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A dichotomous key of thirteen species of *Nepenthes species*, a dichotomous key to subspecies of *Nepenthes curtisii* and a dichotomous varietal key to *Nepenthes sandakanensis* recorded from Mt. Kinabalu in Sabah State of Malaysia are given. In addition botanical descriptions, geographical distribution, altitudinal distribution and-taxonomic affinities of these thirteen species are given; and they are selectively illustrated. Of these, five new taxa are described: they are namely *Nepenthes curtisii* Masters ssp. *zakriana* Adam & Wilcock, *Nepenthes kinabaluensis* Kurata ex Adam & Wilcock, *Nepenthes sandakanensis* Adam & Wilcock, *Nepenthes sandakanensis* var. *eglandulosa* Adam & Wilcock and *Nepenthes sandakanensis* var. *ferruginea* Adam & Wilcock.

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### INTRODUCTION

Nepenthaceae represented by a single genus, *Nepenthes*, comprising 81 species, is a perennial plants which grows only in the tropical areas of the world. It displays a carnivorous habit viz. attract, retain, trap, kill, digest and absorb nutrients from preys. These functions are carried out by pitchers developed on the tips of the extended midribs of some of the leaves.

Pitcher of *Nepenthes* also provides an ideal habitat for some fauna and flora. For example, *Nepenthes ampullaria* with pitchers partly buried in the forest litter of the tropical forest, have the richest fauna of any southeastern phytotelm (Beaver, 1979a); and inhabitants includes fungi, slime moulds, protozoans, desmids, diatoms, rotaria, worms, crustaceans, dipteran larva and tadpoles (Beaver 1979 a, b). Above the liquid level, *Misumenops nepenthicola*, form spider webs, thus robbing the plants of its potential prey. Shelter (1974) reported the small primate, *Tarsius spectrum*, perches on the peristome margin and feeds off the trapped insects. It has been suggested that the two incurved thorns above the mouth of *Nepenthes bicalcarata*, an endemic species in Borneo, is a device to prevent robbing of prey (Burbidge, 1880).

The word *Nepenthes* is of Greek origin, and occurs in Homer's *Odyssey*, where it means a freeing from, or causing an oblivion of grief or may also means banishing sorrow.

The distribution of *Nepenthes* is restricted to but scattered throughout the tropics, with the centre of distribution in Borneo, Sumatra, Peninsular Malaysia, Philippines and New Guinea. It extends eastwards to New Caledonia and Isles of Pines. The genus extends westwards to Sri Lanka, Seychelles and Madagascar. To the south it extends up to the York Peninsula in Australia. It is found as far north as the Khasia Hill in India, Indo-China and Southern China but is absent from Burma.

*Nepenthes* grows from sea level up to about 3500 m. They can be arbitrarily categorized into the lowland group and the highland group. The former group consists of species which commonly grow below 100 m, only occasionally growing above 1000 m. The latter group grows commonly on high mountains at elevation above 1000 m but occasionally growing down to about 500 m, with no records below 100 m. Most of the lowland species can grow at high elevation up to 1000 m. Generally, these species grow in disturbed or opened habitats such as secondary bushes or *belukar*, roadside embankments, edges of the forest, swampy area, heath or kerangas forest, peat swamp forest and in open areas or gaps in primary lowland dipterocarp forest.

The highland species are conspicuous and common on the higher mountains in what Richards (1952) called montane rainforest, also commonly known as mossy forest or montane ericeous forest and exposed montane ridges. They are very rare in submontane forest but species such as *N. tentaculata* grow within the gap or in open areas of the forest.

The flowers of pitcher plants are unisexual. These flowers are arranged in clusters along the axis called inflorescences. The plants are dioecious, male and female inflorescences being borne on separate plants. The inflorescences are commonly racemose in the majority of Bornean species, for example as illustrated by *Nepenthes mirabilis* (Plate XXIVc), but paniculate inflorescences have been recorded in *N. bicalcarata* and *N. ampullaria*. The inflorescence of most species produce a weak foetid smell but in *N. veitchii* the flower nectar emits a strong odour and can be recognised from a very considerable distance. The upper surface of sepal of all species are densely covered with sessile nectary glands seated in very shallow epidermal cavities (Plates XXVa-f); and all species have echinate pollen tetrads, for example, as it is clearly illustrated in *Nepenthes reinwardtiana* (Plate XXIIe) and *Nepenthes lowii* (Plate XXIf).



*Nepenthes* have been categorised by many authors as carnivorous plants or more commonly as insectivorous plants (Macfarlane, 1889 - 1890; Lloyd, 1942; Som 1988; Juniper *et al.*, 1989).

Almost all members of the genus display dimorphism, producing at the leaf tip of climbing stems and ground stems the upper and lower pitchers respectively. These pitchers display a variety of shapes ranging from urceolate, infundibulate, cylindrical, tubulose, ellipsoidal to ovate; and a variety of colours (Plates XXIIa - XXIIc, XXIIIa - XXIIIc and XXIVb). It has been suggested that these varying shapes and colours in carnivorous plants groups are among one of the most common mechanisms used to attract potential prey (Lloyd, 1942; Heslop-Harrison, 1978; Joel, 1984).

All the species found from Mt. Kinabalu have nectar glands on their lower lid surface, which are selectively illustrated in Plates XXa - XXh. The lid is a seductive device. Flying and creeping insects are attracted by the nectar secreted by the glands covering the lower lid surface and marginal glands between peristome teeth; and in addition, the lids are brightly coloured thus further attracts insects to the glands.

On the inner surface of the pitcher, immediately below corrugated peristome, is a whitish, powdery, waxy zone present in most but not all the species. In wholly glandular pitcher cavity, the waxy zone covers a very small triangular area immediately below the lid base and is illustrated by *Nepenthes villosa* (Plate XXIIIc). The wax covering the surface is easily detachable and the function of this slippery zone is generally agreed by many authors to be a trapping device (Lloyd, 1942; Slack, 1980; Juniper *et al.*, 1989).

The surface of inner pitcher cavity is abundantly supplied with digestive glands (Plates XXIa - XXId). Each gland is seated in a cavity, and in most species the upper edge of the epidermis is extended forming an over-arched epidermal flap, partly or totally covering the glands (Plate XXIa, XXIc and XXId). These epidermal flaps probably impede the escape of the prey (Adam & Smith, 1977; Macfarlane, 1908). Knoll (cited in Lloyd, 1942) argued that the epidermal flap serves to prevent the use of the glands as foothold by insects, and prevent damage by their claws to the gland themselves. This argument cannot be applied to species such as *Nepenthes gracilis* (Plate XXIb) and *N. tentaculata* where glands are seated on an exposed epidermal concavity with no extended epidermal flap. The digestive glands are also absorptive in function (Lloyd, 1942; Darwin 1875, cited in Juniper *et al.*, 1989), and are reported to secrete different enzymes.



# KEY TO THE SPECIES OF *Nepenthes* OF MT. KINABALU

- 1 Pitchers' peristome coarsely ribbed ..... 2  
Pitchers' peristome obscured or finely ribbed ..... 3
- 2 Flower pedicel ebracteolate; inner pitcher cavity partly glandular ..... *Nepenthes edwardsiana*  
Flower pedicel bracteolate; inner pitcher cavity wholly glandular ..... *Nepenthes villosa*
- 3 Lower surface of the pitcher lid covered with numerous bristles ..... *Nepenthes lowii*  
Lower surface of the pitcher lid without bristles ..... 4
- 4 Two dark spots present on pruinose zone of inner pitcher cavity ..... *Nepenthes reinwardtiana*  
Two dark spots absent ..... 5
- 5 Inner pitcher cavity covered with exposed digestive glands ..... 6  
Inner pitcher cavity covered with over-arched digestive glands ..... 7
- 6 Marginal hairs on pitcher lid present; lower lid surface densely glandular, glands with wide opening; lamina base amplexicaul and decurrent ..... *Nepenthes tentaculata*  
Marginal hairs absent; lower lid surface sparsely glandular, glands with minute opening; lamina base semi-amplexicaul and decurrent ..... *Nepenthes gracilis*
- 7 Apical glandular appendages present on lower lid surface ..... *Nepenthes curtisii*  
Apical glandular appendages absent ..... 8
- 8 Leaves apex peltate ..... 9  
Leaves apex not peltate ..... 10

- 9 Flower pedicel bracteolate ..... *Nepenthes kinabaluensis*  
 Flower pedicel ebracteolate ..... *Nepenthes rajah*
- 10 Petiole or lamina base decurrent ..... 11  
 Petiole or lamina base not decurrent ..... 12
- 11 Inner cavity of upper pitcher and lower pitcher partly glandular  
 ..... *Nepenthes sandakanensis*  
 Inner cavity of upper pitcher and lower pitcher wholly glandular  
 ..... *Nepenthes burbidgeae*
- 12 Flower pedicels bracteolate ..... *Nepenthes macrovulgaris*  
 Flower pedicels ebracteolate ..... *Nepenthes mirabilis*

**1. *Nepenthes burbidgeae* Hook. fil ex Burbidge, The Gardeners' Chronicle, 1: 56 (1882). Plates XXIIa and XXIIIa.**

Plant climbing 3-10 m high. Upper stem triangular. Leaves petiolate; lamina coriaceous, oblong, lanceolate to elliptic; apex acute, obtuse; base obtuse; longitudinal nerves 2-3 on each side; petiole base distinctly decurrent into two wings. Lower stem cylindrical. Leaves petiolate; lamina oblong, elliptic; apex obtuse; base obtuse; longitudinal nerves 4 on each side; petiole base decurrent into two wings. Upper pitchers infundibulate; anteriorly with 2 prominent ribs; mouth orbiculate, almost horizontal in front elevated towards the lid; inner cavity almost wholly glandular, glands over-arched; lids orbiculate, wholly glandular below, glandular crest present below; spur simple. Lower pitchers ellipsoidal, anteriorly with 2 fringed wings; mouth ovate, almost horizontal in front, elevated towards the lid; inner cavity wholly glandular with over-arched glands; lids below wholly glandular with glandular crest present; spur simple. Dioecious. Inflorescence racemose; pedicels commonly 2-flowered.

Distribution: Borneo - Sabah.

Altitudinal Range: 1100-2300 m.

This species described by J.D. Hooker was published by Burbidge (1882) based on the specimens of Burbidge collected from Mt. Kinabalu. This species is confined to ultrabasic soil on Mt. Kinabalu and Mt.