fringed wings immediately below peristome to 1 cm broad including fringed elements; mouth oblique and slightly concave; peristome woody, 5–15 mm wide, rounded at front, flattened towards lid, ribs 1–2.5 mm apart, to 1.5 mm high, outer edge entire and extending further than inner edge, inner edge toothed, teeth to 2.5 mm long; lid orbicular, 3.2–6.5 cm diam., apex rounded to truncate, base cordate, lower surface lacking appendages, thickened on midline, nectar glands circular, 0.15 mm diam., very numerous, on midline larger, elliptic, to 0.6 mm long; spur simple to 12 mm long. *Male inflorescence* 26–38 cm long, flowers clustered and dense in topmost 1/3–1/4; partial peduncles 1-flowered, rarely 2-flowered, 5–10 mm long; bract c. 6 mm long, flattened, inserted at the base of the partial peduncle, or even somewhat below on the rhachis; tepals ovate, 4–6 by 2–3 mm; androphore 2–4 mm long; anther head 2 by 2.5 mm. Fruit valves 27–32 by 3–4 mm. Seeds unknown. *Indumentum* of erect reddish brown hairs c. 0.5 mm long, more or less dense throughout, absent from upper leaf blade, soon glabrescent, but persistent on tendril and in leaf axils, and dense on inflorescence, including staminal column and valve. *Colour* of pitchers reddish brown; flowers brownish or purple-brown, or tepals rusty, purple inside; anthers pale yellow; fruits rusty brown. — **Fig. 6.**

Distribution — N Sumatra.

Ecology — Montane scrub and mossy forest; 2400–2600 m.

Notes — 1. *Nepenthes diatas* is part of the Sumatran *N. singalana* group. In its ventricose-tubular upper pitchers and attenuate, subparallel-sided leaf bases it resembles *N. singalana* and *N. spathulata*, but differs from both in the woody, rather than papery, peristome. It is probably derived from *N. singalana*, representing a far more robust version of that species.

2. Diatas is a Bahasa Indonesian word for 'on top': the species is found both on top of mountains, and in Aceh, the most northerly, or 'topmost' region of Indonesia.

3. Collections of lower and rosette pitchers are needed to complete our knowledge of *N. diatas*.

19. Nepenthes dubia Danser

Nepenthes dubia Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 285, f. 4; Jebb & Cheek, Blumea 42 (1997) 36. — Type: *Bünnemeijer 938* (lecto BO, iso BO), Sumatra, Mt Talamaku (Ophir), 1900 m, 29 May 1917.

?*Nepenthes tenuis* Nerz & Wistuba, Carnivorous Plant Newsl. (1995) 104, f. 2. — Type: *Meijer 6949* (holo L), Sumatra, Taram, river Tjampo, 1000 m, 24 Aug. 1957.

Nepenthes bongso auct. non Korth.: Tamin & M. Hotta in M. Hotta, Diversity and Dynamics of Plant Life in Sumatra (1986) 83, partim.

Epiphytic climber to at least 0.8 m tall. Stem terete, 3–4 mm diam., internodes of climbing stems 2.5–4 cm long. *Leaves* coriaceous, sessile, rosette and short stem leaves unknown, leaves of climbing stems narrowly oblanceolate-elliptic, 5.9–8 by 1.1–1.9 cm, apex acute, base clasping the stem for 1/2 its circumference, not decurrent or auriculate. Longitudinal nerves 2 on each side of the midrib near the margin, inconspicu-

ous. Pennate nerves numerous, held at 45° from the midrib, not reaching the longitudinal veins. *Lower pitchers* unknown. *Upper pitchers* infundibulate, 4.5–5.5 cm tall, the lower half narrowly subcylindrical, 1–1.1 cm wide, the upper half abruptly broadly infundibulate, 2.6–3 cm wide, fringed wings absent, ridges inconspicuous; mouth orbicular to broadly elliptic, horizontal, straight; peristome flattened, 3–4 mm wide, with fine raised ribs 0.25–0.5 mm apart, outer margin slightly sinuate, inner edge lacking teeth; lid very narrowly oblanceolate-elliptic, flat, 2.7–3.2 by 0.35–0.5 cm, apex rounded, base cuneate, lower surface lacking appendages, nectar glands fairly dense, orbicular, bordered, 0.15 mm diam., along the midline elliptic, c. 0.2 mm long; spur simple, recurved, 3–5 mm long. *Male inflorescence* unknown. Fruit unknown. Seed unknown. *Indumentum* lacking on stem apart from axils with short, simple white and brown hairs. Pitchers sometimes with a very few short white hairs. Blackish hairs present at the base of the lid. *Colour* of pitchers yellowish green.

Distribution — C Sumatra.

Ecology — Forest; 1000–2500 m.

Notes — 1. Prior to Danser's work in Bull. Jard. Bot. Buitenzorg III, 9 (1928), Backer had intended to name this species 'linguifer', and proposed to include it with specimens of *N. inermis*. *Nepenthes inermis* shares a similar shaped pitcher, lid and leaf blade shape. The differences are that *N. dubia* has fewer longitudinal nerves, a slightly broader and reflexed lid (5 mm vs. 3 mm) with more numerous, but much smaller glands, and bears a peristome, which *N. inermis* completely lacks. *Nepenthes dubia* was reduced to *N. bongso*, along with *N. inermis* by Tamin & Hotta in Diversity and Dynamics of Plant Life in Sumatra (1986).

2. *Nepenthes dubia* is possibly a hybrid between *N. inermis* and *N. bongso* (Danser in Bull. Jard. Bot. Buitenzorg III, 9 (1928) 286). *Nepenthes tenuis* is included here with some hesitation, the pitcher being somewhat broader in its lower half and the altitude (1000 m) being considerably lower than in the remaining collections, but in other respects it matches *N. dubia*.

20. Nepenthes edwardsiana H. Low ex Hook.f.

Nepenthes edwardsiana H. Low ex Hook.f., Trans. Linn. Soc. London, Bot. 22 (1859) 420, t. 70; Sh. Kurata, Nepenthes of Mt Kinabalu, Sabah (1976) 44; Phillipps & A.L. Lamb, Nature Malaysiana 13, 4 (1988) 21; Pitcher Plants of Borneo (1996) 82, f. 46; Jebb & Cheek, Blumea 42 (1997) 37; Clarke, Nepenthes of Borneo (1997) 79, f. 52 & 53; J.H. Adam & Wilcock, Sarawak Mus. J. 50 ('1996', 1998) 151. — Type: *Low s.n.* (K), Borneo, Sabah, Mt Kinabalu, N side, 6000–8000 ft, 1877–1878.

Nepenthes edgeworthii Rchb.f. ex Beck, Wiener Ill. Gart.-Zeitung 20 (1895) 183, in syn. — Type: *Herb. Reichenbach s.n.* (n.v.).

Nepenthes villosa auct. non Hook.f.: Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 397, partim.

[*Nepenthes edwardsiana* H. Low ex Hook.f. subsp. *macrophylla* Marabini, Mitt. Bot. Staatssamml Münch. 23 (1987) 427 = *Nepenthes macrophylla* (Marabini) Jebb & Cheek].

Terrestrial or epiphytic, climbing shrub to 15 m tall. Stem terete, 5–10 mm diam., internodes of climbing stems 20–35 cm long. *Leaves* coriaceous, petiolate; blade narrowly oblong, 15–20 by 4–6 cm, apex acute, base cuneate; petiole 6–10 cm long,

canaliculate, clasping the stem for up to 3/4 its circumference, not auriculate or decurrent. Longitudinal nerves 2 or 3 on each side of the midrib in the marginal half, conspicuous. Pennate nerves numerous, patent, reaching the margin, conspicuous. *Lower pitchers* rarely collected, as the upper pitchers, but with two fringed wings 1–7 mm wide, fringed elements 2–3 mm long, 3–5 mm apart. *Upper pitchers* papery, subcylindrical, lower 1/4–1/3 ovoid, upper part narrowly cylindrical to infundibuliform, 10–35(–50) by 2–6(–15) cm, lacking fringed wings, but with two low ridges; mouth elliptic, markedly oblique, concave, gradually rising to the vertical or overarching the mouth, forming a stout column; peristome rounded, 6–12(–25) mm broad, ribs 4–6 mm high, 3–9 mm apart, outer edge not sinuate or curved, inner edge coarsely dentate, teeth up to 10 mm long; lid orbicular, 3–8.5 cm diam., apex rounded, base cordate, lower surface lacking appendages, nectar glands, sparsely scattered, minute, pit-like, not bordered, c. 0.2 mm diam.; spur stout, entire, ± 10 mm long. *Male inflorescence* 30–40 by 3.5 cm; peduncle 15 cm long, 5 mm diam. at base; partial peduncles 1-flowered; pedicels 6–20 mm long; bracts absent; tepals elliptic, 4 by 1.5–2 mm; androphore 2–3 mm long; anther head 1 by 1 mm. Fruit valves 20 mm long. Seed fusiform, 8 mm long, central part smooth. *Indumentum* of stem, midrib, pitcher and inflorescence sparsely hairy with simple red-brown hairs 0.5–0.75 mm long, eventually glabrescent. *Colour* of pitcher yellowish green, sometimes suffused with orange; peristome darker; inner pitcher white.

Distribution — Borneo: Sabah (Mt Kinabalu and Mt Tambuyukon).

Ecology — Moss forest, on ultramafic soils; 1500–2700 m.

Notes — 1. *Nepenthes edwardsiana* is closely related and sometimes confused with *N. villosa* and *N. macrophylla*. *Nepenthes mira* of Palawan also appears to be related. See the key to the *N. villosa* group under *N. mira*. *Nepenthes edwardsiana* is a climber and the pitchers are elongated, ventricose below, tubular above, whereas *N. villosa* is a prostrate scrambler with short urceolate pitchers. An important difference between *N. edwardsiana* and *N. villosa* is in the structure of the internal peristome. In *N. edwardsiana* the flattened peristome teeth bear a narrow-mouthed gland on the abaxial surface (i.e. away from the lid), and below each peristome tooth there is a distinct, elliptic pocket. In *N. villosa* the gland has a toothed opening, and the pockets are so deepened as to form a series of rectangular partitions between the front peristome, and a second series of irregular teeth. Clarke in Nepenthes of Borneo (1997: 79), points out further differences: *N. edwardsiana* has an acute leaf apex, inconspicuous indumentum and no inflorescence bracts, whilst *N. villosa* tends to have an emarginate leaf apex, densely villose indumentum and filiform inflorescence bracts.

2. The pitchers of *N. edwardsiana* are distinct from those of the very closely related *N. macrophylla* in being more papery, narrowly subcylindrical, at least 4 times as long as broad (vs. woody, broadly cylindrical, less than 3 times as long as broad), the lower 1/3–1/4 slightly swollen, the upper part narrower and cylindrical (vs. pitcher with a shallow central constriction), the peristome teeth are larger and sparser, and the leaf blade never exceeds 20 cm long (vs. frequently reaching 35 cm).

Hybrid — *Nepenthes edwardsiana* × *N. villosa*; *Nepenthes* × *harryana* Burb., Gard. Chron. 1, 56 (1882); Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 54; Sh. Kurata, Nepenthes of Mt Kinabalu, Sabah (1976) 45, t. 12. — Type: not located.

21. Nepenthes ephippiata Danser

Nepenthes ephippiata Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 286, f. 5; 426, f. 36; Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) 85, f. 47; Jebb & Cheek, Blumea 42 (1997) 38; Clarke, Nepenthes of Borneo (1997) 83, f. 54 & 55. — Type: *Amdjah 497* (lecto BO sh. 1711–60; iso BO sh. 1711–61), Borneo, Kalimantan, Bt. Batoe Lesoeng, 28 Jan. 1899.

As *N. lowii* but differing as follows: *Leaves* of climbing stems with petiole base decurrent as two prominent, recurved ridges that unite above the node below. Longitudinal nerves entirely absent, rarely 1. Pennate nerves oblique, branching 1 or 2 times before reaching edge of leaf, conspicuous. *Upper pitchers* only very slightly constricted at midpoint; the peristome more pronounced; the lid relatively broader and larger than *N. lowii*, lower surface with numerous stout spike-like processes 2–3 by 1 mm towards the base, nectar glands volcano-like, 1 mm wide with a narrow central opening < 0.1 mm wide, these glands more numerous toward the lid margin, where the processes are absent.

Distribution — Borneo: C Kalimantan (Bukit Raya, Bukit Lesong).

Ecology — Forest, substrate unknown; 1000–1900 m.

Notes — 1. The drawing of *N. ephippiata* in Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 427, f. 36 is not accurate. In *N. ephippiata* the lid bristles are less numerous, more concentrated towards the base of the lid and are both shorter and stouter than those shown. Danser in Bull. Jard. Bot. Buitenzorg III, 9 (1928) 426 seems not to have fully appreciated how similar this species was to *N. lowii*. Both *N. ephippiata* and *N. lowii* have more or less cylindrical lower pitchers with a well-developed peristome: it is only the upper pitchers that are so bizarrely formed. The saddle-like decurrent petiole-bases, from which *N. ephippiata* derived its name, are similar to those of some *N. northiana* collections.

2. *Nepenthes ephippiata* appears to replace *N. lowii* in the central mountains of Kalimantan, the latter being abundant in parts of Sarawak, Brunei and Sabah.

22. Nepenthes eustachya Miq.

Nepenthes eustachya Miq., Fl. Ned. Ind. 1, 1 (1858) 1074, suppl. 151; Ill. Fl. l'Arch. Ind. 1 (1870) 3, pl. 3; Hook.f. in A.DC., Prodr. 17 (1873) 99; Beck, Wiener Ill. Gart.-Zeitung 20 (1895) 217; Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 51; Jebb & Cheek, Blumea 42 (1997) 38. — Type: *Teijsmann 529* (lecto BO; iso BO), Sumatra, Sibolga, on the coast, Feb. 1856.

Terrestrial climber to 5 m tall. Stem terete, 0.3–0.7 cm diam., internodes of climbing stems 1–6.5 cm long. *Leaves* chartaceous, petiolate, leaves of climbing stems obovate to oblong-lanceolate, 14–19.5 by 2.9–5 cm, apex rounded, sub-peltate, or slightly emarginate, base tapering to winged; petiole c. 5 by 0.7 cm wide, broadening at very base, and clasping stem for 1/2 its circumference, not decurrent or auriculate. Longitudinal nerves 2 or 3 (or 4) on each side of the midrib, some arising from midrib base, confined to outer 1/2–1/3 fairly conspicuous. Pennate nerves arising obliquely from the midrib at an angle of c. 30°. *Lower pitchers* not seen. *Upper pitchers* ventricose-tubular, widening abruptly from base, and somewhat woody and angular there, becoming obovoid, then narrowing and gradually enlarging towards the mouth, 11–24.5 by 2.5–4.5 cm, normally lacking wings, but rarely with fringed wings to 0.3 cm wide, the fringe ele-

ments to 0.4 cm long; mouth oblique, more or less straight, attenuate to lid; peristome rounded to slightly flattened in cross section, 0.2–0.5(–0.7) cm wide, ribs 0.3–0.4 mm apart, outer edge entire, inner with no teeth apparent; lid obovate to orbicular, rarely somewhat broader than long, base rounded to scarcely cordate, 3–6.5 by 2.5–6.7 cm, lower surface lacking an appendage or keel, nectar glands orbicular, not prominently bordered, 0.1–0.15 mm diam., scattered, densest near base; spur 2–4 mm long, usually bifid, occasionally with ancillary hair-like appendages arising from near base, rarely simple, flattened to 10 mm long. *Male inflorescence* 50 by 2.5 cm; 15 cm long, 5 mm diam. at base; partial peduncles diffuse, c. 25, 2-flowered near base of inflorescence, 1-flowered above, 4–5 mm long; bracts absent; pedicels 10–23 mm long; tepals lanceolate, 3.5–4 by 2–2.5 mm; androphore 2.5–3 mm long; anther head 1 by 1.5 mm. Fruit valves to 17 by 2.3 mm. Seeds unknown. *Indumentum* sparse, evanescent, most conspicuous on upper surface of midrib, 0.4 mm long, simple, brown and on pitchers below peristome c. 0.2 mm long, branched, dull yellow. *Colour* of pitchers green.

Distribution — Sumatra: from Lake Toba in the north to the Padang region in the south.

Ecology — Forest margins; sea level to 1600 m.

Notes — 1. Danser in Bull. Jard. Bot. Buitenzorg III, 9 (1928) 259 united *N. eustachya* with *N. alata* Blanco of the Philippines. The two species differ most conspicuously in the presence of a lid appendage in *N. alata*. Other differences are described under *N. alata* (see there).

2. Danser in Bull. Jard. Bot. Buitenzorg III, 9 (1928) 261 included Peninsular Malaysia in the range of what he treated as *N. alata* (which also included *N. eustachya*) on the basis of a single misidentified specimen of *N. gracillima* (*Ridley 16097*) from Mt Tahan (Kiew in J. Wildlife and National Parks (Malaysia) 10 (1990) 34–37).

23. Nepenthes eymae Sh. Kurata

Nepenthes eymae Sh. Kurata, J. Insect. Pl. Soc. (Japan) 35, 2 (6 Feb. 1984) 41 (as '*eymai*'); Jebb & Cheek, Blumea 42 (1997) 39. — Type: *Kurata, Atsumi & Komatsu 102a* (not located, probably Nippon Dental College, plate in Sh. Kurata, l.c. p. 44), Sulawesi, G. Lumut, 1850 m, 5 Nov. 1983.

Nepenthes infundibuliformis J.R. Turnbull & A.T. Middleton, Reinwardtia 10, 2 (10 Feb. 1984) 110. — Type: *Turnbull & Middleton 83148a* (BO n.v.), Sulawesi, G. Lumut Kecil, 121°41' E, 1°03' S, 1500 m, 20 Sept. 1983.

Terrestrial climber to c. 5 m (?) tall. Stem 2-ridged, 5–8 mm diam., internodes of climbing stems 1.5–6 cm long, axillary buds spike-like, 6–10(–20) by 1.5 mm, inserted 3–5(–10) mm above the axil. *Leaves* of the climbing stems coriaceous, petiolate, blade oblong-elliptic, 8–13(–20) by 3–4.5(–7) cm, apex acute to obtuse, not peltate, base attenuate, petiole winged, 4.2–8.5 cm long, wings c. 4 mm wide, clasping the stem for 1/2 its circumference, abruptly decurrent as two low ridges to the node below. Longitudinal and pennate nerves inconspicuous. *Lower pitchers* cylindrical, slightly constricted below the mouth, 10–18 by 2–6 cm, with fringed wings in upper 2/3, 2 mm wide, fringe elements 3 mm long; mouth ovate, oblique, concave; peristome rounded in transverse section, 2–5 mm wide at front, expanded, and sinuate towards lid, then to 25 mm wide; lid subtriangular, to 4.5 by 2 cm, apex acuminate, base truncate to auriculate,

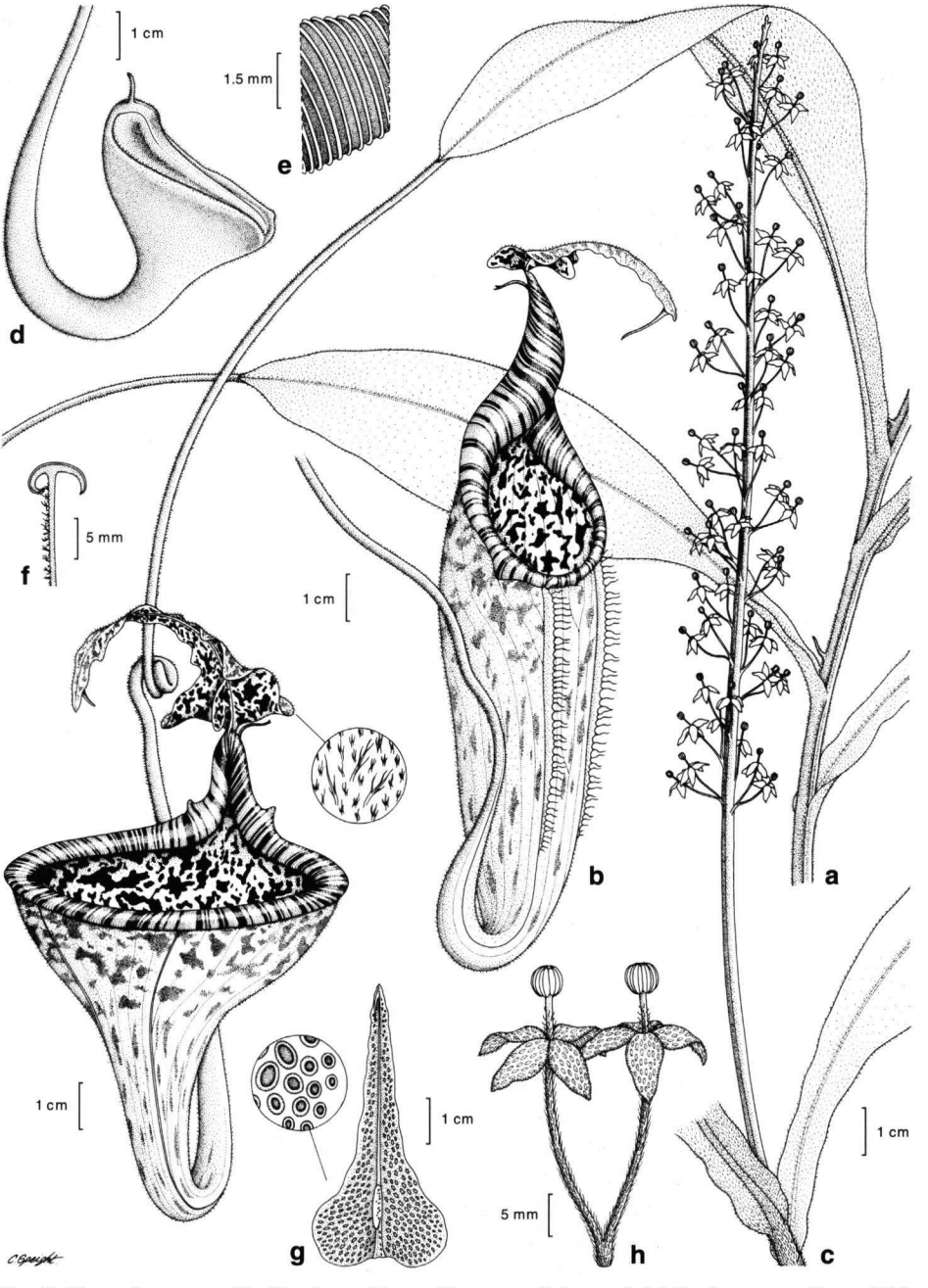

Fig. 7. *Nepenthes eymae* Sh. Kurata. a. Stem with upper pitcher and detail of upper surface of lid; b. lower pitcher; c. male inflorescence; d. expanding upper pitcher; e. detail of peristome, internal view; f. section of peristome; g. underside of lid, with detail of glands; h. partial inflorescence with male flowers (a, e–g: *Lack & Grimes 1786*; b: *Cheek s.n.*; c & h: *Eyma 3968*; d: from photo ex Bruce Sutton). Drawn by Camilla Speight.

with broad, rounded lobes, lower surface with basal appendage hooked, apical appendage filiform, midline and appendages with large, elliptic, bordered glands to 2 by 1 mm, the lid blade with numerous small glands, margin irregular, sinuous. *Upper pitchers* gradually originating from tendril, with a wide tubular curve which expands rapidly at 1/2–3/4 overall height to form a broad bowl, which is sometimes shortly contracted immediately below the peristome; to 11 by 8 cm overall, ventral ridges parallel in lower curve, divergent above, mouth horizontal, straight, rising abrubtly at the rear and forming a 1–3 cm long, vertical, acuminate column, peristome flattened above, sharply curved at outer edge, broadest on inner surface, 0.2–0.4 cm broad at front 0.8 cm towards column, ribs 0.25–0.5 mm apart, fairly conspicuous, outer edge often sinuate immediately adjacent to column, inner edge entire; lid hastate, to 8 cm long, 1 cm broad in middle, 2.5 cm broad at base, basal lobes rounded, apex obtuse to abruptly rounded, margin sinuate; lower surface with basal appendage hook-shaped, to 8 mm long, apical appendage filiform, to 12 mm long; glandulation as in lids of lower pitchers; spur to 10 mm, inserted 10 mm from lid, bifurcate at tip or entire. Unopened pitchers laterally compressed, with a prominent bulge at the dorsal end with spur upright and bifurcation closed. *Male inflorescence* 30 by 2.5 cm; peduncle 11 cm long, 3 mm diam. at base; partial peduncles 2-flowered at base, 1-flowered at apex, 30–40, c. 4 mm long; bracts absent; pedicels c. 10 mm long; tepals elliptic, c. 4 by 2 mm; androphore 4 mm long; anther head 1 by 1.5 mm. Fruit and seed unknown. *Indumentum* reddish brown, on all surfaces, including stem, underside of lid and leaf blade surfaces, of short tufted hairs to 0.05 mm long and simple hairs to 0.8 mm long, especially dense and longer on tendril, midrib, lid and spur where up to 1–2 mm long. *Colour* of leaves dark green, tendrils reddish, pitcher yellowish green or white below becoming blotched with red above, generally more darkly pigmented within, peristome with numerous narrow streaks of red and green, lid green above, with red blotches below; flowers red; indumentum maroon. — **Fig. 7.**

Distribution — Sulawesi: apparently widely distributed in the mountains of the eastern arm of the central area.

Ecology — Ridges in moss forest; 1500–2000 m.

Notes — 1. Closely related to *N. maxima* which also occurs in Sulawesi, but differing in the narrowly hastate lid (not ovate to elliptic) and in that the upper pitchers are strikingly infundibuliform – bowl-shaped in the upper half, arising abruptly from a narrowly cylindrical basal half. The remarkable pitcher appears to be a specialised trap, its relatively horizontal sides would probably make the capture of much of its prey difficult. The pitcher fluid is extremely viscous in cultivated specimens at Kew, interestingly this feature is also reported in *N. inermis*, a species with equally infundibulate upper pitchers from Sumatra (see there for a possible functional explanation).

2. Along with two other species (*N. hamata* and *N. glabrata*) the nomenclatural history of *N. eymae* involved almost simultaneous publication of two competing names. Kurata's publication of *N. eymae* preceded Turnbull & Middleton's *N. infundibuliformis* by just 4 days. Unfortunately the location of the proposed holotype (*Kurata 102a*), and series of isotypes (*103, 104 & 105*) was not stated (although the name is nonetheless valid under article 37 of the ICBN), and none of this material appears to have been deposited in a public institution. However, the holotype is illustrated in the original

publication. Nor do the types proposed by Turnbull & Middleton appear to have been deposited at Bogor as stated. The name Eyma is feminine, even though the collector was male, and the correct ending is therefore '*eymae*'.

24. Nepenthes faizaliana J.H. Adam & Wilcock

Nepenthes faizaliana J.H. Adam & Wilcock, Blumea 36 (1991) 123; Clarke, Nepenthes of Borneo (1997) 85, f. 56. — Type: *S 44163 (Lai & Jugah)* (holo SAR; iso K, L), Borneo, Sarawak, Gunung Mulu National Park, 10 Nov. 1981.

Terrestrial shrub or climber to 4 m tall. Stems terete, those of rosettes 0.3–0.4 cm diam., internodes 0.5–1.7 cm long; climbing stems 0.5–0.8 cm diam., internodes 1–5 cm long. *Leaves* coriaceous, petiolate; rosette leaves with blades oblanceolate, 8.5–11.5 by 4–4.5 cm, apex abruptly acute, base cuneate-decurrent; petiole 2.5–3.5 by 0.35 cm, canaliculate, clasping the stem by 1/2–2/3 its circumference; leaf blades of climbing stems lanceolate to oblong, 12–18 by 2.8–5 cm, apex acute-attenuate, base obtusely rounded; petiole 3.5–4.5 cm, canaliculate, clasping the stem for 1/2–2/3, rarely decurrent as two ridges to the node below. Longitudinal nerves 1 (or 2) on each side of the midrib close to the margin, moderately conspicuous above. Pennate nerves patent, inconspicuous. *Lower pitchers* subcylindrical, 9–10.5 cm long, slightly hipped: the lower half ellipsoid, 2.2 cm wide, the upper half cylindrical, 1.8 cm wide, with two fringed wings 2 mm wide, fringed elements 5 mm long, 1.5 mm apart; mouth oblique, concave, ovate, rising at the elongated apex into a column, peristome subcylindrical, 4 mm wide, with conspicuous ribs c. 0.2 mm high, 0.3–0.5 mm apart, outer edge entire, inner edge shallowly toothed near the column; lid orbicular, 2–2.1 by 1.9–2 cm, apex rounded, base cordate, lower surface with a laterally flattened, semi-circular or keel-like basal appendage up to 6–7 mm long, 1.5 mm tall, nectar glands 30–35 circular, narrowly bordered, 0.3–0.4 mm diam. scattered along the midrib; spur not seen. *Upper pitchers* narrowly infundibulate, rarely subcylindrical, 15–26 by 3.5–5.7 cm, lacking fringed wings, mouth slightly concave, column poorly defined; peristome cylindrical, 2–7 (–13) mm wide, ribs well defined 0.2–0.3 mm high, 0.5 mm apart, outer edge entire or, less usually, sinuate, with up to 3 lobes on each side, each lobe up to 0.4 cm long; lid orbicular, 3.5–4 by 4–4.2 cm, apex rounded or slightly emarginate, base deeply cordate, basal appendage semi-circular, laterally flattened, 5 by 5 mm, on a ridge 10–18 by 2–3 mm, nectar glands orbicular, slightly bordered, 0.2–0.5 mm diam. either densely covering the whole of the surface of the lower lid, or sparsely scattered apart from two arms diverging from the appendage towards the apex where densely spread, sometimes the apex with a cluster of larger elliptic or orbicular glands up to 1 mm long; spur stout, simple, 8–9 by 1.5–1.8 mm, apex rounded. *Male inflorescence* 48–60(–90) by 4–5 cm; peduncle 15–18 cm long, c. 4 mm diam. at the base; partial peduncles 1-flowered, to 20 mm long, bearing a patent filiform bract 0.5(–1.5) mm long, inserted 3–5 mm from the base; tepals patent, obovate, 3 by 2 mm; androphore 1.5 mm long; anther head 1 by 2 mm. Fruit with bract persisting, valves 24 mm long. Seed unknown. *Indumentum* of stems densely short-pubescent with dark red-brown, sometimes whitish, patent hairs 0.2–0.3 mm long, sometimes interspersed with hairs 0.5–1 mm long, extending to lower surface of the midrib, where less dense; lower surface of the leaf blade with

sessile red glands, sometimes interspersed with hairs 0.2–0.3 mm long; pitcher, including upper lid, with same indumentum, but hairs much denser; lower surface of lid glabrous, or with patent simple or branched hairs 0.2–0.3 mm long; spur black sericeous; inflorescence with same indumentum as stem extending from peduncle base to lower surface of tepals, androphore, and ovary. *Colour* of dried leaves brown below, pitchers pale green or yellowish white, splashed with red or purple, lid marbled in same colours; inflorescence dark red with red-brown tomentum, tepals dark brown, stamens yellow.

Distribution — Borneo: Sarawak (Mulu National Park).

Ecology — Scrub amongst limestone blocks; 600–1600 m.

Notes — 1. Although *N. faizaliana* was held by its authors to be closely related to *N. fusca* (their only specimen of *N. faizaliana* lacked a lid), it seems much closer to *N. stenophylla*, being distinguishable only in the inflorescences. Indeed, we formerly united *N. faizaliana* with *N. stenophylla* (Jebb & Cheek in Blumea 42 (1997)). We are grateful to Charles Clarke (pers. comm., 1997) for suggesting the reassessment that leads us to resurrect this species here. *Nepenthes faizaliana* always has 1-flowered partial peduncles with bracts (vs. bractless, 2-flowered partial peduncles in *N. stenophylla*), on inflorescences twice as long, and with male partial peduncles also twice as long as those in *N. stenophylla*. Moreover, *N. faizaliana* is only known from three limestone peaks in the Mulu National Park of N Sarawak, whereas *N. stenophylla* is widespread on sandstone (rarely ultramafic) throughout N Borneo, including the Mulu National Park. It has been suggested that several vegetative characters can be used to distinguish the two species (Clarke in Nepenthes of Borneo (1997) 86). However, after lengthy examination of the eleven herbarium sheets available of *N. faizaliana*, we have found this not to be the case, nor have we found any other characters, besides those of the inflorescence and substrate, that allow us to recognise *N. faizaliana*. This is the only case that we know of in the genus of a species that is maintained purely on inflorescence characters.

2. Apart from the inflorescence, *N. faizaliana* shows a similar degree of variation to that seen in *N. stenophylla*, particularly in peristome diameter and lobing, lid nectar gland size and distribution, in whether the leaf base is sheathing or decurrent, and to a lesser extent, in indumentum length. Generally, *N. faizaliana* has a shorter and darker indumentum than that of *N. stenophylla*, but there is overlap. *Nepenthes faizaliana* is still a poorly known species, with only incomplete female inflorescence and infructescence available. The description of lower pitchers and rosette leaves is taken from *S 30900 (Anderson)*, which appears not full grown.

25. **Nepenthes fusca** Danser

Nepenthes fusca Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 288, f. 6; Sh. Kurata, Nepenthes of Mt Kinabalu, Sabah (1976) 48, t. 13; Phillipps & A.L. Lamb, Nature Malaysiana 13, 4 (1988) 24; Pitcher Plants of Borneo (1996) 87, f. 48; Jebb & Cheek, Blumea 42 (1997) 41; Clarke, Nepenthes of Borneo (1997) 87, f. 57 & 58. — Type: *Endert 3955* (lecto BO, fertile sh.; iso BO, K, L), Borneo, E Kalimantan, G. Kemoel (= G. Kongkemul), 1500 m, 12 Nov. 1925.

Nepenthes curtisii subsp. *zakriana* J.H. Adam & Wilcock, Sarawak Mus. J. 50 ('1996', 1998) 151, f. XXII a & b; syn. nov. — Type: *Adam, Adam & Aliosman 2431* (holo UKMS n.v.; iso ABD n.v.), Borneo, Sabah, Mt Kinabalu, Mamut, 1100 m, 21 Jan. 1988.

Nepenthes fusca subsp. *kostermansiana* J.H. Adam & Wilcock, ined. — Type: *Kostermans 21495* (holo L; iso K), Borneo, E Kalimantan, Berau, Mt Njapa, Kelai River, 1000 m, 25 Oct. 1963.
Nepenthes maxima auct. non Reinw. ex Nees: Kondo & Kondo, Carn. Pl. of the World in Colour (1983) 110.
[*Nepenthes fusca* subsp. *apoensis* J.H. Adam & Wilcock, ined. = *Nepenthes stenophylla* Mast.].

Epiphytic shrub or climber in canopy, less usually terrestrial, stems to 3 m tall. Stems of rosettes terete, 0.8 mm diam., internodes 1 cm long; short stems terete, c. 4 mm diam., internodes 1–2 cm long; tall stems terete or 2-angled or 2-winged, 3–6(–10) mm diam., wings up to 3 mm wide, internodes 3–8.5(–12) cm long, with axillary buds 2–7 by 1.5 mm, 5–15 mm above the axil. *Leaves* petiolate, coriaceous; rosette leaves narrowly to broadly oblong-elliptic, 10–13.5 by 6–8.2 cm, apex obtuse to truncate, not peltate, base truncate to obtuse; leaves of short stems obovate or elliptic, 9–12.5 by 3.5–5 cm, apex obtuse, base attenuate-decurrent; petiole winged, 3–5 cm long, 7 mm wide including the wings, base sheathing and clasping the stem for 3/4 its circumference; leaves of long stems obovate, oblong-elliptic or lanceolate-elliptic, 6–13(–20) by 2.5–5(–6.5) cm, apex obtuse, rounded, emarginate or acute, base decurrent-attenuate, truncate, rounded or obtuse; petiole canaliculate, rarely winged, 2–6 cm long, 0.4 cm wide, clasping the petiole for 1/3–1/2 its circumference, sometimes decurrent to the node below as an arcuate or straight ridge or wing. Longitudinal nerves 2 or 3 on each side of the midrib in the outer 1/3, not very conspicuous. Pennate nerves patent, fairly numerous, reaching the longitudinal nerves, inconspicuous. *Lower pitchers* subcylindrical, lower half slightly ellipsoid, upper half slightly narrower, cylindrical, 10–13 by 2–3 cm, with two fringed wings 3–4 mm wide, fringed elements 4–8 mm long, 3–4 mm apart; mouth oblique, concave, ovate, rising at the rear to a short, tapered column, peristome cylindrical to flattened, 3 mm wide, ribs conspicuous, 0.2–0.5 mm apart, outer edge entire, inner edge lacking teeth; lid triangular-lanceolate, 2.7–3.2 by 1.7–1.8 cm, margin sinuate, usually with a basal and apical appendage, nectar glands as in the upper pitchers; spur filiform, 5 by 0.3 mm, apex acute. *Upper pitchers* subcylindrical to broadly infundibuliform, sometimes abruptly constricted at the mouth, 11–21.5(–30) by 2.5–7(–9) cm, without fringed wings, but with two ridges c. 1 mm wide; mouth ovate, oblique, strongly concave or L-shaped in side profile, the rear part held vertically, rarely slightly reflexed, to form an acute column up to 4 cm high; peristome cylindrical, 2–4 mm wide, or, especially in the column area, flattened, 4–11 (–21) mm wide, ribs as in lower pitchers, outer edge entire, or sinuate with 1–4 shallow lobes on each side, inner edge with inconspicuous, slightly curved teeth 0.3 mm long, with conspicuous nectar glands between them; lid raised from the horizontal, to erect, narrowly triangular-lanceolate, 2.5–5(–7) by 1–3 cm, apex rounded to obtuse, base truncate or cordate, margin involute and sinuate, lower surface with apical appendage filiform, 0–7 mm long, exserted, basal appendage semicircular, laterally flattened, 3–6 by 5–10 mm on ridge up to 10 mm high at the column apex, tapering towards the lid apex, nectar glands narrowly elliptic, 1–1.2 by 0.3 mm along the midrib keel, otherwise circular, thinly bordered, 0.2–0.5 mm diam., densely scattered or sometimes largely absent; spur 10–20 mm long, flattened, apex rounded. *Male inflorescence* 12.5–24 by 2.5–3.5 cm; peduncle 4.75–6(–12) cm long, 1.5–3.5 mm diam. at base; partial pe-

duncles 2-flowered, (20–)50, 1.5–2(–5) mm long; bracts absent; pedicels (6–)8–11 mm long; tepals elliptic, 3.5–4 by 1.5–2 mm; androphore (1.5–)3–4 mm long; anther head 1–1.2 by 1.2–1.25 mm. Infructescence 28–44 by 6–9 cm, bearing 12–20(–60) fruits; peduncle 10–24 cm long, 3–5 mm diam. at base. Fruits with valves 18–22(–39) by 3–3.2 mm. Seeds filiform, 9.5–11.5(–20) by 0.2–0.4 mm. *Indumentum* of stems fairly densely and roughly pubescent with simple or branched, erect to forward-directed red brown to black hairs 0.3–0.5 mm long. *Colour* of the stems dark brown hairy, lower pitchers purplish black, lightly splashed with cream; upper pitchers pale green, usually lightly splashed at the top with red; flowers brown.

Distribution — Borneo: Sarawak, Sabah, Brunei, and Kalimantan.

Ecology — Mossy forest, ridge tops; 800–1500(–2500) m.

Notes — 1. *Nepenthes fusca* is immediately distinguished from the closely related Bornean species *N. faizaliana, N. pilosa, N. stenophylla*, and *N. veitchii* by the lids of the upper pitchers which are narrowly triangular and have involute margins. In lower and mid-pitchers the lids are more ovate, and often flat, and it is only in the upper pitchers that the species-specific characters are constantly found. The inflorescence of this species is also smaller and more delicate than the foregoing species. Danser in Bull. Jard. Bot. Buitenzorg III, 9 (1928) 288 described *N. fusca* from the type specimen alone, and although upper pitchers are present on the two duplicates at Bogor, none have lids. Fortunately the isotypes at K and L have upper pitchers with the characteristic lid.

2. The glandular crest-like appendage at the base of the lid is always developed in this species, but the apical appendage may or may not be developed, and then usually only in upper pitchers. Whilst it was once argued that the presence of an apical appendage characterises *N. maxima*, we view that species as a closely related taxon distinguished from *N. fusca* by a broadly ovate lid. *Nepenthes maxima* occurs from Sulawesi to New Guinea, whilst *N. fusca* is restricted to Borneo.

3. *Kostermans 21495* (K, L) represents an extreme variant of *N. fusca*, approaching *N. eymae* in appearance. We also include in *N. fusca* the recently described *N. curtisii* subsp. *zakriana* on the basis of the photographs that accompany the protologue (*N. curtisii* is a synonym of *N. maxima*).

4. *Nepenthes fusca* subsp. *apoensis* J.H. Adam & Wilcock, ined., based on *Chai 35939*, belongs to *N. stenophylla* by virtue of its sheathing leaf bases, rounded lids and indumentum.

26. Nepenthes glabrata J.R. Turnbull & A.T. Middleton

Nepenthes glabrata J.R. Turnbull & A.T. Middleton, Reinwardtia 10, 2 (10 Feb. 1984) 107 (as '*glabratus*'); Jebb & Cheek, Blumea 42 (1997) 41. — Type: *Turnbull & Middleton 83113a* (holo BO n.v.), C Sulawesi, 120° 55' E, 1° 33' S, Tri Tunggal Eboni Corp. logging concession, 1666 m, 31 Aug. 1983.

Nepenthes rubromaculata Sh. Kurata (non *Nepenthes* × *rubromaculata* Veitch ex Wilson, Gard. Chron. II, 8 (1891) 441), J. Insect. Pl. Soc. (Japan) 35 (6 Feb. 1984) 42. — Type: *Kurata, Atsumi & Komatsu 149a* (holo, not indicated, probably Nippon Dental College, plate in Sh. Kurata, l.c. p. 44), C Sulawesi, route from Malei to Kajoga, 9 Nov. 1983.

Terrestrial climber to 2–3 m tall. Climbing stems terete or slightly 2-ridged, 2–3 mm diam., internodes (2–)2.5–3 cm; stems of short shoots and rosettes not seen. *Leaves* chartaceous, sessile; rosette leaves linear or highly reduced, those of climbing stems narrowly oblong-ligulate or narrowly oblanceolate, 8.5–12 by 1.2–1.8(–3) cm, apex acute, inconspicuously peltate, base slightly attenuate, clasping the stem by 1/3–1/2 its circumference, decurrent as very low ridges to the node below or ridges absent. Longitudinal nerves 1(–3) on each side of the midrib, about a third the distance from the margin, inconspicuous. Pennate nerves patent, soon branching, inconspicuous. *Lower pitchers* reported as globose. *Upper pitchers* shortly cylindrical to slightly infundibuliform, 7.4–14 by 2–3 cm, with two non-fringed wings 5–10 mm wide; mouth oblique, slightly concave, suborbicular; peristome cylindrical, 1–1.25(–2.5) mm diam., with indistinct ribs 0.1 mm high, 0.25–0.5 mm apart, outer edge entire, inner edge lacking teeth; lid orbicular, slightly broader than long, 2.7–2.8 by 2.6–3.1 cm, apex rounded to truncate, base truncate, venation palmate, the midrib branching and anastomosing with the lateral nerves c. 1 cm below the apex; lower surface lacking appendages, nectar glands scattered, inconspicuous, raised, bordered, circular pits 0.1–0.2 mm diam.; spur simple, slightly flattened, 5 by 0.5 mm, apex rounded. *Male inflorescence* racemose c. 20 by 1.5 cm; peduncle 7 cm long, 0.3 cm diam. at base; partial peduncles 1-flowered, c. 55; bracts absent; pedicels patent, 4–5(–8) mm long; tepals oblong, 2.5–3 by 1 mm, apex obtuse-rounded; androphore (1.5–)2 mm long; anther head 1–1.5 by 1.5 mm. Fruit unknown. Seed unknown. *Indumentum* absent from all parts except the spur and inflorescence; spur and rhachis to lower surface of tepals and lower half of androphore sparsely sericeous with white simple hairs 0.2 mm long. *Colour* of pitchers white with a few vertical red stripes; flowers red-green.

Distribution — C Sulawesi.

Ecology — In open, high forest; 1600–2000 m.

Notes — 1. The affinities of *N. glabrata* are unclear, but appear to be with *N. muluensis* of Sarawak (and thus the *N. tentaculata* group, since Clarke in Nepenthes of Borneo (1997) 109 has revealed the tentaculate nature of the lower pitchers of *N. muluensis*). Both species share an unusual lid nervation pattern and have upper pitchers of similar size, shape, and coloration. The coloration of this species, with its red-streaked pitcher, is distinctive. Turnbull & Middleton in their protologue to this species (see above) describe a number of features not apparent from the scant material available to us: young plants are said to have extremely narrow leaves with small globose pitchers, and rosette leaves of mature plants are said to have greatly reduced or even an absence of a blade.

2. Turnbull & Middleton's material, including types of *N. glabrata,* was not found at Bogor in 1995 or 1996, and may never have been distributed. Kurata's *N. rubromaculata* is a later homonym of a horticultural hybrid described in 1891. The type repository is not stated, but is presumably the herbarium of the Nippon Dental College. The holotype is illustrated in the original publication on page 44.

27. Nepenthes gracilis Korth.

Nepenthes gracilis Korth., Kruidkunde, in Temminck, Verh. Nat. Gesch. (1840) 22, t. 1 & 4; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 290; Sh. Kurata, Gard. Bull. Sing. 26 (1973) 229; Shivas,

Pitcher Plants of Peninsula Malaysia & Singapore (1984) 29; Tamin & M. Hotta in M. Hotta, Diversity and Dynamics of Plant Life in Sumatra (1986) 86; Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) 89, f. 49; Jebb & Cheek, Blumea 42 (1997) 42; Clarke, Nepenthes of Borneo (1997) 90, f. 59 & 60; J.H. Adam & Wilcock, Sarawak Mus. J. 50 ('1996', 1998) 159. — Type: *Korthals s.n.* (lecto L; iso K), Borneo, G. Pamatton, 325 m.

Nepenthes laevis Lindl. (non *Nepenthes laevis* C. Morren = *Nepenthes albomarginata*), Gard. Chron. (1848) 655. — Type: not located.

Nepenthes gracilis var. *elongata* Blume, Mus. Bot. Lugd.-Bat. 2 (1852) 10. — Type: *Wallich 2244* p.p. (K-Wall), Singapore.

Nepenthes korthalsiana Miq., Fl. Ned. Ind. 1, 1 (1858) 1071. — Type: *Teijsmann 538* p.p. (L, U n.v.), Sumatra, Sibolga.

Nepenthes teysmanniana Miq., Fl. Ned. Ind. 1, 1 (1858) 1073. — *Nepenthes gracilis* var. *teysmanniana* (Miq.) Beck, Wiener Ill. Gart.-Zeitung 20 (1895) 190. — *Nepenthes tupmanniana* Bonstedt, Parey Blumeng. 1 (1931) 663, sphalm. — Type: *Teijsmann 530* p.p. (BO), Sumatra, Sibolga by the coast, Feb. 1856.

Nepenthes laevis Korth. ex Hook.f. in A.DC., Prodr. 17 (1873) 104; in syn.

Nepenthes angustifolia Mast., Gard. Chron. 2 (1881) 524. — Type: *Burbidge s.n.* (K), N Borneo, 1877–1878.

Nepenthes gracilis var. *longinodis* Beck, Wiener Ill. Gart.-Zeitung 20 (1895) 190, as *Nepenthes longinodis*. — Type: *Lobb s.n.* (K), Borneo.

Nepenthes gracilis var. *arenaria* Ridl. ex Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 59. — Type: *Ridley 1473* (K), Singapore, Praman.

Nepenthes distillatoria auct. non L.: Jack, Comp. Bot. Mag. 1 (1835) 271.

Terrestrial climber 2(–5) m tall. Climbing stems triangular (1.5–)2–4(–5) mm diam., the corners rounded or with 2 wings, wings 1–2(–3.5) mm broad, internodes of climbing stems 2.5–9 cm long. *Leaves* chartaceous, sessile, leaves of the climbing stems narrowly lanceolate (6.5–)12–19 by (1–)1.5–2.8(–3.7) cm, apex acute, rarely acuminate, subpeltate, base narrowing only slightly, decurrent by (0.4–)1–4(–6) mm into stem wings; basal rosette leaves up to 3 cm long, otherwise as leaves of climbing stems. Longitudinal nerves 4–6 from the base, on each side of the midrib, usually confined to the outer 2/3. Pennate nerves numerous, usually ascending at 45° from the midrib, then descending. *Lower pitchers* ellipsoid in the basal half, gradually becoming slightly constricted towards the subcylindrical upper half (5.5–)8–10.5(–16.5) cm long, (1.7–)2.3–3.7 cm wide in the lower half, (1–)1.4–2.4 cm wide in the upper half, with two fringed wings 3–5 mm broad, the fringed elements 1–2.5 mm long, 0.5–2 mm apart; mouth ± ovate, concave, peristome cylindrical in section, c. 0.5 mm wide, without ribs, outer edge entire, inner edge minutely toothed; lid orbicular to ovate, 1–3 by 1–3 cm, lower surface without appendages, nectar glands sparse, few, (6–)20–30, large and thickly bordered, orbicular, dome-shaped, c. 0.4 mm diam., the central aperture pore-like, 0.1 mm diam.; spur simple, to 5 mm long. *Upper pitchers* as the lower, but subcylindrical and gradually and slightly constricted in the middle, (4.5–)7–14.5 cm long, (1.4–)1.8–4(–4.4) cm wide at the base, narrowing to (0.9–)1.5–2.9(–4) at the waist and flaring to (1–)2–4.3 cm at the mouth, with two ridges c. 0.1 cm broad, lacking fringed elements. *Male inflorescence* (9.5–)15–22(–30) by 2.5 cm; peduncle 1.2–5 cm long, 1.5 mm diam. at base; partial peduncles 1-flowered; bracts usually absent; pedicels 5–14 mm long; tepals ovate, 2.5–5 by 1.5–2.5 mm; androphore 0.7–1 mm long; anther head 0.7–1 by 1–1.5 mm. Fruit valves 14–27(–35) mm long. Seeds fusiform, papillate at the

centre. *Indumentum* absent from stems and upper surface of leaves; lower leaf and pitchers with scattered red sessile glands 0.1 mm diam.; pitchers also with minute scurfy brown stellate hairs, particularly in a band immediately below the peristome; inflorescence completely covered, from base of peduncle to the pedicels and ovary in appressed, thick coppery, ± simple hairs 0.1–0.3 mm long. *Colour* of pitchers green, red, or green mottled with red, rarely black-purple. Flowers variously described as white, green, light red or brown.

Distribution — Thailand, Sumatra, Peninsular Malaysia, Singapore, Borneo, Sulawesi.

Ecology — Lowland peat-swamp forest, kerangas, podsol heath scrub, swamp edges or disturbed areas, e.g. roadsides; on poor soils, sometimes on sandstone or ultramafic soils; sea level to 800 m.

Notes — 1. *Nepenthes gracilis* is a widespread, common and weedy species. *Nepenthes albomarginata* and particularly *N. reinwardtiana* have often been confused with *N. gracilis*. From *N. albomarginata*, *N. gracilis* is told apart by the triangular stems, the decurrent leaf bases which run down the stem ridges, and the absence of a white band of hairs below the peristome. From *N. reinwardtiana* it is distinguished by the slender, gracile pitchers, the shortly-toothed peristome (vs. untoothed), the absence of eye-spots, the lid with its few, large nectar glands and the 1-flowered partial peduncles (vs. 2-flowered).

2. Blume cites Jack's misapplication of the name *N. distillatoria* and Wallich's Cat. No. 2244 under his variety *elongata*. The former is not possible to certainly identify, whilst the Wallich herbarium at K comprises at least 5 sheets with *N. gracilis*, and on two of these are attached specimens of *N. albomarginata* also. Five further sheets of this number comprise specimens of *N. khasiana*.

3. *Nepenthes neglecta* Macfarl. is discussed under 'Excluded Species' in relation to *N. gracilis*.

Hybrids — A number of naturally occurring hybrids have been described: *Nepenthes* × *ghazallyana* J.H. Adam, Wilcock & Swaine, J. Trop. Forest Sci. 5 (1992) 22, nomen. A hybrid with *N. mirabilis* from Telupid, Borneo.

Nepenthes × *trichocarpa* Miq., a naturally occurring hybrid with *N. ampullaria* is rare but widespread in Sumatra, Peninsular Malaysia, Singapore, and Borneo (see there).

28. Nepenthes gracillima Ridl.

Nepenthes gracillima Ridl., J. Linn. Soc., Bot. 38 (1908) 320; Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 38; J. As. Soc. Beng. 75, 3 (1914) 282; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 296, excl. syn. *Nepenthes ramispina*; Shivas, Pitcher Plants of Peninsula Malaysia & Singapore (1984) 31, partim; Kiew, J. Wildlife and National Parks 10 (1990) 36; Jebb & Cheek, Blumea 42 (1997) 43. — Type: *Wray & Robinson 5309* (lecto SING; iso BO), Peninsular Malaysia, Pahang, G. Tahan, 990 m, 29 May 1905.

Nepenthes alba Ridl., Fl. Malay Pen. 3 (1924) 22. — *Nepenthes singalana* auct. non Becc.: Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 47, partim; Macfarl., J. As. Soc. Beng. 75, 3 (1914) 282. — *Nepenthes bongso* auct. non Korth.: Ridl., J. Linn. Soc., Bot. 38 (1908) 320. — Type: *Wray & Robinson 5411* (lecto, designated in Blumea 42 (1997) 44, SING; iso BO), Peninsular Malaysia, Pahang, G. Tahan, 1500 m, 3 June 1905.

Terrestrial climber 1–5 m tall. Climbing stems sub-angular (-terete), 0.2–0.5 cm diam., internodes 0.5–1.5(–8) cm; axillary buds inconspicuous. *Leaves* thinly coriaceous, sessile, those of climbing stems lanceolate to oblanceolate, 5–10(–16) by 1–1.5 (–2) cm, apex acute, base cuneate, amplexicaul, clasping the stem for 1/2 its circumference, slightly auriculate, not decurrent; rosette leaves oblanceolate, 4–7 by 1–1.5 cm. Longitudinal nerves 0–3 on each side of midrib, in outer half of blade, fairly conspicuous. Pennate nerves inconspicuous. *Lower pitchers* infundibuliform below, cylindrical above, 5–10 by 1–3.5 cm with two fringed wings c. 2 mm broad, fringed elements to 3 mm long, 0.5–1.5 mm apart, otherwise as upper pitchers. *Upper pitchers* infundibuliform below, abruptly narrowing at 1/2–3/4 height and then cylindrical, but gradually broadening to mouth, 6–15(–17.5) by 0.9–2.8 cm, wings absent; mouth elliptic, oblique, concave; peristome slightly flattened in cross section, 1.5–3 mm wide; lid orbicular to broadly ovate, 1.2–2.3 by 1.2–2 cm, apex rounded, base cordate, lower surface lacking appendages, nectar glands circular, bordered, 0.4–0.5(–0.7) mm diam., more or less even-sized, sometimes interspersed with smaller glands 0.15–0.2 mm diam.; spur 2–3 mm long, flattened, unbranched, slightly curved. *Male inflorescences* 23–27 by 2–2.5 cm; peduncle 9–10 cm long, 1–1.5 mm diam.; partial peduncles 2-flowered at base, 1-flowered at apex, 50–65, 1–4 mm long; bract inserted between rhachis and apex, filiform, 2–6(–8) mm long, spreading; pedicels 4.5–7 mm long; tepals elliptic 3.5–4 by 2 mm; androphore c. 2.5 mm long; anther head c. 1.5 by 1.5 mm. Fruit valves c. 18 by 3 mm. Seed fusiform, 9–10 mm long, central body smooth. *Indumentum* of very short simple hairs, < 0.05 mm long, sparse or absent from stems and leaves; axils sparsely pubescent, pitcher including lid and inflorescence likewise. *Colour* of lower pitchers deep purple to blackish green; upper pitchers pale green in lower part, becoming pale yellow to ivory-white above, with rose coloured markings throughout, rarely purple. — **Fig. 8.**

Distribution — Peninsular Malaysia: the eastern mountain ranges, Banjaran Timur; G. Tahan and G. Tapis.

Ecology — Open areas or amongst scrub, on quartzitic soils or heavily weathered rock; 1300–2100 m.

Notes — 1. *Nepenthes gracillima* can be distinguished from the closely related *N. ramispina* by its smaller size. The pitcher is not as attenuated, the spur is usually simple, the lid glands are larger, fewer and more uniform in size, and the whole plant is somewhat glabrescent. The coloration of the upper pitchers of *N. gracillima* is particularly striking: they are green in their lower part, becoming pale yellow to ivory-white in their upper parts, with rose coloured markings throughout. Kiew discussed the species on G. Tahan in some detail in J. Wildlife and National Parks (Malaysia) 10 (1990) 34–37.

2. There has been confusion about the *Nepenthes* of upland Peninsular Malaysia: *N. gracillima*, *N. macfarlanei*, *N. ramispina*, and *N. sanguinea*. Danser in Bull. Jard. Bot. Buitenzorg III, 9 (1928) 296 reduced *N. ramispina* to a synonym of *N. gracillima*. He regarded the delimitation of the remaining species as confused by hybrids. Amongst herbarium specimens, hybrids seem to be common, but this may be an artifact of collector selection of unusually large or different individuals. The ecology of the species is distinct (Kiew l.c. 1990). *Nepenthes gracillima* and *N. ramispina* are no doubt a closely related pair, but a distinct morphological disjunction correlates with the western and

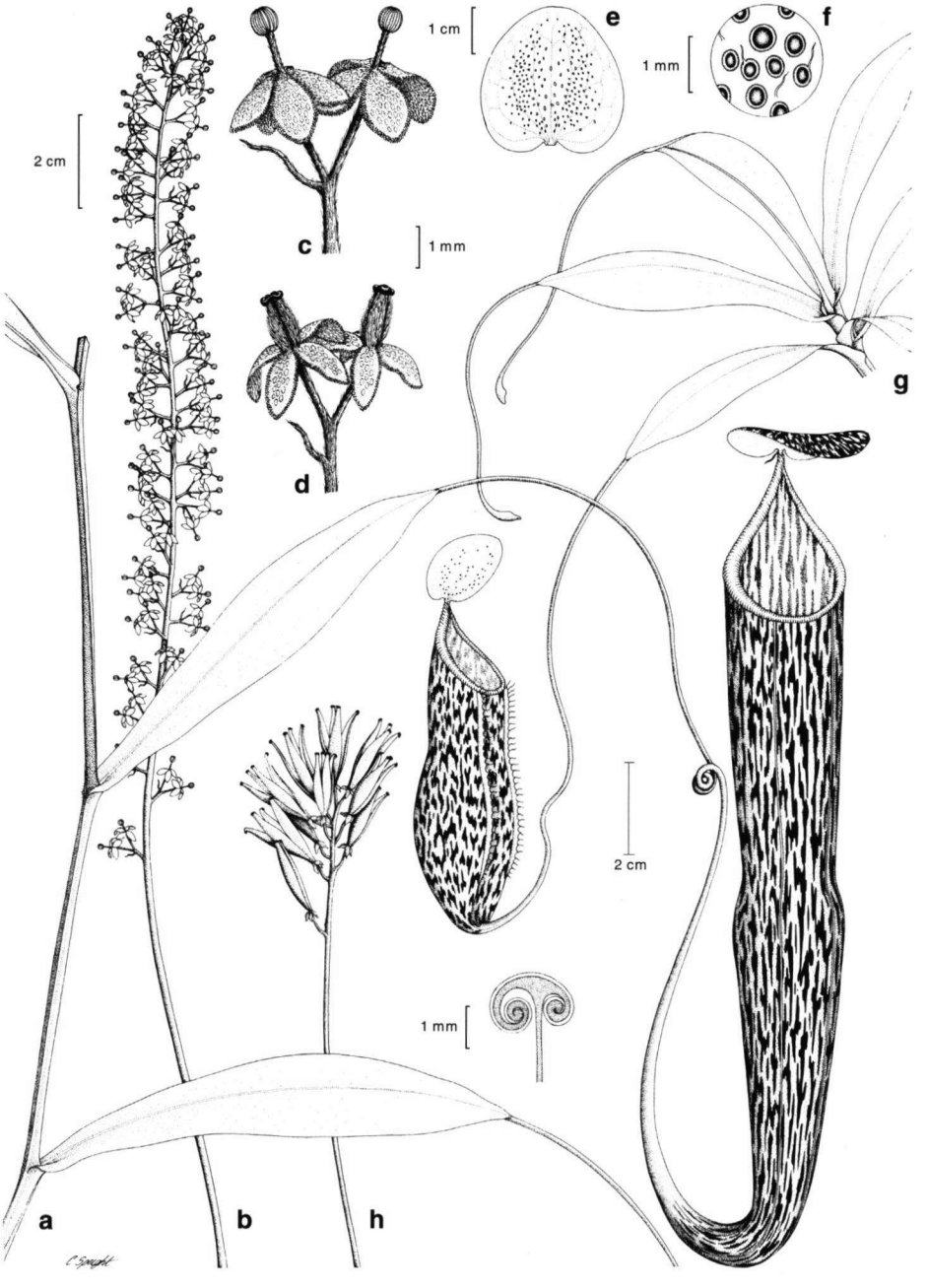

Fig. 8. *Nepenthes gracillima* Ridl. a. Stem with upper pitcher, with detail of peristome showing transverse section; b. male inflorescence; c. partial inflorescence with male flowers; d. partial inflorescence with female flowers; e. lower lid of upper pitcher; f. detail of lid glands; g. rosette stem with lower pitcher; h. infructescence (a, e & f: *Ridley 16174*; b & c: *Haniff 7890*; d & h: *Ridley 16090*; g: *Pannell 1132*). Drawn by Camilla Speight.

eastern mountain ranges of Peninsular Malaysia. Whilst we acknowledge that hybrids are to be found, nonetheless it is possible to key the majority of highland Peninsular Malaysia specimens as follows:

1a. Stem cylindrical or sub-angular; lid orbicular; peristome narrow (< 3 mm) ... 2
b. Stem angular; lid ovate; peristome broader (> 6 mm) 3
2a. Pitcher spur branched; lid glands numerous, small (0.2–0.3 mm) .....
..... **64. N. ramispina**
b. Pitcher spur simple; lid glands few, large (0.4–0.5 mm) ..... **28. N. gracillima**
3a. Stem sharply 3-angled, glabrous; peristome scarcely toothed; lid without hairs .
..... **67. N. sanguinea**
b. Stem perceptibly 3-angled, pubescent; peristome toothed, flattened near lid; lid with many bristle-like hairs below ..... **41. N. macfarlanei**

3. Danser misidentified a specimen of *N. gracillima* (*Ridley 16097*) as belonging to *N. alata* (see there) (Kiew l.c. 1990).

4. Ridley described *N. gracillima* from Mt Tahan collections in 1908 (see reference above). At the same time he identified other specimens collected on the same expedition as *N. bongso* Korth. In 1924 (Ridley, Fl. Malay Pen. 3 (1924) 22) he corrected this identification, and described the latter specimens as a new species: *N. alba*. He also (l.c. 1924) described *N. ramispina* from Mt Semangka in the Genting Highlands. Danser in Bull. Jard. Bot. Buitenzorg III, 9 (1928) 296 reduced all these names to *N. gracillima*, but we have reinstated *N. ramispina* (Jebb & Cheek in Blumea 42 (1997) 66). Danser's illustration (in Bull. Jard. Bot. Buitenzorg III, 9 (1928) f. 7) is of *N. ramispina*.

29. Nepenthes gymnamphora Nees

Nepenthes gymnamphora Nees, Ann. Sci. Nat. 3 (1824) 366, f. 1, t. 19 & 20; Blume, Enum. Pl. Javae (1827) 85; Korth., Verh. Nat. Gesch. (1840) 32, t. 3 & 4: 55–70; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 300, partim; Jebb & Cheek, Blumea 42 (1997) 45. — *Nepenthes melamphora* Reinw. ex Blume, Cat. Gew. Buitenzorg (1823) 111, nomen; Blume, Mus. Bot. Lugd.-Bat. 2 (1852) 8. — Type: Nees, l.c., t. 19 (lecto).

Nepenthes gymnamphora var. *haematamphora* Miq., Pl. Jungh. 1 (1852) 169; Beck, Wiener Ill. Gart.-Zeitung 20 (1895) 186; Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 57. — *Nepenthes melamphora* var. *haematamphora* (Miq.) Miq., Fl. Ned. Ind. 1, 1 (1858) 1073. — Type: *Junghuhn* (n.v.), Java, Mts Patuha & Merapi.

?*Nepenthes melamphora* var. *lucida* Blume, Mus. Bot. Lugd.-Bat. 2 (1852) 8; Becc., Malesia 3 (1886) 5; Beck, Wiener Ill. Gart.-Zeitung 20 (1895) 186. — Type: *Muller*, Borneo.

Nepenthes melamphora var. *pubescens* Kuntze, Rev. Gen. Pl. 2 (1891) 562. — Type: (not located) Java, Gede.

Nepenthes phyllamphora auct. non Willd.: Reinw. ex Miq., Fl. Ned. Ind. 1, 1 (1858) 1073.

Nepenthes melamphora auct. non Blume: Fern.-Vill., Fl. Filip. Nov. App. (1880) 173 = *Nepenthes alata* Blanco.

Nepenthes rafflesiana auct. non Jack: Haberle, Bot. Tropenr. (1893) 227.

[*Nepenthes melamphora* var. *tomentella* Becc., Malesia 3 (1886) 13 = *Nepenthes pectinata* Danser.]

Terrestrial climber to 15(–40) m tall. Stems terete, rarely slightly angular, those of climbing stems 4–7(–8) mm diam., internodes 1.5–10 cm long, axillary buds incon-

spicuous. *Leaves* thinly coriaceous, sessile or subpetiolate; rosette leaves usually highly reduced, narrowly oblong to oblanceolate-elliptic, 3–5 by 1–1.2 cm, apex acute, base sessile, clasping the stem for 1/2 its circumference, rarely the rosette leaves larger, 8.5–12 by 2.5–3.7 cm; short and climbing stem leaves narrowly elliptic, (10–)23–26 (–30) cm long, apex acute, base attenuate, (5–)7–12 mm wide, usually with a petiole-like part 4–5 cm long. Longitudinal nerves 3 or 4 on each side of the midrib in the outer 3/4, fairly conspicuous above. Pennate nerves oblique, highly branched, inconspicuous. *Lower pitchers* ellipsoid, the mouth occupying the upper 1/3–1/4, (3–)6–11.5 by (2.2–)4–4.5 cm, with two fringed wings 5–7 mm broad, fringed elements 3–5 mm long, c. 1 mm apart; mouth oblique, concave, raised at the rear into a short vertical column; peristome flattened, 6–7(–9) mm wide in the rear half of the mouth, 2–3 mm wide in the front half, ribs 0.5 mm apart, c. 0.1 mm high, the outer edge entire, the inner with curved teeth, 1–2(–3) mm long in the rear half of the mouth, absent in the front half; lid ovate, 3–4 by 2–3 cm, apex rounded, base cordate, lower surface lacking appendages but with a raised midrib, nectar glands circular, bordered, 0.3 mm long, confined to the midline or widely scattered, the midline often with larger, elliptic glands 0.6 mm long; spur filiform, 4–5 mm long, entire. *Upper pitchers* subcylindrical, 6–10(–19) by 1.7–2.8(–4.5) cm, slightly inflated in the lower 1/3, rarely slightly infundibular, usually with two fringed wings 0.5–2 mm wide, fringed elements c. 4 mm long, 1 mm apart; mouth slightly oblique, concave; peristome subcylindrical, 1.5–2 mm wide, ribs 0.5 mm apart, outer edge entire, inner with teeth inconspicuous; lid elliptic or ovate, rarely orbicular, 2–2.5(–4.5) by 1.2–1.4(–5) cm, apex rounded, base cordate, lower surface often with a raised keel c. 1 mm long, at the base of the midline, nectar glands and spur as the lower pitchers. *Male inflorescence* 35–50 by 4 cm; peduncle 20–24 cm long, 3–4 mm diam. at base; partial peduncles 2-flowered, c. 70, 2–5 mm long; bracts absent or occasional; pedicels 3–5 mm long; tepals elliptic, 4–6 by 2–3.2 mm; androphore 3.5–4 mm long; anther head 1.5–2 by 2 mm. Infructescence c. 30 by 5 cm; peduncle c. 19 cm long, 4 mm diam. at base; partial peduncles c. 40; fruits with valves 13 by 3 mm. Seeds filiform, 6–15 mm long. *Indumentum* of sessile glands c. 0.1 mm diam. on stems, lower surface of the leaf blade and outer surface of pitchers; patent simple pale brown or white hairs 0.1–0.3 mm long on very young stems, densely on leaf edges, sparsely on the lower midrib, and upper pitchers including spur, dense to sparse on lower pitchers; inflorescence from peduncle base to lower surface of the tepals pubescent with brown, inclined, simple hairs 0.5–0.6 mm long, androphore minutely puberulent. *Colour* of pitchers reddish green to purple.

Distribution — W and C Java (one apparent record from Borneo, see Jebb & Cheek 1997: 92).

Ecology — Forest; 1000–2750 m.

Note — *Nepenthes gymnamphora* is the only Javanese montane species of the genus. It is most similar to *N. pectinata* of C Sumatra. *Nepenthes pectinata* is distinguished from *N. gymnamphora* by several characters; in overall architecture it differs in that the upper leaves rarely produce pitchers; the upper leaves are more gradually attenuated to their bases, with broadly winged and scarcely discernible petioles and are decurrent as wings for several cm on the stem, unlike the shortly amplexicaul base of leaves of *N. gymnamphora*; the pitchers have a more rounded, urceolate form, with a

narrow mouth, and the peristome drawn out into a longer neck; *N. pectinata* usually has a denser indumentum, and the inner peristome margin has larger teeth than that of *N. gymnamphora*.

30. Nepenthes hamata J.R. Turnbull & A.T. Middleton

Nepenthes hamata J.R. Turnbull & A.T. Middleton, Reinwardtia 10, 2 (10 Feb. 1984) 108 (as '*hamatus*'); Jebb & Cheek, Blumea 42 (1997) 46. — Type: *Turnbull & Middleton 83121a* (BO n.v.), C Sulawesi, G. Lumut W ridge, 1850–1900 m, 19 Sept. 1983.

Nepenthes dentata Sh. Kurata, Nepenthes of Mt Kinabalu, Sabah (1976) 11, nom. nud.; Gard. Bull. Sing. 36 (1984) 197, f. 1, t. 1. — Type: *Eyma 3572* (lecto BO; iso BO), C Sulawesi, G. Lumut, between bivouac II and III on N spur, 3 Sept. 1938.

Terrestrial climber to several metres high. Stem terete or obtusely trigonous, climbing stem 4–5 mm diam., internode length 3.5–6 cm, stems of short stems and rosettes 2–3 mm diam., internodes 2–6 mm long. *Leaves* chartaceous, sessile, those of short stems and rosettes oblanceolate or oblong-elliptic, 6–7.5 by 1.7–2.5 cm, apex acute, not peltate, base amplexicaul, subperfoliate, more or less auriculate, not conspicuously decurrent; leaves of climbing stems oblong-elliptic, rarely lanceolate, 5–7(–15) by 1.8–2.5 cm, apex obtuse to acute, base decurrent by 0.5–1.5 cm. Longitudinal nerves 2(–4) on each side of the midrib, in the outer 1/2–1/3(–2/3). Pennate nerves patent, branching, inconspicuous. *Lower pitchers* narrowly ovoid, 7–11.5 cm tall, 2.1–3.2 cm wide at the base, diminishing gradually to 1.6–2.5 cm wide below the mouth; fringed wings 3 mm wide, fringe elements often in pairs, 2 mm apart, 5–10 mm long, branching dichotomously 1 or 2 times; mouth concave, highly oblique, elliptic, with a long tapered apex that becomes erect, or overarches the rest of the mouth; peristome cylindrical to slightly flattened, 1.5–3 mm wide (excluding teeth), ribs c. 3 mm apart, c. 20 on each side, exaggerated into falcate teeth c. 5 mm high, outer edge entire, teeth recurved, c. 2 mm from peristome to apex, inner edge recurved into the pitcher, c. 7 mm from pitcher rim to the tooth apex, teeth of column dagger-like, descending 10 by 2 mm; lid held horizontally, margins ascending, ovate, 3–3.8 by 1.8–2.8 cm, apex rounded, base subcordate, upper surface with up to 45 multicellular 'tentacles' on each side, c. 3 deep around the margin, each 6–8 mm long, often branched, arising from vein ends, lower surface lacking appendages, with sparse and inconspicuous shortly elliptic bordered pits 0.1–0.2 mm broad; spur fasciculate, 5-branched from the base, c. 9 mm long, each repeatedly branched along its length. *Upper pitchers* subcylindrical, usually slightly ovoid in the lower 1/3, the upper 2/3 cylindrical, or gradually dilating slightly towards the mouth, 7–20 by (1.2–)2–4.5 cm, with fringed wings or with the wings reduced to ridges; peristome with teeth 12–16 by 2–3 mm high, 2.5–6 mm apart. *Male inflorescence* 8–15 cm long; peduncle 2.4–10 cm long; partial peduncles 1-flowered, c. 22; bracts absent; pedicels 10–15 by 0.1–0.3 mm; tepals elliptic, reflexed, 1.5–2.5 by 1–1.5 mm; androphore 1–2.5 mm long; anther head 0.6–0.8 by 0.8–1.4 mm. Infructescence 8.5 by c. 5 cm; peduncle 6.5 cm long, 2.25 mm diam. at base. Fruits c. 15; valves 19–20 by 3.5–4.5 mm. Seeds filiform, 8 by 0.4–0.6 mm. *Indumentum* of sessile red glands on stem, lower surface of leaves, outer surface of pitchers, upper and lower lid; outer pitcher arachnoid-tomentose with branched brown, often prostrate and crinkled

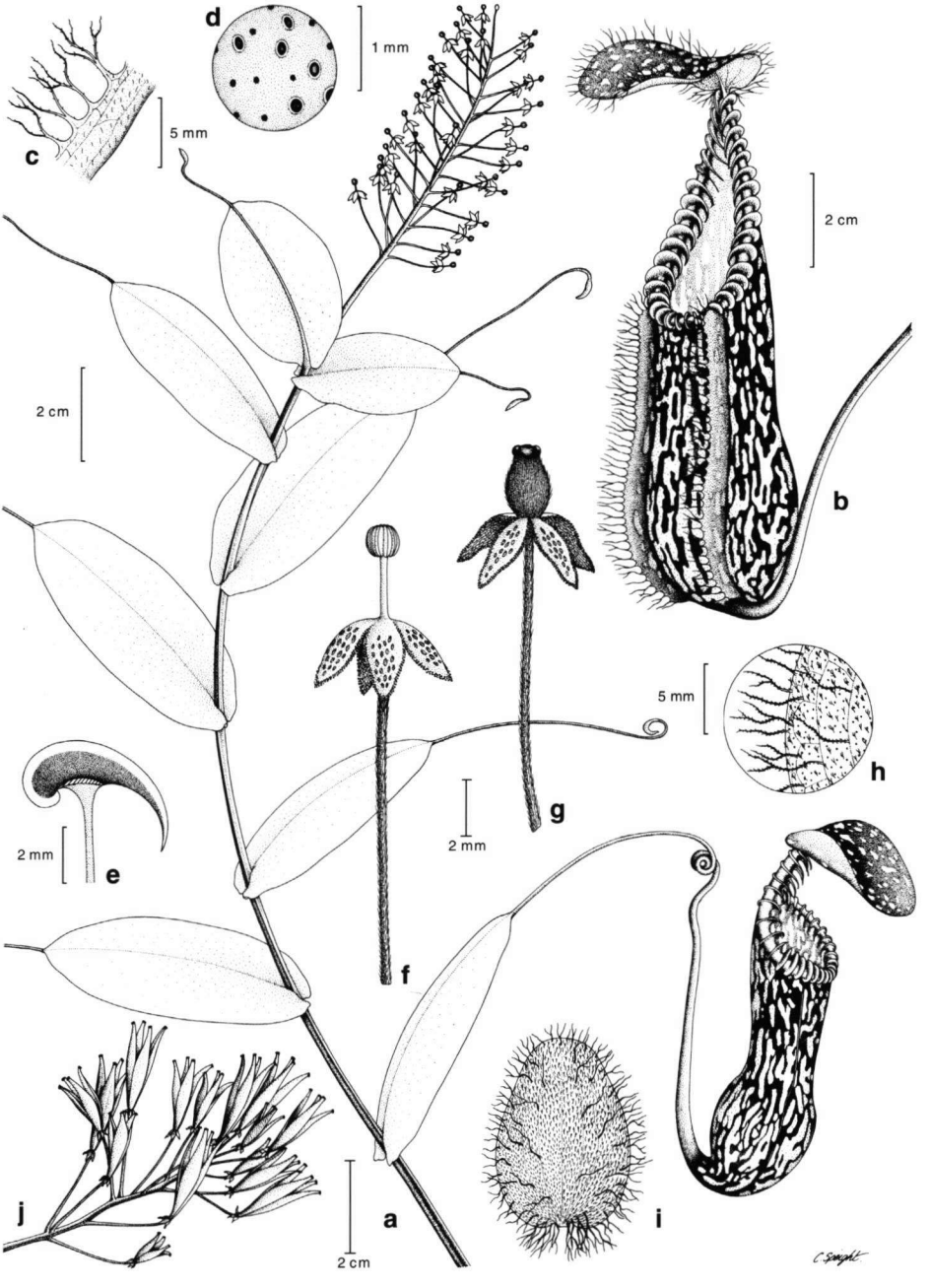

Fig. 9. *Nepenthes hamata* J.R. Turnbull & A.T. Middleton. a. Habit with upper pitcher and male inflorescence; b. lower pitcher; c. detail of wing of lower pitcher; d. detail of glands on lower lid; e. section of peristome; f. male flower; g. female flower; h. detail of upper surface of lid of lower pitcher; i. upper surface of lid of lower pitcher; j. infructescence (a, d & f: *Lack & Grimes 1784*; b, c, e, h & i: *Eyma 3573*; g & j: *Lack & Grimes 1783*). Drawn by Camilla Speight.

hairs 0.3–1.5 mm long; inflorescence from peduncle to lower surface of tepals sparsely to moderately densely covered with appressed brown hairs c. 0.5 mm long; ovary densely hairy with golden-brown appressed hairs. *Colour* of pitchers pale green blotched/reticulated purplish red with mauve wings; peristome red or black, teeth black or greenish white; male flowers green, tepals becoming red. — **Fig. 9.**

Distribution — Sulawesi: C Province (G. Lumut, G. Sojol, Mt Tambusisi, Mt Roroda Timbu, Tomongkobae Mts & G. Poka Pindjang).

Ecology — On open ridge-tops, rooted in moss, climbing into trees; 1400–2500 m.

Notes — 1. This species is related to *N. tentaculata*. Amongst the most notable similarities are the presence of hair-like appendages ('tentacles') on the lid, the branched spur surrounded by other branching appendages, the lids of the lower pitchers often lacking glands, and the upper pitchers which may or may not bear fringed wings. The features which distinguish this species are the striking peristome, with plate-like teeth, but this only develops in the upper pitchers and is variable in the degree of development. It appears that the *N. tentaculata* group of species (*N. adnata*, *N. glabrata*, *N. hamata*, *N. muluensis*, and *N. tentaculata*) are all similar in their lower pitchers and leaves, in particular the presence of tentacles on the upper surface of the lid. Some specimens of *N. hamata* appear to be very close to *N. tentaculata*, and at present the seven or so collections available form something of a continuum. Kurata's description and selected type represent an extreme form (as illustrated in his figure). The material selected by Turnbull & Middleton has not been located, but the description suggests it is somewhat of an intermediate between Kurata's material of *N. hamata* and *N. tentaculata*. Rather than intermediates between species, however, this variation is more likely to be explained by the dimorphy of lower and upper pitchers. A similar case holds with *N. muluensis*, where the lower pitchers have only recently been discovered to show the typical facies of *N. tentaculata* (see there).

2. This species was first mentioned in a list by Kurata (Nepenthes of Kinabalu, Sabah (1976) 10) as *N. dentata* nom. nud., validated in a paper eight years later (Kurata, Gard. Bull. Sing. 36 (1984) 197). A few days before *N. dentata* was validated, however, the description of *N. hamata* appeared in a preprinting of Reinwardtia, with an effective publication date of 10 February 1984, gaining priority by 28 days. The effective publication date of these two names is open to debate. Whether the 'preprinting' fulfilled the condition of being 'freely available (Art. 29)' before the Kurata paper is hard to determine. It was certainly not deposited at libraries at either K or E prior to the accession of volume 36 of the Gardens' Bulletin of Singapore which arrived at both libraries in June 1984. The Reinwardtia volume arrived in August 1985 (K) and November 1985 (E). Turnbull & Middleton published (Reinwardtia 10, 2, 1984) three species names from their Sulawesi collections: *N. hamata*, *N. glabrata*, and *N. infundibuliformis*. None of these collections has been found at the herbaria they cite.

31. Nepenthes hirsuta Hook.f.

Nepenthes hirsuta Hook.f. in A.DC., Prodr. 17 (1873) 99; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 306, f. 8; Phillipps & A.L. Lamb, Nature Malaysiana 13, 4 (1988) 16; Pitcher Plants of Borneo (1996) 92, f. 50; Jebb & Cheek, Blumea 42 (1997) 47; Clarke, Nepenthes of Borneo (1997) 93, f. 61–62. — Type: *Low s.n.* (holo K), Borneo, Lawas River.

Nepenthes hirsuta var. *glabrata* Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 50. — Type: *Lobb 92* (holo K), Borneo, Sarawak.

Nepenthes hirsuta var. *typica* Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 50, inval.

Nepenthes leptochila Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 319, f. 13; Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) 97, f. 52. — Type: *Amdjah 730* (lecto BO, sh. 1711-26; iso BO, K), Borneo, E Kalimantan, G. Djempanga, Sept. 1912.

Terrestrial climber 1–4 m tall. Stem terete, 4–5(–8) mm diam., internodes of short stems 0.5–1 cm long, of climbing stems 2–4.5(–10) cm long. *Leaves* coriaceous, subsessile; leaves of short shoots and rosettes oblanceolate, 10–19 by 3–5.5 cm wide, the lowermost 1/8–1/10 narrowed to a winged, poorly defined petiole, leaf bases shortly sheathing, amplexicaul, encircling the entire stem circumference; leaves of climbing shoots narrowly elliptic, 18–27(–28.5) by 4–6 cm wide, tapering to an acute apex, the basal 1/5–1/6 (i.e. up to 4–5 cm long), usually narrowed to c. 1 cm wide and resembling a winged petiole, base sheathing, encircling c. 1/3 the stem circumference, uppermost leaves smaller, 6–10(–14) by 1.6(–3.2) cm, subsessile. Longitudinal nerves 3–5 on each side of the midrib in the outer half, conspicuous above and below. Pennate nerves numerous, held at ± 90° from the midrib, inconspicuous, not reaching the marginal nerve. *Lower pitchers* ovoid or ellipsoid, tapering into a shortly cylindrical upper part, 11–18 cm long, 5–6(–7.5) cm wide at the base, tapering to 2.5–4(–5) cm wide below the peristome, with two fringed wings 2.5–3(–6) mm broad, the fringed elements 3–6(–15) mm long, (1–)2–2.5(–3) mm; mouth ovate, apex long-acuminate, oblique; the peristome cylindrical to slightly flattened, 3–5(–15) mm wide, with pronounced ribs 0.25–0.5 mm apart, 0.1–0.2 mm high, outer edge rarely slightly sinuate in largest pitchers, inner surface with broad stiff, slightly forward curved teeth 0.3–1 (–2) mm long; column short and broad, the peristome teeth expanded in two protuberant ridges; lid broadly to narrowly ovate or elliptic, 2.5–4.5(–6.2) by 2.7–3.2 cm, apex rounded, base shallowly cordate, lower surface without appendages, with several large circular or elliptic crater-like glands along the midline 0.3–0.5 mm long and numerous smaller, circular ones 0.2–0.1 mm diam., towards the margin, absent at the edge; spur simple 4–15 mm long. *Upper pitchers* as the lower, but much less commonly produced, cylindrical, rarely ovoid-cylindrical or infundibuliform-cylindrical, 10–15.5 by 2.5–4.7 cm, with wings 0.5–4 mm wide, usually fringed, the fringed elements up to 13 mm long, 3–4 mm apart; peristome 2.5–5 mm wide; lid ovate or ovate-oblong, 2–4.7 by 1.8–2.7 cm. *Male inflorescence* (18–)22–25 by 3 cm; peduncle 10.5–12 cm, 2 mm diam. at base; partial peduncles 2-flowered, 35–65, 1–3 mm long, bract 0.25–0.5 mm long, inconspicuous; pedicels (4–)5–8 mm long; tepals elliptic, (3.75–)5–5.5 by 2–2.5 mm, apex rounded; androphore (3.5–)6 mm long; anther head 1.25 by 1.25 mm. Fruits with valves 35–42 by 3.5–4 mm. Seeds filiform, 25 by 0.25 mm. *Indumentum* of stems, lower surface of midribs and inflorescences densely, less usually feebly, substrigose to pilose, with fragile, but not caducous, brown, subappressed, stiff, simple (rarely a few 1–3-branched) hairs (0.5–)1–2 mm long, hair bases swollen; lower leaf blade with sessile red glands very sparsely scattered with patent simple hairs c. 0.5 mm long. *Colour* of lower pitchers green or grey-green splashed with red; upper pitchers always green; tepals red with black spots on inner surface; androphore maroon; anthers white.

Distribution — Borneo: Sarawak, Brunei, Sabah, and Kalimantan.

Ecology — Submontane forest, sometimes on ridgetops, often on sandstone; 500–1100 m.

Notes — 1. *Nepenthes hirsuta*, on account of the shape of its pitchers and its conspicuous dark, pilose indumentum is likely to be mistaken for one of the Regiae (the *N. maxima* group of species). It can be distinguished by the subsessile, not strongly petiolate leaves and the lower surface of the lid, which lacks an appendage. *Nepenthes hirsuta* varies from long-hairy to short-hairy and densely to weakly hirsute, but some hairs are always present though they are brittle and easily removed by abrasion. Hairs are never found on the upper surface of herbarium specimens, for example. *Nepenthes leptochila* is a weakly hairy variant, but not glabrous as has been thought. Inspection of young shoots on the type number of *N. leptochila* at BO shows hair bases and a few remnant hairs on the stems.

2. *Nepenthes hirsuta* is widespread and common in northern Borneo, but its three seemingly close relatives have more restricted distributions. *Nepenthes macrovulgaris* is apparently confined to ultramafic soils in Sabah, *N. hispida* occurs on sandstone in Sarawak, near the border with Brunei and Sabah and *N. philippinensis* grows on ultramafic soils in Palawan. See key to the *N. hirsuta* group under *N. philippinensis*.

32. Nepenthes hispida Beck

Nepenthes hispida Beck, Wiener Ill. Gart.-Zeitung 20 (1895) 187; Jebb & Cheek, Blumea 42 (1997) 48, f. 5; Clarke, Nepenthes of Borneo (1997) 94, f. 63. — Type: *Burbidge s.n.* (lecto W sh. 55649; iso K, W), Sarawak, Lawas River, 2000–3000 ft.

Nepenthes hirsuta auct. non Hook.f.: Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 59, partim; M. Hotta, Acta Phytotax. Geobot. 22 (1966) 7, partim.

Terrestrial climber to c. 5 m tall. Stem terete, 2–4 mm diam., internodes of climbing stems 2–4 cm long; internodes of short shoots 0.25–0.75 cm long. *Leaves* coriaceous, sessile, blade oblanceolate to oblong, sometimes narrowly so; leaves of short stems 7–12 by 1.6–2.8 cm; leaves of climbing shoots 7.5–28 by 1.8–3.3 cm, apex shortly acuminate to obtuse, often unequal, not peltate, base decurrent-amplexicaul, extending down the stem by 0.5–1 cm, and clasping it by 9/10 its diameter, the wings short, but 4–6 mm broad, and almost meeting opposite the axil. Longitudinal nerves 3 on each side of the midrib in the outer half, from the leaf base. Pennate nerves apparently few, patent, inconspicuous. Above each inflorescence, the first leaf of the shoot has an ovate blade, 2.5–4 by 0.7–1.3 cm, with an acute to obtuse apex, and lacks a tendril. *Lower pitchers* ovoid-ellipsoid in the lower half, the upper half subcylindrical, tapering slightly to the mouth, 5–8.5 cm long, 1.5–3 cm wide at the base, 1–1.8 cm wide at the mouth, with two fringed wings, 1–3 mm wide, fringed elements 1–2 mm long, 1–2 mm apart; mouth ovate, oblique, slightly concave; peristome rounded, 0.5–1.2 mm wide, not sinuate, ribs 0.25 mm apart, the inner margin with teeth 0.5–1 mm long; lid ovate-elliptic, 1.4–2.7 by 0.9–2 cm, apex rounded, base truncate to slightly cordate, lower surface lacking appendages, with numerous circular, crater-like glands 0.1–0.15 mm wide, those on the midline, larger, elliptic, to 0.35 mm long; spur c. 5 mm long, entire. *Upper pitchers* as the lower, but more cylindrical, 7–11.5 by 1.2–2.7 cm; wings sparsely fringed near mouth and to 2 mm broad, or lacking fringed elements, 0.4–0.5 mm broad; mouth, peristome, lid and spur as in lower pitchers. *Male inflorescence* 9–13 by 1.5 cm;

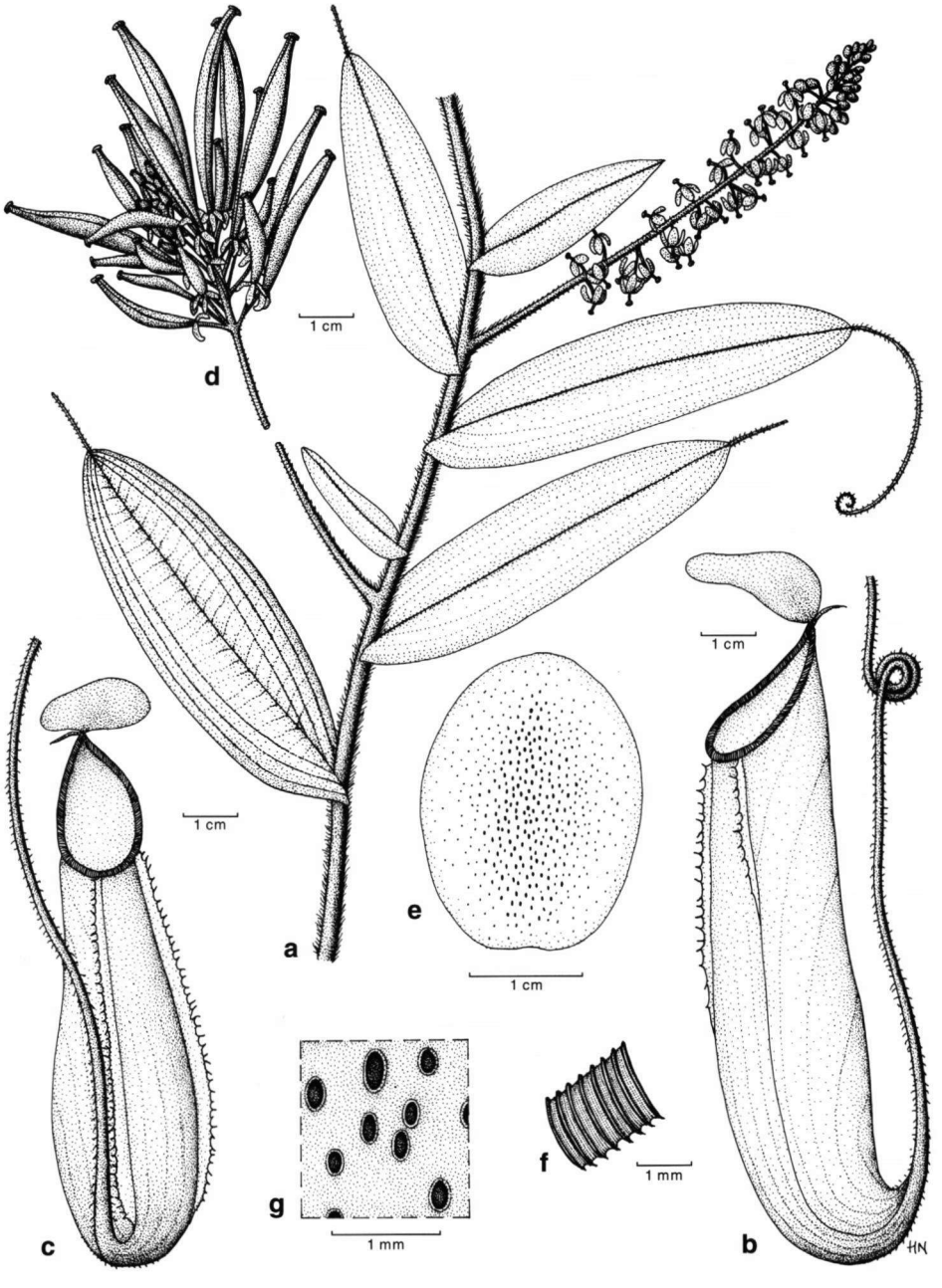

Fig. 10. *Nepenthes hispida* Beck. a. Stem with male inflorescence; b. upper pitcher; c. lower pitcher; d. infructescence; e. underside of lid; f. detail of peristome, internal view; g. detail of glands on lower lid surface (a, b, d–g: *Morshidi 24068*; c: *Burbidge s.n.*). Drawn by Holly Nixon.

peduncle 2.5–4 cm long; partial peduncles 2-flowered near base, but mostly 1-flowered, 0.5–3 mm long; bracts absent; tepals elliptic, c. 3.5 by 2 mm; staminal column 1.5–2 mm, anther head with anthers subglobular, 1–1.25 mm diam. Fruit valves 35–47 by 3–4 mm. Seeds not recorded. *Indumentum* as *N. hirsuta*, but denser and longer, of erect, slightly forward pointing, mostly simple, dark coppery, bristle-like hairs 1.5–4 mm long, persistent and highly conspicuous on the stem, tendril and peduncle, sparser on the lower leaf blade, and shorter and denser on the inflorescence, including the axis, lower tepal surface and staminal column. Upper leaf blade, midrib, upper tepal surface and fruit, glabrous. *Colour* of stems (when dried) purplish grey; pitchers glaucous green, flecked red, especially inside, peristome red or greenish; flowers red. — **Fig. 10.**

Distribution — Borneo: NE Sarawak and Brunei.

Ecology — Heath forest; 100–800 m.

Notes — 1. This species is closely related to *N. hirsuta*, but distinct in the amplexicaul-decurrent leaf base, and also in the pilose character of the indumentum, with dense bristle-like hairs 1.5–4 mm long (1–2 mm long in *N. hirsuta*) on purplish grey stems (brown in *N. hirsuta*). The male flowers have a staminal column only 1.5–2 mm long at anthesis (3.5–6 mm long in *N. hirsuta*). *Nepenthes hispida* appears to be common in the region surrounding the Lambir Hills of northern Sarawak, with one collection being known from nearby Brunei and the type from the Lawas River. It is also related to *N. macrovulgaris* and *N. philippinensis* which can be distinguished by being glabrous and lacking peristome teeth (see key to the *N. hirsuta* group under *N. philippinensis*).

2. This name was long overlooked, partly because of difficulties with its typification. Beck cites the type as "Am Lawas River bei 2000 bis 3000 Fuss (Low)!" At Kew there is a collection with a printed label of F.W. Burbidge attached; however, there is also a larger, hand-written label: "*N.* species, Lawas River, 2000 to 3000 feet no flowering or seeding specimens seen." At Vienna (W) there is a duplicate of this sheet with details presumably transcribed from the Kew label. Beck probably saw the Kew material as well, and probably interpreted the handwriting as Low's. The specimens accord exactly to Beck's description in both dimensions and appearance. Macfarlane in Das Pflanzenreich 4, 3 (1908) 49 placed *N. hispida* as a synonym of *N. hirsuta*, under the var. *typica* which he described there. Under this variety he cites 3 collections '(Low!, Beccari!, Burbidge!)'. Since the former specimen is most likely the type of *N. hirsuta*, the varietal name is superfluous and illegitimate. The last named specimen, however, is in all likelihood the specimen we interpret here as Beck's 'Low' specimen. Danser in Bull. Jard. Bot. Buitenzorg III, 9 (1928) 309 was sceptical of Macfarlane's treatment of *N. hispida*, but did not see the type, and placed it as a questionable synonym of *N. hirsuta*.

33. Nepenthes × hookeriana Lindl.

Nepenthes × *hookeriana* Lindl., Gard. Chron. (1848) 87, nomen; Mast., Gard. Chron. (1881) 812, f. 157; G. Nicholson, Ill. Dict. Gard. 4 (1886) 436; Gard. Chron. (1892) 561, ic. 557; Boerl., Handl. 3, 1 (1900) 54; Burb., Flora & Sylva II, 12 (1904) 111; Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 34; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 309, f. 9; Shivas, Pitcher Plants of Peninsula Malaysia & Singapore (1984) 33; Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) 94, f. 7; Jebb & Cheek, Blumea 42 (1997) 50; Clarke, Nepenthes of Borneo (1997) 153, f. 106. — Type: *Low* (not located), Borneo, Sarawak.

Nepenthes loddigesii W. Baxter, Suppl. Hort. Brit. 3 (1850) 593; Beck, Wiener Ill. Gart.-Zeitung 20 (1895) 227. — Type: not located.
Nepenthes hookeri Alphand ex Hook.f. in A.DC., Prodr. 17 (1873) 96 (in syn. *Nepenthes rafflesiana*). — Type: Alphand, Prom. de Paris, cum ic. (n.v.).
Nepenthes rafflesiana var. *hookeriana* (Lindl.) Beck, Wiener Ill. Gart.-Zeitung 20 (1895) 147.
Nepenthes rafflesiana auct. non Jack: H. Low, Sarawak (1848) 68.
[*Nepenthes hookeriana* auct. non Lindl.: H. Low, Sarawak (1848) 68 = *Nepenthes rafflesiana* Jack.]

Distribution — Sumatra, Peninsular Malaysia, Singapore, Borneo.

Ecology — Only found near populations of the two parents *N. ampullaria* and *N. rafflesiana*.

Notes — 1. *Nepenthes* × *hookeriana* is a naturally occurring hybrid between *N. ampullaria* and *N. rafflesiana* (Macfarlane, Das Pflanzenreich 4, 3 (1908)). In morphology it is intermediate between the parental species. The leaf blade exhibits the typical venation of *N. ampullaria*, with the longitudinal nerves in the outer 1/2 of the blade only, and a shortly petiolate base; the lower pitchers are urceolate with broad pitcher wings and a broad, rounded peristome, but this is not developed into the long apical neck of *N. rafflesiana*; the lid is oblong to oblong-ovate, with a blunt or notched apex, and two prominent lateral veins, the lid glands are distributed throughout, unlike those of *N. rafflesiana*, which are densest near the margins and absent from the centre.

2. Along with another naturally occurring hybrid, *Nepenthes* × *trichocarpa*, this taxon is widespread, albeit scarce. The numbers of plants present in a given population are often small and they tend to be very localised. It is possible that hybrids can only survive in marginal or disturbed habitats, since the ecologies of the two parental species is not identical. Other hybrids such as *Nepenthes* × *kinabaluensis* and *Nepenthes* × *trusmadiensis* are highly restricted in their distribution, and their identification is not problematic on a Malesian scale.

3. *Nepenthes* × *hookeriana* Lindl. in the Gardeners' Chronicle is merely a name in a list of species, referring to the name in Low's book. Hugh Low, however, accidentally, or otherwise, had described what we know as *N. rafflesiana* as *Nepenthes* × *hookeriana* and vice versa in his book Sarawak, its Inhabitants and Productions (1848). Masters was the first author to note this in the Gardeners' Chronicle (II (1881) 818, f. 157), where he gives the first full description and illustration of *Nepenthes* × *hookeriana*. However the species still effectively remained dubious taxonomically (even though its facies were well understood in horticultural circles), until Macfarlane's revision. Macfarlane (op. cit. 1908) cites several specimens, among them a Low collection from Sarawak, which would seem the most appropriate choice for a lectotype, but we have not been able to locate this specimen. *Nepenthes loddigesii* is included on the authority of Macfarlane, but no type material has been located.

34. **Nepenthes inermis** Danser

Nepenthes inermis Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 312, f. 10; Jebb & Cheek, Blumea 42 (1997) 52. — Type: *Bünnemeijer 9695* (lecto BO), Sumatra, G. Kerinci, 1800 m, 26 April 1920.
Nepenthes bongso auct. non Korth.: Tamin & M. Hotta in M. Hotta, Diversity and Dynamics of Plant Life in Sumatra (1986) 83, partim, f. 2 toto.

Canopy epiphyte, climbing to at least 45 cm tall. Stems terete to rounded triangular, (2–)3–5 mm diam., internodes of climbing stems 3.5–5.5(–9.5) cm, axillary buds in-

conspicuous. *Leaves* thinly coriaceous, sessile, those of short stems and rosettes unknown, those of climbing stems oblanceolate-spathulate to oblong, (5–)6.5–8(–12) by 1–1.6(–2.5) cm, apex rounded-acute, margin slightly revolute, base attenuate, clasping the stem for half its circumference, not auriculate or decurrent. Longitudinal nerves 2 or 3 on each side of the midrib in the outer half from the leaf base, fairly conspicuous. Pennate nerves numerous, reticulate. *Lower pitchers* unknown. *Upper pitchers* originating gradually or abruptly from the end of the tendril, incurved with a 1–2 cm arc, infundibuliform 5.5(–9) cm long, lower 1/2–2/3 cylindrical to slightly infundibular, 3.75 cm tall, 1 cm wide; upper part abruptly flaring to 4.7(–5) cm wide at the lip; wings or ribs not apparent; mouth orbicular, horizontal, not forming a column for the lid; peristome barely differentiated from rim of pitcher mouth, 0.2 mm wide, lacking teeth or ribs; lid held arched over mouth, linear-oblong, 4.5–5 by 0.2–0.4 cm, lower surface lacking appendages, nectar glands crater-like, sparsely scattered at the margins, elliptic, 0.2 by 0.1 mm; spur linear, 3–4 mm long, reflexed, unbranched. *Male inflorescence* 17 cm long; peduncle 5 cm long, c. 1.5 mm diam. at base; partial peduncles c. 50, 1-flowered; pedicels 8 mm long at base (4 mm long at apex); bract inserted near the base, small and filiform; tepals oblong-lanceolate, acute, 3 by 1 mm; staminal column c. 4 mm long. Fruits and seeds unknown. *Indumentum* inconspicuous, puberulent, hairs erect, simple, 1–2 mm long, stems soon glabrescent, but hairs persisting in leaf axils and on pitcher lid, leaves and pitchers glabrous. *Colour* of pitchers yellowish green, drying blackish brown.

Distribution — Sumatra.

Ecology — Epiphytic in moss forest; 2300–2590 m (Hopkins et al. in Carnivorous Plant Newsl. 19 (1990) 19–28).

Notes — 1. *Nepenthes inermis* is most likely to be confused with *N. dubia* or *N. bongso* which occur in the same general area of Sumatra and both of which can have similar proportions, indeed, all three species have been united by Tamin & M. Hotta under the name *N. bongso*. *Nepenthes inermis* is easily recognised by the absence of a ridged or dilated peristome and by the linear-oblong lid that overarches the mouth.

2. This species remains poorly known, and as yet the lower pitchers have never been collected. The remarkable upper pitchers lack a peristome, and have a very narrow lid. The tendril may or may not be coiled, an unusual habit – in the majority of species they are always coiled in upper pitchers. The pitcher fluid is said to be extremely viscous, forming long stringy droplets when the pitcher is upset. An unrelated species, *N. eymae* shares the same combination of infundibulate pitcher, narrow lid and viscous pitcher fluid. It has been suggested, and demonstrated in greenhouse-grown plants, that the infundibuliform pitcher and the highly viscous pitcher fluid allows rainwater to be shed from the pitcher without diluting or washing away the partly-digested contents. The weight of rainwater causes the pitcher to overbalance, shedding the water from the broad mouth, whilst the narrow shape of the lower part of the pitcher, and the viscosity of the column of fluid that it contains, prevents mixing with the supernatant rainwater (Wistuba 1994 21 September 1994 09:14:56 GMT+1. 'CP' Bulletin board: listproc@opus.hpl.hpl.com, archived as CP. 94ALL part [41/55]). A survey of 22 pitchers (under the name *N. bongso*) suggests that this species traps a very high proportion of dipterans (flies) compared to other Sumatran species surveyed (Kato et al. in Trop. Ecol. 6 (1993) 11–25).

35. Nepenthes insignis Danser

Nepenthes insignis Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 314, f. 11; Jebb, Science in New Guinea 17 (1991) 24, f. 10; Rischer, Carnivorous Plant Newsl. 24 (1995) 75; Jebb & Cheek, Blumea 42 (1997) 52. — Type: *Pulle 277* (lecto BO; iso BO (1 in alcohol)), New Guinea, Irian Jaya, Beaufort River, 80 m, 9 Nov. 1912.

Epiphytic shrub or climber c. 80 cm tall. Stem triangular, 0.5–0.7 cm diam. *Leaves* thinly coriaceous, sessile, those of climbing stems linear-lanceolate to slightly spathulate, 20–35 by 4–6 cm, apex acute, base attenuate, decurrent into 2 wings descending 1/3–2/3 the length of the internode. Longitudinal nerves 4–6 on each side of the midrib in outer half of the lamina very conspicuous. Pennate nerves numerous, running obliquely, to margin. In the dry state only the longitudinal nerves are visible on the lower surface. *Lower pitchers* ovoid in the lower half, gradually becoming cylindrical in the upper half, to 16 cm high, 5 cm wide, with 2 narrow, sparsely denticulate wings; mouth oblique, fairly straight; peristome expanded, 6–12 mm broad, ribs 0.5–0.75 mm apart, conspicuous, outer edge conspicuously sinuate; lid suborbicular-ovate, rounded at the apex, rounded to cordate at the base, c. 5 by 4.5 cm, lower surface lacking appendages, with a distinct, thickened midline and 2 prominent lateral veins, nectar glands large, bordered, clustered about the veins; spur filiform, 5 mm long, acute, unbranched. *Upper pitchers* stout, infundibulate, sharply triangular in section at base, 16–30 by 5–8 cm, with 2 prominent ribs over the whole length, rarely with two fringed wings c. 2 mm broad; mouth oblique, straight and not concave; peristome expanded, widest at the sides, 0.8–3.5 cm broad, ribs 0.5–1 mm apart, c. 0.2 mm tall, conspicuous, outer edge sinuate, inner edge shortly and inconspicuously toothed; lid 4.5–7.5 by 4.5–7.5 cm, nectar glands dense, pit-like, transversely elliptic or orbicular, 0.6–1 mm long, absent from a 5 mm band along the midline, smaller and sparser in the marginal 1 cm; spur as lower pitcher. *Male inflorescence* 32–54 cm long; peduncle angular and grooved, 12–18 cm long, 5–7 mm diam.; partial peduncles nearly all 2-flowered; bracts absent; pedicels 17–22 mm long; tepals oblong, 4 mm long; androphore c. 5 mm long. Fruit and seed unknown. *Indumentum* absent from stems and leaves; young pitchers with short deciduous stellate hairs; inflorescence with spreading and stellate hairs from base of peduncle to lower surface of the tepals; androphore hairy at base. *Colour* of pitchers dark green in the lower half, yellow above with deep red spots; peristome reddish brown (Rischer in Carnivorous Plant Newsl. 24 (1995) 75–77).

Distribution — New Guinea: Irian Jaya, including Biak Island.

Ecology — Canopy of lowland evergreen forest, rarely terrestrial on river banks; 80–850 m.

Notes — 1. The winged leaf base, decurrent down the stem, the broad peristome with toothed inner margin, and 2-flowered partial peduncles separate *N. insignis* from all others species in New Guinea. *Nepenthes insignis* belongs with a grouping characterised by their often epiphytic nature, sessile leaves, angular stems, often large pitchers with a broad, only slightly rounded peristome which often lacks a revolute outer margin, and a lid in which the glands are absent from the midline and often transversely elliptic. This group was named the Insignes by Danser in Bull. Jard. Bot. Buitenzorg III, 9 (1928) 405 and includes *N. burkei, N. merrilliana N. northiana, N. sibuyanensis, N. ventricosa,* and possibly *N. bellii.*

2. *Nepenthes insignis* was only known from four collections with scanty field notes gathered many decades ago until its recent rediscovery (Rischer l.c. 1995), from which the colour and habitat notes above are derived.

36. Nepenthes × kinabaluensis Sh. Kurata ex J.H. Adam & Wilcock

Nepenthes × *kinabaluensis* Sh. Kurata ex J.H. Adam & Wilcock, Sarawak Mus. J. 50 ('1996', 1998) 152; Sh. Kurata, Nepenthes of Mt Kinabalu, Sabah (1976) 64, pl. 21, nomen. — *Nepenthes* sp. Macfarl., J. Linn. Soc., Bot. 42 (1914) 127. — *Nepenthes rajah* × *Nepenthes villosa* Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 363; Phillipps & A.L. Lamb, Nature Malaysiana 13, 4 (1988) 23; Pitcher Plants of Borneo (1996) 95, f. 51; Jebb & Cheek, Blumea 42 (1997) 53; Clarke, Nepenthes of Borneo (1997) 165, f. 117 & 118. — Type: *Jumaat 2423* (holo UKMS n.v.; iso ABD n.v., SAR n.v., SNP n.v.), Borneo, Mt Kinabalu, Summit Trail, 2790–2850 m, 21 Jan. 1988.

Intermediate between *N. rajah* Hook.f. and *N. villosa* Hook.f.; whole plant covered by villose hairs; leaf peltate tipped; lid large, round; peristome broad wavy, with expanded teeth.

Distribution — Borneo: Sabah (western slopes of Mt Kinabalu).

Ecology — *Leptospermum/Dacrydium* forest on ultrabasic soils; 2420–3030 m (Phillipps & A.L. Lamb in Pitcher Plants of Borneo (1996) 95).

Note — Although long recognised as a hybrid, it has only recently been confirmed that this taxon comprises two large, self-sustaining and apparently true-breeding populations of several hundred individuals (A. Phillipps, pers. comm.). In contrast are the cases of *Nepenthes* × *hookeriana* and *Nepenthes* × *trichocarpa*, which although recorded from many sites where the parental species occur together, are found as isolated individuals and not as self-sustaining populations. In further support of species status for *Nepenthes* × *kinabaluensis*, J.H. Adam & Wilcock in J. Trop. For. Sci. 10, 4 (1992) 456–471 report that the pollen of the much rarer hybrid between *N. burbidgeae* and *N. rajah* produces largely sterile pollen whereas that of *Nepenthes* × *kinabaluensis* is almost 100% fertile and that plants of *N. rajah* are not to be found nearby. However, as there is no character that distinguishes this plant from its parents, we follow Kurata in Nepenthes of Borneo (1976) 64 in maintaining this taxon as a hybrid, rather than a species as advocated by J.H. Adam & Wilcock in Sarawak Mus. J. (1998) 75–77.

37. Nepenthes klossii Ridl.

Nepenthes klossii Ridl., Trans. Linn. Soc. London, Bot. II, 9 (1916) 140; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 317, f. 12; Jebb, Science in New Guinea 17 (1991) 26, f. 12; Jebb & Cheek, Blumea 42 (1997) 54. — Type: *Boden Kloss s.n.* (lecto SING), Irian Jaya, Utakwa expedition to Mt Carstensz, Camp VIb, 26 Jan. 1913.

Terrestrial shrub or climber (?) to unknown height. Stem triangular, c. 1 cm diam. with prominent axillary buds. *Leaves* coriaceous, petiolate, those of the climbing stems lanceolate to oblong-lanceolate, 18–25 by 6.5–9 cm, apex obtuse, base gradually or abruptly tapering; petiole winged, c. 6 cm long, wings 5 mm broad, clasping stem by about 1/2 its circumference, decurrent as two ridges to 1/2 way down the internode. Longitudinal nerves obscure, 3 or more on each side of the midrib, in the outer 1/3 or 1/4 of the leaf blade. Pennate nerves inconspicuous. *Lower pitchers* unknown. *Upper*

pitchers abruptly originating from the tendril, infundibuliform in the lower part, cylindrical above, c. 20 by 5 cm, with two prominent ribs over the whole length, mouth suborbicular, oblique to vertical, facing forward, acuminate and nearly horizontal towards lid; peristome curved, 3–5 mm wide, ribs 0.3–0.7 mm apart, outer and inner edges entire; lid suborbicular, c. 5 by 5 cm, apex rounded, slightly cordate at the base, with 2 appendages on the under side, basal appendage laterally flattened, slightly recurved or triangular, c. 1 by 1 cm, glandular, inserted along a midline ridge 1–2 mm high that extends to the poorly defined, inconspicuous, non-glandular apical appendage, nectar glands orbicular, bordered, 0.4–0.7 mm diam., densely scattered, larger (2(–3) mm long) and longitudinally elliptic along the midline; spur entire, 8–10 mm long. *Male inflorescences* unknown. Infructescence c. 32 cm long; peduncle 18 cm long; partial peduncles 2-fruited (rarely 1- or 3-fruited); pedicels c. 8 mm long; tepals oblong, 3 by 1 mm. Fruit c. 15 mm long. Seeds unknown. *Indumentum* of orange-brown dense long, simple or slightly branched hairs to 1.5 mm long and of short spreading stellate hairs, densest on young parts, lower leaf blade, above and below midrib, pitcher and infructescence, including fruit. *Colour* of lid deep purple, remainder of pitcher probably reddish.

Distribution — New Guinea: Irian Jaya (Nassau Mts and Wissel Lakes).

Ecology — Unknown, possibly grassland at 1000–2000 m.

Notes — 1. The lid appendages, leaf venation and 2-flowered partial peduncles of *N. klossii* show that it is closely related to the highly variable *N. maxima*. Eyma's collection of this species from the Wissel Lakes area, indicate that *N. klossii* and *N. maxima* may well grow together (*Eyma 4893* = *N. klossii, Eyma 4894* = *N. maxima*). The distinction between the two species is slight, and lies in the denser pubescence, thicker leaf blade, and the forward-directed mouth of *N. klossii*, and, in the absence of the evidence of their sympatry we would be less inclined to recognise *N. klossii*.

2. Only three collections of this species have been made, the Kloss collections from the Nassau Mts, and Eyma's Wissel Lakes collection. Eyma's collection (*4893*) is undoubtedly a good match for Danser's specimen (*Kloss s.n.*, BO) and shows features which are obscure on the Kloss specimen (due to the manner in which they have been pressed and mounted), notably the distinctive 'hooded' appearance of the pitcher mouth, and the presence of 2 crest-like appendages on the underside of the lid as opposed to the single crest observed by Danser.

38. **Nepenthes lamii** Jebb & Cheek

Nepenthes lamii Jebb & Cheek, Blumea 42 (1997) 54. — Type: *Lam 1637* (holo BO; iso BO), New Guinea, Irian Jaya, Doorman Top, 3200 m, 17 Oct. 1920.

Nepenthes vieillardii auct. non Hook.f.: Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 393, partim, f. 26, toto; Jebb, Science in New Guinea 17 (1991) 45, f. 27.

Shrub or climber to 2–3 m tall. Stem rounded or angular, often greatly contracted, 0.1–0.6 mm diam., internodes up to 8 cm long. *Leaves* thinly coriaceous, sessile, those of climbing stems lanceolate, 5–14 by 1.2–2.8 cm, apex acute, base decurrent as converging wings or ridges for c. 2 cm below the node. Longitudinal nerves (0–)3 or 4 (or 5) on each side of the midrib in outer 1/3–1/4 of the lamina. Pennate nerves distinct or

indistinct, running obliquely from midrib and forming an irregular network in the outer 1/2 of the blade, fairly conspicuous. *Lower pitchers* obovoid throughout, or somewhat cylindric above, c. 11 by 4 cm, with 2 fringed wings up to 8 mm broad, the fringe elements to 4 mm long, or the wings reduced to 2 ridges; mouth suborbicular, straight, oblique; peristome 1–5 mm broad, ribs 0.3–0.5 mm apart, outer edge entire, teeth on inner margin to 0.3 mm long; lid orbicular, flat, 2.5–4 cm diam., apex rounded, base rounded to cordate, lower surface lacking appendages but often with the midline thickened into a low keel c. 1 mm high, nectar glands throughout, dense, orbicular, thinly bordered, 0.1–0.2 mm diam., 1500–2000 glands/cm^2, larger (0.4 mm long) and longitudinally elliptic along midline; less usually much larger, 3 mm diam. overall with thickened borders (1.5 mm within borders); spur simple, sometimes flattened, 1–5 mm long. *Upper pitchers* cylindrical, slightly constricted in the upper 1/2, rarely obovoid throughout, 4–14 by 1–3 cm, lacking fringed wings, otherwise as the lower pitcher. *Male inflorescence* 8.5–14 cm long; often much contracted; peduncles 5.5–7 cm long, 2 mm diam. at base; partial peduncles 1-flowered; pedicels to 10 mm long; bracts absent; tepals elliptic, 2.2–3 by 1.8–3.3 mm; androphore 1.5–2.5 mm long; anther head 0.7–1.25 by 1.5 mm. *Indumentum* very sparse, sparsely woolly-scurfy, pale brown, 0.2–0.4 mm long on new innovations, but becoming glabrescent except on inflorescence and tendril where inconspicuously puberulent with patent simple, black hairs c. 0.3 mm long. *Colour* of pitchers green, the peristome red, interior of pitcher pale green, sometimes suffused with red.

Distribution — New Guinea: Irian Jaya (Mts Doorman and Erica).

Ecology — Epiphyte in mossy forest, or amongst scrub and grass above tree-line; 1460–3520 m.

Notes — 1. Once treated as an outlying population of the New Caledonian *N. vieillardii* from which it can be distinguished by its almost glabrous nature (vs. sparse to dense white hairs c. 1 mm long in *N. vieillardii*). *Nepenthes lamii* also has somewhat more widely spaced peristome ribs (0.3–0.4 mm apart vs. 0.2–0.3 mm in *N. vieillardii*) and denser nectar glands on the underside of the lid: 1500–2000 glands/cm^2 (vs. 75–100 glands/cm^2 in *N. vieillardii*). *Nepenthes lamii* is a variable species: at high altitudes in grassland it becomes a dwarfed and stunted shrublet (e.g. *Lam 1637 & 1654*) whilst specimens from moss forest at lower altitude are slender climbers. Some of the collections from the Hellwig Mts (*Pulle 803*, *Von Römer 1037*) are very small, delicate plants. In some collections, notably the type specimen, the tendrils are densely glandular.

2. The illustrations of *N. vieillardii* in both Danser in Bull. Jard. Bot. Buitenzorg III, 9 (1928) f. 26 and Jebb in Science in New Guinea 17 (1991) f. 27 are of *N. lamii*.

3. The species is named after Professor Herman Lam, who made the first collections of this plant during the Van Overeem Expedition to Mt Doorman in 1920.

39. **Nepenthes lavicola** Wistuba & Rischer

Nepenthes lavicola Wistuba & Rischer, Carnivorous Plant Newsl. 25 (1996) 106, f. 1–5. — Type: *Wistuba & Rischer 26032* (holo L), Sumatra, Aceh, G. Telong, 2000 m, 26 March 1996.

Terrestrial climber to 3 m tall. Stems of short shoots terete, 5 mm diam., internodes c. 5 mm long; climbing shoots terete with a groove beginning in each axil spreading to

give a flattened side and so stem in part obscurely triangular, 4–7 mm diam., internodes 4–8 cm long, axillary buds inconspicuous. *Leaves* coriaceous, sessile or obscurely petiolate; short shoot leaves oblanceolate to oblanceolate-spathulate, 6.5–11.5 by 2–2.8 cm, apex acute to obtuse, base attenuate, clasping the stem for 1/2–2/3 its circumference and decurrent as wings for c. 3 mm; leaves of climbing stems narrowly oblong, rarely subpetiolate, 11–17 by 2–3.2 cm, apex obtuse, not peltate, base clasping the stem for 1/2–2/3 its circumference, decurrent and slightly amplexicaul as a straight wing c. 5 mm wide, 6–15 mm below the axil. Longitudinal nerves 4 or 5 (2 in the short-stem leaves) on each side of the midrib in the outer 1/2, inconspicuous. Pennate nerves oblique, inconspicuous. *Lower pitchers* broadly ovoid to globose, with a short subcylindrical apex, 4.5–6.5 by 3.5–4.2 cm, with two fringed wings 1.5–4 mm wide, fringed elements 3–5.5 mm long, 1.5–3 mm apart; mouth highly concave, horizontal at the front rising to the vertical, or overarching, at the rear; peristome subcylindrical, 3 mm wide, ribs 0.5 mm apart, 0.2 mm high, with intermediate striae, outer edge entire, inner edge with teeth c. 0.5 mm long, conspicuous only at the rear; lid orbicular, 2–2.2 by 2–2.1 cm, apex rounded, base cordate, lower surface lacking appendages, nectar glands 15–50 scattered along the midline, circular, narrowly bordered, 0.3–0.5 mm diam.; spur 3–5 mm long, tapering to a point, entire or forked within 1 mm of the apex. *Upper pitchers* narrowly infundibuliform or slightly ventricose in the lower half and cylindrical above (9–)12.5–15.5 by 3–3.4 cm, lacking fringed wings but with two ridges; mouth ovate, concave, oblique, rising from near horizontal to near vertical at the rear, peristome as in the lower pitcher, but slightly flattened and up to 8 mm wide in the rear half, c. 2 mm wide in the front; lid ovate, 3.2–3.8 by 2.4–2.9 cm, apex rounded, base cordate, lower surface lacking appendage or keel, nectar glands circular, narrowly bordered, c. 0.3 mm diam. in the centre, 0.2 mm diam. towards the margin, along the midline longitudinally elliptic, 0.4 mm long; spur tapered to a point, 5 by 0.75 mm, entire. *Male inflorescence* c. 38 by c. 3 cm; peduncle 18 cm long, 3 mm diam. at base; partial peduncles c. 60, 2-flowered (1-flowered towards the apex of the rhachis), 0–4 mm long; bract inserted near the base of the partial peduncle or on the rhachis adjoining, attenuate, 6–8 by 0.5 mm, apex acute; pedicels 5–8 mm long; tepals 4–5 by 2–2.5 mm; androphore (2–)3.5–4 mm long; anther head 1.5 by 1.75–2 mm. Infructescence 26.5 by 5.5 cm; peduncle erect, 19.5 cm long, c. 5 mm diam. at base; partial peduncles up to 40, 2-fruited; bracts 16–18 mm long. Fruits with valves 17–20 by 2–4 mm. Seeds filiform, 7 by 0.2 mm. *Indumentum* of sessile red glands c. 0.1 mm diam. on stems, upper and lower leaf surfaces and on pitchers; pale to mid-brown simple or sparsely branched hairs 0.2–0.3 mm long in patches in the axils of the youngest leaves and in the stem grooves, hairs of this type also sparsely and inconspicuously scattered along the upper and lower leaf midrib, and scattered over the pitcher and upper lid including the spur where they are fine, greyer and arachnoid and mixed with minute white stellate hairs; inflorescence velvety with dull, pale brown patent hairs 0.1–0.3 mm long, present from peduncle base to lower tepals; androphore with scattered dull red-brown semi-patent hairs 0.3–0.5 mm long on the lower 2/3. *Colour* of pitchers dark brownish purple to almost black, rarely yellowish green with black spots, peristome yellowish green, sometimes with red stripes, mouth pale green in upper pitchers, spotted red in lower pitchers. Flower colour unknown. — **Fig. 11.**

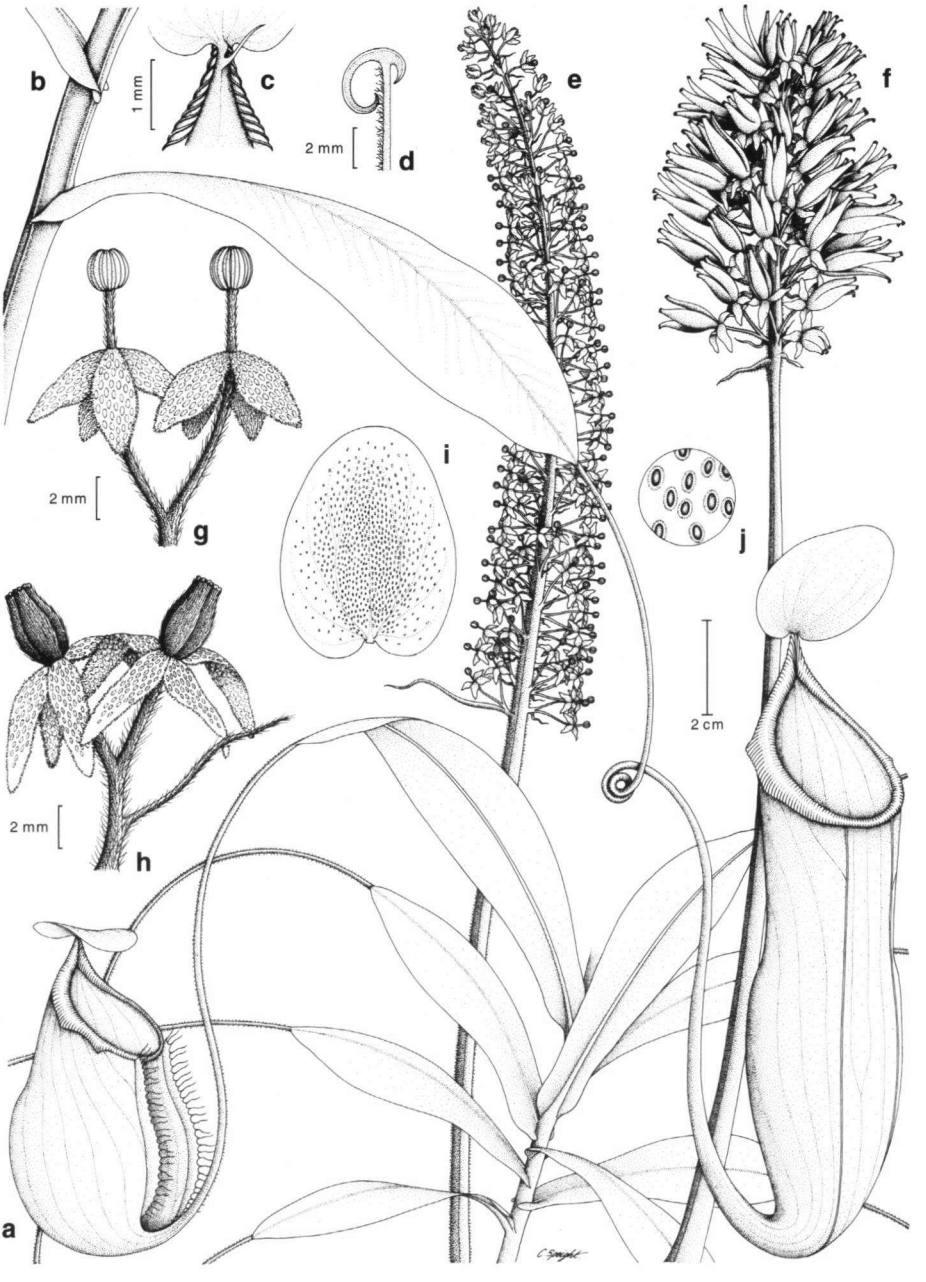

Fig. 11. *Nepenthes lavicola* Wistuba & Rischer. a. Short stem with lower pitcher; b. climbing stem with upper pitcher; c. spur; d. section of peristome; e. male inflorescence; f. infructescence; g. partial inflorescence with male flowers; h. partial inflorescence with female flowers and bract; i. underside of lid; j. detail of glands on lower lid surface (a: *Wistuba & Rischer 26035* (0); e, g: *Wistuba & Rischer 26031* (m); f: *Wistuba & Rischer 26032* (f); b–d, i, j: *Wistuba & Rischer 26033* (0); h: *Wistuba & Rischer 26034* (f)). Drawn by Camilla Speight.

Distribution — Sumatra: C Aceh.

Ecology — Open slopes on old lava flow dating from 1856; 2000–2600 m.

Notes —1. *Nepenthes lavicola* seems most closely related to *N. spectabilis* in its elongated, slightly infundibuliform upper pitchers, in the ovate lid, in the similar nectar gland shape and distribution and in the stem and leaf morphology. However, *N. lavicola* has shorter upper pitchers with a mainly rounded, narrower (not flattened, broader) peristome which has more prominent ribs than in *N. spectabilis*, and in all these characters approaches *N. singalana*. *Nepenthes lavicola* is distinguished from *N. spectabilis* in being distinctly less hairy, in the short (3–5 mm rather than 10–22 mm long), pointed, sometimes bifurcate spur, in the shorter fruit valves (17–20 mm not c. 40 mm) and in the tendency to longer bracts (16–18 mm long in the female of *N. lavicola*).

2. *Nepenthes lavicola* together with *N. mikei* (the latter collected by Frey-Wyssling in the same area in 1930) are the most northerly, by about 120 km, of all Sumatran *Nepenthes*. *Nepenthes lavicola* is the only species of the genus recorded from lava. It is known to us only from the specimens cited, all gathered in a few adjoining hectares. Wistuba & Rischer suggest in their protologue (cited above) that it is likely to be found elsewhere on the G. Geuredong massif, e.g. also on G. Geuredong and G. Popandji.

40. Nepenthes lowii Hook.f.

Nepenthes lowii Hook.f., Trans. Linn. Soc. 22 (1859) 420, t. 71; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 321; Sh. Kurata, Nepenthes of Mt Kinabalu, Sabah (1976) 53; Phillipps & A.L. Lamb, Nature Malaysiana 13, 4 (1988) 19, 20; Pitcher Plants of Borneo (1996) 98, f. 53; Jebb & Cheek, Blumea 42 (1997) 55; Clarke, Nepenthes of Borneo (1997) 96, f. 64–66; J.H. Adam & Wilcock, Sarawak Mus. J. 50 ('1996', 1998) 154, f. XXIVb. — Type: *Low s.n.* (lecto K; iso K), Borneo, Sabah, Kinabalu.

Terrestrial or epiphytic climber to 10 m tall. Stems terete or slightly ridged, 6–10 mm diam., internodes of climbing stems 3–7 cm long, axillary buds absent. *Leaves* coriaceous, petiolate; leaves of rosettes obovate, c. 7 by 4 cm, apex truncate to retuse, base cuneate; petiole to 2–3 cm long; leaves of short and climbing stems with blade narrowly oblong-lanceolate, 15–30 by 6–9 cm, apex rounded, base obtuse; petiole stout, canaliculate, 4–14 cm long, not auriculate, but slightly sheathed at the base, clasping the stem for 1/2–4/5 its circumference and sometimes with narrow, straight, decurrent ridges up to 10 mm long. Longitudinal nerves 2–4 on each side of the midrib in the outer 1/3, conspicuous. Pennate nerves inconspicuous. *Lower pitchers* rarely collected, subcylindrical, up to 13 by 4 cm, with two fringed wings in the upper 3/4, each 4–5 mm wide, fringed elements 3–5 mm long, 1–2 mm apart; mouth broadly ovate, oblique, concave, rising to the vertical near the lid to form a short column; peristome ± cylindrical, 2–3 mm wide, with well-defined ribs 1–1.5 mm apart, outer edge entire, inner edge long, flat, to 10 mm wide, with teeth 1–2 mm long; lid orbicular to ovate, c. 3.5 by 3.5 cm, lacking appendages, but with numerous patent, hair-like growths up to 10 mm long, nectar glands pit-like, c. 0.1 mm diam., situated at truncated ends of hair-like growths and on lid surface, often surrounded by dome-like, thick border c. 0.4 mm diam. *Upper pitchers* subwoody, 15–20(–28) cm high, the lower part globose or obliquely ovoid, 5–10 cm wide, held horizontally, with one side lowest, upper part

curved upwards, then highly constricted before abruptly flaring out in the upper, infundibuliform part to about 6–12 cm wide at the mouth, wings reduced to ribs; mouth broadly ovate, oblique, straight; peristome reduced, detectable only as a line of corrugations 2 mm apart inside the rim; lid ovate-elliptic, 9–14 by 5.5–9 cm, apex rounded, base cordate, strongly keeled and vaulted and held erect, at c. 120° to the mouth, lower surface without appendages, but with numerous hair-like structures on the lower surface (see lower pitchers); spur unbranched, 14 mm long. *Male inflorescence* 15–37 cm long; peduncle 7–17 cm long, 0.3 cm diam. at base; partial peduncles 2-flowered, 0.5–4 mm long; bracts absent; pedicels 12–15 mm long; tepals elliptic, 4 by 3 mm; androphore 2–4 mm long; anther head 0.7–1.5 by 1.7–2 mm. Fruit valves 17–27 by 3–4 mm. Seed fusiform, 12–14 mm long, central part smooth. *Indumentum*: pubescent with short brown stellate hairs, rarely persisting on mature parts apart from lower midrib and edge of leaf blade. *Colour* of pitcher dark green outside, dark red inside; inflorescence dark red.

Distribution — Borneo: Sabah (Mts Kinabalu, Trus Madi), Sarawak (Hose Mts, G. Buli, Tama Abu range, Bario, Mt Murud, Mt Mulu), Brunei, and Kalimantan.

Ecology — Mossy forest, ridge tops on sandstone, granite, ultramafic or limestone; 1600–2600 m.

Notes — 1. *Nepenthes lowii* is distinguished from the similar *N. ephippiata* by its relatively smaller lid, with longer, slender bristles (6–7 by 0.5 mm tapering to a point) vs. the short, stout processes (3 by 2 mm tapering to a blunt 1 mm diam. apex) of the latter, and by its distinctive pitchers with their highly constricted waist, and the much reduced peristome which is still evident in the upper pitchers of *N. ephippiata*.

2. *Nepenthes lowii* is a singular species in the semi-woody, upper pitchers which have the lower part laterally reclined, lack a proper peristome and are extremely constricted at their midpoint. The lower pitchers are somewhat cylindrical and bear a well-developed peristome. The upper pitcher is green outside and a deep maroon red inside. The lid is relatively small, reflexed and has many long tapering bristles c. 6 mm in length. These bristles generate a white gelatinous exudate, although the composition and purpose is unknown (Phillipps & A.L. Lamb in Pitcher Plants of Borneo (1996) 98). Wistuba (1994) has suggested that the unusual pitcher shape may be an adaptation to prevent rainwater from diluting or leaching the pitcher contents below the narrow 'waist'. Some collectors have remarked on the ability of these pitchers to trap leaf litter 'a *vegetarian* pitcher plant' (Ed de Vogel, pers. comm.). The tree shrew *Tupaia montana* has often been referred to by collectors as 'licking' the underside of the lids (presumably ingesting the white exudate), or 'hunting for snails' on the underside of the lids (Smythies in Symposium on Ecological Research in Humid Tropics Vegetation (1965) 170–178). Clarke in Nepenthes of Borneo (1997) 96 speculates that *N. lowii* may benefit from trapping tree shrew excrement as well as fallen leaves, and found animal excrement accounting for a large part of the pitcher detritus at five of the seven sites from which he studied pitchers of this species. Perhaps ingestion of the lid exudate prompts defecation in *Tupaia*! The species can be locally common in undisturbed areas but suffers greatly from curious humans (Phillipps & Lamb l.c. 1996).

Hybrids — Three naturally occurring hybrids involving this species have been described:

1. *Nepenthes lowii* × *N. macrophylla* — *Nepenthes* × *trusmadiensis* Marabini, Mitt. Bot. Staatssamml. Münch. 19 (1983) 449; Phillipps & A.L. Lamb, Nature Malaysiana 13, 4 (1988) 21, 22; Pitcher Plants of Borneo (1996) 142, f. 76; Clarke, Nepenthes of Borneo (1997) 160, f. 112.

Upper pitchers with the form of *N. lowii*, with constricted middle, and a broadening mouth, but with a large peristome, and a very large lid lacking bristles below. The outer surface is predominantly green, and the inner surface deep red as in *N. lowii*.

Distribution — Borneo: Sabah (Mt Trus Madi).

Note — This natural hybrid between *N. macrophylla* and *N. lowii* was said to be frequent on the summit of Mt Trus Madi in Sabah. However, recent visitors to the mountain suggest that their may be only a solitary, although somewhat large individual (Martin Sands, pers. comm.). It is of note that no equivalent hybrids have been found on Mt Kinabalu, where the closely related *N. edwardsiana* is to be found growing with *N. lowii*.

2. *Nepenthes lowii* × *N. pilosa* Clarke, Nepenthes of Borneo (1997) 160, f. 113, 114.

Upper pitchers narrowly campanulate, similar to the lower pitchers of *N. lowii* with a somewhat swollen basal part, and prominent flattened peristome; lid triangular, base and apex truncate, with a narrow glandular crest.

Distribution — Borneo: Sarawak (Baram District, Bt. Batu Buli); Sabah (Crocker Range).

Note — Clarke (l.c. 1997) illustrates two very distinct colour forms of this hybrid.

3. *Nepenthes lowii* × *N. stenophylla* Phillipps & A.L. Lamb, Nature Malaysiana 13, 4 (1988) 10; Pitcher Plants of Borneo (1996) 154, f. 82; Clarke, Nepenthes of Borneo (1997) 162, f. 115.

Pitchers tubular, but constricted towards middle, with a large, rounded peristome, and lid with bristles, and which produces white exudate.

Distribution — Borneo: Sabah (Mt Mentapok); Brunei (Bukit Pagon).

Note — Found as rare individuals in mixed populations of *N. lowii* and *N. stenophylla* (Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) 154). Mossy forest above 1500 m.

41. Nepenthes macfarlanei Hemsl.

Nepenthes macfarlanei Hemsl., Proc. Linn. Soc., 6/4/1905 (1905) 12; Hook.f., Icon. (1906) 29, t. 2814, 2815; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 323; Shivas, Pitcher Plants of Peninsula Malaysia & Singapore (1984) 35; Jebb & Cheek, Blumea 42 (1997) 57. — Type: *King's Collector 7421* (lecto K; iso K), Peninsular Malaysia, Perak, nearly on top of G. Bubu, 4800–5300 ft, 1885.

Terrestrial, sometimes epiphytic, climber to 3 m tall. Stems obtusely angular, 3.5–6.5 mm diam. *Leaves* coriaceous, sessile, blade oblong or narrowly elliptic-oblanceolate, apex rounded to acute, base cuneate, clasping the stem for 1/2–3/4 its circumference, auriculate, auricles 2–4 mm wide, shortly decurrent for 3–4 mm at an angle of

45°; basal rosette leaves not seen; leaves of short stems subspathulate, ± 15.5–35 by 1.8–4 cm; leaves of climbing stems shorter and more oblong, 4–10.5(–11.9) by 1.5–2.3(–2.7) cm. Longitudinal nerves 3 or 4 on each side of the midrib in the marginal 2/3 of the blade, obscure except in lower leaves. Pennate nerves numerous, at 50–90° from the midrib, overlapping the longitudinal nerves. *Lower pitchers* ovoid or broadly cylindrical and slightly ventricose, 13–15 by 6–8 cm, with two fringed wings 3–4 mm broad, fringed elements 5–7 mm long, 3–5 mm apart; mouth ovate, acute near lid, oblique, at ± 45° to the pitcher axis, concave; peristome flattened, 5–10 mm wide, ribs conspicuous, 0.5 mm apart, interspersed with 10 striae, outer edge not sinuate, inner edge with teeth 0.7–1.25 mm long; lid suborbicular, usually oblate, 5.5–5.7 by 5.7–7 cm, apex rounded, base ± deeply cordate, lower surface appendages absent, nectar glands numerous, round to elliptic, crater-like, 0.5–0.7 mm diam., each with a low, thin pale margin; spur flattened, 8–20 mm long, apex entire or divided into 2 or 3 lobes each c. 2 mm long. *Upper pitchers* as the lower but slightly infundibulate and abruptly contracted immediately below the peristome, rarely infundibulate in the lower half and constricted, then cylindrical in the upper, 9–14(–18) cm high, 1.8–2 cm wide at the base, 4–4.7 cm wide below the peristome, with two ribs < 1 mm wide; mouth horizontal at front, abruptly vertical at lid end; peristome flattened, 1–10 mm wide, ribs 0.3–0.6 mm apart, c. 0.5 mm high, outer edge entire, inner edge with teeth 1 mm long; lid broadly ovate, often broader than long, 2.4–5.5 by 2.7–5.5 cm, apex rounded, base cordate, lower surface with nectar glands crater-like, orbicular, (0.3–)0.4–0.6(–1.25) mm wide; spur ± 4 mm long. *Male inflorescence* 14–26 cm long; peduncle 8–13 cm long; partial peduncles 30–40, 2-flowered, 2–5 mm long; bracts 1.5–3 mm long; pedicels ± 6 mm long; tepals oblong, ± 4 by 2.5 mm; androphore 2–3 mm long; anther head 1–1.5 mm wide. Fruit valves 14.5–20 mm long. Seeds fusiform, ± 12 mm long, tuberculate at centre. *Indumentum* of stem and leaves lacking, except midrib and young stem with dense, stout, erect, white or red hairs, 0.2–0.3 mm long, sparsely branched; pitchers with appressed simple white or coppery hairs 1 mm long, or glabrous; inflorescence axis with appressed simple copper-coloured hairs. *Colour* of lower leaf brown when dry; pitchers pale green, often the upper half white or cream, mottled with red, sometimes the whole purplish red with darker blotches; inner surface waxy white with red blotches; lowers pale green, red or waxy brown

Distribution — Peninsular Malaysia (Perak, Selangor, Kelantan, Terengganu, Pahang, Malaka).

Ecology — Mountain ridges, usually in shady sites on mossy banks; 1000–2150 m.

Notes — 1. *Nepenthes macfarlanei* is immediately recognisable by the presence of bristles on the underside of the lid, seen in no other species of Peninsular Malaysia. The upper pitchers are unusual in the way they are abruptly contracted at the mouth. Other features are that the peristome is flattened, and developed into a short column at the apex, the inner part of which is markedly toothed. The lower pitchers may be on tendrils up to 90 cm long.

2. Danser in Bull. Jard. Bot. Buitenzorg III, 9 (1928) 323 has already pointed out that some collections appear intermediate between *N. macfarlanei* and *N. gracillima* or *N. sanguinea* (see *N. gracillima* for notes).

42. Nepenthes macrophylla (Marabini) Jebb & Cheek

Nepenthes macrophylla (Marabini) Jebb & Cheek, Blumea 42 (1997) 58; Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) 101, f. 54; Clarke, Nepenthes of Borneo (1997) 99, f. 67. — Type: *Marabini 2167/48* (holo ER n.v.; iso M n.v.), Borneo, Sabah, Mt Trus Madi, 2500 m, 1983.

Nepenthes edwardsiana Hook.f. subsp. *macrophylla* Marabini, Mitt. Bot. Staatssamml. Münch. 23 (1987) 427; Phillipps & A.L. Lamb, Nature Malaysiana 13, 4 (1988) 21 (as *N. edwardsiana*).

As for *N. edwardsiana*, but leaf blade larger, to 35(–60) by 12(–20) cm. *Upper pitchers* semi-woody, shortly cylindrical, slightly constricted at the midpoint, 22–28 cm long, 6.5–8.5 cm wide at base and apex, 6–7 cm wide at midpoint; peristome ribs shallower, 1(–3) mm high, 5–8 mm apart; lid larger, 9–12 by 9–10.5 cm. *Inflorescence* 38–78 cm long; peduncle 15–23 cm long, 0.4 cm diam. at the base; partial peduncles 1-flowered, pedicels ± 250, 15–16 mm long; bracts 1–2 mm long, 1–5 mm from main axis; tepals elliptic, 5–6 by 3 mm; androphore 3–4 mm long; anther head 1.5–2 by 2–2.5 mm. *Colour* of pitcher suffused dull red, peristome glossy dark red, inner pitcher surface pale green, lid red above, green below, inflorescence dull reddish brown and green.

Distribution — Borneo: Sabah (Mt Trus Madi); type collection only.

Ecology — Moss forest, ridge-tops, probably on sandstone; 2200–2400 m.

Note — The leaves of *N. edwardsiana* reach a maximum size of about 20 by 6 cm, whilst the smaller blades of *N. macrophylla* start at 35 by 12 cm. It is also distinct from *N. edwardsiana*, by its shorter, more ventricose pitcher, which is narrowed in its upper 1/3, and by its relatively larger lid. See key to *N. villosa* group under *N. mira*.

Hybrids — A hybrid with *N. lowii* (see there) has been named *Nepenthes* × *trusmadiensis* Marabini.

43. Nepenthes macrovulgaris J.R. Turnbull & A.T. Middleton

Nepenthes macrovulgaris J.R. Turnbull & A.T. Middleton, Bot. J. Linn. Soc. 96 (1988) 352, f. 1 & 2; Lowrie, Carnivorous Plant Newsl. 12, 4 (1983) 88, nomen; Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) 103, f. 55; Jebb & Cheek, Blumea 42 (1997) 58; Clarke, Nepenthes of Borneo (1997) 102, f. 68; J.H. Adam & Wilcock, Sarawak Mus. J. 50 ('1996', 1998) 155. — Type: *Turnbull & Middleton 81166j* (lecto K; iso BO n.v., K, L, US n.v.), Borneo, Sabah, Mt Silam, 4° 58' N, 118° 10' E, 550 m, 1 June 1981.

Nepenthes sp. Sh. Kurata, Nepenthes of Mt Kinabalu, Sabah (1976) 76, f. 27.

Terrestrial climber to 6 m tall, but often sprawling on ground. Stems terete, 5–7(–9) mm diam.; short shoots with internodes 0.5–1 cm long, climbing shoots with internodes 3–5.5 cm long. *Leaves* chartaceous, subpetiolate; leaves of short stems with blade oblanceolate, 12–21 by 3–5 cm wide, apex acute to obtuse, base gradually attenuate into a poorly defined, winged leafstalk c. 1 cm wide, amplexicaul, clasping the stem for 3/4 its circumference, shortly decurrent, rarely sheathing; leaves of climbing stems with blade narrowly elliptic-oblong, 13–33.5 by 2.5–5 cm, apex acute, base cuneate, the lowermost 1/5–1/6, resembling a winged petiole 2–3.5 cm long, usually narrowed to 1–1.5 cm wide and encircling 1/2–1/3 the stem circumference, not sheathing or decurrent. Longitudinal nerves 3 or 4 on each side of the midrib in the outer 1/2 or 1/3, conspicuous above and below. Pennate nerves numerous, arising at 45–60° from the midrib, becoming patent, not reaching the marginal vein. *Lower pitchers* ovoid and tapering into a shortly cylindrical upper part, or the whole ovoid or ellipsoid, 9–18

(–23) cm long, 3.8–7(–9) cm wide at the base, tapering to 2.5–4(–5) cm wide below the peristome, with two fringed wings 2.5–5(–8) mm broad, the fringed elements 3–6(–15) mm long; mouth ovate, apex long-acuminate, oblique, slightly convex; peristome cylindrical to slightly flattened, 1.5–7(–15) mm wide with pronounced ribs 0.3–0.5 mm apart, 0.1–0.2 mm high, outer edge often slightly sinuate in the largest pitchers, inner lacking teeth; column short and broad, the peristome forming two ridges; lid broadly to narrowly ovate or elliptic, 2.5–4.5(–5.5) by 1.7–4.5(–5) cm, apex rounded, base shallowly cordate, lower surface without appendages, nectar glands with several large circular or elliptic crater-like glands 0.3–0.7 mm long along the midrib and numerous smaller, circular ones 0.2–0.1 mm diam. scattered over the blade, smallest towards the margin, absent at the edge; spur dorsiventrally flattened, 4–7(–12) by 0.7–1 mm, divided by 1/3 its length into 2 (or 3) branches, rarely entire. *Upper pitchers* as the lower, but much more infrequent, less inflated, with reduced wings and generally smaller, ovoid at the base, cylindrical at the apex, 12–16 cm tall, c. 4 cm wide, the upper, cylindrical part 2.5–3 cm wide, wings 1–2 mm wide, usually fringed, fringed elements 2–5 mm long; peristome 1.5–5 mm wide, ribs 0.25 mm apart; outer edge entire, not sinuate; lid 1.5–4.5 by 1–3.8 cm. *Male inflorescence* 26–39(–51) by 3–4 cm; peduncle 8.5–16.5 cm long, 0.2–0.5 cm diam. at the base; partial peduncles 2-flowered, 48–84, 2–3(–5) mm long; bract 1.3–3(–8) mm long, conspicuous, inserted anywhere between base and apex; pedicels 8–1.1(–1.3) mm long; tepals elliptic, 4–5 by 2–3.5 mm, apex rounded; androphore 3–4(–5) mm long; anther head 1.5–2 by 1.5(–2) mm. Fruits with valves 20–25 by 3.5–4 mm. Seeds filiform, dimensions unrecorded. *Indumentum* absent from stems; lower leaf blade, outer pitcher, upper and lower lid and peduncle with sessile red glands, outer pitcher also very sparsely scattered with patent simple hairs c. 0.5 mm long; rhachis of inflorescence to the lower surface of the tepals moderately densely tomentose with appressed brown hairs c. 0.5 mm long. *Colour* of lower pitchers green or pinkish green, often splashed with red; peristome green with deep pink stripes; inner surface of pitcher with a waxy bluish pink bloom with darker purple blotches; upper pitchers always green; tepals brown or yellowish green.

Distribution — Borneo: Sabah.

Ecology — Shrubberies, landslides or cliffs on ultramafic soils, often with *Casuarina*; 300–1200 m.

Notes — 1. Most similar to *N. philippinensis* (q.v.), *N. macrovulgaris* is also closely related to *N. hirsuta* and *N. hispida,* the four comprising the *N. hirsuta* group. It can be distinguished from the second two species by its toothless peristome margin, and its total lack of hairs on stems and leaves. The lower pitchers, often inflated, have a constriction immediately below the peristome, not unlike that of *N. macfarlanei. Nepenthes macrovulgaris* is confined to ultramafic soils.

2. Specimens of this species collected over the last two decades have often been incorrectly labelled '*N. hybrida*'.

44. Nepenthes mapuluensis J.H. Adam & Wilcock

Nepenthes mapuluensis J.H. Adam & Wilcock, Blumea 35 (1990) 265; Jebb & Cheek, Blumea 42 (1997) 59; Clarke, Nepenthes of Borneo (1997) 104, f. 69. — Type: *Kostermans 14017* (lecto L; iso BO, K, L), Borneo, E Kalimantan, Berouw, Mt Ilas Mapulu, 800 m, 23 Sept. 1957.

Terrestrial shrub to at least 20 cm tall, possibly climbing. Stem terete, strongly flexuose, 5 mm diam., internodes of climbing stems 2.5–4 cm long, axillary buds hemispherical, 1 by 1 mm, inserted about 1 mm above the axil. *Leaves* coriaceous, subsessile, lanceolate-obovate 13–26 by 2–5.5 cm, apex acute to rounded, peltate, base attenuate, parallel sided and somewhat dilated and amplexicaul at the very base, clasping the stem for c. 1/2 its circumference. Longitudinal nerves 4 or 5 on each side of the midrib, in outer 2/3–3/4 of blade, arising from base, or some from lower part of midrib. Pennate nerves arising obliquely, curving towards margin. *Lower pitchers* ellipsoid throughout, and narrowest at mouth, or somewhat tubular in upper 1/2; 12–22 by 3.5–8 cm, fringed wings 2–8 mm broad, with fringe elements c. 3 mm long, 2–4 mm apart; mouth oblique, elliptic, straight; peristome rounded at front, somewhat broadened near rear, 3–22 mm wide, ribs 0.6–0.7 mm apart, 0.3 mm high, outer edge undulate, inner with teeth to 1.5 mm long; lid ovate to narrowly ovate, 4.5–9.2 by 3–5 cm, apex rounded, base abruptly attenuate to scarcely cordate, lower surface lacking appendages, with a prominent central ridge 1–2 mm high, nectar glands dense near base and along midline, obscurely rimmed, pit-like, longitudinally elliptic, 0.3 mm long, remaining surface glandless apart from a few orbicular glands 0.1–0.2 mm diam. near the midline; spur flattened, c. 10 by 1 mm, apex rounded. *Upper pitchers* ellipsoid in lower 1/2, constricted above and widening to mouth; to 19 by 5 cm; mouth ovate; peristome 4 mm wide, rounded at front, expanded near lid to 12 mm wide, ribs 0.3–0.5 mm apart, outer edge sinuate, inner with teeth to 2 mm long; wings fringed as in lower pitcher, but near mouth only. (*Upper pitchers* of *Kostermans 14017*, BO specimen ellipsoid below, tubular in upper 1/2; to 12 by 2 cm; peristome 1–2 mm wide, rounded, not expanded; wings absent). *Male inflorescence* 15–20 by c. 2.5 cm; peduncle 7.5 cm long, 1.5–2 mm diam. at base; partial peduncles 1-flowered; bracts absent; pedicels 6–7 mm long; tepals elliptic, c. 3 by 2.25 mm; androphore 2.25 mm long; anther head 1 by 1.25 mm. *Indumentum* densely puberulent of simple, patent hairs 0.1–0.2 mm long, present on stems and upper leaf surfaces (hairs brownish white) and on inflorescence (hairs red) from base of peduncle to lower surface of tepals; androphore glabrous; lower surface of leaves with sessile red glands c. 0.1 mm diam. *Colour:* leaves drying a characteristic grey-green above, and reddish brown below. Live pitchers pale green to white with black-purple specks to dark purple with greenish purple spots; peristome brown; wings brown. — **Fig. 12.**

Distribution — Borneo: E Kalimantan (Sambaliung Range).

Ecology — Limestone; 700–800 m.

Notes — 1. This species has a striking similarity to *N. northiana*: the reclined ellipsoid lower pitchers with a large oblique mouth, the expanded peristome with an undulate outer edge, the large vaulted narrowly ovate lid and the peltate leaf tips. However, these similarities may be purely superficial. *Nepenthes mapuluensis* differs particularly in the slender, terete, strongly flexuose, puberulent stems, smaller, puberulent leaves, auriculate, non-decurrent leaf base, pitcher lid with keeled midline bearing numerous longitudinally elliptic nectar glands, nectar glands otherwise absent, diminutive inflorescence with 1-flowered partial peduncles and pedicels comparatively truncated. The upper pitchers of *N. mapuluensis* are so incompletely known that a full comparison with those of *N. northiana* cannot be made at this stage. Like *N. northiana*, *N. mapu-*

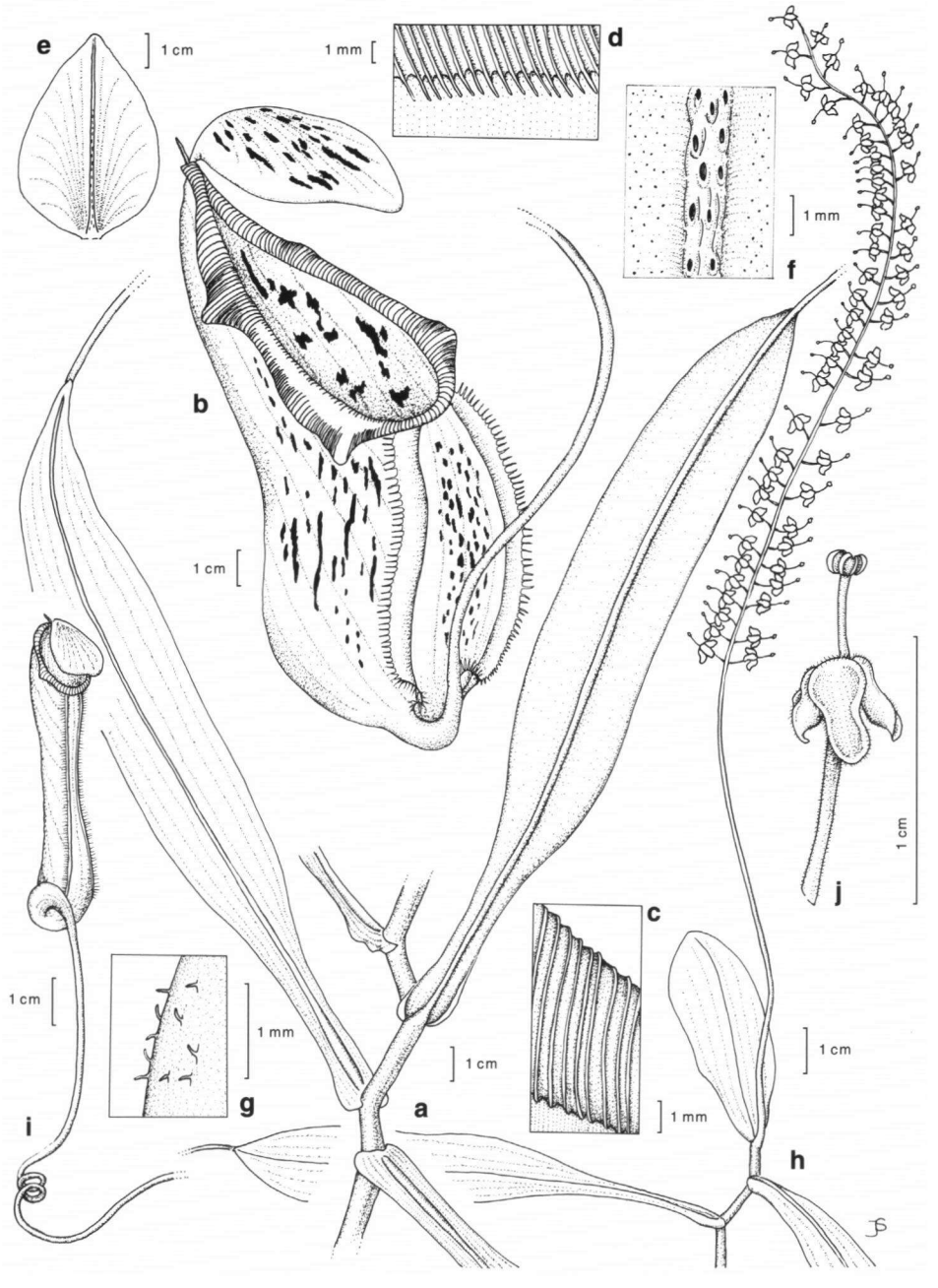

Fig. 12. *Nepenthes mapuluensis* J.H. Adam & Wilcock. a. Habit; b. lower pitcher; c. peristome, outer view; d. peristome; inner view; e. underside of lid; f. detail of glands on lower surface; g. stem indumentum; h. male inflorescence; i. upper pitcher (immature); j. male flower (*Kostermans 14617*). Drawn by Judi Stone.

luensis is only known from limestone. One collection comes from the type locality of *N. campanulata*.

2. The majority of the isotype material at Bogor exhibits very different upper pitchers from the remaining material, but the leaves match the remaining specimens, and we may presume that the species either shows an extreme dimorphy in shape of the upper pitchers, or that that material is a mixed collection with an unknown species.

3. In the protologue (cited above), J.H. Adam & Wilcock only cited the holotype and so apparently based their description on this alone. Two other collections at Leiden and Bogor (*Kostermans 13821* and *Geesink 9314*) allow us to make the more complete description of *N. mapuluensis* above. The description in the protologue does not entirely match the specimen that it is based on, for example, the specimen concerned does not have angular or glabrous stems, nor do the other specimens of this species that we have examined. We have modified the description above accordingly.

45. **Nepenthes maxima** Reinw. ex Nees

Nepenthes maxima Reinw. ex Nees, Ann. Sci. Nat. 3 (1824) 369, t. 20, f. 2; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 325, partim; Jebb, Science in New Guinea 17 (1991) 29, f. 14 & 15; Jebb & Cheek, Blumea 42 (1997) 61. — Type: ? *Reinwardt 1537* (L), Sulawesi, Manado, G. Roemengan, 1821.

Nepenthes celebica Hook.f. in A.DC., Prodr. 17 (1873) 100. — Type: *Meyer s.n.* (lecto K), Sulawesi, Gorontalo.

Nepenthes curtisii Mast., Gard. Chron. 2 (1887) 681, t. 133. — Type: *Curtis 426* (lecto K selected here), Sulawesi, G. Sopoetan (= G. Soputan), 5000 ft.

Nepenthes curtisii var. *superba* Hort. Veitch ex Marshall, Gard. Chron. III, 14 (1893) 756. — *Nepenthes maxima* var. *superba* (Hort. Veitch ex Marshall) Veitch, J. Roy. Hort. Soc. 21 (1897) 238; Mast., Gard. Chron. III, 38 (1905) 379. — Type: not located.

Nepenthes oblanceolata Ridl., Trans. Linn. Soc. London, Bot. II, 9 (1916) 140; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1940) 344. — Type: *Kloss*, Wollaston Expd. (lecto K), New Guinea, Carstensz Mts, camp VIa, 930 m.

Nepenthes maxima var. *minor* Macfarl. in Gibbs, Contr. Phytogeog. & Flora Arfak Mountains (1917) 141. — Type: *Gibbs* (BM), New Guinea, Arfak Mts.

Nepenthes boschiana auct. non Korth.: Becc., Malesia 1 (1878) 214; 3 (1886) 3, f. 3 & 9.

[*Nepenthes maxima* var. *lowii* (Hook.f.) Becc., Malesia 3 (1886) 3 = *Nepenthes stenophylla* Mast.]

[*Nepenthes maxima* var. *sumatrana* (Miq.) Becc., Malesia 3 (1886) 3 = *Nepenthes sumatrana* (Miq.) Beck.]

Terrestrial or epiphytic shrub or climber to 4 m tall. Climbing stems terete to triangular, 0.3–1 cm diam., often winged at two angles, occasionally with four, marked wings to 2.5 mm wide, internodes 5–12 cm long, axillary buds conspicuous, spike-like. *Leaves* chartaceous, petiolate; blade obovate to lanceolate, 15–30 by 2.5–7 cm, apex obtuse to acute, base attenuate, petiole canaliculate or narrowly winged, to 7 cm long, dilated at the base into an amplexicaul sheath which may be decurrent as two ridges or narrow wings for 1 cm or up to 2 internodes. Longitudinal nerves 1–3 on each side of the midrib, in the outer 1/3–1/4 of the blade, indistinct. (The leaf blade is occasionally strongly furrowed on its upper surface giving the impression of veins at regular spacing, the veins themselves are more apparent in dried specimens or when held against the light.) Pennate nerves numerous, not parallel, often branched, perpendicular near midrib, but

irregular towards margin, indistinct. *Lower pitchers* narrowly ovoid, becoming cylindrical above, occasionally 'waisted', or the whole pitcher subcylindrical or cylindrical-ellipsoidal 8–20 by 2.2–5 cm, with 2 fringed wings up to 8 mm broad with fringed elements to 6 mm long, 1–4 mm apart; mouth ovate, concave, rising at the rear to a short, ill-defined column; peristome subcylindrical at the front, 2 to 5 mm wide, more flattened towards the lid, up to 15 mm wide, ribs 0.25–1 mm apart, conspicuous, outer edge entire or slightly sinuate, inner edge toothed; lid ovate, c. 2.5 by 2.5 cm, apex rounded, base cordate, lower surface usually with two appendages, basal appendage laterally flattened, often hooked towards base, apical appendage usually filiform, up to 12 mm long, rarely reduced to an inconspicuous swollen area, nectar glands sparsely scattered to fairly dense, orbicular, thinly bordered, 0.1–0.2(–0.4) mm diam., along the midline, sparsely scattered, larger, longitudinally elliptic, 0.5(–0.8) mm long, extending to appendages, where dense; spur filiform, entire, to 6 mm long. *Upper pitchers* abruptly or gradually originating from the tendril, narrowly infundibuliform, rarely tubular, or with an ovoid basal and cylindrical upper part, 6.2–19(–30) by 1.8–6(–8) cm, occasionally waisted, with 2 prominent ribs, occasionally with small fringed wings near the mouth, or rarely with wings as the lower pitchers; mouth ovate, acuminate and elongate towards the lid forming a column up to 3 cm tall; peristome flattened, up to 20 mm broad near the lid, ribs 0.25–0.5 mm apart, outer edge entire or irregularly sinuate, inner edge with teeth 1–2 mm long; lid elliptic to ovate, 2–5 by 3–6 cm long, apex obtuse, more or less cordate at base, lower surface with a laterally flattened, often hooked crest up to 8 mm long on the basal part of the midrib, and a filiform or dorsally flattened appendage near the tip, nectar glands as in lower pitchers, especially numerous and large on the two appendages; spur entire or shortly bifid, stout, 4–8 mm long. *Male inflorescence* 16–19(–40) by 2.5–3(–5) cm; peduncle 5.5–8(–14) cm long, 1.25–1.5 (–4) mm diam. at base; partial peduncles c. 85, mostly 2-flowered, 2–4(–5) mm long; bracts linear, recurved, c. 2.5 mm long, inserted 0–2 mm from base of partial peduncles; pedicel 6–9(–16) mm long; tepals elliptic, 3–4.5 by 1.5–2.5(–3.5) mm; androphore 2.5–4 mm long; anther head 1.25–1.5 by 1.5–2 mm. *Indumentum* variable, glabrous to densely pubescent with reddish brown hairs on stems, petioles, midrib, leaf margin, tendril and inflorescence from peduncle base to lower surface of the tepals, 0.2–0.3 mm long, androphore puberulent. *Colour* green to greenish white or yellowish green, usually mottled with red, peristome crimson; flowers dark red.

Distribution — Sulawesi, Moluccas, New Guinea.

Ecology — Epiphytic in mossy forest, or terrestrial in swamp grassland, on ridge tops, in open forest on white sand, in thin soils over rock or on metalliferous ultramafic soils; (600–)1200–2500 m.

Notes — 1. Within its natural range (Sulawesi to New Guinea), *N. maxima* is only likely to be confused with two other species: *N. klossii* and *N. eymae*. All have lids with two (rarely one) appendage (best seen in upper pitchers), well-defined petioles, leaves with irregular pennate nerves, spike-like axillary buds, 2-flowered partial peduncles and dense, long, patent indumentum. *Nepenthes eymae* of Sulawesi is distinguished by its more broadly infundibuliform upper pitchers and *N. klossii* of western New Guinea differs in its lateral pitcher mouth. *Nepenthes maxima* is also closely related to *N. fusca* of Borneo which is distinguished by the narrowly triangular lid of the upper pitchers.

References to *N. maxima* occurring in Borneo are erroneous and usually refer to *N. fusca*. The foregoing species, united by the characters mentioned above, are all part of Danser's Regiae group in Bull. Jard. Bot. Buitenzorg III, 9 (1928) 405 which we maintain, including *N. clipeata, N. faizaliana, N. pilosa, N. stenophylla,* and *N. truncata.*

2. *Nepenthes maxima* is a widespread and very variable species. The upper pitchers range greatly in form, from narrowly cylindrical to strongly infundibulate. In some populations the upper pitchers are winged along their entire length, resembling the rosette pitchers. In others the lower pitchers are ovoid throughout while the upper pitchers vary from slender and cylindrical to markedly infundibulate.

3. *Nepenthes curtisii* Mast. has been the subject of much enquiry and speculation as to its origin and identity. It was formerly thought to be based only on cultivated material grown from seed at Veitch's nurseries after collection by Curtis, according to the protologue, from Borneo. Accordingly, we lectoypified this name on cultivated material ex Veitch at K, citing it as "Curtis s.n. (K) cultivated ex Borneo" (Jebb & Cheek 1997). However, this material was pressed after publication of the species name and there is no evidence that it was seen by the name's author, nor that it had come from Curtis. This choice is overturned by the discovery of the specimen selected above to replace it as lectotype, namely *Curtis 426* (K). We had passed over this specimen since the original field label, hastily written in faint pencil, does not bear a collector's name, though a later annotation says "?Curtis". Nor are country or date indicated on the label. However, the original handwriting does match that in letters from Curtis in the archives at K and the locality indicated on the label is the colonial Dutch spelling prevalent in the 1880s for a mountain (G. Sopoetan = G. Soputan) in the northern arm of Sulawesi from which general area similar material of *N. maxima* is known. Curtis visited Sulawesi in 1881–1882 (TL-2). The citation of 'Borneo' in the protologue was probably a deliberate attempt by Veitch's to mislead rival nurseries: a common practice at that time, especially with orchids. This ruse has misled botanists for over a century. A third hand on the label of the specimen, identifying it as *N. curtisii* Mast. is that of Masters. Unfortunately Masters does not date his annotation.

46. **Nepenthes merrilliana** Macfarl.

Nepenthes merrilliana Macfarl., Trans. & Proc. Bot. Soc. Pennsylv. 3, 3 (1911) 208, t. 1; Sh. Kurata & Toyosh., Gard. Bull. Sing. 26 (1972) 157; Jebb & Cheek, Blumea 42 (1997) 62. — Type: *W.J. Hutchinson 7545* (PNH n.v.), Philippines, Mindanao, Surigao Province, Dinagat Island, 20 m, 1907.

Nepenthes merrillii Elmer, Leafl. Philipp. Bot. 8 (1915) 2787, sphalm.

Nepenthes surigaoensis Elmer, Leafl. Philipp. Bot. 8 (1915) 2785. — Type: *Elmer 13705* p.p. (PNH†?), Philippines, Mindanao, Agusan Province, Mt Urdaneta, 1700 m, Sept. 1912.

Terrestrial or epiphytic shrub or low climber to 4 m tall. Stem usually winged, sometimes partly terete, 7–10 mm diam. *Leaves* thinly coriaceous, sessile, narrowly oblong to oblanceolate, 20–60 by 3.5–7 cm, apex acute or obtuse, base attenuate, clasping the stem by c. 1/2 the circumference and decurrent into two wings 3–7 mm wide extending half to one internode down the stem. Longitudinal nerves 6 or 7 on each side of the midrib in the outer 2/3, ± evenly spaced. Pennate nerves oblique, numerous, branching and inconspicuous near the margin. *Lower pitchers* broadly ovoid, to 31 by 16 cm, with

two fringed wings, 7–14 mm broad, fringed elements 7–8 mm long, 1–4 mm apart, mouth elliptic, slightly oblique, straight; peristome flattened, 8–27 mm broad, ribs ± 1 mm apart, 0.5 mm high, outer margin sinuate, inner with teeth as long as broad; lid broadly ovate, 6–12 by 5–9 cm, apex rounded, base shallowly cordate, lower surface glossy, lacking appendages but midline carinate at base, nectar glands minute, inconspicuous, thinly scattered, pit-like, orbicular, 0.2–0.3 mm diam.; spur 10–12 mm long. *Upper pitcher* as the lower, but 20–26 by 9 cm, lacking fringes to the wings. *Male inflorescence* 30–51 cm long; peduncle 9.5–14 long, 0.6 cm diam. at base; partial peduncles 7–9 mm long, those at the base 2-flowered, at the apex sometimes 1-flowered; bracts absent; pedicels 14–15 mm long; tepals elliptic, 4 mm long; androphore 4–5 mm long; anther head 1 mm wide. Fruit unknown. Seed unknown. *Indumentum* absent from stems and leaves. Pitchers with sparsely scattered appressed simple hairs 0.75 mm long. Inflorescence minutely puberulent. *Colour* green, inner surface of pitcher glossy, splashed with red, peristome red.

Distribution — Philippines: Mindanao, Surigao and Agusan Provinces including Dinagat Island.

Ecology — Forest, steep slopes near the coast; sea level to 1700 m. Reported as being epiphytic by Macfarlane (1911), based on notes added to the specimen at Kew by Merrill and supported by recent field observations. However, there are also reports of *N. merrilliana* growing terrestrially in thin woodland. It seems restricted to ultramafic areas.

Notes — 1. *Nepenthes merrilliana* vies with *N. rajah* of Borneo for the largest pitchers of the genus. From other Mindanaoan species of the genus it can be distinguished by its long, slender oblong or oblanceolate leaves, 20–60 by 5–7 cm, and the large pitchers with a broad, sinuous-edged peristome. Our knowledge of this species is still fragmentary.

2. *Nepenthes merrilliana* is one of four endemics confined to the Surigao & Agusan Provinces of NE Mindanao, the others being: *N. bellii*, *N. truncata,* and *N. petiolata.*

3. Danser in Bull. Jard. Bot. Buitenzorg III, 9 (1928) 330 identified a specimen (*Riedel s.n.*, BO) from Gorontalo, Sulawesi as belonging to this species. However, it seems to us that the acute leaf apex, narrowed mouth and long peristome teeth of this specimen does not suggest that they are conspecific. Further material is needed from northern Sulawesi to elucidate the placement of this specimen.

47. Nepenthes mikei B. Salmon & Maulder

Nepenthes mikei B. Salmon & Maulder, Carnivorous Plant Newsl. 24 (1995) 82, f. 3 & 4. — *Nepenthes* sp. Hopkins, B. Salmon & Maulder, Carnivorous Plant Newsl. 19 (1990) 23 (f.), 25; Jebb & Cheek, Blumea 42 (1997) 63. — Type: *Salmon & Maulder AK 221719* (holo AK n.v.), cult. ex Sumatra, S. Utara Province, Lake Toba, Mt Pangulubau, 2000 m, 17 Feb. 1995.

Nepenthes angasanensis Maulder, D. Schubert, B. Salmon & B. Quinn, Carnivorous Plant Newsl. 28 (1999) 15, f. 1; syn. nov. — Type: *Salmon & Maulder 234372* (holo AK n.v.; iso BO n.v., K n.v.), Sumatra, Aceh Province, G. Puncak Angasan, slopes above Penosan, 2500 m, 25 Sept. 1997.

Terrestrial climber to 3(–9) m tall. Stems terete or slightly 2-angular-ridged; rosette stem 2 mm diam., internodes 1–6 mm long; climbing stem slightly flexuose, (1.5–) 2–2.5(–3) mm diam., internodes (1.5–)3–5(–6.5) cm, axillary buds broadly conical,

0.5–1 by 1–1.5 mm, 2–4 mm above the axil. *Leaves* coriaceous, sessile, rosette leaves narrowly oblanceolate-elliptic, 3–7 by 0.6–1.3 cm, apex obtuse to acute, not peltate, base clasping the stem for 1/2 its circumference; leaves of climbing stems narrowly oblanceolate-oblong, 3.5–15 by 0.7–2.5 cm, apex acute, base clasping the stem for 1/2 the circumference, winged, the wings sometimes decurrent to the node below as two low ridges; rarely perfoliate-adnate. Longitudinal nerves 1–3 on each side of the midrib in the outer 1/3 of the blade, inconspicuous. Pennate nerves perpendicular, few, inconspicuous. *Lower pitchers* ovoid in the lower half, cylindrical above, 3.5–11.5 by 0.9–2 cm, the upper part 3/4 the breadth of the lower, with two fringed wings 1–2 mm broad, fringed elements 2–3.5 mm long, 0.5–1 mm apart, mouth ovate, concave, oblique, peristome cylindrical, 0.75–1 mm wide, with inconspicuous ribs, outer and inner edges entire; lid elliptic or ovate, 0.8–2 by 0.6–1.8 cm, apex rounded, base rounded or shallowly cordate, lower lid lacking appendages, nectar glands inconspicuous, sparsely and evenly scattered, bordered, circular, 0.1 mm diam.; spur 2–6 branched, divided from the base or from about 1/2 its length, 4–6 mm long. *Upper pitchers* resembling the lower, but more contracted at the midpoint, to about 1/2 the diameter of the basal part, often widening slightly towards the mouth, 3.5–13 by 0.9–2 cm, lacking fringed wings; mouth strongly oblique, peristome 0.75–1.5 mm broad, ribs inconspicuous, 0.25–0.5 mm apart, outer edge entire, inner entire or shallowly toothed; lid 1.1–1.9(–3.8) by 0.8–1.3(–2.1) cm, nectar glands and spur as lower pitchers. *Male inflorescence* 3.8–15 by 1–1.8 cm; peduncle 1.5–3 cm long, 1 mm diam. at the base; partial peduncles c. 20(–45?), 1-flowered; pedicels 3–6 mm long; bracts absent; tepals oblong, 2–3 by 1 mm; androphore 1(–1.2) mm long; anther head 1 by 1 mm. Infructescence 5–9 by 4.5–5 cm; peduncle 1.5–5.2 cm long, 1.1–1.5 mm diam. at base; fruits 6–10, valves 1.7–2.2 by 0.2–0.3 cm. Seeds filiform, 10.5 by 0.5 mm. *Indumentum* absent from stem apart from a cluster of white hairs around the axillary bud; leaves with sessile red glands 0.1 mm diam. on the lower surface, otherwise glabrous; pitchers, upper lid and spur sparsely covered with white appressed simple hairs c. 0.5 mm long; inflorescence from base of peduncle to apex of pedicel sparsely (rarely densely) sericeous with the same hair type; lower tepals with minute white stellate hairs; ovary densely fawn sericeous; androphore glabrous. *Colour* of specimens black when dry; live stem purplish black; pitchers purplish black, splashed one part in ten with cream; tepals dirty purplish or brown.

Distribution — Sumatra: Aceh & Sumatera Utara Provinces, Angasan to Lake Toba.

Ecology — Mossy forest and scrub, especially on ridges; 1100–2500 m.

Notes — 1. *Nepenthes mikei* has long been confused with *N. tobaica* with which it looks extremely similar, but differs in the branched (not simple) spur and the 1-flowered (not 2-flowered) partial peduncles.

2. *Van Steenis 8331A* represents an exceptionally large specimen of this otherwise morphologically uniform species, and accounts for the higher figures in the dimensions given in the description above for pitcher and leaf. It may represent a hybrid with another species such as the sympatric *N. densiflora*.

3. The type material of *N. mikei* (named for Mike Hopkins of New Zealand), on which the protologue description appears solely based, was cultivated in New Zealand from material collected by its authors on Mt Pangulubau in 1989.

4. *Nepenthes angasanensis* Maulder, D. Schubert, B. Salmon & B. Quinn was published (Salmon & Maulder, Carnivorous Plant Newsl. 28 (1999) 15) in the closing stages of this manuscript. The authors argue that specimens we assigned to this species in Blumea 42 (1997) 63 represent a separate taxon. We suspect that it may prove not distinct from *N. mikei* and here treat it as a synonym.

48. Nepenthes mira Jebb & Cheek

Nepenthes mira Jebb & Cheek, Kew Bull. 53 (1998) 966; 54 (1999) 891, f. 893. — Type: *G.C.G. Argent, Q. Cronk, M. Mendum, D.J. Middleton, P. Wilkie, R. Fuentes & R.V. Chavez 25438* (holo K; iso E, PNH), Philippines, Palawan, fl. 22 Jan. 1998.

Terrestrial climber to 3 m tall. Stem terete, 8–14 mm diam., internodes 3–5 cm long on climbing part; axillary buds inconspicuous, in sunken pockets. *Leaves* chartaceous, petiolate; those of rosettes and short stems, unknown; those of climbing stems narrowly oblong, 35–50 by 8–10.5 cm, apex rounded, not peltate, base acute and abruptly decurrent into the petiole; petiole winged, 3.5–8 by 0.6 cm, wings ascending, 3–4 mm wide, petiole base clasping the stem by about 2/3 its circumference and decurrent down the internode for c. 8 mm. Longitudinal nerves 4(–6) on each side of the midrib in the outer half, conspicuous on both surfaces. Pennate nerves numerous, arising at 70–80° from the midrib, slightly ascending, then proceeding towards the margin, branching, becoming highly reticulate, fairly conspicuous on both surfaces. *Lower pitchers* shortly ellipsoid to globular, 26 by 13 cm, the lowest part of the mouth 14 cm from the base of the pitcher, mouth c. 11 cm diam., body of pitcher with two fringed wings in the upper half of the pitcher only, 5.5 cm by 7 mm, fringed elements 8–9 mm long, usually paired, the pairs 2.5–3 mm apart, mouth circular to broadly ovate, oblique, abruptly arising in the rear to provide a stout column almost 5 cm high by 1.5–3 cm wide, in transverse section an isosceles triangle, the long sides being formed by the extended peristome, the apex with two rows of teeth, each tooth up to 8 mm long; peristome very broad, gently rounded in the middle, ribs laterally flattened, papery, highly pronounced, 1–5 mm high, 2 mm apart, with c. 10 striae parallel to and intermediate between each pair of ribs, outer edge of peristome flattened, 0.5–1 cm wide, shallowly sinuate, with 2–4 shallow, pointed lobes on each side or more or less entire, the inner peristome surface flattened, 2.5–3 cm long, held close to the inner pitcher wall at the mouth but slowly diverging from the wall towards the base of the pitcher, so as to form a funnel and terminating in stout, straight teeth c. 7 mm long on the inner edge below the mouth or up to 8 mm long on the column; lid ovate-elliptic, 6.5 by 4.5 cm, apex rounded, base gently rounded to shallowly cordate, lower surface lacking appendages, glands dense and evenly spread over the lower surface, volcano-like, circular, less usually shortly elliptic, 0.15–0.2 mm diam., smallest towards the edge of the lid; spur erect, stout, c. 4 mm long, undivided. *Upper pitchers* cylindrical to funnel-shaped, 15.5 cm tall, c. 4 cm diam. in the lower half, gradually widening to c. 6 cm wide at the mouth, lacking wings, mouth circular, slightly oblique, column c. 3 cm high, peristome with ribs 0.5 mm high, c. 1 mm apart, outer edge of the peristome appressed to the pitcher wall, inner edge as the lower pitcher, but c. 1.5 cm long, teeth 3 mm long; lid ovate, 4.5 by 3 cm, apex rounded, base cordate; spur dorsiventrally flattened, 6.5 by 1.5 mm, divided into two

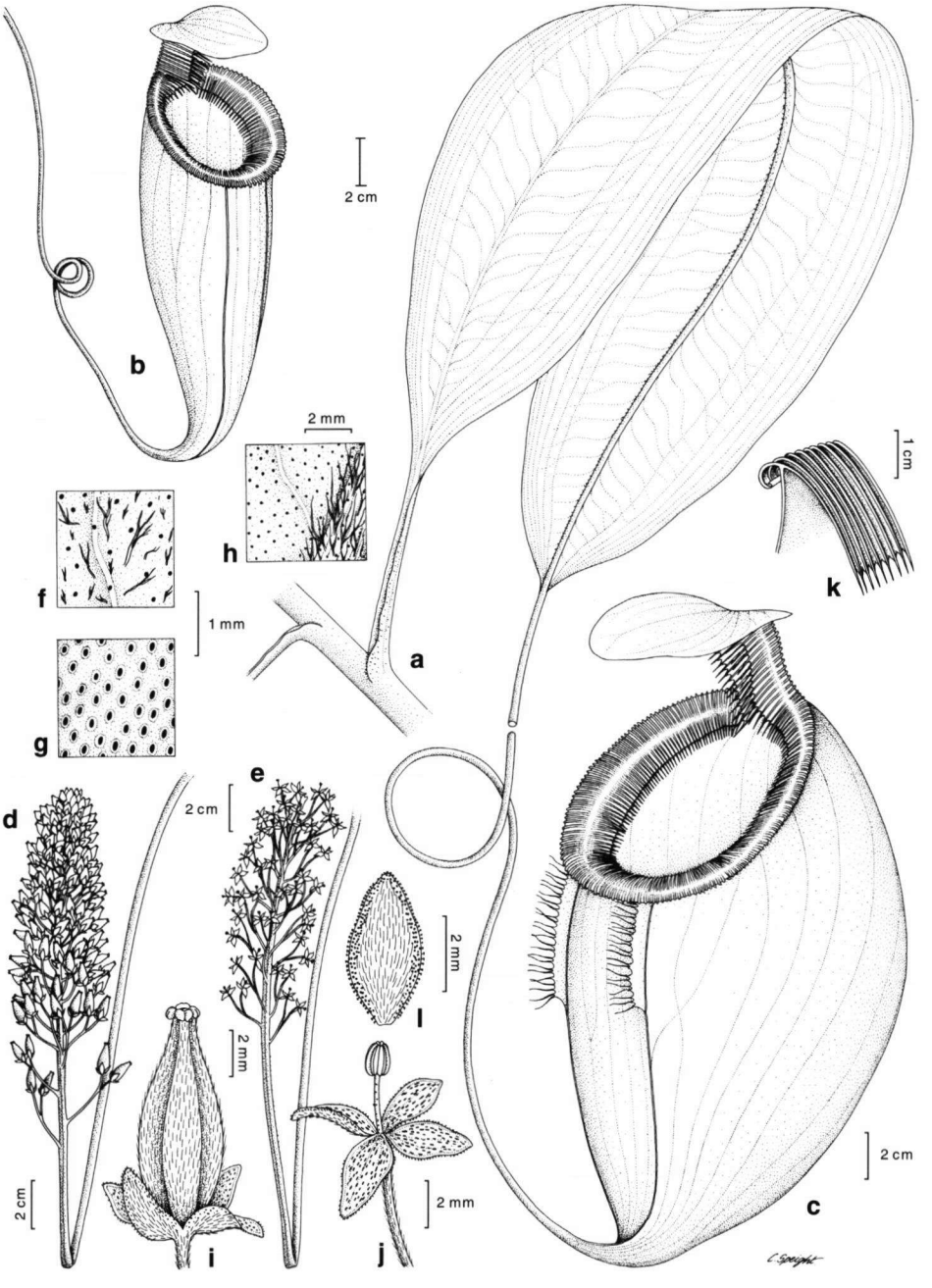

Fig. 13. *Nepenthes mira* Jebb & Cheek. a. Climbing stem leaf; b. upper pitcher; c. lower pitcher; d. female inflorescence; e. male inflorescence; f. pitcher outer surface; g. underside of lid; h. detail of lower surface of midrib; i. female flower; j. male flower; k. transverse section of peristome; l. abaxial surface of tepal (*Argent et al. 25438*). Drawn by Camilla Speight.

acute parts for half its length. *Inflorescences* with unpleasant smell. *Male inflorescence* 61 cm long, 3 cm at widest point; peduncle 53 cm long, 5 mm wide at base; partial peduncles c. 35, evenly spaced, 2-flowered, lacking bracts, 5–7 mm long; pedicels 10–13 mm long; tepals elliptic, 4 by 1.75 mm; androphore 2.5–3 mm, anther head 1 by 1.1–1.25 mm. Fruit and seed unknown. *Indumentum* of red sessile glands densely and evenly spread on stem, upper and lower leaf surfaces and pitchers; youngest parts of stem, lower midrib, tendril, upper surface of the lid of the upper pitchers and the peduncle densely pubescent with numerous caducous, unequally 2–4-armed, pale reddish brown hairs, the arms ascending or decumbent, longest arms up to 1.5 mm long; pitchers with densely scattered simple stout red multicellular hairs, 0.2–0.4 mm long; partial peduncles, pedicels, the central area of the abaxial tepals, the carpels and androphore, more or less completely concealed by appressed coppery hairs 0.4 mm long. *Colour* of pitchers maroon, lightly speckled with darker purple or green, speckled dark red. Peristome purple, lid purple on greenish background. Flowers opening green, turning dark red. — **Fig. 13.**

Distribution — Philippines: Palawan.

Ecology — Submontane forest and grassland on unknown substrate; c. 1580 m.

Notes — 1. *Nepenthes mira* falls within the *N. villosa* group, comprising four species, of which the remaining three are all found in Sabah, Borneo. These species are robust plants with stout stems reaching the 1–2 cm diameter range, with a villose indumentum that is usually caducous. The leaves are large, with well-defined, winged petioles. The pitchers are large (10 cm diam. or more in most specimens of all species), with unusual papery ribs 1–5 mm high, that are not reduced and indeed, are sometimes exaggerated, on the stout column. The pitcher lids lack appendages and the inflorescences are densely covered in coppery red hairs. Although *N. mira* has all these characters, it is unusual in occurring below 2000 m altitude, in having both upper and lower pitchers commonly expressed (in the other species, only one or the other are usually found), in the lower pitchers having lids only about half as long as the mouths and in possessing constantly 2-flowered partial peduncles.

KEY TO THE NEPENTHES VILLOSA GROUP

1a. Largest pitchers about as tall as broad 2
b. Largest pitchers twice to thrice as tall as broad 3
2a. Pitchers densely villose; upper pitchers extremely rare; ultramafic substrates on Mt Kinabalu (Borneo) ..... **82. N. villosa**
b. Pitchers puberulent; upper pitchers common, about half the size of the lower pitchers probably on ultramafic substrates on Palawan ..... **48. N. mira**
3a. Pitchers about twice as tall as broad, hour-glass-shaped (constricted at midpoint); sandstone on Mt Trus Madi, Borneo ..... **42. N. macrophylla**
b. Pitchers about three times as tall as broad, lower 1/4 globose, upper cylindrical; ultramafic substrates on Mt Kinabalu, Borneo ..... **20. N. edwardsiana**

2. '*Nepenthes* spec. Philippines II' of Rischer & Nerz (URL: http://www.schwaben.de/home/schmidt/nepenthes/cpframes.html (14 October 1998 08:12:48 (1998)), represented by four pictures, with captions, taken in habitat, appears to fall within *N. mira*.

Photographed in moss forest, it appears to differ from *N. mira* only in the lower pitcher having a less prominently toothed peristome column and in the pitcher wings running from peristome to tendril. These differences seem compatible with infraspecific variation. However, their photographs of '*Nepenthes* spec. Philippines I' (l.c.) depicts non-climbing, shrubby plants in a grassland habitat and differ more significantly from the material available to us of *N. mira* in the smaller leaves with less conspicuous petioles and in the pitcher wings running from peristome to tendril. In some respects their 'spec. Philippines I' approaches the description of the mysterious *N. deaniana* (see 'Little Known Species', p. 156). However, it might also represent a variant of *N. mira*. Without specimens it is difficult to reach a firm conclusion.

3. The earliest reference to *N. mira* may be that by Elmer in Leafl. Philipp. Bot. 4 (1912) 1494–1496 at the end of his protologue for *N. graciliflora* (a synonym of *N. alata*), where he wrote: "recently the writer observed a large sterile species on Mount Pulgar of Palawan. Some of its pitchers were a foot long and six inches thick!"

49. Nepenthes mirabilis (Lour.) Druce

Nepenthes mirabilis (Lour.) Druce, Rep. Exch. Cl. Br. Isl. (1916) 637; Merr., Interpr. (1917) 242; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 330; Sh. Kurata, Nepenthes of Mt Kinabalu, Sabah (1976) 56; Tamin & M. Hotta in M. Hotta, Diversity and Dynamics of Plant Life in Sumatra (1986) 88; Jebb, Science in New Guinea 17 (1991) 32, f. 16; J.H. Adam & Wilcock, Mal. Nat. J. 46 (1992) 76; Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) 109, f. 57; Jebb & Cheek, Blumea 42 (1997) 63; Clarke, Nepenthes of Borneo (1997) 105, f. 70 & 71; J.H. Adam & Wilcock, Sarawak Mus. J. 50 ('1996', 1998) 160. — *Phyllamphora mirabilis* Lour., Fl. Cochin. 2 (1790) 606. — *Nepenthes phyllamphora* Willd., Sp. Pl., ser. 4, 2 (1805) 874. — Type: *Loureiro s.n.* (P n.v.), Vietnam, near Hue.

Cantharifera Rumph., Amb. 5 (1750) 121, f. 2, t. 59.

Nepenthes moluccensis Oken, Allg. Naturgesch. 3, 2 (1841) 1368, n.v.

Nepenthes phyllamphora var. *platyphylla* Blume, Mus. Bot. Lugd.-Bat. 2 (1852) 7. — Type: *Blume s.n.* (L n.v.), Java, Bantam, not located.

Nepenthes macrostachya Blume, Mus. Bot. Lugd.-Bat. 2 (1852) 7. — Type: Sumatra, Bencoolen, not located.

Nepenthes fimbriata Blume, Mus. Bot. Lugd.-Bat. 2 (1852) 7. — Type: *Korthals s.n.* (L n.v.), Borneo, Pulau Lampei.

Nepenthes fimbriata var. *leptostachya* Blume, Mus. Bot. Lugd.-Bat. 2 (1852) 8. — Type: *Blume s.n.* (L n.v.), Borneo.

Nepenthes kennedyana F. Muell., Fragm. 5, pt. 37 (1866) 154. — *Nepenthes kennedyi* Benth., Fl. Austr. 6 (1873) 40, sphalm. — Type: *Jardine* (MEL n.v.), Australia, Queensland, Cape York, near Somerset.

Nepenthes echinostoma Hook.f. in A.DC., Prodr. 17 (1873) 95; Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 70. — *Nepenthes mirabilis* var. *echinostoma* J.H. Adam & Wilcock, Mal. Nat. J. 46 (1992) 81, f. 2; Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996). — Type: *Beccari 121* (FI n.v., K), Borneo, Sarawak, Kuching.

Nepenthes phyllamphora var. *macrantha* Hook.f. in A.DC., Prodr. 17 (1873) 97. — Type: *Beccari s.n.* (FI n.v.), Borneo, Sarawak.

Nepenthes bernaysii F.M. Bailey, Proc. Linn. Soc. NSW 5 (1881) 185. — Type: *Haskett s.n.* or *Beddome s.n.* (BRI n.v.), Australia, Queensland, Cape York at Bowden Park.

Nepenthes obrieniana Linden & Rodigas, Ill. Hort. 37 (1890) 109, t. 66 (as *'o'brieniana'*). — Type: not located, ?Borneo.

Nepenthes jardinei F.M. Bailey, Qld. Agric. J. 1 (1897) 230, t. s.n. — Type: *Jardine s.n.* (BRI n.v.), Australia, Queensland, Somerset.

Nepenthes rowanae F.M. Bailey, Qld. Agric. J. 1 (1897) 231, t. s.n. — Type: *Jardine s.n.* (BRI n.v.), Australia, Queensland, Somerset.

Nepenthes albolineata F.M. Bailey, Qld. Agric. J. 3, 5 (1898) 355, t. 58 (as *'albo-lineata'*). — Type: *Jardine s.n.* (BRI n.v.), Australia, Queensland, Somerset.

Nepenthes moorei F.M. Bailey, Qld. Agric. J. 3, 5 (1898) 355. — Type: *Jardine s.n.* (BRI n.v.), Australia, Queensland, Somerset.

Nepenthes alicae F.M. Bailey, Qld. Agric. J. 3, 5 (1898) 356. — Type: *Jardine s.n.* (BRI n.v.), Australia, Queensland, Somerset.

Nepenthes cholmondeleyi F.M. Bailey, Qld. Agric. J. 7, 5 (1900) 441, t. 59. — Type: *Cholmondeley Jardine s.n.* (BRI n.v.), Australia, Queensland, 5 miles S Jardine River.

Nepenthes pascoensis F.M. Bailey, Qld. Agric. J. 16, 2 (1905) 190, t. 2. — Type: *Garraway s.n.* (BRI n.v.), Australia, Queensland, Head of Pascoe River.

Nepenthes armbrustae F.M. Bailey, Qld. Agric. J. 16, 2 (1905) 191, t. 3. — Type: *Armbrust s.n.* (BRI n.v.), Australia, Queensland, Coen.

Nepenthes garrawayae F.M. Bailey, Qld. Agric. J. 16, 2 (1905) 191, t. 4. — Type: *Garraway s.n.* (BRI n.v.), Australia, Queensland, between York Downs & Weipa.

Nepenthes tubulosa Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 60. — Type: *Teijsmann 6759* (BO), Moluccas, P. Gebe, Aug. 1871.

Nepenthes beccariana Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 67, f. 17. — Type: *Modigliani s.n.* (FI n.v.), Sumatra, Nias Isl.

Nepenthes phyllamphora var. *pediculata* Lecomte, Fl. Gén. Indo-Chine 5 (1910) 52. — Type: *Harmand 47* (P), Laos, Champasak Prov., Sé-moun Basin.

Nepenthes mirabilis var. *biflora* J.H. Adam & Wilcock, Mal. Nat. J. 46 (1992) 80, f. 1. — Type: *Jumaat Adam 1065* (UKMS), Sarawak, 7th Div., Kp. Bawang, 10 m, 6 Feb. 1987.

Nepenthes phyllamphora auct. non Willd.: Sims, Bot. Mag. (1826) t. 2629 = *Nepenthes khasiana* Hook.f.

Nepenthes distillatoria auct. non L.: Steud., Nom. ed. 2, 2 (1841) 190.

Nepenthes phyllamphora auct. non Willd.: Regel, Gartenfl. (1881) 371, t. 372 = p.p. *Nepenthes khasiana* Hook.f.

Nepenthes phyllamphora auct. non Willd.: Stapf, Trans. Linn. Soc. London, Bot. II, 4 (1894) 217 = *Nepenthes burbidgeae* Hook.f. ex Burb.

Terrestrial shrub or climber to 10 m tall. Climbing stems terete, 6–10(–14) mm diam., internodes 1.5–10 cm long, axillary buds inconspicuous. *Leaves* thinly chartaceous, rarely membranous or thickly chartaceous, petiolate, leaves of rosettes and short stems lanceolate or oblong, apex acuminate, not peltate, margin fimbriate, fimbriae c. 2 mm long, petiole base sheathing, leaves of climbing stems broader, obovate, oblong or lanceolate, (15–)20–40 by 4–10 cm, apex acute, margin entire, petiole canaliculate, rarely slightly winged, 3–20 cm long, clasping the stem by 1/2 its circumference. Longitudinal nerves originating from along the midrib, 4–8 on each side of the midrib, scattered throughout lamina, conspicuous. Pennate nerves numerous, curving towards margin, to almost perpendicular, forming distinct rectangles with longitudinal nerves, conspicuous. *Lower pitchers* ovoid in lower half, cylindrical in upper half, 8–20 by 2.5–4(–5) cm, with 2 fringed wings 2–3 mm wide, 1.5–2.5 mm long, c. 1.5 mm apart; mouth elliptic or broadly ovate, slightly oblique, straight; peristome slightly to conspicuously flattened, 2–8(–20) mm broad, ribs c. 0.25 mm apart, conspicuous (var. *echinostoma* with ribs free, attached only at base, each ridge forming a tooth c. 30 by 1–2 mm with

an apical nectar gland), outer edge of peristome entire, inner lacking conspicuous teeth; lid held close to the mouth, elliptic, rarely orbicular, 1.8–2.8 by 1.4–2 cm, apex rounded or slightly retuse, base rounded or truncate, very slightly vaulted, with 2 prominent veins above, lower surface lacking appendages, but often with a slight pucker on the midline, c. 1/8 from apex, nectar glands dense, evenly spread, orbicular, thinly-bordered to volcano-like, 0.15–0.2 mm, smallest towards margin, larger and slightly longitudinally elliptic, 0.25 mm long, along midline; spur flattened, 4–5 by 1 mm, entire or rarely divided into 3 or more branches. *Upper pitchers* gradually originating from tendril, wholly subcylindrical and slightly laterally flattened, or slightly infundibuliform at base, cylindrical above, with distinct 'hipped' point 1/3–1/2 from the base, 12–20 by 2.5–4 cm, with 2 ridges; mouth, peristome and lid more or less as lower pitcher; spur usually entire, dorsiventrally flattened, 4–5 by 1–1.5 mm, apex rounded. *Male inflorescence* scented of mice droppings, 24–41(–50) by 2(–3.5) cm; peduncle 8–12 (–15) cm long, 2–3(–4) mm diam. at base; partial peduncles 1-flowered (rarely 2-flowered); bracts absent; pedicels c. 14 mm long; tepals broadly elliptic, (2–)4–4.5(–6) by (2–) 3.5–4(–4.5) mm; androphore (2–)2.5–3(–5) mm long; anther head 1–1.5 by 1.5–2 mm. *Indumentum* usually inconspicuous, of fine white stellate or sparingly branched, crinkled, sometimes with arachnoid hairs 1–3 mm long, soon falling and usually only visible on youngest growth and inflorescence, androphore glabrous; sessile red glands 0.1 mm diam. present on stem; scattered nectar glands present on stem. *Colour* of pitchers green, rarely streaked or wholly suffused with red.

Distribution — Thailand and Indochina to Micronesia (Palau) and Australia. Malesia: throughout except northern Philippines (Luzon and Palawan) and the eastern Nusa Tengarras (E Java, Bali to Lombok).

Ecology — Found in a remarkable range of habitats, but usually most abundant in disturbed, swampy or grassland situations. Usually at low altitude up to 200 m, but up to 1000 m, and more rarely to 1500 m (New Guinea).

Notes — 1. The most widespread species of the genus, *N. mirabilis* can be encountered with almost all lowland species. It is variable, but unique in having a fimbriate margin to the leaves of rosettes and short stems. These fimbriae are not trichomes, but attenuated extensions of the leaf. Other distinctive characters of *N. mirabilis* are the numerous longitudinal nerves scattered throughout the leaf blade, the sericeous, dorsiventrally flattened spur with a rounded apex, the elliptic to orbicular lid held close to the mouth, the usually flattened peristome, and the subcylindrical often laterally flattened upper pitcher.

2. In 19th century literature, *N. mirabilis* was known under the name *N. phyllamphora* due to Willdenow's incorrect combination of Loureiro's *Phyllamphora mirabilis*. In 1916, both Druce and Merrill made the correct combination, the former having priority by a few months (see synonymy above).

3. The peristome of western populations is usually flattened and extends well beyond the pitcher wall. In eastern populations it is more rounded.

4. The variety *echinostoma* is one of the most striking aberrations, with long peristome teeth developing from the inner peristome. Large populations of this variety are said to exist in Sarawak, but herbarium material is very scanty.

50. Nepenthes mollis Danser

Nepenthes mollis Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 338, f. 14; Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) 113, f. 60; Jebb & Cheek, Blumea 42 (1997) 65; Clarke, Nepenthes of Borneo (1997) 107. — Type: *Endert 4282* (holo BO), Borneo, E Kalimantan, G. Kemoel (= G. Kongkemul or G. Kemal), 1800 m, 17 Oct. 1925.

Climber, probably terrestrial, height unknown. Stems terete or slightly angular or flattened, 6–9 mm diam., internodes 10–15 cm long, axillary buds 3–10 mm long, inserted 5–10 mm above the node; rosettes and short stems unknown. *Leaves* of climbing stems coriaceous, sessile, oblanceolate or oblanceolate-spathulate, 18–20 by 3.5–4.5 cm, apex acute, base attenuate, 2 cm wide, subperfoliate-adnate, decurrent as two attenuate wings for 4–6 cm to the node below, wings up to 1 cm wide. Longitudinal nerves indistinct. Pennate nerves oblique, soon curving towards the margin and forming one or rarely two longitudinal nerves near the margin. *Lower* and *upper pitchers* not known. *Male inflorescence* 22–27 cm long; peduncle 7.5 cm long, 4 mm diam. at base; partial peduncles 2-flowered; bracts absent; pedicels 12 mm long; tepals elliptic c. 4 mm long; androphore and anther head 4.5 mm long. *Indumentum* of stem velvety with dense coarse brown spreading hairs both short and branched and long and simple, up to 2 mm long; the same denser and longer on youngest stem, axils, leaf midrib below and basal part above; the same less dense, shorter and finer on the lower surface of the leaf blade; upper surface of blade densely hairy with short, white, simple hairs; peduncle and rhachis of inflorescence densely hirsute with red-brown hairs; pedicels lower tepals and androphore with short crisped hairs. *Colour* of herbarium specimen fallow-dun to ochraceous brown, the indumentum dark red-brown.

Distribution — Borneo: W Kalimantan (G. Kemal).

Ecology — Dense forest on steep slope; 1800 m.

Note — The description above is largely taken from that of Danser in Bull. Jard. Bot. Buitenzorg III, 9 (1928) 338. The combination in *N. mollis* of sessile, oblanceolate leaves which are decurrent as wings down the stem, the dense indumentum of simple and branched red hairs, the virtual absence of longitudinal nerves except for their development from the pennate nerves, and the 2-flowered, bractless partial peduncles distinguish it from all other species. It is possible that the only specimen known represents a hybrid between e.g. *N. fusca* and *N. hirsuta*. The type of *N. fusca* was collected from the same locality. The pitchers of *N. mollis* are completely unknown and it is likely that a visit to the type locality is needed before this cryptic taxon is elucidated fully.

51. Nepenthes muluensis M. Hotta

Nepenthes muluensis M. Hotta, Acta Phytotax. Geobot. 22 (1966) 7, f. 2; Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) 115, f. 61 & 62; Jebb & Cheek, Blumea 42 (1997) 66. — Type: *Hotta 14791a* (holo KYO n.v.; iso L), Borneo, Sarawak, Mt Mulu, western ridge, 1900–2400 m, 18 March 1964.

Nepenthes sarawakiensis J.H. Adam & Wilcock, Sarawak Mus. J. 43 (1992) 291. — Type: *J.H. Adam, Julaihi H. Adam, A. Mahdi 2403* (holo UKMS n.v.; iso SAR n.v.), Borneo, Sarawak, G. Mulu, 2320 m, 8 Dec. 1987.

Terrestrial climber 1–3 m tall. Rosette and short stems unknown, climbing stems slightly flexuose, terete or 2-ridged, (2–)3(–4) mm diam., internodes 1–2 cm long.

Leaves thinly coriaceous, sessile, glossy above, those of rosettes with bases semi-amplexicaul, those of climbing stems narrowly oblanceolate-oblong to lanceolate-oblong, 4.2–6.5 by 1.1–1.7(–2) cm, apex acute to rounded, not peltate, base slightly attenuate, clasping the stem for 1/3–1/2 its circumference, not decurrent. Longitudinal nerves 3 or 4 on each side of the midrib, scattered fairly evenly, fairly conspicuous above and below. Pennate nerves numerous, patent, straight, fairly conspicuous above and below. *Lower pitchers* not seen but reported similar to those of *N. tentaculata* (Clarke in Nepenthes of Borneo (1997) 109). *Upper pitchers* subcylindrical, the basal 1/4 obcampanulate, gradually becoming slightly constricted in the middle and then dilating slightly at the mouth, (5.2–)6.8–8.5(–9) by (1.4–)1.6–2.2(–2.5) cm, with two narrow, non-fringed wings 0.3–0.7 mm wide; mouth elliptic to broadly elliptic, slightly concave, oblique, peristome rounded, 0.8–1 mm wide, ribs indistinct, c. 0.2 mm apart, outer edge entire, inner edge without teeth; lid orbicular to transversely elliptic, (1.1–)1.5–2.1 by (1.4–)1.7–2.4 cm, apex rounded to truncate, base cordate to truncate, lower surface lacking appendages, midrib forking 3–4 mm before the apex; nectar glands conspicuous, sparsely scattered over the whole surface, bordered, circular, 0.1–0.2 mm diam.; upper surface lacking tentacles; spur stout, entire, dorsiventrally flattened, unbranched, 2.5–3 by 1 mm, apex rounded. *Male inflorescence* 9.5 by c. 1.8 cm; peduncle 1.5 cm long, 1.5 mm wide at base; partial peduncles 1-flowered, bracts absent; pedicels c. 50, 4–6 mm long; tepals elliptic, 3–3.5 by 1.5 mm, apex obtuse; androphore 2–2.5 mm; anther head 1.5 by 1.5 mm. Infructescence c. 8 cm long, with 11–13 fruits. Fruit with valves elliptic, (13–)15–19 by 5.5–7 mm. Seeds c. 90 per fruit, fusiform, 10–12 by 0.6–1 mm. *Indumentum* of sessile red glands on stem and lower surface of blade; midrib conspicuously pubescent with erect orange-brown simple hairs c. 0.2 mm long; pitcher, including spur, glabrous; inflorescence from peduncle to lower surface of tepals and base of androphore with scattered appressed coppery simple hairs 0.1–0.2 mm long. *Colour* on drying matt black; live plants with stems black or dark red, "pitchers ranging from dark red to almost black, with cream blotching. Lid of pitcher creamy white, often tinged pink. Lip yellow. Flower pale green maturing brown. Fruit like two pyramids end to end, upper half yellowish, lower half red." (*Lewis 354*).

Distribution — Borneo: Sarawak (Mt Mulu, Mt Murud, Batu Lawi, and the Tama Abu Range).

Ecology — Stunted montane forest or ericoid scrub on sandstone ridges; altitude 1750–2400 m.

Notes — 1. *Nepenthes muluensis* is a distinct, slender species not easily confused in the climbing stems and upper pitchers with the only other small highland species in Borneo, *N. tentaculata*. *Nepenthes muluensis* differs in its non-perfoliate-adnate leaves, entire, short spur and orbicular to transversely elliptic lid. The lid and peristome are usually a delicate whitish green or white in colour, contrasting strikingly with the pitcher which is predominantly purple and only lightly blotched with white.

2. The lower pitchers are reported by Clarke in Nepenthes of Borneo (1997) 109, f. 37 & 73 as being almost identical with those of *N. tentaculata*, with bristles around the edge of the upper surface of the lid. Thus we conclude that the purported hybrid between *N. tentaculata* and *N. muluensis*, *N.* × *sarawakiensis* from Mulu, is probably merely a young plant of *N. muluensis*. Whether the leaves of the short stems are perfo-

liate-adnate, as characteristic of that species group, is not reported, but this species presumably belongs here. The few-flowered, diminutive, ebracteate raceme and the inconspicuously ridged peristome of *N. muluensis* are all characters seen in the *N. tentaculata* group. Unfortunately all specimens available to us show only the climbing stems and upper pitchers. This is also the case with *N. glabrata* of Sulawesi to which *N. muluensis* is extremely similar, sharing many unusual characters not otherwise seen in the *N. tentaculata* group, such as the plants being glabrous in most parts, in the white lid and white and red pitcher, in the orbicular to transversely elliptic lid with its unusual nervation, the short, entire spur, the conspicuous bordered nectar glands and the androphore, being hairy at the base. *Nepenthes glabrata* differs in its pitchers being more broadly cylindrical, lacking a campanulate base and in having wings twice as broad as in *N. muluensis*. Its inflorescence indumentum is white, not coppery, and its spur is hairy. Moreover its leaves are twice as long as those of *N. muluensis* and with only 1 (not 3 or 4) pairs of longitudinal nerves.

52. Nepenthes murudensis Culham ex Jebb & Cheek

Nepenthes murudensis Culham ex Jebb & Cheek, Blumea 42 (1997) 66; Clarke, Nepenthes of Borneo (1997) 111, f. 74. — Type: *S 44623 (Yii Puan Ching)* (holo K; iso SAR), Borneo, Sarawak, Mulu N.P., G. Murud, 2200 m, 13 Sept. 1982.

Nepenthes reinwardtiana × *N. tentaculata*?, Phillipps & A.L. Lamb, Nature Malaysiana 13, 4 (1988) 9. — *Nepenthes murudensis* Culham ined., Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) 117, f. 63, nomen.

Terrestrial climber to 5 m tall. Stem erect, strongly triangular, 4–5 mm diam., internodes 7–8 cm long, axillary buds rounded, projecting less than 1 mm c. 4 mm above the node. *Leaves* thickly coriaceous, sessile; oblong-elliptic, 4.5–8.6 by 1.5–3 cm, apex rounded to obtuse, base clasping the stem and adnate, decurrent to 2 cm below the node. Longitudinal nerves 4 or 5 on each side of the midrib, closer together near the margin, conspicuous above and below. Pennate nerves obscure. *Lower pitchers* unknown. *Upper pitchers* subcylindrical; 12–25 by 2–5 cm; the basal 1/5 swollen, ellipsoid, in the larger pitchers to 4–5 cm wide, the mouth about the same diameter, both tapering gradually to 2–2.5 cm at the centre of the pitcher; with two ridges to 0.1 cm broad lacking fringed elements; the inner pitcher surface glaucous; mouth ovate, oblique; peristome cylindrical to slightly flattened in section, 1.5–2 mm wide, with very low ribs 0.1–0.2 mm high, 0.4–0.5 mm apart, outer edge not sinuate, the inner edge appearing entire; lid ovate to obovate, 2.7–5.5 by 2–4 cm, apex rounded, base rounded-truncate, lower surface without appendages, nectar glands crater-like, small, rounded, with lumina c. 0.15 mm diam., 320–440 per cm^2; spur simple, stout, blunt and slightly flattened, to 9 by 1.5 mm, or filiform with numerous branches, to 9 mm long, puberulent. *Male inflorescence* to 9 cm long; peduncle to 2.3 cm long; partial peduncles 1-flowered; bracts absent; pedicels 0.4–0.7 mm long; androphore to 2 mm long; anther head to 0.9 mm wide. Infructescence c. 11 cm long; peduncle c. 5 cm long; pedicels 4–7 mm; tepals oblong, 4–4.5 by 1 mm, inner surface densely covered in raised elliptic glands. Fruits with valves 14–22 by 3–4 mm. Seeds filiform, 10 by 1 mm. *Indumentum* of short dense pale brown velvety, erect 3–5-branched hairs 0.25–0.5 mm long; per-

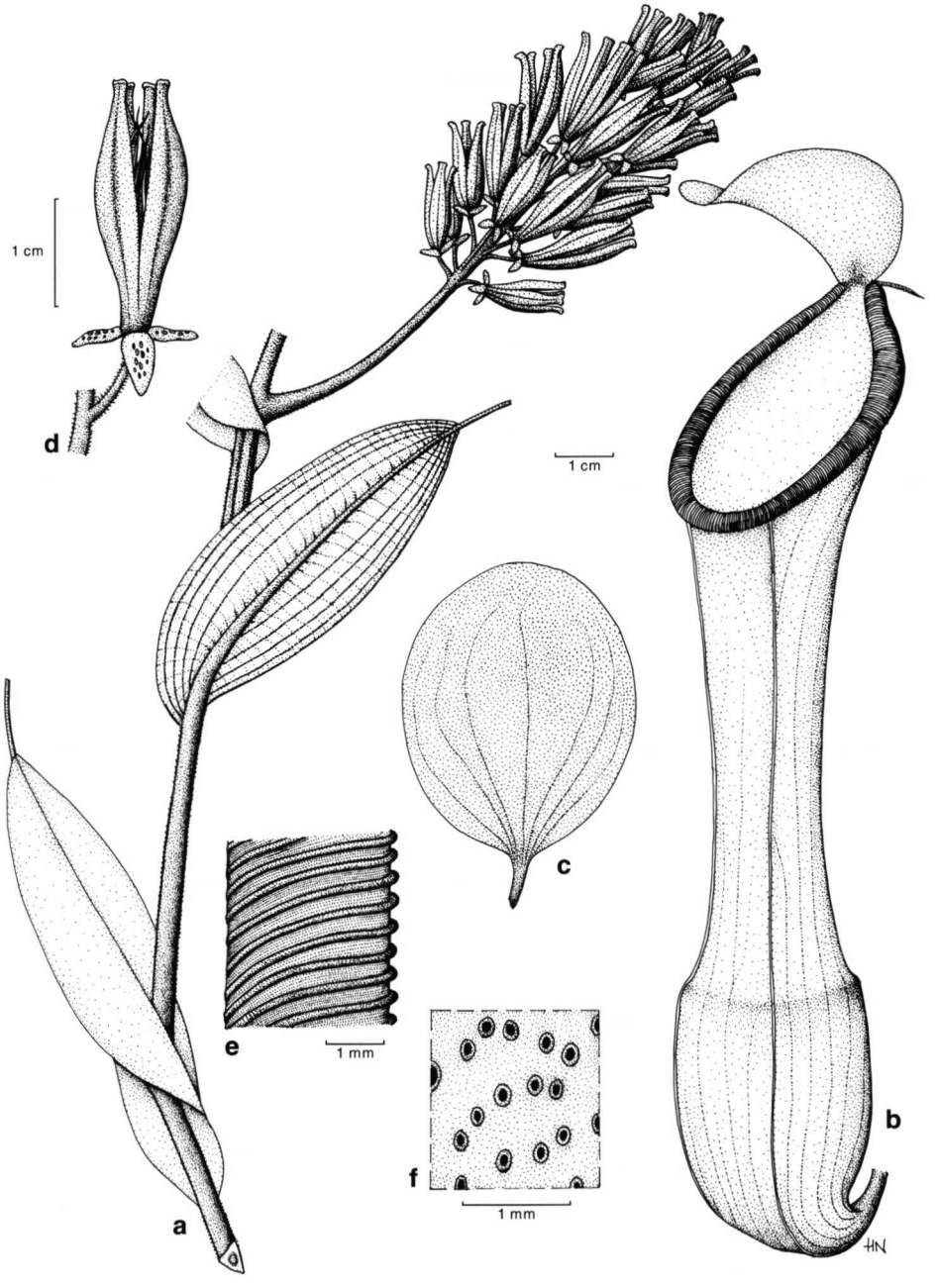

Fig 14. *Nepenthes murudensis* Culham ex Jebb & Cheek. a. Stem with female inflorescence; b. upper pitcher; c. upper surface of lid and spur; d. fruit; e. detail of peristome viewed from above; f. detail of glands on lower surface (*S 44623 (Yii Puan Ching)*). Drawn by Holly Nixon.

sisting on stems, midrib and inflorescence axis; leaf blade glabrous; pitcher inconspicuously hairy with scattered appressed, simple white hairs 0.1–0.3 mm long; lid subglabrous; fruit valves with strongly appressed white or brown hairs c. 0.5 mm long. *Colour* of stem and midribs black; pitchers green, sometimes suffused with red or with black streaks on the back side; inner surface pale green or almost white, glaucous; peristome green or bronze; fruits brown. — **Fig. 14.**

Distribution — Borneo: Sarawak, known only from Gunung Murud (also known as Mt Murut).

Ecology — Stunted scrub-forest, or moss forest on sandstone; 2200–2500 m.

Notes — 1. *Nepenthes murudensis* has been confused with the lower altitude *N. reinwardtiana* which it resembles in the shape of the upper pitchers, but differs in lacking the inner pitcher 'eye-spots' and visibly perforate inner peristome margin. The stem, leaf shape and aspects of the pitcher morphology and the small inflorescence are those of the variable and widespread *N. tentaculata* with which *N. murudensis* has also been confused. *Nepenthes tentaculata* differs from *N. murudensis* in being a much more slender species with multicellular hairs on an ovate lid. Both *N. reinwardtiana* and *N. tentaculata* have glabrous stems unlike the densely velvety hairy stem of *N. murudensis*.

2. As first indicated by Phillipps & A.L. Lamb (see synonymy above), this species is somewhat intermediate between *N. reinwardtiana* and *N. tentaculata*. Indeed, *N. murudensis* may have originated as a hybrid between these two species. With the former it shares a pitcher with a ventricose base, a narrow waist and flared mouth, with the latter it shares a broad adnate leaf, and a fasciculated spur with tentacle-like appendages. The relatively large pitchers combined with the small oblong leaves which clasp the stem distinguishes the species from all others.

53. Nepenthes neoguineensis Macfarl.

Nepenthes neoguineensis Macfarl., Nova Guinea 8 (1910) 340, t. 67; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 341; Jebb, Science in New Guinea 17 (1991) 36, f. 19; Jebb & Cheek, Blumea 42 (1997) 68. — Type: *Versteeg 1746* (BO, K), New Guinea, Lorentz River, Sabang, 25 Sept. 1907.

Nepenthes neoguineensis auct. non Macfarl.: Ridl., Trans. Linn. Soc. London, Bot. II, 9 (1916) 139 = *Nepenthes papuana* Danser.

Terrestrial climber to 10 m or more tall. Climbing stems 4-angular below internodes, rarely with 4 prominent wings, otherwise rounded, 0.3–0.6 cm diam., internodes 1–4 cm long; short stems and rosettes unknown. *Leaves* chartaceous, petiolate, leaf blades of climbing stems narrowly oblanceolate, 15–35 by 2.5–5(–8) cm, apex acute, base abruptly tapering to winged petiole, petiole 2–7 cm long, clasping the stem for 1/2 its circumference and decurrent down the stem with wings to 4 mm in breadth, 1–10 mm long. Longitudinal nerves 3 or 4 on each side of the midrib running in outer 1/3 of lamina, inconspicuous. Pennate nerves numerous, ascending obliquely and then curving towards the margin; irregularly reticulate in the outer 1/2 of the lamina. *Lower pitchers* ovoid, becoming cylindrical towards the mouth, but narrowest there, 14 by 4.5 cm, with prominent fringed wings to 10 mm broad, fringe elements to 3 mm long; mouth ovate, acuminate, oblique, straight; peristome flattened, to 8 mm broad, sloping inwards. *Upper pitchers* subcylindrical and curved over most of their length, gradually originating from the tendril, infundibulate in the lower part, becoming swollen at 2/5

its length, then slightly narrowed and barely widened again towards the mouth, to 24 by 5 cm, the fringed wings throughout the basal curve, often reaching close to the tendril, 5–8(–20) mm wide, fringed elements 3 mm long, 2–5 mm apart; mouth as in lower pitcher; peristome cylindrical or flattened, 1–3 mm broad, ribs 0.25–0.3 mm apart, outer edge entire, inner inconspicuously toothed; lid suborbicular, to 6 cm diam., apex truncate to emarginate, base rounded or cordate; lower surface lacking appendages, nectar glands orbicular, bordered, 0.2–0.3 mm diam., densest and largest about the 2 more prominent lateral veins; spur simple, dorsiventrally flattened, 2–5 mm long. *Male inflorescence* 35–50 cm long; peduncle 4–12 cm long, 2.5–4 mm diam. at the base; partial peduncles corymbose, (2–)4- or 5-flowered at base, to 5 cm long; bracts present or absent; tepals orbicular-elliptic, 4 mm long; androphore c. 3 mm long. Fruit and seed unknown. *Indumentum* very sparse, stems glabrous or, in the axils, brown-tomentose; leaves ciliate at the margin with sparingly branched, red-brown hairs 0.5 mm long or shortly hairy on the midrib when young, otherwise glabrous; pitchers densely stellately hairy when young, glabrescent except for a tomentose band below the peristome; lid as the pitcher; spur densely stellately hairy; inflorescence with short, brown or white stellate hairs, densely tomentose on pedicels, tepals and ovary, sparser on peduncle and rhachis, hairs 0.2–0.5 mm long, appressed. *Colour* of pitchers green.

Distribution — New Guinea mainland and d'Entrecasteaux archipelago.

Ecology — River edge and river gravel bars, ridge crests, rarely open grassland or disturbed forest; sea level to 900(–1400) m.

Notes — 1. The curved, upper pitchers with broad, fringed wings which are widest at the base of the pitcher, and the corymbose partial peduncles are diagnostic of *N. neoguineensis*.

2. The type number has rather poorly developed inflorescences in which the partial peduncles are mostly 2-flowered, and 3-flowered near the base. The bract on the female partial peduncles is not always well developed. The upper pitchers may be strongly infundibulate (i.e. Cycloops Mts near Jayapura), approaching in appearance those of the closely allied *N. paniculata*. This latter species may be distinguished by its wholly infundibuliform upper pitchers (which are neither narrowed nor cylindrical towards the mouth) and the much reduced wings.

3. We are not certain that we have seen all the duplicates examined by the author of *N. neoguineensis*, since the sheets at Bogor and Kew do not appear to have been used in the production of the protologue plate.

54. Nepenthes northiana Hook.f.

Nepenthes northiana Hook.f., Gard. Chron. II (1881) 717, t. 144 & p. 724 & 725; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 342; Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) 119, f. 64; Jebb & Cheek, Blumea 42 (1997) 69; Clarke, Nepenthes of Borneo (1997) 113, f. 75. — Type: *Curtis s.n.* (K), Borneo, Sarawak, Jambusan.

Nepenthes spuria Beck, Wiener Ill. Gart.-Zeitung 20 (1895) 187. — Type: not located.

Nepenthes nordtiana Boerl., Handl. 3, 1 (1900) 54.

Nepenthes northiana var. *pulchra* Hort. ex Macfarl., Bail. Std. Cycl. Hort. 4 (1922) 2129.

Nepenthes decurrens Macfarl., Kew Bull. (1925) 35; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 282, f. 3. — Type: *Hewitt 100* (lecto K (pitcher & stem); iso BO, K (infl.)), Borneo, Sarawak, Baram.

Terrestrial shrub or climber, 1–4 m tall. Stems 4–6-angular-rounded, 1–2.2 cm diam., with 4 wings, each c. 5 mm wide, decurrent from the leaf base above and abruptly uniting above the axil below, and on the same side of the stem; short shoots with internodes c. 1 cm long, wings forming a saddle-like shape; climbing shoots with internodes 7–8 cm long. *Leaves* coriaceous, sessile to weakly petiolate; leaves of short shoots long-elliptic to spathulate, 20–59 by 7–11 cm, apex acute with tendril peltate by several mm, base attenuate, forming an ill-defined, winged petiolar area 2–4.5 cm wide, clasping the stem for 1/2 its circumference, the wings decurrent, initially sheathing, then patent; leaves of climbing stems narrowly oblong-elliptic to ligulate, 37–60 by 4.4–6.5(–9) cm. Longitudinal nerves 3 (or 4) on each side of the midrib in the outer half, prominent above and below. Pennate nerves patent, straight, little branched, conspicuous above and below. *Lower pitchers* recumbent, ellipsoid, 14–36 by 5.8–12.5 cm, with two fringed wings 5–10 mm wide, the fimbriae 5–7 mm long, 2–4 mm apart; the mouth oblique, slightly concave, narrowly ovate; peristome flattened, with ribs 0.2–0.3(–0.5) mm high, 0.7–1 mm apart, 5 or 6 striae between each ridge, outer edge of peristome 12–40 mm broad, gradually widening towards the lid, dentate, folded into 12–16 shallow teeth 3–7 mm long, inner edge appressed to pitcher wall, 5–10 mm wide, the margin with falcate teeth 1 mm long; column absent; lid as large or larger than mouth, held at 45° elevation from mouth, narrowly elliptic, 5.5–15 by 3.2–5 cm, apex rounded, base cordate, lower surface lacking appendages, midrib raised, glands restricted to a thickened area about half the width of the lid and running nearly its length, absent from the midrib, circular or transversely elliptic, bordered, black, 0.2–0.3 mm diam.; spur c. 5 mm long, entire. *Upper pitchers* cylindrical-infundibulate, 20–36 by 6–8 cm, fringed wings running the length of the pitcher, 3–4 mm wide, fimbriae 3–7 mm long; peristome rounded, 2.5–4 cm wide in the widest part, ribs to 1 mm high; lid 7–9 by 3–4 cm. *Male inflorescence* c. 145 by c. 10 cm; peduncle 33 cm long, 7 mm diam. at base; partial peduncles 2-flowered, 7–22 mm long; bracts 2–3 mm long, absent in some inflorescences; pedicels 17–35 mm long; tepals ovate, 3.5–4 by 2.5–3 mm; androphore 1–3 mm long; anther head 1.5–2 by 2–3.5 mm. Infructescence c. 103 cm long; peduncle 46 cm long, 1 cm wide at base, with a pulvinus c. 1.5 cm wide; partial peduncles 4–5 cm long; pedicels 2.8–3.2 cm. Fruits with valves 25–28 by 3.5–4 mm. Seeds filiform, 8 by 0.3 mm (probably immature). *Indumentum* of sessile red glands on lower surface of leaf blade and outer pitcher and lid intermixed, on the outer pitcher, with simple, patent red hairs 0.5 mm long; partial peduncles to lower surface of tepals and ovary fairly densely covered in coppery coloured, 1 or 2 branched appressed hairs 0.3 mm long. *Colour* of the pitcher yellow or pale green marbled red; peristome red often striped yellow and green; lid pale green suffused with olive.

Distribution — Borneo: Sarawak (near Bau).

Ecology — Bare or lightly wooded limestone cliff faces and slopes with permanent water seepages; 40–800 m.

Notes — 1. *Nepenthes northiana* is restricted to limestone in a small area of Sarawak. It is not likely to be confused with any other species in Sarawak on account of the very large, ovoid, recumbent lower pitchers with a broad, sinuate peristome protected by a narrowly elliptic lid. *Nepenthes mapulensis*, which occurs also on limestone, on the opposite side of Borneo, shares these characters, but is immediately distinguished by

its terete, puberulent, flexuose stems which lack the unusual saddle-shaped ridges seen on the short stems of *N. northiana*.

2. *Nepenthes decurrens*, based on a specimen with only upper pitchers, was possibly described because, at that time, the only specimens of *N. northiana* available to Macfarlane had lower pitchers. *Nepenthes northiana* is only known from the Bau region near Kuching, whereas the type of *N. decurrens* was said to have been collected at Baram. If the Baram referred to is the Baram River, some 500 km to the north-east, it seems astonishing the species has not been recollected there or found in the other limestone areas in between. Hewitt's numbering system provides no positive clue, but it is of note that a specimen of *Trevesia burckii* Boerl. (Araliaceae) at K also bears the number *Hewitt 100*, and was collected on Mt Poi near Kuching.

3. Beck based his *N. spuria* on part of Hooker's original protologue of *N. northiana*. He regarded the English text and f. 144 to represent a separate species. There seems no justification for this.

4. This species came to the attention of the world through a painting by Marianne North. When this was seen by the nurseryman Harry Veitch, he arranged for his collector Charles Curtis to obtain the plant for his London nurseries from whence Hooker described it from live plants and dried pitchers.

5. Plants of this species growing in open rocky places will flower freely as non-climbing shrubs, lacking upper pitchers. However, in lightly wooded areas, upper pitchers, as well as lower, are abundantly produced (pers. obs.).

55. Nepenthes ovata Nerz & Wistuba

Nepenthes ovata Nerz & Wistuba, Carnivorous Plant Newsl. 23 (1994) 108, f. 4; Jebb & Cheek, Blumea 42 (1997) 70. — Type: *Nerz 1601* (L), Sumatra, Sumatera Utara, Prapat, G. Pangulubao, 1800 m, 16 March 1989.

Nepenthes sp. Hopkins, Maulder & B. Salmon, Carnivorous Plant Newsl. 19 (1990) 21 & 25.

Nepenthes pectinata auct. non Danser: Kondo & Kondo, Carniv. Pl. World (1976?) 113 (f.).

Epiphytic, rarely terrestrial shrub or climber to 1 m tall. Stem terete, climbing stem 4–6 mm diam., internodes 4–15 cm, axillary buds barely visible. *Leaves* thinly coriaceous, sessile, those of rosettes oblanceolate-spathulate, 10–15 by 2–3 cm, apex shortly acuminate, base attenuate, 1–1.5 cm wide; leaves of climbing stems oblanceolate-spathulate, 5–16.5 by 2.5–3.5(–5.7) cm, apex acuminate, barely peltate, base attenuate, 1.2–1.4 cm wide, clasping the stem for 9/10 its circumference, decurrent for 3–7 mm down stem, wings 2–4 mm wide. Longitudinal nerves 3 on each side of the midrib in the outer 1/2, fairly conspicuous. Pennate nerves, arising obliquely, then patent, straight, inconspicuous. *Lower pitchers* broadly ellipsoid, 10–15(–25) by 5–8(–9) cm, the upper half mostly occupied by the mouth; with two fringed wings 2–5 mm wide, fringed elements 3–10 mm long, 1–5 mm apart; mouth ovate, oblique, highly concave, the rear elevated to form a conspicuous vertical or overhanging column; peristome mostly flat, in the front half of the pitcher 3–8 mm broad, in the rear half of the pitcher, including the column, 15–25(–40) mm wide, the ribs c. 1.5 mm apart, c. 1 mm high, papery, striate, outer edge of the peristome with 8–11 shallow lobes 1–10 mm long, inner edge with conspicuous teeth, at the rear half of the mouth, teeth 1–7 mm long, projecting

outwards from the column, in the front half of the mouth teeth inconspicuous or to 3 mm long; lid elliptic, 5.5–7 by 4.5–6 cm, apex rounded, base shallowly cordate, lower surface with a laterally flattened symmetrical or recurved appendage 2–5 mm high, 5–9 mm long, 5–13 mm from the base of the lid on a keel 10–25 mm long, 1–2 mm high, running along the midline, nectar glands circular, 0.1–0.2 mm diam. with a thin raised border, fairly dense on the appendage and along the basal 2/3 of the midline in a band 0.5–1.5 mm wide on each side of the keel, otherwise absent, the keel with a few large elliptic glands up to 0.3 mm long; spur 8–9 mm long, entire or divided into two arms for half its length. *Upper pitchers* infundibuliform, 12–18 by 4.8–6 cm, the base 1.5–2 cm wide, slightly contacted at the mouth, with two ridges; mouth as in the lower pitchers, but peristome and column reduced, peristome c. 3 mm wide in the front half, c. 14 mm wide in the rear half, inner edge with teeth curved, c. 3 mm wide in the rear, 1 mm long in the front half; lid broadly ovate, 32 by 33 mm, apex truncate to shallowly retuse, base truncate to shallowly cordate, lower surface and spur as the lower pitcher. *Male inflorescence* reported as 9 cm long; peduncle 4 cm long, 2 mm diam. at base; partial peduncles 1-flowered; bracts basal, filiform, c. 5 mm long; pedicels 5 mm long; tepals, ovate-lanceolate, 3 by 2 mm; androphore c. 3 mm long. *Indumentum* of sessile glands 0.1 mm diam. on stem, upper and lower surface of leaf, outer pitcher and lid; pitcher, including lid and spur, puberulous with sparsely scattered white simple hairs c. 0.5 mm long. *Colour* of lower pitchers, including the lid, green, inner pitcher green mottled red, peristome brilliant scarlet; upper pitchers yellow, peristome red with yellow stripes.

Distribution — Sumatra (N): Mt Pangulubao, Mt Sipualai.

Ecology — Epiphytic in open, wet mossy forest; 1800 m.

Notes — 1. *Nepenthes ovata* is easily distinguished from all other Sumatran species by its conspicuous, laterally flattened, sometimes hooked, basal lid appendage. It appears confined to the Lake Toba area. Its upper pitchers are most similar in shape to those of *N. bongso* which occurs in a disjunct area to the south.

2. The description above is partly taken from the protologue.

56. Nepenthes paniculata Danser

Nepenthes paniculata Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 344, f. 15; Jebb, Science in New Guinea 17 (1991) 38, f. 20; Jebb & Cheek, Blumea 42 (1997) 70. — Type: *Lam 1569* (lecto BO; iso BO, U), New Guinea, Irian Jaya, Doorman Top, 1460 m, 9 October 1920.

Terrestrial (probably) climber to 7 m tall. Stems terete 0.5–1 cm diam., internodes 3–10 cm long, rosette and short shoots unknown. *Leaves* coriaceous, petiolate, those of climbing stems with blade narrowly elliptic or lanceolate, 20–30 by 4–7 cm, apex acuminate, base gradually attenuate into a narrowly winged petiole 3–9 cm long, base of petiole a semi-amplexicaul sheath, not decurrent. Longitudinal nerves 3 or 4 on each side, in outer 1/3 of the lamina. Pennate nerves numerous, running obliquely to margin and there forming an irregular network. *Lower pitchers* unknown. *Upper pitchers* gradually originating from the tendril, wholly infundibuliform, 8–11 by 3–5 cm, with 2 prominent ribs, occasionally narrowly winged in the upper part, wings fringed; mouth suborbicular, straight, oblique; peristome flattened 4–10 mm broad, ribs 0.5–1 mm

apart, outer edge entire, inner conspicuously toothed; lid suborbicular, 4–4.5 by 4.5–5 cm, apex rounded, base cordate, lower surface lacking appendages but with thickened midline, nectar glands small, orbicular, bordered, scattered over the entire surface apart from the margin; spur entire, 3 mm long, apex acute. *Male inflorescence* c. 30 cm long; peduncle c. 10 cm long, 3 mm diam. at base; partial peduncles 5-flowered at base, c. 3 cm; bracts absent; tepals orbicular-elliptic, 2.5–3.5 mm long; staminal column and anther head c. 2 mm long. Fruit and seed unknown. *Indumentum* mostly absent; pitchers sparsely brown tomentose when young, glabrous when mature; as is the inflorescence, indumentum persisting only on the pedicels and tepals. *Colour* of stems and leaves light green, pitchers yellowish green, peristome dark green, inner pitcher with violet spots, lid yellowish green suffused with red below and with violet spots below; peduncle green with a red hue; tepals light green at first, later dark red; androphore light green.

Distribution — New Guinea: Irian Jaya (Doorman).

Ecology — Mossy forest on ridge top; 1460 m.

Notes — 1. This species is closely related to *N. neoguineensis* and the means of distinguishing them are slight: the partial panicles of the inflorescence are not corymbiform; the upper pitchers are wholly infundibulate, and not narrowed at the mouth, and have much reduced wings; the peristome is broader, more rounded, and has more widely spaced ribs (0.6–1 mm vs. 0.25–0.35 mm); the numerous, large (0.5 mm), lipped glands are present on the upper surface of the leaf sheaths, and scattered along the upper sides of midrib (absent in *N. neoguineensis*).

2. *Nepenthes paniculata* is only known from the type number and more collections and observations are needed. The description above is largely taken from that of Danser in Bull. Jard. Bot. Buitenzorg III, 9 (1928) 344.

57. Nepenthes papuana Danser

Nepenthes papuana Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 346, f. 16; Jebb, Science in New Guinea 17 (1991) 40, f. 22; Jebb & Cheek, Blumea 42 (1997) 71. — Type: *Docters van Leeuwen 10341* (lecto BO; iso BO, L), New Guinea, Irian Jaya, affluent C of the Rouffaer River, 300 m, Sept. 1926.

Nepenthes neoguineensis auct. non Macfarl.: Ridl., Trans. Linn. Soc. London, Bot. II, 9 (1916)139.

Terrestrial climber to several m tall. Climbing stems terete, 5–7 mm diam., internodes 5–7 cm long. *Leaves* thinly coriaceous, sessile or weakly petiolate, those of climbing stems lanceolate or narrowly elliptic, 15–30 by 2.5–5 cm, apex acute, base attenuate into a weakly formed petiole up to 4 cm long, semi-amplexicaul at base, not sheathing or decurrent. Longitudinal nerves 4–6 on each side of the midrib, running parallel in the outer 2/3 of the lamina, highly conspicuous. Pennate nerves running obliquely towards the margin, and there irregularly reticulate, inconspicuous. *Lower pitchers*, of the rosettes, obliquely ovoid in the lower part, gradually narrowed towards the mouth, 3–6 by 1.25–2.5 cm, 1–1.75 cm broad at the mouth, with 2 fringed wings over the whole length, 2–4 mm broad, fringe elements 1–2 mm long, 0.5 mm apart; mouth ovate, oblique, slightly concave; peristome cylindrical, 1–2 mm wide, ribs 0.5 mm apart, outer edge entire, inner edge conspicuously toothed; lid suborbicular 1–2 by 1–2 cm, apex round, base slightly cordate, lower surface lacking appendages, nectar

glands densest in centre, absent from base of lid and marginal 2 mm, minute, orbicular, thinly bordered or volcano-like, 0.1–0.2 mm diam.; spur entire, dorsiventrally flattened, surrounded by filiform appendages. *Upper pitchers* subcylindrical, basal 1/3 slightly ventricose, upper 2/3 tubular or slightly attenuate and dilated at the mouth, 12–15 by 2.5–3 cm, with 2 narrow wings 1–3 mm wide, fringed or not, fringe elements up to 3 mm long, up to 2 mm apart; mouth broadly ovate, oblique, straight; peristome slightly flattened, 1–2 mm wide, ribs 0.5 mm apart, outer edge entire, inner toothed; lid orbicular, 2.5–3.5 by 2.25–3.25 cm, lower surface lacking appendages, nectar glands densely set near base of midrib, as lower pitcher. *Male inflorescence* c. 25 cm long; peduncles c. 6 cm long, 2 mm diam. at base; partial peduncles 1-flowered; bracts absent; pedicels 5–10(–15) mm long; tepals suborbicular 3 by 2.5 mm; androphore 3–4 mm long including the anther head. Fruit with valves lanceolate, 25–35 by 3–5 mm. Seeds filiform 12–15 mm long, centre transversely wrinkled. *Indumentum* absent from stem; leaf with midrib densely and shortly brown tomentose, leaf margin densely brown velvety hairy; pitchers densely and shortly stellately hairy when young, more sparse later; inflorescences densely brown tomentose when young, more sparse later, androphore sparsely hairy, fruit densely hairy. *Colour* of upper pitchers green, mouth and lid with red spots; lower pitchers more densely red spotted. Dried specimens a characteristic reddish brown colour.

Distribution — New Guinea: southern Irian Jaya (Fakfak to Balim Valley).

Ecology — Forest edges and forest on white sand soils; 250–900 m.

Notes — 1. *Nepenthes papuana* has subcylindrical upper pitchers with a somewhat narrow peristome and resembles *N. mirabilis* in general appearance. It differs in its more leathery leaf blades with somewhat indistinct pennate nerves, the blades of lower rosette pitchers lack the fimbriate margin of this latter species, while the upper pitchers have blades with a pubescent margin below. *Nepenthes papuana* might also be confused with, and is possibly most closely related to *N. neoguineensis*. The latter differs mainly in the paniculate inflorescence, the conspicuous pennate nerves and the curved upper pitchers with wings broadest at the base, towards the tendril.

2. Ridley incorrectly identified the first known material of this species, from the Wollaston expedition, as *N. neoguineensis* Macfarl.

58. Nepenthes pectinata Danser

Nepenthes pectinata Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 350, f. 17a, b, d, partim; Jebb & Cheek, Blumea 42 (1997) 71. — Type: *Bünnemeijer 700* (lecto L (Schlauer & Nerz 1994); iso BO), Sumatra, Sumatera Barat, G. Talakmau, 1850 m, 13 May 1917.

Nepenthes melamphora var. *tomentella* Becc., Malesia 3 (1886) 13. — Type: *Beccari 48* (K, L), Sumatra, Sumatera Barat, Mt Singgalang, 6–7/1878.

Nepenthes rosulata Tamin & M. Hotta in M. Hotta, Diversity and Dynamics of Plant Life in Sumatra (1986) 95, f. 4, nom. nud.

Nepenthes xiphioides B. Salmon & Maulder, Carnivorous Plant Newsl. 24 (1995) 78, f. 1 & 2. — Type: *Salmon & Maulder 221720* (AK), Sumatra, Sumatera Utara, G. Pangulubao, 1900 m, 17 Feb. 1995.

Nepenthes gymnamphora auct. non Nees: Miq., Pl. Jungh. 2 (1852) 169.

Terrestrial climber to 4 m tall. Stems terete to 1 cm diam. *Leaves* thinly coriaceous, more or less sessile; those of climbing stems elliptic-spathulate to oblong, 15–27 by

3–6 cm, apex acute to acuminate, base cuneate or broadly winged, clasping the stem and decurrent for 1–3 cm. Longitudinal nerves 3 or 4 on each side of the midrib, scattered throughout lamina, innermost arising from midrib. Pennate nerves numerous, arising obtusely and forming a net-like pattern with the longitudinal nerves. (Leaves of rosettes usually highly reduced, sometimes as small as 3 by 0.7 cm, triangular in outline, dilated at the base, and clasping the stem, sometimes forming a sheath, with pennivenous venation only, only the largest ones with the beginning of longitudinal veins). *Lower pitchers* ellipsoid-urceolate, narrowing towards mouth, 6–16 by 2–6.5 cm, with 2 fringed wings 2–5 mm wide, fringe elements 2–4 mm long; mouth ovate, acute to acuminate towards lid, slightly concave, oblique; peristome rounded at front, expanded towards sides and narrowing towards lid, 2–12 mm wide, with prominent, papery, thin ribs 0.8–2 mm apart, 0.5–1.5 mm high, outer edge entire, inner with teeth 2–4 mm long; lid ovate 2–7.3 by 1.5–5.3 cm, apex rounded, base truncate to cordate, lower surface lacking appendages, nectar glands few, prominently lipped, 0.1–0.5 mm wide, near midline and towards base of lid only, absent from margin; spur filiform or flattened, rarely many branched, 1–4 mm long. *Upper pitchers* apparently only produced rarely, or (?) only in some populations (e.g. G. Malintang), somewhat ventricose in lower half, tubular above; 7–22 by 1.5–4.5 cm, with two fringed wings to 0.5 cm wide, fringe elements to 0.6 cm long; peristome expanded towards lid, to 2.5 cm wide, outer edge entire, inner with teeth to 1 cm long; lid broadly ovate, lower surface lacking appendages, nectar glands numerous near midline, largest in centre of lid, to 0.8 mm wide. *Male inflorescence* similar to that of *N. gymnamphora* to 50 cm long; partial peduncles 2-flowered near base, 1-flowered above, with a filiform bract near base, rarely wholly 1-flowered, to 0.5 mm long; pedicels to 1.5 mm long; tepals to 5 by 2.5 mm; androphore to 5 mm long; anther head to 1.5 mm wide. *Indumentum* densely brown tomentose on young pitchers, hairs stellate, c. 0.1 mm wide; leaf margin often with dense brown indumentum on lower surface; inflorescence axis and pedicels densely pubescent. *Colour* of lower pitchers green, densely blotched with maroon.

Distribution — C Sumatra.

Ecology — Undisturbed dense forest, hill dipterocarp forest or wet mossy forest on ridge tops; 950–2750 m.

Notes — 1. *Nepenthes pectinata* is very closely related to the Javanese *N. gymnamphora*. They differ in that the leaves of *N. pectinata* are more gradually attenuate to the base, and decurrent down the stem, the margin of the blade is usually densely pubescent below, and the whole plant is generally more tomentose. The peristome teeth of the lower pitchers of *N. pectinata* are longer than those of *N. gymnamphora*. Upper pitchers are not often produced, whereas they are regularly found in *N. gymnamphora*. *Nepenthes pectinata* can be distinguished from *N. bongso* and *N. singalana* by its large upper leaf blades which are decurrent down the stem; from *N. bongso* it is further distinguished by its long peristome teeth and because its upper pitchers, when produced, are subcylindrical, not infundibulate.

2. Authors prior to Danser usually treated the Sumatran *N. pectinata* only as a variety of the Javanese *N. gymnamphora*. Danser described *N. pectinata* from mixed material based on *N. pectinata* and *N. singalana*. Schlauer & Nerz in Blumea 39 (1994) 139–142 were the first authors to recognise this and lectotypified with a specimen of

N. pectinata (which they recognised as *N. gymnamphora*). Tamin & M. Hotta in Diversity & Dynamics of Plant Life in Sumatra (1986) did not recognise the presence of *N. pectinata* (or *N. gymnamphora*) in Sumatra, referring the majority of collections to *N. singalana*, and establishing the invalid name *N. rosulata* for specimens of *N. pectinata* from G. Gadut and G. Talang.

59. Nepenthes petiolata Danser

Nepenthes petiolata Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 353, f. 18; Sh. Kurata & Toyosh., Gard. Bull. Sing. 26 (1972) 158; Jebb & Cheek, Blumea 42 (1997) 74. — Type: *Elmer 13705* p.p. (holo BO), Philippines, Mindanao, Agusan Province, Mt Urdaneta, 1700 m, Sept. 1912.

Terrestrial climber to at least 1 m tall. Stem shape and diam. unknown. *Leaves* thinly chartaceous, petiolate, blade elliptic-oblong, 10–15 by 3–5.5 cm, apex acute, base cuneate, tapering into the petiole; petiole 5.5–6 by 0.3–0.5 cm, subcanaliculate, wing 1–2 mm wide, clasping the stem for 2/3 its diameter and sheathing. Longitudinal nerves 3 or 4 each side of the midrib in the marginal third, conspicuous. Pennate nerves normal or slightly oblique, branching before reaching the longitudinal nerves, branches reaching the margin. *Intermediate pitchers* only known, subcylindrical, the lower half slightly dilated, the upper half shortly cylindrical, 7–13 by 2–4 cm; with two fringed wings in the upper 2/3, the wings to 3 mm broad, the fringed elements c. 4 mm long, c. 3 mm apart; the mouth ovate-acuminate, concave, oblique, rising gradually from the front to form a broad, vertical column for the lid at the rear; peristome flattened to 9(–15) mm broad near the lid, ribs 1(–2) mm apart, high, outer edge slightly sinuate, inner edge long-dentate; lid broadly ovate to broadly elliptic, 3.5 by 3 cm, apex rounded, base rounded, then abruptly and inconspicuously cordate at the spur; lower surface lacking appendages or barely carinate at the base, nectar glands scattered, inconspicuous, thinly bordered, longitudinally elliptic, or orbicular, c. 0.2 mm diam.; spur unknown. *Inflorescence* unknown. Fruit and seed unknown. *Indumentum* of leaf margin ciliate, hairs 0.8 mm long, tendril, pitcher and midrib villose to puberulent with hairs 0.4 mm long. *Colour* of pitchers olive and maroon, mouth maroon, peristome crimson.

Distribution — Philippines: Mindanao (Agusan & Surigao Provinces).

Ecology — Montane or submontane forest including *Agathis* and Oak, possibly on ultramafic soils; 1500 m.

Notes — 1. Characterised by its slender pitchers which lack appendages on the lower surface, by its thin, deeply flanged peristome ribs, with long flattened teeth, and also by the petiolate leaves. *Nepenthes petiolata* is unlikely to be confused with any other Mindanaoan species. *Nepenthes mira* is probably the most similar Philippine species but differs in the broadly ellipsoid lower pitchers and infundibuliform upper pitchers.

2. This species is only known from three incomplete specimens. No fertile material is known. The affinities of this species are unclear and more collections are needed if this is to be rectified.

Hybrids — 1. *Nepenthes petiolata* × *N. alata* Sh. Kurata & Toyosh., Gard. Bull. Sing. 26 (1972) 158. — Type: *Kurata 1113a* (Nippon Dental College n.v.), Philippines, Mindanao, Surigao del Sur, E slope Mt Legaspi, 270 m, 19 Aug. 1965.

2. *Nepenthes petiolata* × *N. truncata* Sh. Kurata & Toyosh., Gard. Bull. Sing. 26 (1972) 158. — Type: *Kurata 1109a* (Nippon Dental College n.v.), Philippines, Mindanao, Surigao del Sur, E slope Mt Legaspi, 270 m, 19 Aug. 1965.

Note — We have seen neither of these specimens, but the description appears to place them intermediate between the parental species which were reportedly both present at the site.

60. **Nepenthes philippinensis** Macfarl.

Nepenthes philippinensis Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 43; Cheek & Jebb, Kew Bull. 54 (1999) 888, f. 1. — Type: *Curran 3896* (lecto K), Philippines, Palawan, Mt Pulgar.

Nepenthes wilkiei Jebb & Cheek, Kew Bull. 53 (1998) 966. — Type: *Mendum et al. 25545* (holo K; iso E, PNH), Philippines, Palawan.

Terrestrial climber to 10 m tall. Stem terete, 3.5–5 mm diam., internodes 2–5 cm long on climbing part; axillary buds inconspicuous. *Leaves* chartaceous, sessile, those of climbing stems oblanceolate-ligulate 14–28 by 1.7–3.6 cm, apex acute, base more or less parallel-sided, clasping the stem by a 1/3–1/2 its circumference, then decurrent in two wings, each 3 mm wide, extending 2–3 cm below the node, sometimes converging to only 4 mm apart on the opposite side to the leaf blade. *Leaves* of short stems and rosettes oblong-spathulate, up to 16 by 3.2 cm. Longitudinal nerves 4 or 5 on each side of the midrib, in the outer half of the blade, conspicuous. Pennate nerves numerous, at 45° from the midrib, branching sporadically, proceeding more or less straight to the margin, conspicuous on the upper surface. *Lower pitchers* ovoid in the lower 1/2–2/3, cylindrical towards the mouth, 8.5–16 by 3.5–8.5 cm (the cylindrical portion 2.2–3.8 cm wide), with two fringed wings each 2–4 mm broad with fringed elements 3–7 mm long, 2–4 mm apart; mouth oblique, ovate, 3–5 by 1.5–2.5 cm; peristome rounded, 1.5–2 mm wide in the front, or more usually unevenly flattened, 2.5–8.5 mm wide at the sides of the mouth, ribs 0.3–0.5 mm apart, conspicuous, about 0.1 mm high, outer edge with one or two shallow lobes, inner edge lacking teeth; lid broadly ovate to suborbicular, 2.6–3.7 by 2.5–3.2 cm, apex rounded or truncate, slightly retuse, usually with a slight fold, base slightly cordate; lower surface lacking appendages, glands sparsely scattered, absent from the midrib area (in a band c. 6 mm wide) and the marginal 2 mm, shortly elliptic or circular, crater-like, 0.2–0.3 mm long; spur unbranched, straight or curved, 3–4(–5) by 0.8 mm. *Upper pitchers* subcylindrical, slightly inflated in lower third, 18 by 4 cm (2.9 cm wide in the upper part), with two ridges 0.1–0.2 cm broad, lacking wings with fringed elements, otherwise as the lower pitchers. *Male inflorescence* 67 cm long; peduncle 18 cm long; partial peduncles c. 130, 2-flowered, 2.5–3(–4) mm long; bracts absent; pedicels 5–9 mm long; tepals 3–3.5 by 2–3 mm; androphore 3–4 mm long; anther head 1.25(–1.75) mm wide. Fruits and seeds unknown. *Indumentum* of sessile glands on lower surface of leaves and on exterior of pitchers; exterior of pitchers with scattered, unequally 2–5 armed red hairs 0.1–0.4 mm tall; inflorescence and lower surface of tepals pubescent with dull red-brown erect hairs 0.1–0.2 mm long. *Colour* of stems pale greyish brown with white waxy bloom; petioles red or green; pitchers green, speckled maroon in lower half, maroon speckled

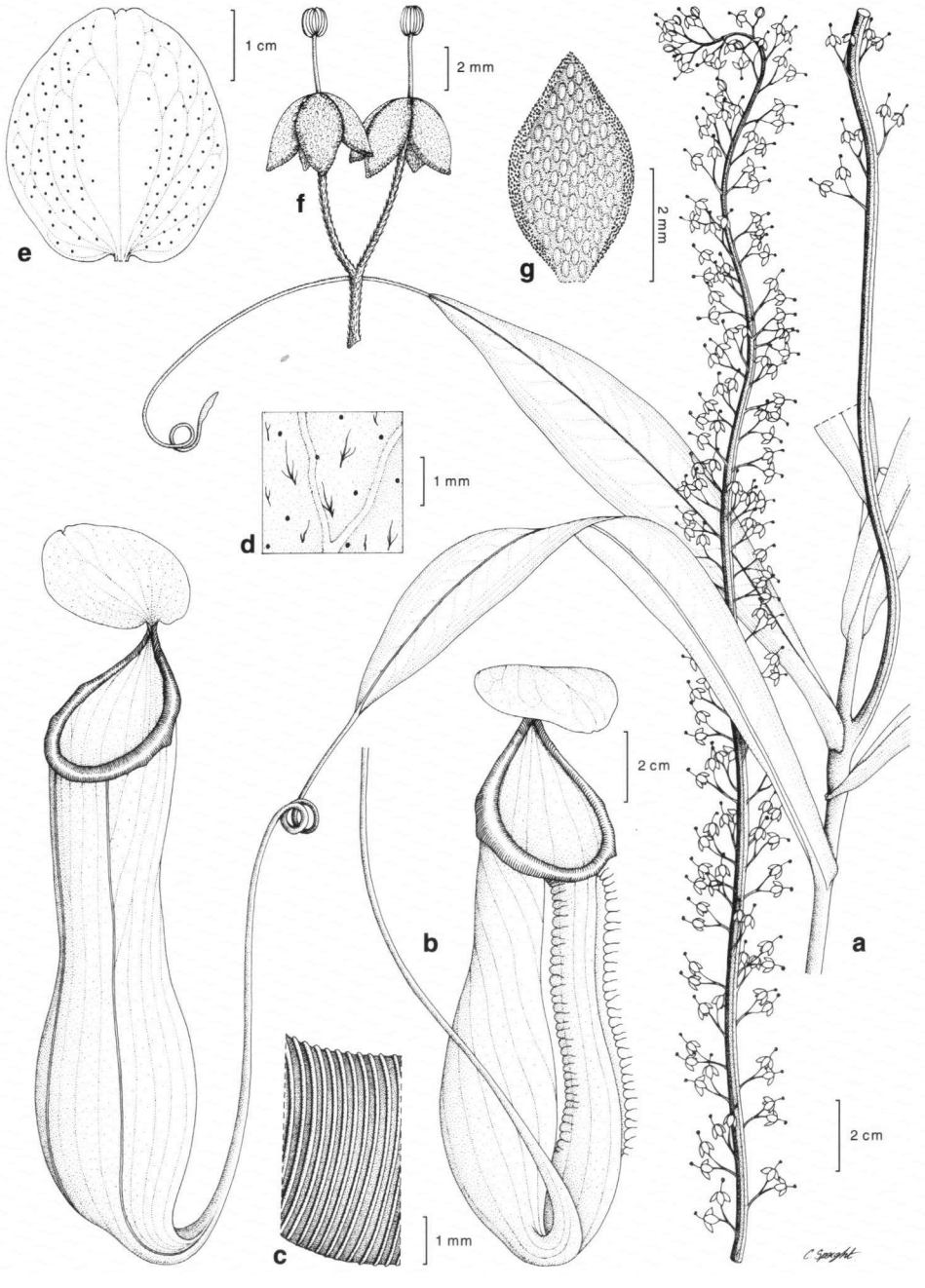

Fig. 15. *Nepenthes philippinensis* Macfarl. a. Habit with male inflorescence and upper pitcher; b. lower pitcher; c. peristome; d. detail of upper surface of lid; e. lower surface of lid; f. partial inflorescence with male flowers; g. upper surface of tepal (*Mendum et al. 25545*). Drawn by Camilla Speight.

green in upper half; peristome maroon, inside of pitcher and lid green speckled maroon or entirely red, sometimes the whole pitcher maroon; flowers brown. — **Fig. 15.**

Distribution — Philippines: Palawan.

Ecology — Scrub on ultramafic soils; 25–520 m.

Notes — 1. *Nepenthes philippinensis* is an addition to the *N. hirsuta* group (Jebb & Cheek in Blumea 42 (1997) 7), previously thought to be confined to Borneo and centred in the north-east of that island. Of the species in that group, *N. philippinensis* is most closely related to *N. macrovulgaris*, a species confined to Sabah and, like *N. philippinensis*, apparently restricted to ultramafic areas. The species of this group are all low altitude species (only *N. macrovulgaris* sometimes occurs above 1100 m) with a well-developed rosetted, non-climbing phase (in some species, e.g. *N. hirsuta*, the climbing stems usually have few, and rather diminutive upper pitchers compared with the lower pitchers of the rosettes). In all species of the *N. hirsuta* group, both lower and upper pitchers are 'hipped', i.e. with an ovoid base and a cylindrical apex; the upper pitchers are never infundibuliform. The pitchers have oblique mouths, held at 45° from the vertical, lack a column, and have a cylindrical peristome c. 5 mm wide with a tendency, usually seen in some of the lower pitchers of most plants, to be slightly flattened with 1–3 shallow lobes at each side. Their lids lack appendages and their inflorescences have 2-flowered partial peduncles usually bearing small filiform bracts.

KEY TO THE NEPENTHES HIRSUTA GROUP

1a. Stems hairy; peristome teeth conspicuous on inner edge of mouth; on sandstone substrates 2
b. Stems glabrous, often white-waxy; peristome teeth absent or inconspicuous; on ultramafic substrates 3
2a. Stem hairs brown, 1–2 mm long; leaves petiolate, not amplexicaul; widespread in Borneo ..... **31. N. hirsuta**
b. Stem hairs black, 1.5–4 mm long; leaves sessile, amplexicaul; Sarawak/Brunei border ..... **32. N. hispida**
3a. Pitcher lid with apex rounded; lower lid surface with largest glands densely spread in midrib (Sabah) ..... **43. N. macrovulgaris**
b. Pitcher lid with apex slightly retuse; lower lid surface of midrib area lacking glands (Palawan) ..... **60. N. philippinensis**

2. *Nepenthes philippinensis* Macfarl. has long been passed over. It was originally published without an illustration and the type was destroyed at PNH. No duplicate of the type has been located. On the basis of the description, it was ascribed to synonymy under *N. alata* Blanco (Jebb & Cheek in Blumea 42 (1997) 15) to which it is superficially similar though it lacks a lid appendage. However, a duplicate of the only other specimen cited in the protologue, *Curran 3896*, has now been located. Examination of the lid shows the characteristic gland distribution and slightly retuse apex of *N. wilkiei* and there is no doubt that the type of the latter is conspecific with *Curran 3896*.

3. The earliest illustration that we have traced for this species is Mann in Carnivorous Plant Newsl. 27 (1998) f. 5. According to Mendum and Wilkie (pers. comm.)

Mann's description of the site at which he discovered in October 1996 "an unknown species from Palawan Island" is identical to the site at which they collected the type of *N. wilkiei* climbing on trees of *Gymnostoma*. Mann's figure 5 matches their material closely.

61. Nepenthes pilosa Danser

Nepenthes pilosa Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 355, f. 19; Phillipps & A.L. Lamb, Nature Malaysiana 13, 4 (1988) 25; Pitcher Plants of Borneo (1996) 121, f. 65; Jebb & Cheek, Blumea 42 (1997) 74; Clarke, Nepenthes of Borneo (1997) 114, f. 76. — Type: *Amdjah 491* (holo BO), Borneo, E Kalimantan, G. Lesung, 28 Jan. 1899. Epitype: *S 50980 (Awa & Lee)* (epitype K, selected here; iso KEP, L, SAR), Borneo, Sarawak, Bt Lawi, Bario, 1630 m, 24 Aug. 1995.

Terrestrial or epiphytic climber 2–3 m tall. Climbing stems terete, 6–9 mm diam. *Leaves* coriaceous, petiolate; leaf blades of climbing stems oblong to elliptic, (10–)18–24.5(–30) by (4.5–)6.6–8.5 cm, apex obtuse to truncate, base obtuse; petiole 2.5–7 cm long, wings 3–4 mm wide, clasping the entire stem, forming a laterally flattened sheath. Longitudinal nerves 3 on each side of the midrib in the outer 1/3, conspicuous. Pennate nerves indistinct. *Lower pitchers* not known. *Upper pitchers* slightly infundibulate or cylindrical, laterally compressed, 16–24 by 5–6.5(–9) cm, wings absent, with two ventral ridges; mouth ovate, oblique, concave, rising to the vertical at the rear, forming a short column; peristome mostly cylindrical, sometimes slightly sinuous, 4–6(–10) mm broad at the front, ribs (0.15–)0.3–0.5 mm apart, outer margin entire, inner edge obscurely dentate, teeth 0.3–0.5 mm long with subapical aperture; lid orbicular, 4.2–6 (–8.2) by 4.2–6.5(–8.7) cm, apex rounded, base cordate, lower surface lacking an apical appendage, basal appendage strongly hooked towards the base, laterally flattened, c. 7 mm high, 10 mm long; spur c. 14 mm long, unbranched. *Inflorescence* known only from fruiting fragment, partial peduncles 2-flowered. A single male flower with pedicel 10 mm long; tepals oblong 5 by 3 mm; androphore 3 mm long; anther head 1.25 by 1.25 mm. Fruit valves c. 30 mm long. Seed fusiform, 13–14 mm long, smooth. *Indumentum* densely villose, the hairs 4–6 mm long, soft, golden to rust coloured on all surfaces apart from upper leaf blade and inside of pitcher, sparingly hairy on outer pitcher. *Colour* of outer pitcher pale or yellowish green, peristome sometimes with red streaks.

Distribution — Borneo: Kalimantan, Sabah, and Sarawak.

Ecology — Mossy forest on sandstone; (1000–)1600–1800 m.

Notes — 1. *Nepenthes pilosa* is one of the Bornean species of the *N. maxima* group. It is similar and sometimes confused with *N. stenophylla*, but has laterally compressed yellowish green pitchers which lack red or white blotching, with a strongly hooked basal lid appendage and uniformly longer, denser indumentum. *Nepenthes pilosa* is widespread throughout Borneo, but rare and incompletely studied: only six collections are known to us. These vary widely in their pitcher proportions. Clarke in Nepenthes of Borneo (1997) 115 reports on the ecology of *N. pilosa*.

2. The pitcher of the type specimen at BO is badly damaged, and the lid has lost the diagnostic apex of the basal crest. For this reason we propose the epitype above. The illustration in the protologue indicates that the pitcher of the type was not entirely representative of *N. pilosa* in shape, but this seems within the bounds of infraspecific variation.

62. Nepenthes rafflesiana Jack

Nepenthes rafflesiana Jack, Mal. Misc. ex Hook.f., Comp. Bot. Mag. 1 (1835) 270; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 357; Shivas, Pitcher Plants of Peninsula Malaysia & Singapore (1984) 39; Tamin & M. Hotta in M. Hotta, Diversity and Dynamics of Plant Life in Sumatra (1986) 90; Phillipps & A.L. Lamb, Nature Malaysiana 13, 4 (1988) 14; Pitcher Plants of Borneo (1996) 123, f. 66–68; Jebb & Cheek, Blumea 42 (1997) 75; Clarke, Nepenthes of Borneo (1997) 116, f. 77–80. — Type: *Jack s.n.* (lecto SING), Singapore.

Nepenthes raflesea Hort., Rev. Hortic. (1869) 130.

Nepenthes rafflesiana var. *nivea* Hook.f. in A.DC., Prodr. 17 (1873) 97. — Type: Singapore & Borneo, not located.

Nepenthes rafflesiana var. *glaberrima* Hook.f. in A.DC., Prodr. 17 (1873) 97. — Type: Singapore, Borneo & Sumatra, not located.

Nepenthes rafflesiana var. *insignis* Mast., Gard. Chron. II, 18 (1882) 424, f. 69. — Type: Borneo, not located.

Nepenthes rafflesiana var. *nigro-purpurea* Mast., Gard. Chron. II, 18 (1882) 424, f. 70 (as *Nepenthes nigro-purpurea* sphalm.). — Type: Borneo, not located.

Nepenthes hookeriana H. Low ex Becc., Malesia 3 (1886) 3.

Nepenthes rafflesiana var. *minor* Becc., Malesia 3 (1886) 3, 11, t. 1: 2. — Type: *Teijsmann 10910* (not located), Borneo, Pontianak, Sintang.

Nepenthes rafflesiana var. *typica* Beck, Wiener Ill. Gart.-Zeitung 20 (1895) 146.

Nepenthes rafflesiana var. *ambigua* Beck, Wiener Ill. Gart.-Zeitung 20 (1895) 147. — Type: *Low s.n.* (not located), Borneo, Labuan Isl.

Nepenthes rafflesiana var. *elongata* Hort., Kew Bull. (1897) 405. — Type: not located.

Nepenthes sanderiana Burb., Flora & Sylva II (1904) 113. — Type: not located.

Nepenthes hemsleyana Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 61. — Type: *Burbidge s.n.* (K), Borneo, Sarawak, Lawas River.

Nepenthes rafflesiana var. *alata* J.H. Adam & Wilcock, Mal. Nat. J. 44 (1990) 32, t. 2; Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) f. 68. — Type: *SAN 35792 (Meijer)* (holo SAN), Borneo, Sabah, Sandakan, Mt Walker FR, 13 April 1963.

Nepenthes hookeriana auct. non Lindl.: H. Low, Sarawak (1848) 68. — *Nepenthes rafflesiana* var. *hookeriana* (Lindl.) Beck, Wiener Ill. Gart.-Zeitung 20 (1895) 147.

Nepenthes rafflesiana auct. non Jack: H. Low, Sarawak (1848) 68 = *Nepenthes hookeriana* Lindl.

[*Nepenthes rafflesiana* var. *excelsior* (Lindl.) Beck, Wiener Ill. Gart.-Zeitung 20 (1895) 147. — *Nepenthes* × *excelsior* B.S. Williams, Garden Lond. 28 (1885) 463 = *Nepenthes hookeriana* Lindl.]

[*Nepenthes rafflesiana* var. *longicirrhosa* auct. non: Tamin & M. Hotta in M. Hotta, Diversity and Dynamics of Plant Life in Sumatra (1986) 93, f. 3 = *Nepenthes sumatrana* (Miq.) Beck.]

Terrestrial climber 2–6 m tall. Stems terete, those of short stems and rosettes 7–9 mm diam., internodes 0.5–1.5 cm long; climbing stems 5–9(–12) mm diam., internodes (4–)6–12(–17) cm, axillary buds inconspicuous. *Leaves* papery, distinctly petiolate, leaves of short stems narrowly oblong, (12–)17–37(–45) by (3–)4–7(–11) cm, apex acute or slightly acuminate, base abruptly acute or attenuate; leaves of climbing stems generally smaller, 10–20(–30) by (3–)3.5–5.5(–7) cm; petiole canaliculate, 4–17 by 0.3–0.5 cm (lower leaves), (5–)6–14 by 0.3–0.6(–1.2) cm (upper leaves), the base, in short stems/rosettes, sheathing the stem and clasping it for 2/3–3/4 its circumference, in climbing stems, neither sheathing nor winged, clasping the stem for c. 1/2 its circumference. Longitudinal nerves 3 or 4 (or 5) on each side of the midrib, inconspicuous above. Pennate nerves usually patent, nearly reaching the margin, rarely branched, inconspicuous. *Lower pitchers* broadly ovoid to subglobose, or ovoid or nar-

rowly ovoid, 8.5–25 by 5.5–9 cm, with two fringed wings, 1–3 cm wide, widest at the base, fringed elements 5–10(–14) mm long, (1–)2–3(–4) mm apart; mouth oblique or horizontal, strongly concave, rising gradually at the rear and tapering to form a more or less distinct column 3–5 cm high and 1–2 cm deep, column apex swollen, the inner surface beset with protruding teeth 3–5 mm long; some pitchers with the mouth horizontal, flat, forming a 90° angle with the vertical column; peristome subcylindrical, but sometimes slightly flattened in the largest pitchers, 4–8(–10) mm wide at the sides, where widest, ribs 0.7–1(–1.5) mm apart, 0.1–0.2(–0.5) mm high, outer edge entire, inner edge about twice to thrice as long as the outer, with straight, conspicuous teeth, 2(–5) mm long; lid orbicular, broadly or narrowly ovate to long elliptic, the first in the smaller globose pitchers, the latter in the largest, narrowly ovoid pitchers, 4–9.5 by 3.2–7.5 cm, apex rounded, truncate or retuse, base shallowly cordate or rounded, lower surface lacking appendages, with two prominent main veins diverging from the base, nectar glands conspicuous, circular, narrowly bordered, 0.3–0.5 mm diam., scattered in a band around the periphery; spur (8–)13–25(–30) by 0.7–1(–2) mm, bifurcate 1–2 mm from the apex. *Upper pitchers* infundibulate or narrowly infundibulate, rarely subcylindrical, 9–34 by 3–8 cm, lacking fringed wings but with two ridges, mouth oblique, more or less straight, usually rising abruptly at the front, at the rear with a short stout column 1–3 cm high, as in the lower pitchers, peristome cylindrical, 2–8 mm wide, ribs (0.5–)0.75–1 mm apart, 0.2–0.5 mm high, outer edge entire, inner edge with broad short teeth 1(–2) mm long; lid broadly or narrowly ovate, rarely orbicular, trapezoidal, elliptic or obovate, (3.5–)4.2–7(–9) by (3–)3.8–7 cm, apex rounded, truncate, or slightly emarginate, base obtuse to slightly cordate, lower surface lacking appendages, nectar glands conspicuous in a dense band around the periphery, 0.7–0.8 mm diam., sometimes containing 3 or 4 smaller nectar glands; spur 8–12(–26) mm, usually entire. *Male inflorescence* (12–)18.5–49 by (2–)3.5–4(–5.5) cm; peduncle (5–)6–12 (–17) cm long, 2–3(–5) mm diam. at the base; partial peduncles 1-flowered, rarely mostly 2-flowered, (30–)60–80-flowered; bracts usually absent; pedicels (10–)12–15 (–20) mm; tepals elliptic, (5–)6–7 by 5 mm; androphore 4.5–6 mm long; anther head 1.2–1.5 by 2–2.5 mm. Infructescence (15–)23–35 by 7–11 cm; peduncle (6.5–)12–16 cm long, (2–)3–5 mm diam. at the base; fruits (15–)30–50. Fruits with stipe (3–)4–8 mm long, valves (16–)32–50 by (5–)6–10 mm. Seed filiform, (12–)17–18 by 0.2–0.4 mm. *Indumentum* of stems, midribs, lower surface of the leaf blade and inflorescences from base of peduncle to lower surface of the tepals white or grey arachnoid, lower leaf surface with minute white stellate hairs; pitcher surface with red sessile glands c. 0.1 mm diam., sometimes with short red simple patent hairs 0.1–0.2 mm long; inflorescence sometimes with admixture of semi-patent brown hairs 0.3 mm long; androphore glabrous. *Colour* of lower surface of the leaf blade drying brown, upper often yellowish green, stem white. Live lower pitchers generally white, strongly mottled with purplish red, rarely pure white, or white flushed pink; upper pitchers pale green, with peristome striped yellow, green and red; inflorescence with red or brown-red tepals.

Distribution — Sumatra, Peninsular Malaysia, and Borneo.

Ecology — Kerangas or swamp forest, often with *N. ampullaria*, also in secondary forest and old clearings, often on sand, rarely on ultramafic; sea level to 300(–1000) m.

Notes — 1. *Nepenthes rafflesiana* is a widespread and variable lowland species often abundant in weedy regrowth at the sides of roads. It can be recognised by its characteristic white arachnoid indumentum, its distinctly petiolate leaves and the manner in which the peristome rises into an extended, and laterally flattened neck, which is broadest immediately below the lid. The lid is often notched or blunt at its apex, and the glands are confined towards the edge. It is not easily confused with any other species, apart from *N. sumatrana* and *N. treubiana* (q.v.). Rather rare in mainland Sumatra and Peninsular Malaysia, but abundant on offshore islands such as the Riau archipelago and Singapore. In northern Borneo it is one of the most abundant species of the genus. A number of striking variants have been described (Phillipps & A.L. Lamb in Pitcher Plants of Borneo (1996) 126). It has been erroneously reported from New Guinea (J.H. Adam, Wilcock & Swaine in J. Trop. For. Sci. 5 (1992) 13–25), due to a misidentified specimen at Bogor.

2. Low created confusion by transposing the names of *N. rafflesiana* and *N. hookeriana* in his book Sarawak: its Inhabitants and Productions (1848). This confusion was cleared up by Masters writing in the Gardener's Chronicle (1881: 812).

63. Nepenthes rajah Hook.f.

Nepenthes rajah Hook.f., Trans. Linn. Soc. 22 (1859) 421, t. 72; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 361; Sh. Kurata, Nepenthes of Mt Kinabalu, Sabah (1976) 61, t. 19 & 20; Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) 129, f. 69 & 70; Jebb & Cheek, Blumea 42 (1997) 76; Clarke, Nepenthes of Borneo (1997) 120, f. 81–83; J.H. Adam & Wilcock, Sarawak Mus. J. 50 ('1996', 1998) 155, f. XXIIIc. — Type: *Low s.n.* (holo K), Borneo, Sabah, Mt Kinabalu, 1500 m.

Terrestrial shrub up to 2 m tall, sometimes scrambling. Stems terete, 15–30 mm diam. *Leaves* coriaceous, petiolate; blade oblong, 20–50(–80) by 9–13(–15) cm, apex rounded, peltate: midrib detaching to form tendril up to 3.2 cm from the apex, base obtuse; petiole canaliculate, 3.5–14 cm long, 1–2 cm deep, base sheathing and clasping the stem for c. 3/4 its circumference, not decurrent or auriculate. Longitudinal nerves 3(–5) each side of the midrib in the outer half. Pennate nerves numerous, running obliquely to the margin, conspicuous. *Lower pitchers* subellipsoid, 20–35 by 11–18 cm, with two fringed wings, 4–9 mm wide, the fringed elements c. 4 mm long, c. 2 mm apart; mouth broadly elliptic, flat, oblique at 45° from the horizontal; peristome rounded or slightly flattened, 25–35 mm wide, slightly widest towards the lid, ribs 1.5–5 mm apart, with at least 10 striae in between, inner edge dentate, teeth 3–5 mm long, outer edge with 5 or 6 folds per side, each protruding up to 1–1.5 cm; lid larger than the mouth, vaulted, oblong to obovate, 15–20 by 10–13 cm, apex truncate to rounded, base truncate-cordate, lower surface lacking appendages but with a robust keel-like midrib in the basal half, nectar glands minute, crater-like c. 0.1 mm diam; spur stout, 10 mm long. *Upper pitchers* rarely produced, as the lower, but infundibulate, not ellipsoid, lacking fringed elements to the reduced, ridge-like wings. *Male inflorescence* 60–85 cm long, peduncle 28–34 cm long, 0.6–0.7 cm diam.; partial peduncles c. 100, 9–15 mm long, 2-flowered; bracts absent; pedicels 6–9 mm long; tepals elliptic, 4–5 by 2.5 mm; androphore 2–3 mm long; anther head 1 mm long, 1.5–2 mm wide. Fruits with valves 20 mm long. Seeds unknown. *Indumentum* of brown spreading hairs on stem

when young, absent from leaves apart from the brown woolly margin; outer lid and pitcher surface with appressed, brown simple hairs c. 0.5 mm long, glabrescent. *Inflorescence*, particularly the partial peduncles and pedicels, lower tepal surface and androphore, densely covered in the same hair type; infructescence with hairs persisting on fruit valves. *Colour* of pitchers purplish red, peristome dark purple, inner surface of pitcher and lower surface of lid green or yellow. Flowers dull greenish white, flushed maroon outside.

Distribution — Borneo: Sabah (Mt Kinabalu & Mt Tambuyukon).

Ecology — Open sites in mossy forest, on ridges or landslips, restricted to ultramafic soils; 1500–2650 m.

Note — *Nepenthes rajah* is renowned as the largest pitchered of all pitcher plants (though less well known species such as *N. merrilliana* and *N. truncata* may bear equally voluminous pitchers) and for trapping rats (see p. 12). The peltate leaf blade tip, oversized and vaulted lid, as well as its overall large size, make this a very distinct species. The inner peristome wall is elaborated to form three layers; these are interconnected by a series of staggered cross-walls, creating two rows of box-like compartments.

Hybrids — 1. *Nepenthes rajah* × *N. villosa* (*Nepenthes* × *kinabaluensis* Sh. Kurata ex J.H. Adam & Wilcock). — See *Nepenthes* × *kinabaluensis*.

2. *Nepenthes rajah* × *N. burbidgeae* (*Nepenthes* × *alisaputrana* J.H. Adam & Wilcock). — See under *N. burbidgeae*.

64. Nepenthes ramispina Ridl.

Nepenthes ramispina Ridl., J. Fed. Mal. St. Mus. 4 (1909) 59; Fl. Malay Pen. 3 (1924) 22; Jebb & Cheek, Blumea 42 (1997) 77. — Type: *Ridley 12064* (lecto SING; iso SING), Peninsular Malaysia, Selangor, top of Ulu Semangka, Aug. 1904.

Nepenthes gracillima var. *major* Ridl., Fl. Malay Pen. 3 (1924) 22. — Type: *Ridley s.n.* (SING), Peninsular Malaysia, Pahang, G. Telom.

Nepenthes gracillima auct. non Ridl.: Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 296, partim, f. 7 toto.

Terrestrial climber to 5 m tall. Stem terete, 0.3–0.6 cm diam. *Leaves* coriaceous, sessile, obovate-oblong, to 16 by 3.1 cm, apex acute to rounded, base clasping at least half stem, auriculate. Longitudinal nerves (0 or) 1–3 (or 4) on each side of the midrib in the outer half. Pennate nerves irregular. *Lower pitchers* shortly cylindric, 5–10 by 1–2.5 cm; slightly ventricose in lower half, cylindric and somewhat narrowed in the upper half, with two fringed wings, 0.3 cm wide, fringe elements to 0.5 cm long. *Upper pitchers* long cylindric, to 18(–24) by 2.5 cm, basal half gradually infundibulate, upper half gradually narrowing but broadening again at mouth, and usually broadest there; wings usually absent, or very much reduced; mouth ovate, oblique, slightly concave; peristome cylindrical, 0.5–1 mm wide, ribs 0.25 mm apart, inconspicuous, outer and inner edge entire; lid orbicular, often slightly broader than long, c. 3.2 by 3.8 cm, apex rounded, base cordate, lower surface lacking appendages, nectar glands circular, not bordered, 0.1–0.3 mm diam.; larger and denser near centre where 0.4 mm diam.; spur somewhat flattened at base, with 3–7 branches above, 3–10 mm long. *Male inflorescence* 20–36 by 1.8–2.8 cm; peduncle 8–11 cm long, 1.5–2 mm diam. at base; partial

peduncles 1-flowered, rarely 2-flowered at base, c. 60; bracts filiform, (1–)2–3 mm long, spreading, inserted 0–2 mm from base of pedicel; pedicel 8–10.5 mm long; tepals elliptic, c. 4.5 by 2 mm; androphore 2.5–3 mm long; anther head 1.5–2 by 1.5–2 mm. Fruit valves 20 by 3 mm. Seed fusiform, 12 mm long, central body tuberculate. *Indumentum* on stems sparingly tomentose, upper and lower surface of midrib tomentose, hairs branched, 0.3–0.5 mm long; other parts subglabrous. *Colour* of lower pitchers maroon-green to deep blackish green, inner surface glaucous pale green; upper pitchers either purple-green throughout, peristome deep red or pale green, or pale green throughout, inner surface of pitcher glaucous pale green.

Distribution — Peninsular Malaysia: the western mountain ranges, Banjaran Titiwangsa.

Ecology — Forest edges, ridgetops; 900–2000 m.

Notes — 1. *Nepenthes ramispina* is closely similar to *N. gracillima*. It can be diagnosed by its larger habit, broader, oblong-obovate leaves, the more slender and longer upper pitchers with long, fasciculated spurs (vs. simple and < 3 mm), the glands on the underside of the lid which are numerous, unbordered, and range from 0.1 mm near the margin to 0.4 mm wide near the middle (vs. lipped and evenly sized from 0.4–0.6 mm), and the pubescent stem and midrib (vs. glabrous to sparsely pubescent).

2. This species was synonymised with *N. gracillima* Ridl. by Danser, but we reinstated it in 1997 (Jebb & Cheek, Blumea 42 (1997) 77). The illustration of *N. gracillima* in Danser in Bull. Jard. Bot. Buitenzorg III, 9 (1928) f. 7 is of *N. ramispina*. From the other Peninsular Malaysian species it can be distinguished by its cylindrical, pubescent stems, slender pitchers and branched spur. See key under *N. gracillima*.

65. Nepenthes reinwardtiana Miq.

Nepenthes reinwardtiana Miq., Pl. Jungh. (1852) 168; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 363; Sh. Kurata, Nepenthes of Mt Kinabalu, Sabah (1976) 65, t. 22; Tamin & M. Hotta in M. Hotta, Diversity and Dynamics of Plant Life in Sumatra (1986) 93; J.H. Adam & Wilcock, Edinb. J. Bot. 50 (1993) 99; Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) 132, f. 71; Jebb & Cheek, Blumea 42 (1997) 78; Clarke, Nepenthes of Borneo (1997) 123, f. 84–86; J.H. Adam & Wilcock, Sarawak Mus. J. 50 ('1996', 1998) 161. — Types: *Junghuhn s.n.* (sh. 00274, U n.v.), Sumatra, Batak region, Pager-utang, 600 m, Sept. 1840. Or *Junghuhn s.n.* (sh. 00273, U n.v.), Sumatra, Batak region, Simur-wasos, 1350 m.

Nepenthes reinwardtii Hook.f., Trans. Linn. Soc. 22 (1859) 422, sphalm.

Nepenthes reinwardtiana var. *samarindaiensis* J.H. Adam & Wilcock, Edinb. J. Bot. 50 (1993) 103. — Type: *Meijer 1047* (holo L; iso BO, K), Borneo, E Kalimantan, Samarinda, S. Titan Complex, 20 m, 3 Aug. 1952.

Terrestrial or epiphytic shrub or climber 2–8(–20) m tall. Stem triangular, rarely ± rounded, 3–7.5 mm diam., the corners rounded or 2 with wings up to 3 mm broad. *Leaves* chartaceous, sessile; basal rosette leaves not known; climbing leaves with blade narrowly elliptic to rectangular, or slightly oblanceolate (8–)11–25(–28) cm by 1.1–3.1(–4.5) cm, apex acute, base distinctly attenuate for 4–5 cm, or narrowing slightly at the stem, decurrent as wings by up to 8.5 cm, rarely only slightly decurrent, clasping the stem for 1/2 its circumference. Longitudinal nerves 1 or 2 (or 3) on each side of the midrib, usually in the outer third, ascending from the midrib. Pennate nerves, ascending from the midrib, sometimes extending into longitudinal nerves, inconspicuous.

Lower pitchers rarely collected, ellipsoid in the basal half, gradually becoming slightly constricted towards the subcylindrical upper half, up to 11 by 4 cm, 3 cm wide at the apex, with two fringed wings, the mouth ± ovate, oblique, peristome ± cylindrical in section, 0.5–1(–1.25) mm wide, without ribs, the inner edge with a row of minute, deeply sunken hollow glands, not dentate; lid ovate-shortly elliptic, up to 3.9 by 3.7 cm, apex rounded, base truncate, lower surface without appendages, nectar glands thickly to thinly bordered, fairly dense, evenly sized and spread, orbicular, 0.15–0.2(–0.3) mm diam.; spur simple, to 3 mm long. *Upper pitchers* as the lower but slightly ventricose, 9–19.5(–31) cm long, 3.2–4.8(–6.8) cm wide at the base, 1.8–3.4(–4.1) wide at the waist, 2–5.7(–6.2) cm wide at the mouth; with two ridges to 0.1 cm broad lacking fringing elements; the inner pitcher surface glaucous, usually with 2 (rarely 0, 1, or 3) conspicuous darker eye-like dots 1(–5) mm wide set symmetrically c. 1 cm apart on the dorsal wall of the pitcher more or less level with the front of the peristome; lid 2.1–5.2 (–7.8) by 2.1–4.7(–6.5) cm. *Male inflorescence* 20–38 cm long; peduncle 2.8–10 cm long, 3 mm diam. at base; partial peduncles 2-flowered, 0.2–1 cm long; bracts absent; pedicels 1–1.5 cm long; tepals ± elliptic 3.5–4 by 2.5 mm; androphore 0.25–0.3 mm long; anther head 0.7–1 by 1.5 mm. Fruits with valves 28–40 mm long. Seeds fusiform, 18–20 mm long, minutely tuberculate at the centre. *Indumentum* absent from the stem and leaves, rarely present on the pitcher just below the peristome; inflorescence covered, sometimes only sparsely, with appressed brownish hairs c. 0.2 mm long that extend from the rhachis to the lower surface of the tepals, the androphore and the ovary; fruit glabrous. *Colour* of pitcher light green, rarely suffused red or with red spots; flowers reddish black.

Distribution — Sumatra and Borneo.

Ecology — Lowland peat-swamp forest or high altitude ridges (sandstone or limestone) or more rarely moss forest, occasionally on ultrabasic soils; 0–1450(–2100) m. Often growing epiphytically.

Notes — 1. *Nepenthes reinwardtiana* is unusual in the 'eye-spots', which contrast strongly against the back of the glaucous inner pitcher wall. In some populations there may be pitchers with one, three or no eye-spots (Phillipps & A.L. Lamb in Pitcher Plants of Borneo (1996) 135). Similar spots have been reported, but only as single pitchers on odd plants, in *N. sanguinea*, *N. stenophylla,* and *N. tentaculata* (Clarke in Nepenthes of Borneo (1997) 126). *Nepenthes reinwardtiana* is sometimes confused with *N. gracilis*, with which it shares sharply triangular stems and decurrent, sessile leaf bases. *Nepenthes reinwardtiana* can be distinguished by its leaves with 1–3 (vs. 4–6) pairs of longitudinal nerves, by the inner peristome which lacks teeth and has instead a prominent row of glandular pits. Furthermore, *N. reinwardtiana* has the base of the lid truncate and not cordate, and bears numerous small nectar glands (those of *N. gracilis* are few and large) and the partial peduncles are 2-flowered (vs. 1-flowered). Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) 135 report that red pitchers seem to be found only on plants growing on ultrabasic, sandy heath or podsolic soils.

2. J.H. Adam & Wilcock base their variety *samarindaiensis* on specimens with rounded stems and non-decurrent leaf bases found in E Kalimantan. As indicated by J.H. Adam & Wilcock in Edinb. J. Bot. 50 (1993) 91, reports of this species in Peninsular Malaysia are based on the misidentification of specimens or misinterpretation of localities from collecting notes.

66. Nepenthes rhombicaulis Sh. Kurata

Nepenthes rhombicaulis Sh. Kurata, [The Heredity 26, 10 (1972) 44, nomen]; Gard. Bull. Sing. 26 (1973) 229, f. 1; Jebb & Cheek, Blumea 42 (1997) 79. — Type: *Kurata 4300* (Nippon Dental College n.v., SING), Sumatra, near Prapat, G. Pangulubao, 1700–1900 m, 29 March 1972.

Terrestrial climber to 20 m tall. Climbing stem 4-angled, 5–10 mm diam.; short shoots and rosettes present. *Leaves* sessile, those of rosettes and short shoots scattered, lanceolate, several cm long; those of climbing shoots lanceolate, 12–22 by 3–4 cm, apex subpeltate to emarginate, the base clasping the stem by 1/2–2/3 its circumference, not decurrent or sheathing. Longitudinal nerves 2 or 3 on each side of the midrib in the outer 1/4 of the blade, innermost vein arising from 1/3–1/2 way along midrib. Pennate nerves oblique. *Lower pitchers* ventricose in the lower half, cylindrical in the upper part, 6–12 by 2.5–3.5 cm, with two fringed wings; mouth orbicular, oblique; peristome subcylindrical, 3–5 mm broad, ribs c. 0.5 mm apart, outer edge expanded and undulate, inner toothed; lid elliptic-oblong or ovate, 2.5 by 1.7–2.5 cm broad, apex rounded, base truncate, lower surface with an appendage near the apex, nectar glands bordered, c. 0.15 mm diam.; spur divided to the base with two filiform branches, c. 5 mm long. *Upper pitchers* unknown. *Inflorescence* 30–40 cm long; peduncle 15–20 cm long; partial peduncles 2-flowered, length unknown; bracts absent (not mentioned or figured in the protologue); pedicels 10–15 mm long; tepals elliptic, 4 by 3 mm; androphore 4 mm long. Fruits fusiform, valves lanceolate 20–25 by 5 mm. *Indumentum* of stem glabrous, with prominent glands; leaf margin reddish brown hairy; pitchers sparsely pubescent; lower surface of tepals, and fruit valves minutely pubescent. *Colour* of lower pitchers red or pale green with purple spots, peristome red.

Distribution — N Sumatra: G. Pangulubao.

Ecology — Subalpine forest; altitude unknown.

Note — The description above is largely taken from the protologue. *Nepenthes rhombicaulis* is extremely poorly known although reported in the protologue as being 'common' on the mountains surrounding Lake Toba. Only the type collection exists. Subsequent purported field observations (Hopkins et al. in Carnivorous Plant Newsl. 19 (1990) 19–28, Schmid-Hollinger in Carnivorous Plant Newsl. 23 (1994) 62–63) have not been supported by voucher specimens and their descriptions and photographs do not appear to match the type. The combination of a sharply 4-angled stem, absence of upper pitchers and presence of an apical appendage on the lower surface of the lower pitcher lid (not seen in the SING specimen) is unique: each are individually unusual characters within the genus.

67. Nepenthes sanguinea Lindl.

Nepenthes sanguinea Lindl., Gard. Chron. (1849) 580, cum icon.; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 366, f. 20; Shivas, Pitcher Plants of Peninsula Malaysia & Singapore (1984) 43 & 79; Jebb & Cheek, Blumea 42 (1997) 79. — Type: *Griffith 4411* (K), G. Ledang.

Nepenthes pumila Griff., Post. Papers 4 (1854) 349.

Terrestrial climber to at least 6 m tall. Stems obtusely angular, rarely rounded, 5–9 mm diam. *Leaves* coriaceous, sessile, leaves at base of the climbing stems largest, thinnest and long-spathulate, up to 20 by 5.2 cm, apex obtuse to slightly acuminate, base

spathulate or cuneate, clasping the stem for 1/2–2/3 its diam., decurrent for 3–4 mm at 45°, auriculate, the lobes 3–6 mm long, rarely not auriculate; towards the stem apex the leaves are shorter, oblong, 10–15.5 by 2.1–3.4 cm, and more auriculate at the base; leaves of the basal rosettes mostly oblanceolate-spathulate, 7–8.5 by c. 2.5 cm. Longitudinal nerves 3 (or 4) on each side of the midrib in the outer half, obscure in the upper stem leaves. Pennate nerves numerous, c. 80° from the midrib, overlapping the innermost longitudinal nerves, obscure in the upper stem leaves. *Lower pitchers* ± broadly, rarely narrowly ellipsoid in the basal 2/3 or 1/2, gradually becoming constricted towards the subcylindrical upper half, sometimes ± broadly subcylindrical overall, 13–21.5(–26.5) cm long, 5.5–8.5 cm wide in the basal part, 3.5–6.7(–8.2) cm wide in the upper part, with two fringed wings 2–4 mm broad, fringed elements 4–6 mm long, c. 4 mm apart, mouth ovate, acuminate towards the lid, oblique, at 45° to the pitcher axis, concave; peristome flattened (3–)8–14(–15) mm wide, ribs 1 mm apart, each interspersed with 10–12 striae, outer margin usually markedly sinuate where the peristome is widest, inner edge lacking teeth; lid broadly elliptic-ovate, 3.2–6.5 by 2.8–4.5 cm, apex rounded, base truncate to shallowly cordate, appendages absent, nectar glands scattered, concentrated along distal part of midline, orbicular, thickly bordered, 0.2–0.5 mm diam., along midline sometimes longitudinally elliptic, c. 0.8 mm long; spur simple or branched, up to 17 mm long; rosette pitchers smaller and more slender in proportion than the lower pitchers, peristome not usually sinuate. *Upper pitchers* as the lower, but either subcylindrical, 13–27.5 cm long, or very narrowly infundibular, flaring gradually from the base where 1.3–2.2(–2.6) cm wide, to the peristome where 2.6–4.5 cm wide, or slightly hipped, constricted slightly but abruptly above the basal third where 4–4.7 cm wide to a slightly narrower upper cylindrical portion 3.5–4.5 cm wide, lacking fringed elements, but with two ridges up to 1 mm wide; peristome narrower, not always sinuate, ribs 0.3 mm apart, with 5 or 6 striae. *Male inflorescence* 35–65 cm long; peduncle (9–)11.5–23(–27) cm long; partial peduncles 2- (or 3-)flowered, (1–)6–10 mm long; bracts usually present, 4–5 mm long; pedicels 7–20 mm long; tepals elliptic 3 by 1.5(–2) mm long; androphore (1.5–)2–3 mm long; anther head 1–1.25 mm wide. Fruits with valves 20–25 mm long. Seeds fusiform, 10 mm long, rugose in centre. *Indumentum* of scattered sessile, red globular glands 0.1 mm diam. on most parts; stem glabrescent, with short white erect simple hairs, rarely 3-branched; leaves glabrescent above, below as the stems; pitchers with erect simple to 4-branched coppery hairs or with a mixture of long simple and sparsely branched hairs and short 5 or 6 armed hairs; inflorescence with appressed simple translucent hairs from peduncle to fruit valves. *Colour* either all green or with pitchers suffused and spotted with red-brown, inner surface blotched with red; peristome green, striped red; rarely the whole outer surface vivid red, the peristome yellow, and the inner surface lacking red pigment. Lower surface of the leaves drying brown below.

Distribution — Thailand, Peninsular Malaysia.

Ecology — Mountain ridges amongst scrub of *Dacrydium* and *Rhododendron*; 900–1800 m.

Note — *Nepenthes sanguinea* is distinguished from *N. macfarlanei* in the more or less sharply 3-angled, glabrescent stems, the lower lid surface either lacking or possessing very few hairs, the pitchers not abruptly contracted below the peristome, and

the inner edge of the peristome lacking teeth. It is not likely that *N. sanguinea* would be confused with the other montane species of Peninsular Malaysia (*N. ramispina* and *N. gracillima*) since these are much smaller species with more slender pitchers. See the key to highland Peninsular Malaysian species under *N. gracillima*.

68. Nepenthes sibuyanensis Nerz

Nepenthes sibuyanensis Nerz, Carnivorous Plant Newsl. 27 (1998) 18, f. 1 & 2 & frontcover. — Type: *P. Mann & T. Smith 051001* (holo L n.v.), Philippines, Sibuyan, Mt Guintguintin (Guiting-Guiting), 1300 m, 5 Oct. 1996.

Terrestrial shrub or climber 0.7–2 m tall. Stems terete or 3- or 4-angled, 0.8–0.9 cm diam., internodes 1–5 cm long in climbing stem. *Leaves* thinly to thickly coriaceous, sessile, linear-lanceolate, linear-oblong or slightly spathulate, 10–21 by 2.4–3.8(–5) cm, apex acute to rounded, often slightly peltate, base gradually or barely attenuate to the stem, decurrent as narrow wings 2–3 mm wide for 2/3, to a whole internode and converging towards the opposite surface of the stem. Longitudinal nerves 5 or 6 on each side of the midrib, in the outer 1/2–2/3 of the blade. Pennate nerves not conspicuous. *Lower* and *upper pitchers* apparently similar, shortly ovoid-cylindrical, to 20(–25) by 12(–15) cm, fringed wings 2–3 mm wide in the upper 2/3 of the lower pitchers only, absent in the upper pitchers; mouth ovate to suborbicular, horizontal to slightly oblique, abruptly rising at the rear into a short, broad neck c. 2 by 2 cm; peristome slightly rounded, 20–30 mm broad, the ribs 1 mm high, 2 mm apart, outer margin undulate, with 6–8 shallow lobes; inner margin recurved, bearing teeth 3–4(–5) mm long and up to 5 times as long as broad; lid held over and parallel with mouth, ovate, 8–10.5 by 6.5–7.1 cm, apex rounded or obtuse, base shallowly cordate; lower surface lacking appendages, glands few, absent from the midline, the central area and the marginal area, 35–60 in total, sparsely scattered, pit-like, transversely elliptic, 0.8–2.1 mm long; spur filiform, 2–3 by 0.5 mm. *Male inflorescence* c. 32 cm long, c. 3 cm at the widest point; peduncle 18 cm long, 0.6 cm diam. at the base; partial peduncles 1-flowered; bracts highly reduced; pedicels 12–14 mm long at the base of the inflorescence; tepals oblong, 3 mm long, obtuse; androphore c. 5 mm long. Fruit 18–22 by 3–4 mm. Seeds filiform, 8 mm long. *Indumentum* of sessile red glands 0.1 mm present only on the densely appressed stellate-hairy inflorescence; androphore puberulent. *Colour* of pitchers green or yellowish to dull orange or pink with a few red blotches 5–10 mm diam. in the upper third; peristome bright glossy red to purplish black; lid yellowish orange or pale green suffused with pink above. — **Fig. 16.**

Distribution — Philippines: Sibuyan Island.

Ecology — Open grassy slopes among *Dipteris conjugata* and high grasses with small shrubs, probably on ultramafic soils, 1350–1800 m. Flowering: Oct. 1996.

Notes — 1. *Nepenthes sibuyanensis* is closely similar and seems very closely related to *N. ventricosa*, a species fairly widespread in Luzon, and to *N. burkei*, endemic to Mindoro. The differences are given in the key, the most conspicuous being the larger pitchers which lack any sign of constriction at the midpoint. These three species form part of the Insignes group.

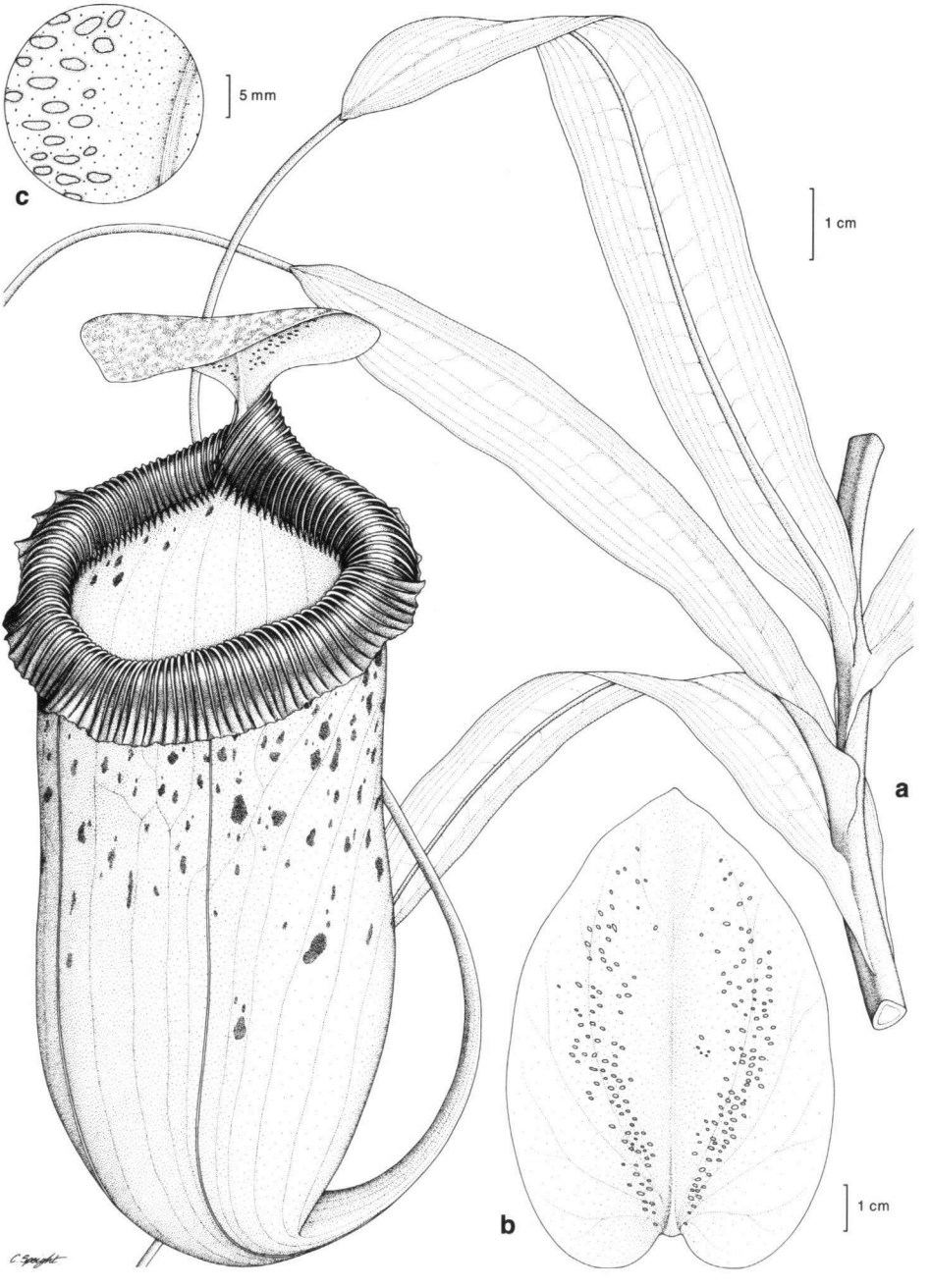

Fig. 16. *Nepenthes sibuyanensis* Nerz. a. Stem with upper pitcher; b. underside of lid; c. detail of glands on lower surface of lid (*Argent & Reynoso 89128*). Drawn by Camilla Speight.

2. The above description is taken partly from the protologue, in which the description of the upper and lower pitchers are united. Figures given in brackets in the description are taken from dimensions given by the collector of the type in a detailed article on the discovery of this species (Mann in Carnivorous Plant Newsl. 27 (1998) 6). Apparently nearly sympatric with *N. argentii*, from which it is inferred that the shrubby grassland habitat of *N. sibuyanensis* is also induced by ultramafic soils. Known only from five collections (*P. Mann & T. Smith 015001–015004*, L n.v.) collected at the type locality on 5 October 1996 and *Argent & Reynoso 89128* (E n.v., K, PNH n.v.).

69. Nepenthes singalana Becc.

Nepenthes singalana Becc., Malesia 3 (1886) 4 & 12, t. 3; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 371; Sh. Kurata, Gard. Bull. Sing. 26 (1973) 231; Tamin & M. Hotta in M. Hotta, Diversity and Dynamics of Plant Life in Sumatra (1986) 98, excl. syn., non f. 5 & 6; Jebb & Cheek, Blumea 42 (1997) 80. — Type: *Beccari 187* (FI n.v., K, L), Sumatra, near Padang, Mt Singgalang ('Singalan').

Nepenthes junghuhnii Macfarl. ex Ridl., J. Fed. Mal. St. Mus. 8, 4 (1917) 79. — Type: *Robinson & Kloss s.n.* (BM, BO), Sumatra, G. Kerinci, 2600 m, 27/4/1914.

Nepenthes sanguinea auct. non Lindl.: Beck, Wiener Ill. Gart.-Zeitung 20 (1895) 185, partim.

Nepenthes singalana auct. non Becc.: Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 47, p.p. = *Nepenthes gracillima*; nec Macfarl., J. As. Soc. Beng. 75, 3 (1914) 282 = *Nepenthes gracillima* Ridl.

Terrestrial climber to ?4 m tall. Climbing stems obscurely 4-angular, (2.5–)3–6(–7) mm diam., internodes 5–13.5(–16) cm long, axillary buds inconspicuous; short stems, and those of rosettes, terete, c. 5 mm diam., internodes c. 1.5 cm long. *Leaves* coriaceous, sessile or weakly petiolate; leaves of climbing stems narrowly oblong-oblanceolate, oblanceolate or oblanceolate-spathulate, 7–21 by 1.9–2.8(–3.8) cm, apex acute to obtuse, not usually peltate, base attenuate, sometimes with a poorly defined winged petiole c. 1.5 cm wide, clasping the stem for 1/2 its circumference, rarely slightly auriculate, decurrent down the stem as two low ridges almost to the node below; rosette and short stem leaves oblanceolate to subspathulate, c. 17 by 3.5 cm. Longitudinal nerves 3 (or 4) on each side of the midrib in the outer 1/2–3/4, fairly conspicuous on the lower surface. Pennate nerves inconspicuous. *Lower pitchers* not seen, intermediate pitchers slender, obovoid in the lower 2/5, upper 3/5 subcylindrical, 13–18 cm tall, 3.4–3.9 cm wide in the lower part, c. 3 cm wide in the upper part, with two fringed wings in the upper part, c. 4 mm wide, fringed elements 7 mm long, 1.5 mm apart, mouth ovate, oblique, concave, raised in the rear part to form a slender vertical or overarching column c. 2.5 cm tall, peristome cylindrical in the front half, in the rear half flattened, c. 5 mm wide, ribs 0.3–0.5 mm high, 1–1.5 mm apart, outer edge entire, inner entire in the front half, the rear half with teeth c. 5 mm long extending up the column and protruding; lid orbicular, c. 4 by 5 cm, apex rounded, base cordate, lower surface lacking appendages or keel, nectar glands thinly bordered, circular or shortly elliptic, 0.2–0.3 mm diam., scattered sparsely and evenly over the whole surface; spur c. 3 by 0.5 mm, flattened, bifurcate at apex. *Upper pitchers* obovoid in lower 2/5–1/2, upper part cylindrical or narrowly infundibuliform, (7.2–)10–15(–20) cm tall, (1.8–)2.5–4.5(–5.5) cm wide in the lower part, 1.8–4(–5) cm wide in the upper part, lacking fringed wings, but with two inconspicuous ridges, mouth suborbicular, horizontal or

slightly oblique, straight in the front part, concave at the rear and rising to form a short, poorly defined vertical column, peristome subcylindrical to slightly flattened, 1.5–2 mm wide in smaller pitchers, flattened, 4–6 mm wide in larger pitchers, ribs 0.3–0.5 mm high, 0.5–1.25(–1.5) mm apart, outer edge entire, inner edge entire apart from 2–8 toothed ribs on each side near the column, column weakly toothed; lid orbicular, (1.7–) 2.7–4.2(–5.2) by (1.9–)3–4.2(–4.8) cm, lower surface as the lower pitchers, nectar glands (0.1–)0.3–0.5 mm; spur flattened, 3–4.5 by 0.5 mm, apex bifurcate or rounded. *Male inflorescence* 10–15 by 1.8–2 cm; peduncle 2.5–5 cm long, 1–1.5 mm diam. at base; partial peduncles 1-flowered, 30–40; pedicels c. 7 mm long; bracts filiform 1.5–5 mm long; tepals 4–5 by 2.25 mm; androphore 2 mm long; anther head 1.5 by 2 mm. Infructescence 12–15.5 by 4–5 cm; peduncle 7.5–8 cm long, 2–2.5 mm diam. at base; pedicels c. 14 mm long; fruit valves c. 21 mm long (immature). Seeds unknown. *Indumentum* of stems, lower surface of leaf and outer pitcher with sessile red glands 0.1 mm diam.; axils with pubescent patches 2–6 mm long of patent brown, sometimes mixed with white, stellate, branched and simple hairs 0.1–0.3 mm long, also present on pitcher lid; spur glabrous; inflorescence sparingly hairy with patent or appressed white or pale brown simple hairs 0.1–0.2 mm long from base of peduncle to apex of pedicels; tepals glabrous below; androphore glabrous; ovary densely fawn sericeous. *Colour* of lower pitchers purplish red; upper pitchers reddish green streaked dull blood red, inner pale green blotched crimson, peristome dull blood red.

Distribution — Sumatra: Mt Ophir (S. Barat) to G. Dempo (S. Selatan).

Ecology — Montane forest; 1900–2800 m.

Note — Together with *N. spectabilis*, *N. singalana* is one of the most widespread and commonly collected of all montane Sumatran species of *Nepenthes*. Specimens of *N. diatas*, *N. pectinata*, and *N. spathulata* can be mistaken for this species. *Nepenthes diatas* has broader, more robust, rigid upper pitchers, with teeth conspicuous around the inner edge of the peristome rather than being restricted to near the column. *Nepenthes pectinata* has a larger, lanceolate leaf with a decurrent base, and the lid glands are usually sparser and restricted to the basal part of the midline. *Nepenthes spathulata* has sharply 4-angled stems in the climbing phase, and the peristome is greatly expanded at the sides.

70. Nepenthes spathulata Danser

Nepenthes spathulata Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1935) 465; Jebb & Cheek, Blumea 42 (1997) 81. — Type: *Lieftinck 11* (lecto L; isolecto BO), Sumatra, Lampongs, Mt Tanggamus, 2000 m, Jan. 1935.

Terrestrial or epiphytic shrub or climber to 1–2 m tall. Stems of short shoots terete or slightly angular, 0.8 cm diam., internodes 1–2 cm long; climbing stems strongly 4-angular, 0.5–0.8 cm diam., internodes 2.5–8 cm long, axillary buds conical, 1 by 1 mm, 3 mm above the axil. *Leaves* coriaceous, sessile or petiolate; leaves of rosettes and short stems petiolate, blades spathulate-obovate, 17–25 by 5–7 cm, apex rounded, slightly emarginate or obtuse, barely peltate, base attenuate into a 4–7 cm long, petiolar portion, 0.8–1 cm wide, sheathing the stem and clasping it by 4/5 its circumference; leaves of climbing shoots sessile oblanceolate-oblong or spathulate-elliptic to spathu-

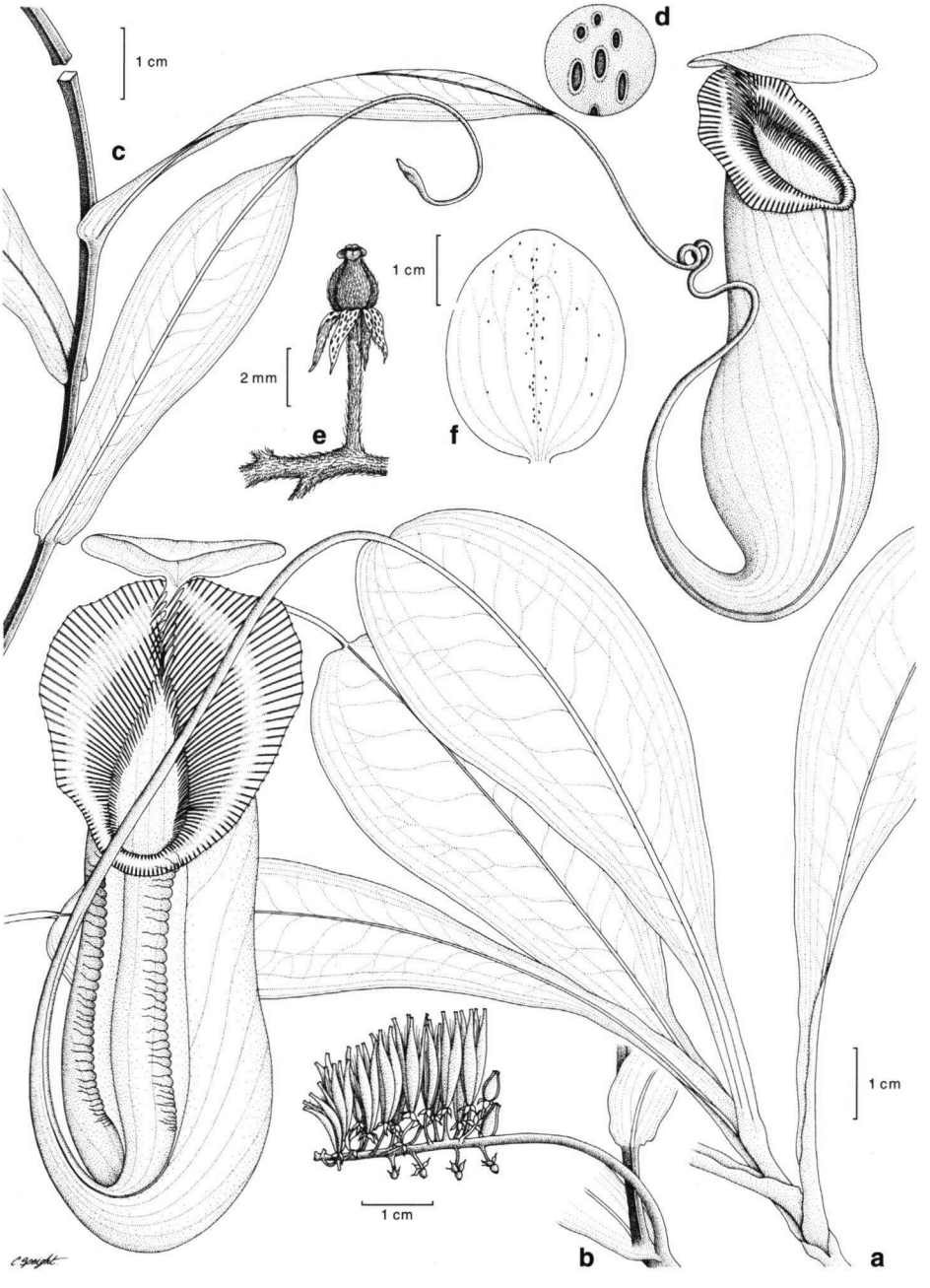

Fig. 17. *Nepenthes spathulata* Danser. a. Short stem with lower pitcher; b. infructescence; c. climbing stem with upper pitcher; d. detail of glands on lower surface of lid; e. female flower; f. underside of lid (a, d & f: *Lieftinck 7*; b: *Toropeu 17*; c & e: *Jacobs 8261*). Drawn by Camilla Speight.

late (8–)10.5–18(–22) by (1.5–)3–4(–4.6) cm, apex acute, base gradually attenuate, or abruptly contracted into a subpetiolate oblong 3–4.5 by 1.5–2 cm, clasping the stem by 1/2 its circumference, the base more or less auriculate, the auricles nearly meeting on the opposite side of the stem. Longitudinal nerves 2 or 3 on each side of the midrib in the outer 2/3–1/2, fairly conspicuous. Pennate nerves inconspicuous. *Lower pitchers* ovoid-cylindrical, 16–19 by 5–6 cm, tapering to 3.5–4.5 cm wide at the mouth, with two fringed wings 3–6 mm wide, fringed elements 3–7 mm long, 1–3 mm apart; mouth narrowly ovate, oblique, concave, rising at the rear into a column; peristome flattened, 3–4 mm wide in the front half of the mouth, 2–3.5 cm wide in the rear half, ribs c. 0.7 mm high, 1 mm apart, outer edge with 3–6 shallow lobes on each side in the rear half, more or less entire in the front half, inner edge with teeth 3–5 mm long in the rear half, inconspicuous in the front half; lid ovate, (4.9–)6–6.5 by 3.8–5 cm, apex rounded, base truncate or shallowly cordate, the lower surface lacking appendages, but sometimes with a low keel along the midline, nectar glands circular or shortly elliptic (to elliptic on the midline), narrowly bordered, 0.4–0.8 mm diam., usually confined to the midline, rarely scattered over the entire surface; spur dorsiventrally flattened, 10 by 1 mm, divided by 3–8 mm into 3–6 branches. *Upper pitchers* either subcylindrical, slightly constricted in the middle, or, with the lower half broadly to narrowly ellipsoid and the upper half cylindrical, (10–)16–23.5 cm tall, (4–)5–6(–8.5) cm broad in the lower half, (2.5–)3–4(–5.5) cm broad in the upper half, with two unfringed narrow wings or prominent ridges 1–2 mm wide running the length of the pitchers; mouth less concave and oblique than the lower pitchers; peristome narrower, (0.5–)1–1.6 cm wide in the upper half, ribs shallower, 0.1–0.3 mm high, outer margin shallowly lobed; lid as the lower pitcher, but 5–5.5 by 4–4.5 cm, keel absent, nectar glands 0.3–0.6 mm diam.; spur unknown. *Male inflorescences* 14–24 by 2.5–3 cm; peduncle 6–6.5 cm long, 2–3 mm diam. at the base; partial peduncles 40–60, 1-flowered; bract filiform, 1.5–2.5(–5) mm long; pedicels 9–10 mm long; tepals oblong-elliptic, 4–5.5 by 2.5–3 mm; androphore 3–4 mm long; anther head 1.5 by 1.75 mm. Infructescences held horizontally, 16–25 by 3.5–7 cm; peduncle 11–15 cm long, 3.5–4.5 mm diam. at the base; fruits all held erect, 20–40. Fruit with valves 20–24 by 3–3.5 mm. Seed 11–15 by 0.5–0.75 mm. *Indumentum* of stems, lower leaf blade and pitcher with sessile red glands c. 0.1 mm diam.; pitcher matted or sparsely puberulent with simple or branched pale brown or white hairs 0.2–0.5 mm long; spur lightly white sericeous; inflorescence sericeous with fine white simple hairs 0.3–0.5(–0.7) mm long, sparse on peduncle, dense on rhachis to lower tepals; ovary golden with dense sericeous hairs; androphore glabrous. *Colour* of lower surface of leaf blade, orange-brown when dry; live pitchers green or green spotted light purple or red, with scarlet peristome. — **Fig. 17.**

Distribution — S Sumatra.

Ecology — Forest or open slopes; 1550–2200 m.

Notes — 1. Although closely related to *N. singalana*, *N. spathulata* can be distinguished by the sharply angular stems (although collections of *N. singalana* overlap in this character), the greatly expanded peristome, in which the ribs are not as tall and papery as those in *N. singalana*, in the lid which is ovate (vs. orbicular-cordate in *N. singalana*), and the lid glands which are fewer, and generally densest and largest near the midline of the lid (vs. evenly distributed in *N. singalana*) in a manner similar

to those of *N. gymnamphora* and *N. pectinata*. Danser considered these latter two species as the most closely allied species to *N. spathulata*, but we see a closer affinity with *N. ovata*.

2. *Nepenthes spathulata* shows one of the more extreme examples of leaf dimorphy in the genus. The leaf blades of the rosettes/short stems are strikingly broad and spathulate with a distinct petiole and sheathing base around the terete stem, whereas the leaves of the longer stems are sessile and almost ligulate, auriculate at the base and clasping the markedly quadrangular stem.

71. **Nepenthes spectabilis** Danser

Nepenthes spectabilis Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 373, f. 21; Tamin & M. Hotta in M. Hotta, Diversity and Dynamics of Plant Life in Sumatra (1986) 103; Jebb & Cheek, Blumea 42 (1997) 82. — Type: *Lörzing 7308* (lecto BO; iso BO, L), Sibolangit, Sibajak, 1800 m, 5 June 1920.

Terrestrial climber 2–3 m tall. Rosette and short stems more or less unknown; climbing stems terete, but with a groove above each axil extending 1 or 2 nodes towards the stem apex, sometimes rounded-quadrangular, 5(–7) mm diam., internodes 3.5–7(–10) cm, axillary buds inconspicuous. *Leaves* coriaceous, subpetiolate; leaves of climbing stems narrowly oblong or oblong-oblanceolate, 15–24(–30) by 3.4–5.4 cm, apex acute or slightly acuminate, almost peltate, base more or less abruptly contracted into a broad, winged petiole 2–7 by 1.1–1.5 cm, clasping the stem for 1/2–3/4 its diameter and decurrent down the stem for 0.5–2.4(–4.5) cm as a wing c. 4 mm wide. Longitudinal nerves 3–6 on each side in the outer 1/3–1/2, fairly conspicuous. Pennate nerves oblique, much branched, fairly conspicuous. *Lower pitchers* poorly known, ovoid to narrowly ovoid, 11–15 by 3.2–6 cm, with two fringed wings 2–5 mm wide, fringed elements 4–10 mm long, 1–3 mm apart; mouth oblique, slightly concave, peristome flattened, up to 4 mm wide at the front, 12 mm wide in the rear half, ribs 1 mm apart, 0.1 mm high, outer edge entire, reflexed, inner edge with teeth 2 mm long; lid ovate, 3.2–5 by 2.2–3.8 cm, apex rounded, base truncate, lower surface lacking appendages, nectar glands densely packed, extending to within 2–3(–10) mm of the margin, along the midline 0.4–0.5 mm diam., sometimes elliptic, narrowly bordered, rarely sunken, towards the margin 0.1–0.2 mm diam., sometimes crater-like; spur 10–16 by 1 mm, apex rounded, unbranched. *Upper pitchers* narrowly infundibuliform to narrowly cylindrical, 17–28 by 3.2–4.5 cm, lacking fringed wings or with two fringed wings in the upper half, wings c. 1.5 mm wide, fringed elements 5–7 mm long, 1–2 mm apart; mouth concave, horizontal at the front, gradually rising to the vertical in the rear where extended into a slender column, peristome flattened 4–14 mm wide in the rear half, c. 2 mm wide at the front, ribs 0.5 mm apart, 0.1 mm high, outer surface reflexed, more or less entire, rarely sinuate, inner edge with teeth c. 1.5 mm long, conspicuous only in the rear half; lid 3.5–5.5 by 3.2–5 cm, apex rounded, base shallowly cordate, lower surface usually with a keel 7–16 by 1–1.5 mm high, nectar glands as in the lower pitchers; spur as in lower pitchers, 11–22 by 1–1.5 mm. *Male inflorescence* 21–33 by 2.5–3.5 cm; peduncle 10–15.5 cm long, 3–4 mm diam. at the base; partial peduncles 25–60, 2-flowered, often mixed with 1-flowered, 0–2(–2.5) mm long; bracts inserted near the base, sometimes displaced onto the rhachis, ligulate, (1.5–)4–8 mm long, apex attenu-

ate; pedicels 6–8.5 mm long; tepals 4–6 by 2–3 mm; androphore 3.5–4.5 mm long; anther head 1.5–1.75 by 1.5–2 mm. Infructescence 23–29 by 9–11 cm; peduncle (9.5–)15–19 cm long, (2–)5–6 mm diam. at the base; partial peduncles c. 40, 2-fruited. Fruits with valves 41–45 by 3.5–4.5 mm. Seeds 18–20 by 0.4–0.6 mm. *Indumentum:* densely tomentose with erect, dull coppery red simple or sparsely branched, 0.3–0.7 mm long hairs, persisting usually only on the first internode and in lower internodes only in axillary patches 5–18 mm above the axil; the same indumentum, 0.2–0.3 mm long, also on the midribs above and below, rarely on the edge of the leaf blade, and on the pitchers, where up to 1 mm long; inflorescence with similar indumentum 0.3–0.4 mm long, rarely with indumentum sparse, white, 0.1–0.2 mm long; androphore puberulent along whole length; lower surface of leaf blade with sessile glands 0.1 mm diam. *Colour* of stems purple; upper pitchers purplish brown or purplish red with cream spots or stripes; male flowers yellowish green or brown, androphore reddish, anther head yellow.

Distribution — N Sumatra: Aceh to Lake Toba.

Ecology — Open mossy forest or sub-alpine shrubberies; 1450–2000 m.

Note — *Nepenthes spectabilis* is not easily confused with any other Sumatran montane species apart from *N. lavicola*. In both species the upper pitchers are narrowly infundibuliform to narrowly cylindrical and have a predominantly dark purple-brown colour. *Nepenthes spectabilis* differs from *N. lavicola* in its broader peristome with less prominent ribs, much longer spur (10–22 mm long compared to less than 6 mm long) and in its overall denser indumentum of reddish brown hairs, particularly in the axils of the leaves, on the underside of the midrib, and on the pitcher spur and inflorescence, but sparse elsewhere.

72. Nepenthes stenophylla Mast.

Nepenthes stenophylla Mast., Gard. Chron. III, 8 (1890) 240; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 376, f. 22; Sh. Kurata, Nepenthes of Mt Kinabalu, Sabah (1976); Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) 136, f. 73; Jebb & Cheek, Blumea 42 (1997) 82; Clarke, Nepenthes of Borneo (1997) 127, f. 87 & 88. — Type: *Veitch & Son s.n.* (lecto K), Borneo; epitype selected here *S 50879 (Awa & Lee)* (K, KEP, L, SAN, SAR), Borneo, Sarawak, 2nd Summit Bukit Lawi, 1840 m, 17 Aug. 1985.

Nepenthes boschiana var. *lowii* Hook.f. in A.DC., Prodr. 17 (1873) 98. — *Nepenthes maxima* var. *lowii* (Hook.f.) Becc., Malesia 3 (1886) 3, 10. — Type: *Low s.n.* (K), Sarawak.

Nepenthes fallax Beck, Wiener Ill. Gart.-Zeitung 20 (1895) 191. — Type: *Low s.n.* (W), Borneo.

Nepenthes fusca var. *apoensis* J.H. Adam & Wilcock, Kew Bull. ined. — Type: *S 35939 (Chai)* (holo K), Borneo, Sarawak, Baram Dist., Kelabit Highlands, Apo Dari, 1550 m, 17 Nov. 1974.

Nepenthes sandakanensis J.H. Adam & Wilcock, Sarawak Mus. J. 50 ('1996', 1998) 156, f. XXIIc; syn. nov. — Type: *Jumaat 2298* (holo UKMS n.v.; iso ABD n.v., SNP n.v.), Borneo, Sabah, Ranau, Lombong Tembaga Mamut, 1400 m, 22 Sept. 1987.

Nepenthes sandakanensis var. *eglandulosa* J.H. Adam & Wilcock, Sarawak Mus. J. 50 ('1996', 1998) 158; syn. nov. — Type: *SAN 44442 (Meijer)* (holo SAN n.v.), Borneo, Mt Tawai, 3000 ft, 19 June 1965.

Nepenthes sandakanensis var. *ferruginea* J.H. Adam & Wilcock, Sarawak Mus. J. 50 ('1996', 1998) 158; syn. nov. — Type: *Jumaat 1151* (holo UKMS n.v.), Borneo, Sabah, Telupid, Bukit Tawai, 1020–1200 m, 26 Feb. 1982.

Nepenthes boschiana auct. non Korth.: Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 71.

Terrestrial climber (sometimes epiphytic?) to 10 m tall. Stem terete (less usually ridged or winged), 6–11 mm diam. *Leaves* coriaceous, petiolate (indistinctly so in rosette leaves); leaf blade lanceolate or oblong-lanceolate, (8.5–)15–23 by (3.5–)4–9 cm, apex rounded or acute, rarely peltate, base obtuse to decurrent; petiole 4–7.5 cm long, canaliculate, sheathed at base, less usually decurrent with two wings 1–2 mm wide descending as curved ridges to the internode below. Longitudinal nerves 2 or 3 on each side of the midrib in the outer 1/4, inconspicuous. Pennate nerves numerous, indistinct. *Lower pitchers* rarely collected, cylindrical, slightly waisted and narrowing c. 2/3 from the base, 10–18 by 3–4 cm, with two fringed wings 6 mm wide, fringed elements 4–6 mm long, 2–4 mm apart; mouth ovate, oblique, concave, rising to the vertical at the rear, forming a short column; peristome cylindrical, rarely slightly flattened, 2–3 mm broad in front, 3–5 mm broad near the lid, ribs 0.2–0.3 mm apart, with a conspicuous gland between each rib, outer margin entire, inner edge obscurely dentate, teeth 0.5 mm long; lid ovate to circular, 3–5 cm diam., apex rounded, base cordate, lower surface with a laterally flattened, semicircular basal appendage, apical appendage absent; nectar glands scattered throughout, orbicular, narrowly bordered, 0.1–0.15 mm diam., a few larger glands 0.2–0.4 mm diam. near margin and on appendage and often in a small aggregation near the apex; spur 5–15 mm long, unbranched. *Upper pitchers* as the lower, but cylindrical to very narrowly infundibuliform, 15–25 by 3–6 (–7.5) cm, wings reduced to ridges but often with scattered fringed elements 4.5 mm long; peristome 2–3 mm broad and slightly raised in front, 4–7(–9) mm broad at rear, ribs 0.2–0.5 mm apart, teeth 0.5 mm long, outer edge entire, rarely slightly sinuate; lid orbicular, usually slightly broader than long, 3–5.5(–8) by 5–6(–7.5) cm, apex slightly retuse or rounded, base cordate; basal appendage semi-orbicular, 3–8 by 3–5 mm high, nectar glands orbicular, thinly to thickly bordered, 0.2–0.35(–0.5) mm diam. *Male inflorescence* 18.5–35 cm long; peduncle 10–11 cm long; partial peduncles to c. 140 (male), 2-flowered, 5 mm long; bracts absent; pedicels 3–8 mm long; tepals elliptic 4–5 by 1.5–3 mm; androphore 5 mm long; anther head 1–1.5 by 1–1.5 mm. Fruit valves 18–35 mm long. Seed fusiform, 8–18 mm long, central body tuberculate. *Indumentum* coppery hirsute, of dense short, branched hairs c. 0.5 mm long mixed with scattered long simple hairs 2–3(–4) mm long, on stems (glabrescent), petioles, tendrils and pitchers; lower surface of leaf with only scattered simple hairs 2–3 mm long; pitcher lid appendage and adjacent surface puberulent. *Colour* of outer pitcher and lid cream to yellow to pale green, splashed with red; peristome yellowish with dark red stripes. Lower leaf blade drying dark brown.

Distribution — Borneo: Sarawak, Brunei, Sabah, and Kalimantan.

Ecology — Open bushy areas or montane forest, usually on ridge tops, usually on sandstone; sometimes in heath forest; 1000–2600 m.

Notes — 1. *Nepenthes stenophylla* is distinguishable from other Bornean allies of *N. maxima* by the lid which is more or less orbicular, with a cordate base, and the semicircular crest near the base of the lid. The majority of the lid glands are small (0.1–0.15 mm) and dispersed throughout the underside of the lid, but scattered among these are a few larger (0.2–0.4 mm), prominently lipped glands, which are present near the margin and on the basal crest, and often in a small aggregation near the apex. The peristome lacks teeth along its inner margin, although a conspicuous gland is present between

each rib. *Nepenthes pilosa* is apparently closely related to *N. stenophylla* (for differences see there) but is especially similar to *N. faizaliana* (see there also).

2. At Kew there is a specimen from Veitch & Sons annotated in Masters handwriting "*N. stenophylla* Masters Type specimen! Presented 1890." It can be argued that since this, the type specimen, has only intermediate and not upper pitchers, there is ambiguity as to the species involved. However, a plate published a few years later of older plants of the same origin showed the distinctive upper pitchers, removing this doubt, as far as we are concerned. Not all agree, and J.H. Adam & Wilcock in Sarawak Mus. J. 50 (1998) 156 imply that the type of *N. stenophylla* is specifically different from the taxon usually referred to under this name, since they cite *N. stenophylla* sensu Danser in Bull. Jard. Bot. Buitenzorg III, 9 (1928) as a synonym of their newly described *N. sandakanensis*. Clearly, it is undesirable to change the name of this well-known and common montane species. In order to buttress the application of the name *N. stenophylla* to this species, we therefore here propose the epitype nominated above which has the virtue of being available in several herbaria, fertile, and representative of this common ridge-top species in northern Sarawak and Sabah.

Hybrids — A hybrid with *N. lowii* (see there) has been reported from Sabah and Brunei. Hybrids with *N. veitchii* are reported to be relatively common in heath forest in NW Borneo (Clarke in Nepenthes of Borneo (1997) 162).

73. Nepenthes sumatrana (Miq.) Beck

Nepenthes sumatrana (Miq.) Beck, Wiener Ill. Gart.-Zeitung 20 (1895) 149; Tamin & M. Hotta in M. Hotta, Diversity and Dynamics of Plant Life in Sumatra (1986) 103; Jebb & Cheek, Blumea 42 (1997) 83. — *Nepenthes boschiana* var. *sumatrana* Miq., Fl. Ned. Ind. 6 (1858) 1074; Ill. Fl. l'Arch. Ind. (1870) 7; Hook.f. in A.DC., Prodr. 17 (1873) 98. — *Nepenthes maxima* var. *sumatrana* (Miq.) Becc., Malesia 3 (1886) 3. — Type: *Teijsmann 535* (BO, L, U), Sumatra, Sibolga, 0 m, Feb. 1856.

Nepenthes rafflesiana var. *longicirrhosa* Tamin & M. Hotta in M. Hotta, Diversity and Dynamics of Plant Life in Sumatra (1986) 93, nom. nud.

Nepenthes spinosa Tamin & M. Hotta in M. Hotta, Diversity and Dynamics of Plant Life in Sumatra (1986) 103, f. 7 & 8, nom. nud.

Nepenthes longifolia Nerz & Wistuba, Carnivorous Plant Newsl. 23 ('1994', 1995) 105, f. 3. — Type: *Nerz 2801* (L n.v.), Sumatra, West Sumatera, Taram, Tjampo Mts, 1000 m, 25 Sept. 1992.

Nepenthes boschiana auct. non Korth.: Miq., Fl. Ned. Ind. Suppl. (1860) 151.

Nepenthes treubiana auct. non Warb.: Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 69; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 387, partim, f. 25 toto.

Terrestrial climber to several metres tall. Stem of the climbing shoots more or less D-shaped in section, 0.8 cm diam. with a pair of prominent ridges or wings, or terete, internodes to 16 cm long; rosette and short stems unknown. *Leaves* coriaceous, petiolate; blades of climbing shoots lanceolate to obovate-lanceolate, 39–54 by 5–9 cm, apex acute to rounded-emarginate, base attenuate to the winged and decurrent petiole; petiole 5–9 cm long, winged, clasping the stem for 1/2 its circumference, usually decurrent as two wings or ridges almost to the node below. Longitudinal nerves 6–8 on each side of the midrib, in outer 3/5 of blade. Pennate nerves numerous, more or less parallel, at 60–70° to midrib. *Lower pitchers* globose throughout, or ventricose in lower half, tubular above and narrowing to mouth; up to 23 by 6 cm; with fringed wings to

4 cm broad, fringe elements to 6 mm long; mouth oblique. *Upper pitchers* wholly infundibulate, or cylindrical, scarcely ventricose below, 18–30 by 4–6 cm, without wings; mouth oblique, and often raised at front; peristome rounded at front, to 1.2 cm wide, flattened towards lid, or flattened and irregular throughout, then 0.5–1.5 cm wide, ribs 0.2 mm apart, c. 0.1 mm high, outer edge entire, inner without teeth, but with conspicuous glands between the ribs; lid orbicular to elliptic, 6–9.5 by 3.5–7.5 cm, apex rounded, base cordate, lower surface lacking appendages, nectar glands orbicular, thinly bordered, dense over the whole surface, 0.2–0.5 mm diam.; along midline larger, elliptic, 0.7–0.9 mm long; spur simple, 0.8–1.4 cm long. *Inflorescence* to 28 cm long; partial peduncles 1- or 2-flowered, 0.5–0.8 cm long; pedicels about as long as partial peduncles; bracts infrequent; tepals 5–6 by 3 mm. Fruit with valves 44–56 by 3.5 mm. Seeds fusiform, 26 by 0.75 mm. *Indumentum* of brown simple and branched hairs 0.1–0.2 mm long on all parts, especially in leaf axils of stems, and on tendrils; dense below leaf margin and on all new parts; glabrescent. *Colour* of lower pitchers brownish red, peristome green or red-streaked; upper pitchers pale green.

Distribution — West-Central Sumatra.

Ecology — Lowland secondary forest (?); sea level to 1000 m.

Notes — 1. *Nepenthes sumatrana* appears restricted to the western half of Sumatra from Sibolga in the north to Padang in the south. The only Sumatran species with which it could be confused is *N. rafflesiana*. They can occur together (Clarke, pers. comm.). Both are robust lowland species with petiolate leaves and large narrowly, infundibuliform pitchers which have the front of the mouth raised. However, *N. rafflesiana* has terete stems, distinctively white, arachnoid indumentum, pitchers with the peristome prominently toothed on the inner edge and nectar glands absent from the central part of the lower surface of the lid. The stems of *N. sumatrana* when winged-ridged (they are sometimes terete) are virtually identical to those of *N. burbidgeae* of Borneo, which otherwise differs markedly.

2. Although we treat *N. longifolia* as a synonym, it is representative of other specimens from inland Sumatra, at higher altitudes (c. 1000 m) that show differences from the plants at sea level on the coast. The inland plants have more slender pitchers which are ellipsoid in the lower half and cylindrical in the upper (not infundibuliform), with an elliptic (not a suborbicular) lid. However, intermediates are reported. More specimens are needed before *N. longifolia* can be fully resolved.

3. Danser in Bull. Jard. Bot. Buitenzorg III, 9 (1928) 387 placed *N. sumatrana* with the remarkably similar *N. treubiana* of New Guinea. *Nepenthes sumatrana* differs by lacking teeth on the inner edge of the peristome, by lacking hairs on the leaf margins, by having 'simple' (i.e. with one long branch), not stellate hairs and in having larger lid nectar glands (0.2–0.7 mm diam. vs. 0.2–0.4 mm diam.).

4. Although we have seen no authentic material of Tamin & M. Hotta's *N. rafflesiana* var. *longicirrhosa* n.n. or *N. spinosa* n.n., they appear to belong with *N. sumatrana*.

74. Nepenthes tentaculata Hook.f.

Nepenthes tentaculata Hook.f. in A.DC., Prodr. 17 (1873) 101; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 379; Sh. Kurata, Nepenthes of Mt Kinabalu, Sabah (1976) 69; Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) 138, f. 74; Jebb & Cheek, Blumea 42 (1997) 85; Clarke, Nepenthes

of Borneo (1997) 129, f. 89 & 90; J.H. Adam & Wilcock, Sarawak Mus. J. 50 ('1996', 1998) 161 — Type: *Lobb 83* (lecto K), Borneo, Sarawak, 810 m, 1857.

Nepenthes tentaculata var. *imberbis* Becc., Malesia 3 (1886) 13. — Type: *Beccari 2930* (FI n.v.), Borneo, Sarawak, Kuching, Mt Matang.

Nepenthes tentaculata var. *tomentosa* Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 43. — Type: *Burbidge s.n.* (K), Borneo, Sabah, Kinabalu.

Terrestrial climber to 4 m tall, but often climbing only rarely and existing largely as gregarious rosettes c. 10 cm tall arising from creeping stems. Stems sharply to rounded 4-angular, (1.5–)2–3(–6) mm diam., internodes in rosette shoots c. 0.6 cm; climbing stems with internodes 2.5–4.5(–7) cm long, often with conical axillary buds 1.5 by 1.5 mm inserted 3–3.5 mm above the axil. *Leaves* chartaceous, sessile, those of rosettes and short stems elliptic-oblong or oblanceolate-oblong, 6–11 by 1.5–2 cm, apex acute often inconspicuously peltate, base amplexicaul, subperfoliate, shortly decurrent down the stem by 0.3–0.6 cm; leaves of climbing stems lanceolate, oblanceolate-spathulate or oblong, (4.5–)6–9(–17) by (1.5–)1.8–2.5(–2.8) cm, base perfoliate or subperfoliate, decurrent down the stem by (0.1–)1.5–1.8(–2.5) cm. Longitudinal nerves 2 (or 3) on each side of the midrib, usually in the outer third, prominent above and below. Pennate nerves sparse, patent, branching and anastomosing, inconspicuous. *Lower pitchers* ovoid or broadly subcylindrical, 4.5–10(–12) by 1.5–4.2 cm, with two fringed wings 2.5–4 mm wide, fringed elements filiform, 3–5 mm long, 1–1.5 mm apart; mouth concave, narrowly ovate-rhombic, peristome cylindrical, 0.75–1.5(–3) mm diam., ribs 0.1(–0.2) mm high, 0.25–0.5 mm apart, outer edge not sinuate, inner edge entire; column absent; lid ovate to elliptic-rhombic, 1.7–4 by 1–2 cm, apex rounded, base rounded or shallowly cordate, upper surface bearing up to 24 'tentacles' i.e. thick multicellular simple hairs 3–5(–10) mm long as extensions of the nerves from the marginal 5 mm, lower surface lacking appendages, midrib pronounced as a low keel c. 0.1 mm high, nectar glands absent or sparse and inconspicuous, circular, bordered, 0.1–0.2 mm wide; spur a fascicle of 4–7 branches 5–10 mm long, each usually dichotomously branched about 1/3 the length from the apex. *Upper pitchers* cylindrical or with a narrowly ovoid base tapering gradually to a cylindrical apex, (5.5–)6.5–8.5(–13.5) by 1.5–2.2(–3) cm, usually with fringed wings 3.5–5 mm wide, fringed elements 3–5 mm long, 2.5–3 mm apart; mouth in the larger pitchers sinusoidal from the side view: the front and rear parts much more steeply sloping than at the middle. *Male inflorescence* patent, 5–12 (–14.5) by c. 0.7 cm; peduncle (0–)2–4.5 cm long, 0.75–1.5 mm wide at the base; partial peduncles 30–40(–50), 1-flowered; bracts absent; pedicels 2–3.5(–8) mm, often curved; tepals oblong, 1.75–3 by 1–1.5 mm, apex obtuse; androphore 0.5–1.5 (–2.5) mm long; anther head 0.5–1 by 0.75–1.5 mm. Infructescence 1–6(–11) by 4–5 cm; peduncle 1.2–4.2 cm long bearing 5–10 fruits; fruits with valves 20–32 by 4–6.5 mm. Seeds fusiform, 14–16 by 0.7–0.8 mm. *Indumentum* of sessile red glands on stems, lower leaf blade, outer pitcher, upper and lower lid, and peduncle; rhachis, pedicels and lower tepals moderately densely hairy with rusty or coppery appressed simple hairs c. 0.2 mm long; upper surface of lid with 'tentacles'. *Colour* of stems purple to green, leaves glossy dark green, sometimes suffused with purple; pitchers usually brownish purple, sometimes flecked with dark purple; peristome pale green or purplish black; mouth waxy green or pale purple; lid as pitcher; inflorescence yellowish green.

Distribution — Borneo, Sulawesi.

Ecology — Moss forest, often in Sphagnum beds or on peaty soils (but also on sand and ultramafic substrates); (800–)1200–2100(–2550) m.

Notes — 1. *Nepenthes tentaculata* is the most ubiquitous montane *Nepenthes* in Borneo, occurring on most mountains there. This diminutive species is recognised by the perfoliate-adnate leaves, the tentacles on the upper surface of the lid, the rhombic pitcher mouth and the fasciculate pitcher spur. These characters are all shared by a group of apparently related species in which the multicellular 'tentacles' and a fasciculate spur are conspicuous in the lower pitchers but absent in the upper pitchers, viz.: *N. adnata*, *N. glabrata*, *N. hamata*, *N. muluensis*, and *N. murudensis*.

2. In Sulawesi *N. tentaculata* can be distinguished from the extremely closely related *N. hamata* by the lack of dramatically large, falcate peristome ribs. The Sulawesi specimens of *N. tentaculata* tend to have longer, more lanceolate leaves. In addition the lids tend to be less frequently tentaculate, and the inflorescence is longer (17.5 cm vs. 13 cm). A robust variant of *N. tentaculata* which lacks lid tentacles occurs on ultramafic areas at Mt Kinabalu. More work is needed to elucidate whether these plants warrant specific status.

3. Hooker's protologue cites both a Lobb and Beccari specimen from Sarawak. The former, *Lobb 83* was collected at 2700 ft in Sarawak, matching the altitude range (2500–3000 ft) given by Hooker in the protologue and for that reason was elected as lectotype.

75. **Nepenthes tobaica** Danser

Nepenthes tobaica Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 382, f. 23; Sh. Kurata, Gard. Bull. Sing. 26 (1973) 232; Tamin & M. Hotta in M. Hotta, Diversity and Dynamics of Plant Life in Sumatra (1986) 107; Jebb & Cheek, Blumea 42 (1997) 86. — Type: *Lörzing 6573* (lecto BO; iso BO, L), Sumatra, Habinsaran plateau, ESE of Lake Toba, 1200–1300 m, 11 May 1919.

Terrestrial climber to 5 m tall. Stem ± terete or rounded-triangular, 0.15–0.4 cm diam., usually zigzagging slightly, with prominent axillary buds 0.5–1 mm long, basal rosettes unknown. *Leaves* coriaceous, sessile, often reflexed; leaves of climbing stems narrowly elliptic or oblanceolate (4–)5.5–14 by 0.7–1.9 cm, apex acute, the basal third often distinctly constricted, c. 3.5 mm wide, clasping the stem for 2/3 its circumference, very shortly and obliquely decurrent, and slightly auriculate, the auricles reflexed. Longitudinal and pennate nerves inconspicuous. *Lower pitchers* very rarely collected, ± ellipsoid in the lower half, gradually tapering to the cylindrical upper half, c. 8.5 cm long, 2.7 cm wide at the base, 2.1 cm wide at the apex, with 2 fringed wings to c. 5 mm broad, the fringed elements to 0.4 cm; mouth ± ovate, oblique, peristome cylindrical, 0.5–0.75(–1.2) mm wide, with fine, raised ribs, outer edge entire, inner without teeth; lid broadly elliptic, c. 1.9 by 1.7 cm, apex rounded, base slightly cordate to truncate, lower surface lacking appendages, nectar glands numerous, dense over whole surface, minute, volcano-like or thickly bordered, 0.1–0.15 mm diam.; spur simple, unbranched, to 4 mm long. *Upper pitchers* as lower pitchers but very slightly ventricose, (4.5–)6–9.7(–13) cm long, 1.3–2.2 cm wide at the base, narrowing slightly to (0.5–)1.2–2.1 cm wide at the waist and expanding to (7.5–)1.5–2.5 cm at the mouth, with two ridges to c. 0.1 cm broad, lacking fringed elements. *Male inflorescence* 15–30 cm long; peduncle

7–14 cm long; partial peduncles 2-flowered, 4.5–6.4 mm long; bracts rarely present; pedicels 5.5–11 mm long; tepals 3–3.5 by 2–2.5 mm; androphore 2–2.5 mm; anther head 1 by 1–1.25 mm. Fruit with valves 16–35 mm long. Seeds fusiform, minutely tuberculate in the centre. *Indumentum* absent from the stems apart from distinct tufts of white hairs in the leaf axils; leaves glabrous when expanded, slightly hairy in bud; inflorescence with appressed stiff white hairs often sparse, extending to the androphore; ovary with sparse coppery hairs. *Colour* of stems light green to dark brown; pitchers light green or yellowish green with red parts; rarely wholly red or green; staminal column light green.

Distribution — Sumatra: Lake Toba to G. Leuser.

Ecology — Montane forest edges, amongst *Leptospermum/Rhodomyrtus* and in the scrub of old clearings; 950–2750 m.

Notes — 1. *Nepenthes tobaica* was long confused with *N. mikei*. The last can be distinguished by its fasciculate or branched pitcher spurs, its broader peristome (2.5 mm vs. 0.5–1 mm wide) and its shorter inflorescence (7–15 cm vs. 15–35 cm) with 1-flowered, not 2-flowered, partial peduncles. *Nepenthes tobaica* is sometimes also confused with *N. reinwardtiana* but can be distinguished by the absence of pitcher 'eye-spots', the presence of tufts of white hairs in the leaf axils, and the rounded stem with non-decurrent leaf bases.

2. Of the three duplicates of *Lörzing 6573*, the sheet with both male and female inflorescences is the lectotype. The Lörzing number *'6802'* in Danser in Bull. Jard. Bot. Buitenzorg III, 9 (1928) 384 is an error for *8602*, as shown in the caption to f. 23 (1928).

76. Nepenthes tomoriana Danser

Nepenthes tomoriana Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 384, f. 24; Jebb & Cheek, Blumea 42 (1997) 87. — Type: *Rachmat 645* (lecto BO; iso BO (spirit), L), Sulawesi, Gulf of Tomori, G. Kolonodale, Sept. 1913.

Terrestrial climber to 5 m tall. Stems terete, those of rosettes 3–4 mm diam., internodes c. 10 mm long; short shoots c. 5 mm diam., internodes c. 6 cm long; climbing stems 3.5–5 mm diam., internodes 2.5–6.3 cm long, axillary buds broadly conical, 0.5 mm long, 0.6–1.2 cm above the axil. *Leaves* chartaceous, weakly petiolate to subsessile, clasping the stem for half its circumference, not sheathing; rosette leaves oblanceolate, 7–9 by 1.8–2.7 cm, apex obtuse, not peltate, base attenuate-decurrent, 0.2–0.4 cm wide; short stem leaves weakly petiolate, narrowly oblong-lanceolate, 18–22 by 3.5–4.5 cm, apex acute, base attenuate, petiole 4–6.5 by 0.5 cm, winged; leaves of climbing shoots subsessile to weakly petiolate, narrowly oblong-ligulate to narrowly oblanceolate-elliptic, 10–12 by 1.5–3 cm, apex acute, base attenuate, subsessile or with a broadly winged petiole 4–7 by 0.6–0.7 cm. Longitudinal nerves 4 (or 5) on each side of the midrib in the outer 3/4, conspicuous above. Pennate nerves arising obliquely from the midrib, becoming more or less patent at junction with longitudinal nerves, reaching the margin, conspicuous above. *Lower pitchers* of rosettes ellipsoid, 5–8.5 cm tall, 2.5–4.5 cm broad, with two fringed wings 5–8 mm broad, fringed elements clustered in 2s, 3s or 4s, 6–7 mm long, groups c. 1 mm apart; mouth ovate, oblique, concave, column ill-

Fig. 18. *Nepenthes tomoriana* Danser. a. Lower pitcher; b. upper pitcher; c. male inflorescence; d. partial inflorescence with male flowers; e. infructescence; f. spur; g. section of peristome; h. lower surface of lid with detail of glands (a: *Kofman 113*; b, e–h: *Kofman 111*; c, d: *Meijer 11074A*). Drawn by Camilla Speight.

defined, peristome rounded, 2 mm wide, ribs fairly conspicuous, 0.5 mm apart, with striae in between, outer edge entire, revolute, inner edge parallel to the pitcher wall, c. 4 mm long, with teeth 0.5 mm long; lid orbicular to transversely elliptic, 1.6–2.2 by 2–2.5 cm, apex rounded to truncate, base cordate, lower surface lacking appendages, nectar glands orbicular, sunken, not bordered, 0.1(–0.2) mm diam., evenly scattered over the lid; spur entire, 4–6 by 0.75 mm, apex rounded. *Lower pitchers* of short stems elliptic-subcylindrical, 11.5–12.5 by 4.5–5.5 cm, wings up to 8 mm broad, abruptly arrested 2 cm from the base; mouth with a short, toothed column c. 7 mm tall, peristome 5 mm broad; lid 3.5 by 3.7 cm. *Upper pitchers* subcylindrical, slightly infundibuliform to 'hipped': lower half slightly ellipsoid, upper half cylindrical, (6–)7.5–9 by (1.5–)2–2.4(–2.6) cm, lacking fringed wings, but with two ridges, highly pronounced and subwing-like in the lower half; mouth orbicular, slightly oblique and concave, column absent; peristome cylindrical, 1–2 mm broad, ribs inconspicuous, 0.3 mm apart, the outer edge entire, inner with teeth inconspicuous; lid (1.2–)1.5–1.8(–2) by (1.6–)2–2.5 cm, lower surface lacking appendages, with nectar glands circular, sunken or bordered, 0.1–0.2 mm diam.; spur 2–3 mm long. *Male inflorescence* 24–38 by 3.5–4 cm; peduncle 7–14 cm long, 2 mm diam. at base; partial peduncles 30–35, 3- or 4-flowered, 7–10(–14) mm long with bract at apex; bract patent, 2–3.5 mm long; partial-rhachis up to 3 mm long; pedicels 3.5–5 mm long; tepals obovate, 3–3.5 by 2.5–3 mm; androphore 1–1.5 mm long; anther head 1 by 1.4 mm. Infructescence 30–43 by 6.5–7.5 cm; peduncle 10–14 cm long, 4 mm diam. at base; valves 15–18 by 2.5–4 mm. Seed fusiform, 14 by 0.4 mm. *Indumentum* absent from stem and leaf apart from sessile red glands 0.1 mm diam.; pitcher inconspicuously puberulous with minute orange-brown stellate hairs 0.1–0.2 mm diam., tendril and inflorescence bearing pitcher indumentum admixed with patent, simple hairs 0.5 mm long. *Colour* of leaves when dry brown below. Live pitchers pale green, with red blotches on the inside and on the peristome, lid with purple blotches; male flowers with green tepals; ovary brown; flowers murky red, orange-brown or green. — **Fig. 18.**

Distribution — C Sulawesi.

Ecology — Open scrub-land on ultramafic soils, occasionally in mangrove swamps; sea level to 400 m.

Notes — 1. *Nepenthes tomoriana* is unlikely to be confused with any other species within its range. It is the only paniculate species (i.e. partial peduncles bearing more than two flowers) known from Sulawesi. It is distinguished from the similar *N. danseri* of Waigeo Island, by the more numerous and smaller lid glands, and the presence of a bract on the partial peduncles.

2. The lower pitchers, rosette and short stem leaves of this species have only recently been discovered (*Kofman 112, 113*), and show remarkable similarities with those of *N. bellii* of Mindanao: the globular shape of the pitcher which dries a characteristic red-brown, the broad wings with fringed elements grouped in clusters, the inner edge of the peristome descending parallel to the pitcher wall and terminating in small, straight teeth, the orbicular to transversely elliptic lid which lacks a midrib, and a lower surface with a ceramic luster and very small, deeply sunken, sparsely scattered nectar glands are held in common by both species. *Nepenthes bellii* may have derived from the eastern paniculate group of species despite having 1-flowered partial peduncles.

77. Nepenthes treubiana Warb.

Nepenthes treubiana Warb. in Engl., Bot. Jahrb. Syst. 13 (1891) 318; Boerl., Handl. 3, 1 (1900) 54; Jebb, Science in New Guinea 17 (1991) 43, f. 25; Jebb & Cheek, Blumea 42 (1997) 87. — Type: *Warburg 20581* (B), New Guinea, McCluer Gulf, Sigar, 1889.

Nepenthes treubiana auct. non Warb.: Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 69; nec Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 387, f. 25, p.p. = *Nepenthes sumatrana* (Miq.) Beck.

Terrestrial climber 6–9 m tall. Climbing stem terete 0.8–1.3 cm diam., sometimes ridged or winged, internodes c. 8 cm long, axillary buds not seen. *Leaves* chartaceous, petiolate, those of climbing stems lanceolate, elliptic or oblong, 30–39 by 7–12 cm; apex acute or rounded, sometimes peltate by < 1 mm, base attenuate or obtuse, petiole short, 7–15 by c. 1 cm, narrowly winged, these wings running down stem, to 0.3 cm broad, 5 cm long or petiole clasping stem by 1/3 its circumference and stem completely unwinged. Longitudinal nerves 3–7, some arising from midrib, running in outer 2/3 of blade, conspicuous. Pennate nerves numerous, oblique initially, then curving towards margin, reticulate in outer part of blade. *Lower pitchers* urceolate-globose, to 20 by 10 cm, fringed wings to 1.9 cm broad, fringe elements 0.3–0.5 cm long, dense; peristome rounded, to 1.5 cm wide, ribs 0.3–0.5 mm apart, outer margin entire, inner margin with teeth to 0.3 mm long, 1.5 mm long towards lid; lid orbicular, to 8 cm, apex rounded, base slightly cordate, lower surface lacking appendages, nectar glands dense throughout, thinly bordered or pit-like, shallow, orbicular, 0.2–0.4 mm diam.; spur simple. *Upper pitchers* infundibulate or broadly infundibulate, constricted at the mouth, (11–)14–24 by 6–7.5(–9) cm, broadest 2/3 from base and then narrowing gradually to the mouth by 1.5–3 cm, rarely dilating at the mouth; wings in lower half 0.3–1 cm wide, unfringed, upper half with ridges, or the whole pitcher with ridges only; mouth subelliptic, almost horizontal, slightly or highly concave, the rear half rising to form a column; peristome rounded, 4–12 mm wide, ends at lid folding outwards forming two obtuse angles c. 2 cm long, ribs 0.5 mm apart, 0.3 mm high, conspicuous, outer edge entire, inner with teeth 0.5 mm long, decreasing to 0.3 mm long near lid; lid suborbicular(-elliptic), 5–6.3 by 5.2–6.5 cm, apex rounded to slightly retuse, base shallowly cordate to rounded, lower surface lacking appendages, glossy, nectar glands scattered over whole surface or absent from the central area, orbicular, pit-like, 0.2 mm diam.; spur filiform, c. 9 mm long, entire or shortly bifid. *Male inflorescence* c. 40 by c. 5 cm; peduncle c. 11 cm long, 0.7 cm diam. at base; partial peduncles c. 80, 1- or 2-flowered, 0.5–0.7(–2.5) cm long, bracts inserted along length; bracts filiform, patent, 1–2 mm long; pedicels 14–22 mm long; tepals 5–6 by 3–3.5 mm; androphore 3.5–5 mm long; anther head 1.5 by 1.5 mm. Fruit with stipe 2–3 mm long; valves 18–19 by 3.5 mm. Seed fusiform, 7–9 mm long. *Indumentum* generally sparse, simple on leaf margins and tendrils, stellate on pitcher surface and leaf underside, 0.15–0.3 mm wide, especially dense beneath blade margin; inflorescence brown puberulous with stellate hairs 0.1–0.2 mm diam. *Colour* of pitchers and flowers not known. — **Fig. 19.**

Distribution — W New Guinea: Sorong, Misool Islands.

Ecology — Margin of *Agathis* or coastal forest; 0–500 m.

Note — *Nepenthes treubiana* is unlikely to be confused with any other lowland species of *Nepenthes* in the island of New Guinea (*N. ampullaria, N. insignis, N. mirabilis, N. neoguineensis,* and *N. papuana*). None of these species has the combination of

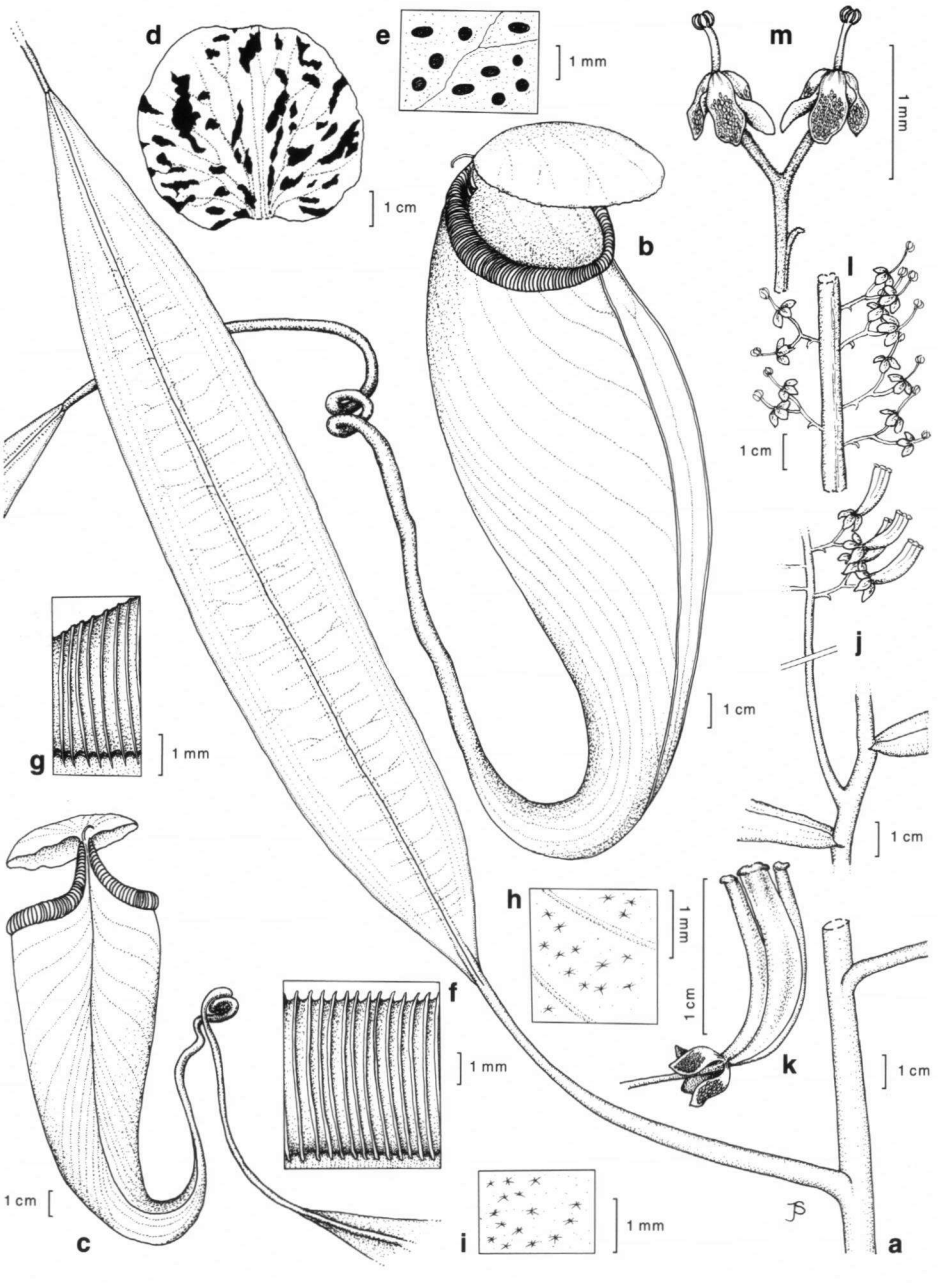

Fig. 19. *Nepenthes treubiana* Warb. a. Climbing stem; b. upper pitcher; c. upper pitcher, rear view; d. underside of lid; e. detail of glands on underside of lid; f. peristome, outer view; g. peristome, inner view; h. indumentum of pitcher, outer surface; i. indumentum of leaf, lower surface; j. infructescence (lower part); k. fruit; l. portion of male inflorescence; m. partial inflorescence with male flowers (*Pleyte 813*). Drawn by Judi Stone.

markedly petiolate, large leaf blades (30–39 by 7–12 cm) conspicuously stellate hairy below and strongly infundibuliform upper pitchers. *Nepenthes treubiana* is similar to and was formerly united with *N. sumatrana* from Sumatra. *Nepenthes treubiana* differs by having teeth on the inner margin of the peristome (vs. peristome entire), the densely hairy leaf margin, and relatively uniform lid glands, 0.2–0.4 mm diam. (vs. 0.2–0.7 mm diam. in *N. sumatrana*), evenly spread throughout the lid surface or absent from the centre (vs. largest along the midline and smaller elsewhere). *Nepenthes treubiana* is also similar to *N. rafflesiana* of Borneo, Sumatra and Peninsular Malaysia, but differs in lacking the characteristic long white arachnoid hairs of that species.

78. Nepenthes × trichocarpa Miq.

Nepenthes × *trichocarpa* Miq., Fl. Ned. Ind. 1, 1 (1858) 1072; J. Bot. Neerl. 1, 3 (1862) 275, t. 1; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 389; Tamin & M. Hotta in M. Hotta, Diversity and Dynamics of Plant Life in Sumatra (1986) 108; Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) 140, f. 75; Jebb & Cheek, Blumea 42 (1997) 87; Clarke, Nepenthes of Borneo (1997) 150, f. 104. — Type: *Teijsmann 532* p.p. (BO, L n.v., U n.v.), Sumatra, Sibolga, 0 m, Feb. 1856.

Nepenthes trichocarpa var. *erythrosticta* Miq., J. Bot. Neerl. 1, 3 (1862) 276. — Type: *Teijsmann 533* p.p. (BO, L n.v., U n.v.), Sumatra, Sibolga, 0 m, Feb. 1856.

Distribution — Sumatra, Peninsular Malaysia, Borneo.

Ecology — Nearly always in mixed populations of *N. ampullaria* and *N. gracilis*, its putative parents; sea level to 800 m.

Notes — 1. *Nepenthes* × *trichocarpa* has sessile leaves which exhibit *N. ampullaria* -like venation, texture and hairiness, whilst the angular stem, with sub-decurrent leaf bases and the lid with its few, broad-bordered glands are similar to those of *N. gracilis*. The pitchers are characteristically barrel-shaped and slightly constricted at the mouth.

2. At Bogor several duplicates of Teijsmann's Sibolga collections exist; of these one duplicate of *532* represents *N.* × *trichocarpa*, the remaining 2 sheets are *N. gracilis*. Of *533*, one fragmented sheet may be *N. gracilis*, while the two other sheets are annotated *N. trichocarpa* var. *erythrosticta*, characterised by its larger size. Danser (1928) states that the number *532* represents authentic specimens of the var. *erythrosticta*, however. Without viewing the Utrecht specimens it is impossible to be certain of Miquel's designation, since Teijsmann's collections are mixed, and Miquel refers to no numbers in his protologues.

3. Holttum was the first to suggest that this species was a hybrid between *N. ampullaria* and *N. gracilis*. As with *N.* × *hookeriana* this supposition is based upon the fact that it only occurs in mixed populations of the parent species.

79. Nepenthes truncata Macfarl.

Nepenthes truncata Macfarl., Trans. & Proc. Bot. Soc. Pennsylv. 3, 3 (1911) 209, t. 2; Jebb & Cheek, Blumea 42 (1997) 89. — Type: *Allen 191* (?PENN n.v.), Philippines, Mindanao, Surigao Province, near Samsolang, 600 m, 1907.

Terrestrial shrub to at least 1 m tall, probably not climbing. Stems terete, 1.5–3 cm diam. *Leaves* thickly coriaceous, strongly petiolate, blade of short stems subrectangular to obtriangular, widest at the apex, to 45 by 22 cm, several cm wider at the apex than

the base, apex ± deeply emarginate or retuse, base truncate to shallowly cordate, margin ± undulate; petiole to 27 cm long, stout, canaliculate-winged, wing 1.8 cm wide at the base, amplexicaul, clasping the stem for its whole circumference, sheathed, not auriculate or decurrent. Longitudinal nerves 5 on each side of the midrib, ± equidistant, conspicuous. Pennate nerves numerous, initially at a steep angle with the midrib, then at 90°, overlapping the longitudinal nerves, conspicuous. *Lower pitchers* poorly known, but with two fringed wings. *Upper pitchers* cylindrical, up to 30 by 10 cm, wings absent, mouth ovate, oblique, slightly concave, sometimes the front protruding in a triangle upwards; peristome flattened, up to 6 cm wide, with coarse ribs 1 mm apart, outer markedly sinuate, inner surface dentate; lid ovate to subtriangular, up to c. 9.5 by 6.5 cm, apex acute to rounded, base cordate, lower surface with rounded basal appendage c. 13 mm high, 12 mm wide, midline with a keel c. 1 mm high extending to lid apex, nectar glands very sparsely scattered (c. 100 per lid), longitudinally elliptic, bordered, 0.3–0.6 mm long, mixed with sessile red glands c. 0.1 mm diam.; spur 10–12 mm long. *Inflorescence* incompletely known, length unknown, peduncle to 30 by 1 cm, partial peduncles 2-flowered, 7 mm long; bracts absent; pedicels 18–30 mm long, tepals elliptic-ovate, 5 by 3 mm, androphore 6 mm long, anther head 1.25 mm wide. Fruit valve 2.5–3.8 cm long. Seed unknown. *Indumentum* absent from stem and leaves excepting the leaf margin which densely fringed with red, branched hairs c. 0.8 mm long; pitcher ferruginously villose; inflorescence densely covered in short, 3- or 4-armed white hairs. *Colour* of pitcher green, excepting peristome which is red, striped green.

Distribution — Philippines: Mindanao (Surigao & Agusan Provinces).

Ecology — Open mountainside, probably on ultramafic substrate; 230–600 m.

Notes — 1. *Nepenthes truncata* is not likely to be confused with any other species on account of its strikingly truncate to deeply notched leaf blade apex, large size and lid with a basal glandular crest. The species appears to be very restricted in distribution, being found only in the highly ultramafic north-eastern corner of Mindanao as are *N. bellii*, *N. merrilliana*, and *N. petiolata*. *Nepenthes truncata* shows affinities to the *N. maxima* group in its strongly petiolate leaves, appendaged pitcher lid, 2-flowered partial peduncles and the venation of the leaf blade. *Nepenthes truncata* is still only known from a few fragmentary collections.

2. Macfarlane cites two collections in the protologue, one (*Bolster 270*) comprising a small, juvenile leaf, the other (*Allen 191*), which is illustrated, a large mature leaf. Although we have not been able to see the PENN material, this latter specimen seems the most appropriate for lectotypification.

80. Nepenthes veitchii Hook.f.

Nepenthes veitchii Hook.f., Trans. Linn. Soc. 22 (1859) 421; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 391; Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) 144, f. 77 & 78; Jebb & Cheek, Blumea 42 (1997) 89; Clarke, Nepenthes of Borneo (1997) 131, f. 91 & 92. — Type: *Lobb s.n.* (lecto K), Borneo.

Nepenthes lanata Hort. ex Linden, Ill. Hort. 23 (1876) 192, t. 261; Mast., Gard. Chron. (1872) 542, nomen. — Type: not located.

Nepenthes veitchii var. *striata* Veitch, Gard. Chron. III, 12 (1892) 561, nomen.

Nepenthes villosa auct. non Hook.f.: Hook., Bot. Mag. (1858) t. 5080.

Nepenthes sanguinea auct. non Lindl.: Mast., Gard. Chron. II, 18 (1882) 808, f. 143.

Epiphytic or terrestrial climber (rarely a shrub) 0.5–6(–10) m tall, climbing by means of the clasping, distichous leaf blades. Stem often flexuose, ± terete, rarely 2-ridged, 4–10 mm diam. *Leaves* coriaceous, petiolate, obovate to oblanceolate, rarely suborbicular (10–)14–25 by 4–10 cm, apex truncate to retuse, rarely acute, base cuneate to obtuse; petiole to 5 cm long, canaliculate, sheathing the stem, not auriculate, but rarely with two decurrent wings reaching the node below. Longitudinal nerves 2–4 on each side of the midrib in the outer half, often inconspicuous. Pennate nerves slightly oblique, faint near margin, inconspicuous. *Lower pitchers* broadly cylindrical, broadest near the middle, 15–28 by 4–10 cm, with two fringed wings 4–5 mm wide, fringed elements 5–7 mm long, 3–4 mm apart; mouth ovate, horizontal in front, abruptly concave behind, rising into a long, broad, stout column terminating c. 9 cm above the front of the mouth; peristome flattened, 4–15 mm wide at front, 10–80 mm wide near lid, the ribs 0.5–1 mm apart, outer edge undulate, inner edge with teeth 2–4 mm long; lid held towards vertical, at obtuse angle with mouth, narrowly ovate or elliptic, 3–9 by 1.75–5 cm, apex acute to rounded, base rounded, with a laterally flattened asymmetrical appendage c. 6 mm high, 20 mm long on the lower surface near the peristome and often a smaller one at the apex, glands dense, crater-like, orbicular, c. 0.2 mm diam., on the appendages elliptic, 1.75 mm long; spur entire, slender, 3–14 mm long, inconspicuous. *Upper pitchers* as the lower, to 30 by 8.5 cm, with two fringed wings 5–10 mm wide, fringed elements c. 10 mm long, 2–7 mm apart. *Male inflorescence* 17–45 cm long; peduncle 14–27 cm long; partial peduncles c. 50, 2- (or 3-)flowered, 0.5–2 mm long; bracts absent; pedicels 9–14 mm long; tepals elliptic, 4 by 1.5 mm; androphore 2.5–4 mm long; anther head 1 by 1.5 mm. Fruit long and slender, valves 35(–40) by 2–2.5 mm. Seed fusiform, c. 18 mm long, central part tuberculate. *Indumentum* dense, spreading, of simple, coppery hairs 3 mm long, on stem, lower leaf, tendril and pitcher, including lower surface of lid when young, becoming sparser, in places glabrous, when mature. *Colour* of pitcher golden yellow or green, rarely splashed with red, peristome striped red and yellow or all green, yellow or brown.

Distribution — Borneo: C Sarawak, Brunei, Sabah, rarely in Kalimantan.

Ecology — Lowland dipterocarp forest, especially near rivers, 55–500 m; moss forest on mountain ridges; 750–1800 m.

Notes — 1. *Nepenthes veitchii* is immediately recognisable from its close relative *N. fusca* by the very broad, flattened peristome and the dense, hispid hairs. Possibly unique in the genus in climbing by means of distichous clasping leaf blades. There appears to be a lowland form of *N. veitchii* with long, narrow, spathulate leaves, a narrow lid, and a golden yellow peristome, which is often found near streams or rivers, and a highland form, with abruptly rectangular-elliptic blades, a rounded lid, and usually a green and red streaked (but sometimes yellow) peristome, which is commonly found on ridge tops. But morphological intermediates occur. *Nepenthes veitchii* is variable in life-form, apparently starting as a terrestrial shrub, then climbing, the stem dying below and the plant becoming epiphytic, reaching up to 30 m into tree crowns (pers. obs.). Part of the *N. maxima* complex.

2. William Hooker published (Bot. Mag. (1858) t. 5080) the first description of *N. veitchii* basing it on a Lobb collection from Sarawak, taking it to be the then incompletely known *N. villosa* Hook.f. which had been published without knowledge of the

pitchers. His error was realised by his son Joseph who applied a new name to this plant (*N. veitchii* Hook.f., Trans. Linn. Soc. 22 (1859) 421), citing a Lobb specimen from 1000 ft and a Low specimen from G. Mulu at 3000 ft. The former specimen at Kew is the lectotype. It was previously identified as *N. villosa* in pencil, and this has been partly rubbed out, presumably indicating that it was the specimen mistaken by William.

81. Nepenthes ventricosa Blanco

Nepenthes ventricosa Blanco, Fl. Filip., ed. 1 (1837) 807; Blume, Mus. Bot. Lugd.-Bat. 2 (1852) 10; Hook.f. in A.DC., Prodr. 17 (1873) 100; Becc., Malesia 3 (1886) 4; Beck, Wiener Ill. Gart.-Zeitung 20 (1895) 149; Burb., Flora & Sylva II, 12 (1904) 114; Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 54; Jebb & Cheek, Blumea 42 (1997) 90. — Type: *Blanco* (PNH†), Philippines, Luzon, Ilocos Prov., Piddig.

Climber, sometimes epiphytic, to at least 2 m tall. Stems winged to strongly triangular, 3.5–9 mm diam. *Leaves* chartaceous to thinly coriaceous, sessile, rosette leaves unknown, stem leaves with blade oblanceolate or narrowly oblong, 15–25 by 2–3 cm, apex acute, inconspicuously peltate, base gradually tapered, clasping the stem for 2/3 its circumference, decurrent, prominently winged to the node below or for only ± 1 cm. Longitudinal nerves 3–6 on each side of the midrib, evenly scattered. Pennate nerves oblique, obscure. *Lower pitchers* rare, as the upper but with tendril in front. *Upper pitchers* hourglass-shaped, 9–16 by 3–8 cm, basal half obliquely ellipsoid, apical half broadly infundibular, up to twice as broad as basal portion, waist constriction central, 1/2–1/3 the width of the base or apex, fringed wings absent, reduced to ridges < 1 mm wide; mouth circular to shortly elliptic, horizontal or slightly oblique, straight; peristome broad, subcylindrical, 10–25 mm wide, ribs coarse, 1–2 mm apart, outer edge with 4–6 slight undulations on each side, each protruding 3–4 mm, inner edge shortly dentate; lid membranous, narrowly elliptic, 4–6 by 1.8–2.25 cm, apex rounded, base rounded, lower surface lacking appendages, nectar glands absent from a band c. 6 mm wide along the midline, pit-like or slightly bordered, mostly orbicular 0.4–0.5 mm diam., less usually transversely elliptic, 0.8 mm long; spur flattened, 9 mm long, entire. *Male inflorescence* 28–60 cm long; peduncle 11–21 cm long; partial peduncles 70–180, 1-flowered; bracts absent; pedicels 5–10 mm long; tepals elliptic, 2–3.5 by 1.5 mm; androphore 3–3.5 mm long; anther head 1.5 mm wide. Fruit valves 25–32 mm long. Seed unknown. *Indumentum* absent from stems and leaves; pitchers with inconspicuous appressed scattered, simple reddish hairs 0.5 mm long; inflorescence as the pitchers, but densely hairy. *Colour* of pitchers uniformly creamish white, peristome red, inner surface yellowish.

Distribution — Philippines: Luzon.

Ecology — Low mossy oak forest; 1200–1500 m.

Notes — 1. *Nepenthes ventricosa* is unlikely to be confused with the only other Luzon *Nepenthes*, *N. alata*. The angular stems and white, hourglass-shaped, upper pitchers of *N. ventricosa* make it easily distinguished. *Nepenthes ventricosa* is closely related to *N. burkei* of Mindoro and *N. sibuyanensis* of Sibuyan, but neither have the white, highly constricted pitchers of *N. ventricosa*.

2. Blanco's types were destroyed at PNH, but duplicates may exist elsewhere (see notes under *N. alata*).

82. Nepenthes villosa Hook.f.

Nepenthes villosa Hook.f. in Hook., Ic. (1852) t. 888; Beck, Wiener Ill. Gart.-Zeitung 20 (1895) 183, p.p., excl. *Nepenthes edwardsiana*; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 396, p.p., excl. *Nepenthes edwardsiana*; Sh. Kurata, Nepenthes of Mt Kinabalu, Sabah (1976) 73, t. 25 & 26; Phillipps & A.L. Lamb, Pitcher Plants of Borneo (1996) 149, f. 79; Jebb & Cheek, Blumea 42 (1997) 91; Clarke, Nepenthes of Borneo (1997) 135, f. 93 & 94; J.H. Adam & Wilcock, Sarawak Mus. J. 50 ('1996', 1998) 159, f. XXIIId. — Type: *Low s.n.* (K), Borneo, Sabah, Mt Kinabalu.
Nepenthes villosa auct. non Hook.f.: Hook., Bot. Mag. (1858) t. 5080 = *Nepenthes veitchii*.

Terrestrial shrub, not known to climb, 0.6(–1.5) m tall. Stem terete, 6–10 mm diam., often at length prostrate. *Leaves* coriaceous, petiolate; blade elliptic or oblong, 10–20 by 5–10 cm, apex emarginate, base obtuse; petiole canaliculate, 4–12 cm long, clasping the stem for up to 4/5 its circumference, sheathing, not auriculate or decurrent. Longitudinal nerves 1–3 on each side of the midrib in the outer third, conspicuous. Pennate nerves numerous, arising at 45° from the midrib, reaching the outer longitudinal nerve, conspicuous. *Lower pitchers* broadly ellipsoidal, 5–16 by 5–12 cm with two fringed wings in the upper 1/3 or 1/2, the wings 5–12 mm wide, fringed elements 2.5–8 mm long, 1–4 mm apart; mouth subcircular, almost horizontal, then abruptly rising to the vertical in the rear to provide a stout column 2–3.5 cm high; peristome rounded, 6–12 mm broad, ribs 3–10 mm apart and 4–6 mm high, outer surface entire, never sinuate, inner surface with teeth 7–12 mm long, in two distinct ranks, strikingly protruding up the column; lid suborbicular 5–12 by 5–12 cm, apex rounded, base conspicuously cordate, lower surface lacking appendages, glands very dense, circular, 0.1–0.3 mm diam.; spur stout, entire, c. 10 mm long. *Upper pitchers* rarely seen, as the lower pitchers, but ovoid to infundibulate, 10–18 by 5–12 cm. *Male inflorescence* 35–70 cm long; peduncle 20–50 cm long; partial peduncles 1-flowered, c. 100; pedicels 9–15 mm long; bracts absent; tepals elliptic, 5–7 by 2–3 mm; androphore 2–2.5 mm long; anther head 1–1.5 by 1.5–2 mm. Fruit not seen. Seed not seen. *Indumentum* villose, hairs simple, 3–4 mm long, red-brown, densely covering all parts of the plant, persistent on lower leaf and leaf edge, tendril and pitcher. *Colour* of outer pitcher and lid yellow, suffused with pink or red, inner white or pale green, indumentum brown.

Distribution — Borneo: Sabah (Mt Kinabalu and Mt Tambuyukon).

Ecology — Mossy forest with *Dacrydium* and *Leptospermum*, or amongst boulders, shrubs and grass; ultramafic substrates; 2400–3200 m.

Notes — 1. *Nepenthes villosa* is closely related and sometimes confused with *N. edwardsiana* (which also occurs on Mt Kinabalu) and *N. macrophylla*. It overlaps slightly in altitudinal range with *N. edwardsiana* but is found in a different habitat (Phillipps & A.L. Lamb in Pitcher Plants of Borneo (1996) 149). *Nepenthes edwardsiana* is easily distinguished by its more elongated, less hairy pitchers which are slightly constricted about the middle. Intermediate taxa can be ascribed to the hybrid *N.* × *harryana* Burb. *Nepenthes villosa* differs from both *N. edwardsiana* and *N. macrophylla* in its emarginate leaf blade, long villose tendril, and in its ellipsoid, villose pitcher which lacks any narrowing at its middle. The recently described *N. mira* of Palawan also seems to be a part of the *N. villosa* group. See key to the species of this group under *N. mira*.

2. *Nepenthes edwardsiana* and *N. villosa* were united by Danser in Bull. Jard. Bot. Buitenzorg III, 9 (1928). Macfarlane reinstated them in Das Pflanzenreich 4, 3 (1908).

Hybrids — 1. *Nepenthes villosa* × *N. edwardsiana* = *Nepenthes* × *harryana* (Burb.) Macfarl. (see under *Nepenthes edwardsiana*).

2. *Nepenthes villosa* × *N. rajah* = *Nepenthes* × *kinabaluensis* Sh. Kurata (see *Nepenthes* × *kinabaluensis*).

LITTLE KNOWN SPECIES

Nepenthes deaniana Macfarl.

Nepenthes deaniana Macfarl. in Engl., Pflanzenr. 4, 3 (1908) 57. — Type: *Curran 3891* (holo PNH†), Philippines, Palawan, Mt Pulgar.

Notes — *Nepenthes deaniana* was described from Palawan but referred tentatively, on the basis of its short and incomplete description, to *N. alata* (Jebb & Cheek in Blumea 42 (1997)). It may well yet represent a fourth species of *Nepenthes* for Palawan, but neither illustration nor original material has been traced. *Nepenthes deaniana* has characteristics in common with *N. mira*, but differs, for example, in being a much smaller, non-climbing plant, 20–30 cm tall, with glabrous stems (not strongly petiolate, 35–50 by 8–10.5 cm) and partial peduncles bracteate and 1-flowered (not ebracteate and 2-flowered).

The Manila herbarium was destroyed in 1945. We have searched the following herbaria without success for duplicates of the type specimen or for any other material that matches the original description: B, BM, BO, DBN, FHO, FI, K, KEP, L, OXF, P, S, SAR, TCD, U, US, W.

'*Nepenthes* spec. Philippines I' of Rischer & Nerz (at URL: http://www.schwaben.de/home/schmidt/nepenthes/cpframes.html (14 October 1998 08:12:48 (1998)), photographed in a grassland habitat, is a non-climbing, shrubby plant differing from *N. mira* in the smaller leaves with less conspicuous petioles and with the pitcher wings also running from peristome to tendril. It may represent *N. deaniana*. Alternatively, these differences could be attributable to differences in habitat and to infra-specific variation within *N. mira*. Without specimens it is difficult to be certain.

EXCLUDED SPECIES

1. *Nepenthes cincta* Mast., Gard. Chron. II, 21 (1884) 576. — Type: *J. Veitch & Sons s.n.* (K), cultivated from material collected by David Burke in Borneo.

Note — Described from material grown from seed collected by David Burke in Sarawak, a collector for J. Veitch and Co. As Masters states in the original description, it is in all likelihood a natural hybrid between *N. albomarginata* and *N. northiana*.

2. *Nepenthes cristata* Brongn., Ann. Sci. Nat. 1 (1824) 48. — Types: *Commerson s.n.* (P n.v.), Madagascar; *Nöe s.n.* (P n.v.), Philippines, Mauban.

Note — A nonsense species based on mixed types, comprising *N. alata* and *N. madagascariensis*.

3. *Nepenthes lindleyana* H. Low ex W. Baxter, Suppl. Hort. Brit. 3 (1850) 593. — Type: not located.
   Note — Without original material, we have been unable to identify this taxon.

4. *Nepenthes neglecta* Macfarl. ex Icon. Becc. in Engl., Pflanzenr. 4, 3 (1908) 58; Danser, Bull. Jard. Bot. Buitenzorg III, 9 (1928) 29. — Types: Icon. Beccarii (not located); *Low s.n.* (not located), *Burbidge s.n.* (not located), Borneo, Sabah, Labuan Island.
   Note — This name is probably referable to *N. gracilis* as detailed by Jebb & Cheek in Blumea 42 (1997) 93.

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