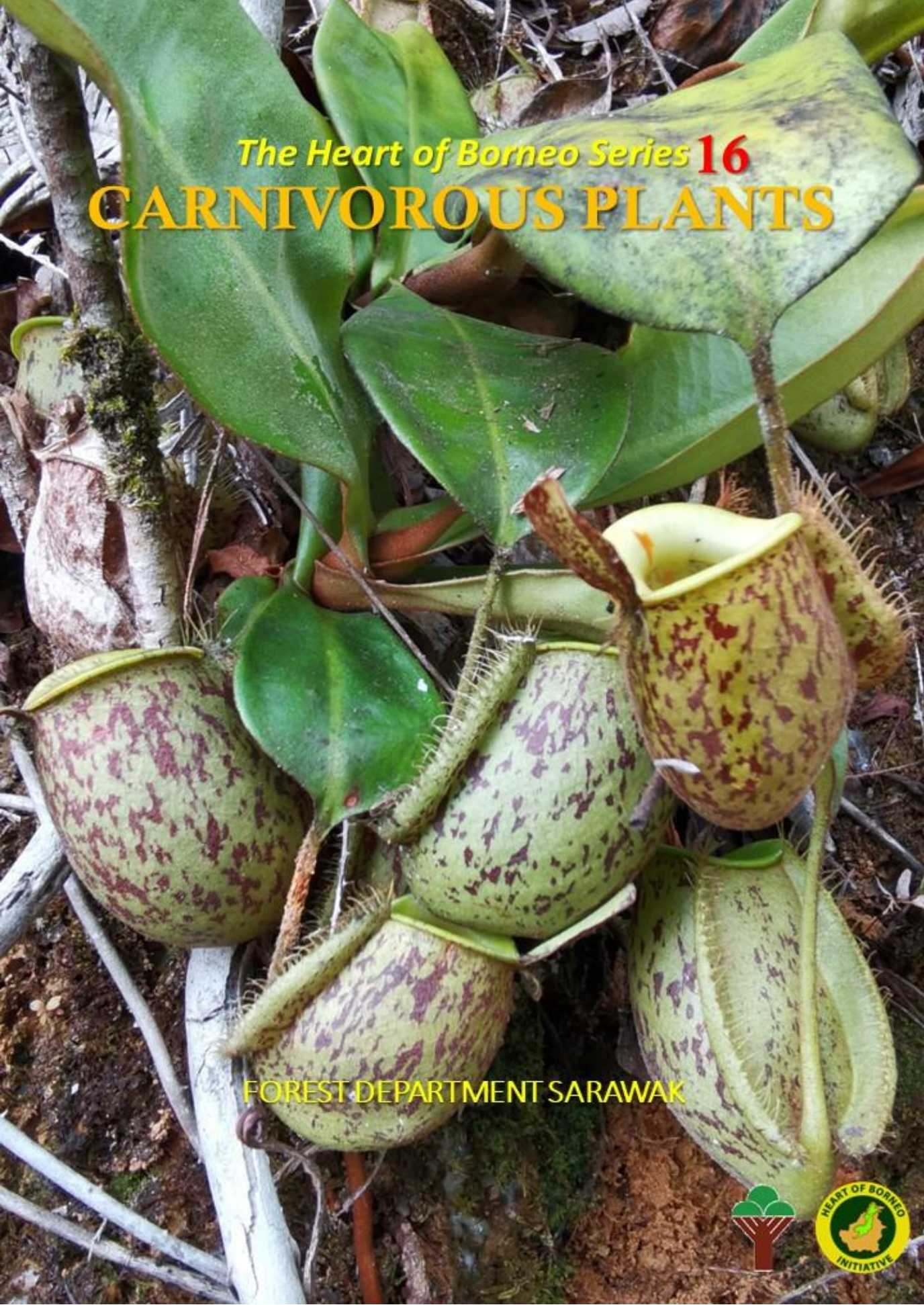
The Heart of Borneo Series 16
CARNIVOROUS PLANTS
FOREST DEPARTMENT SARAWAK
HEART OF BORNEO INITIATIVE

The Heart of Borneo Series 16

Carnivorous Plants

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FOREST DEPARTMENT SARAWAK

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Cover: *Nepenthes ampullaria* (upper pitcher)
Rear cover: *Drosera spatulata* var. *bakoensis*
Back cover: *Utricularia caerulea*

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FOREWORD

The Heart of Borneo Initiative was launched in 2007 by three countries that share the island of Borneo - Brunei Darussalam, Indonesia, and Malaysia. The importance of the initiative is the recognition of the area as a “life support system” and committed to work together to protect it and ensure its sustainable development. The Heart of Borneo is also a hotspot for unique and endemic fauna and flora and some of them are not so well-known to the lay people. It is with this in mind that this book is published so as to increase the understanding and knowledge of these specialised flora - carnivorous plants.

There are hundreds of plant species around the world that have evolved to cope with life in poor, often waterlogged soils by attracting prey and trapping them in ingenious ways. These intriguing, beautiful and complex plants are probably the most misunderstood of the plant world. Carnivorous plants usually occur in extremely sensitive habitats, and are often in areas experiencing direct conflict with human activities.

I do sincerely hope that through the information provided by this book, it will further help promote the conservation and interest in these unique biodiversity and their respective habitats.

DATU HAMDEN BIN HAJI MOHAMMAD
Director of Forests
SARAWAK

"the fact that a plant should secrete, when properly excited, a fluid containing an acid and ferment, closely analogous to the digestive fluid of an animal, was certainly a remarkable discovery."

- Charles Darwin, July 1875 -

What is the Heart of Borneo (HoB) Initiative?

Heart of Borneo (HoB) Initiative is a voluntary transboundary cooperation between Brunei, Indonesia and Malaysia to enable conservation and environment protection while enhancing sustainable development that improves the welfare of those living on the island. The cooperation of the three ASEAN nations was officially launched in Brazil on 27 March 2006. On 12 February 2007, the Minister of Natural Resources and Environment, Malaysia; the Minister of Forestry, Republic of Indonesia and the Minister of Industry and Primary Resources, Brunei Darussalam signed and jointly issued a Declaration in Bali, Indonesia.

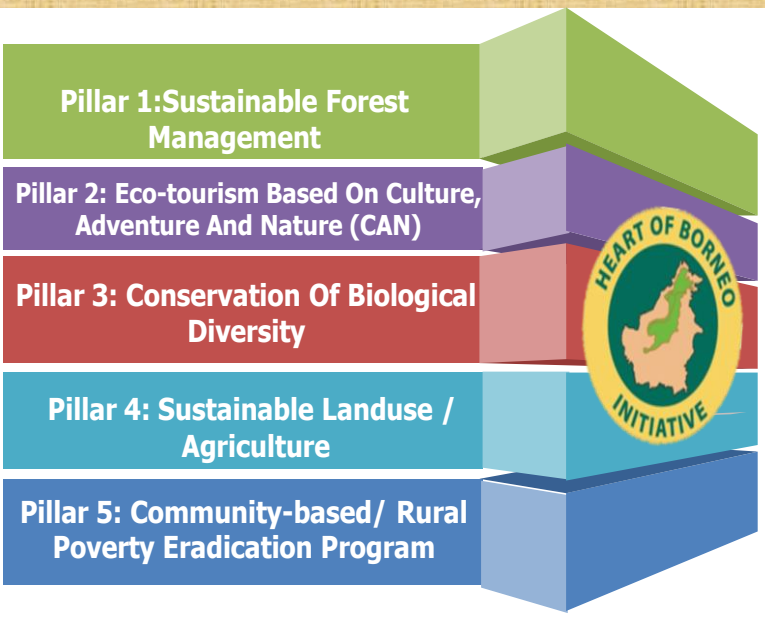
Bali Declaration 2007

Because of the global concerns and controversies about tropical forest development, the long-term objective of the HoB Initiative, as enshrined in the Bali Declaration, is as follows:

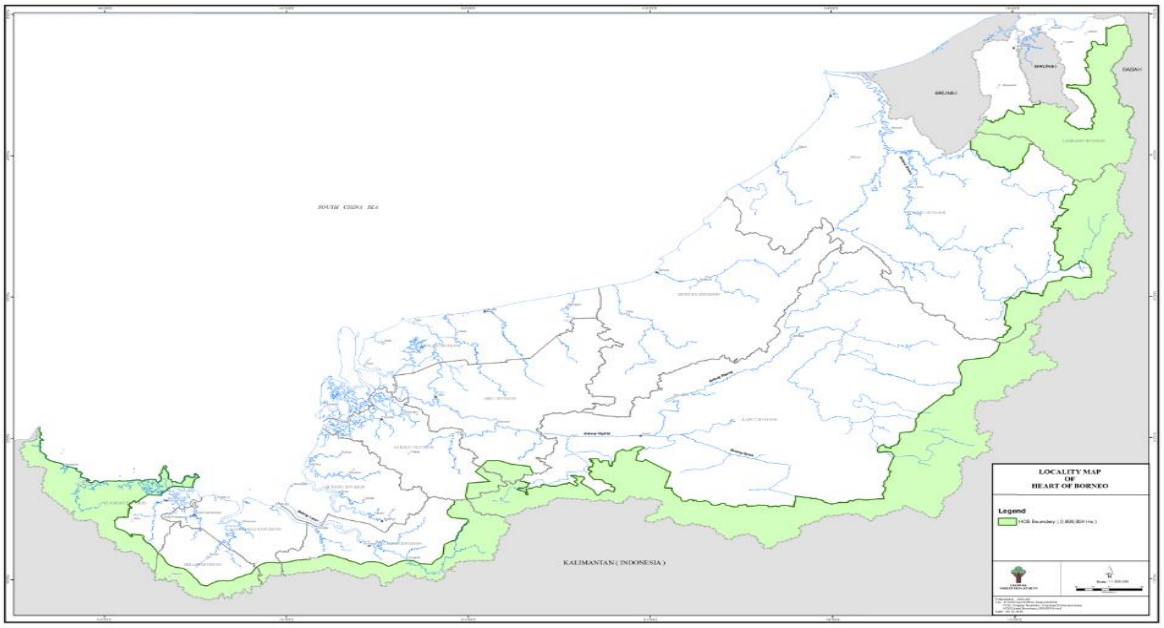
> "With one conservation vision and to promote people's welfare, we will cooperate in ensuring the effective management of forest resources and conservation of a network of protected areas, productive forests and other sustainable uses".

1	Represents the area designated as the Heart of Borneo area.
2	Represents the boundary of Heart of Borneo.
3	Represents the integrity of the forest which is crucially important. All in gold denoting under the good care of the 3 respective countries.
4	Represents the forest as the core element of the HoB initiative.
5	Represents the Global Earth
6	• Leaves representing the three pillars of sustainable development which are Economic, Social and Environmental requirements. • They are interlinked to represent the importance of forest connectivity for biodiversity conservation.

5 PILLARS OF THE HEART OF BORNEO



HoB Carnivorous Plants: 2



In Sarawak, the HoB covers 2.7 million ha over a contiguous block along Sarawak's boundaries with Kalimantan and with Sabah and Brunei. The HoB is fully in line with existing policies by both state and federal governments.

Heart of Borneo Sarawak started with a total area of 2.1 million hectares and is divided into three regions namely Northern, Central and Southern Regions. In 2018, the HoB areas were extended to 2.7 million hectares and approved by the State Cabinet. The expansion involves the area from Batang Ai to the western region of Sarawak. This covers the Kelingkang Range FR, Gunung Apeng NP, Bungo Range NP, Gunung Pueh NP, Kubah NP, Gunung Gading NP, Samunsam WS, Matang WC, Kuching Wetland NP, Bako NP, Sampadi NP, Santubong NP and Tanjung Datu NP.

The Carnivorous Plants

When it comes to asking, ‘What is a carnivorous plant?’ We often get the idea of scary, huge, vicious plants with fangs that will eat their prey. Why do we get this idea? It is because we often see this image, probably when we were kids, when we watch movies, cartoons, and video games, as they paint our minds with certain images of carnivorous plants. The truth is, carnivorous plants are not that huge; some of them are tiny and you do not even notice that they live around you. Let’s ask ourselves the real question. What do carnivorous plants do?

One trait that all carnivorous plants have in common is the capacity to capture other living things (animals or protozoans, typically insects and other arthropods) and use them as a food source. Trapping mechanisms of various types can be found in carnivorous plants. While it may appear surprising, practically all traps are heavily modified leaves. Despite receiving some or most of their nourishment from insects, carnivorous plants continue to use photosynthesis for some of their energy needs. These plants also have evolved to flourish in conditions where the soil is thin or deficient in nutrients, particularly nitrogen, such as acidic bogs.

DROSERACEAE

Droseraceae, also known as the sundew, is a family of carnivorous flowering plants. *Drosera* (sundew), *Dionaea* (Venus flytrap), and *Aldrovanda* (waterwheel plant) are the three genera that make up the Droseraceae family, with *Dionaea* and *Aldrovanda* both being monotypic genera. These species can be identified by their alternating, adaxially circinate hairs that have mucilage-producing glands on the tips of at least one surface. The Droseraceae can stock up their nutrient intake, particularly that of nitrogen, by capturing and digesting tiny creatures like insects, just as carnivorous plants of other families can. This family would use stalked mucilaginous glands that cover their leaf surfaces to lure, trap, and devour insects. By doing this, the plants can flourish in nutrient-poor surroundings like the kerangas forest.

With over 194 species, *Drosera* is one of the largest genera of carnivorous plants. The common name "sundew" in English is a derivative of the Latin "ros solis," which means "dew of the sun," and refers to the glittering beads of mucilage at the tip of the glandular trichomes that look like drips of morning dew. The scientific name "drosos" in Greek means "dew, dewdrops."

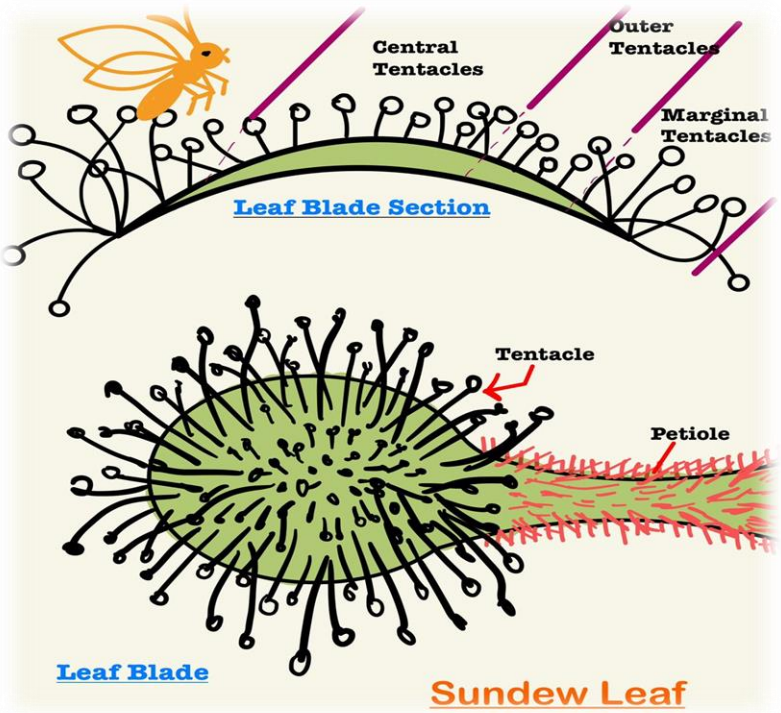
The exclusivity of *Drosera* species is that they would characteristically conceal a sticky fluid from hairs on their leaves to trap their prey as a source of nitrogen. Prey of an insectivorous plant includes insects, spiders, crustaceans, mites, and protozoa. These kinds of plants use adapted leaves as setup mechanisms; the delicate, sticky hairs with glands that conceal digesting enzymes will kill any insects that come into contact with them. This species is astonishingly rare. At the time, Charles Darwin admitted in a letter written in 1860 that he “cares more about *Drosera* than the origin of all the species in the universe.”

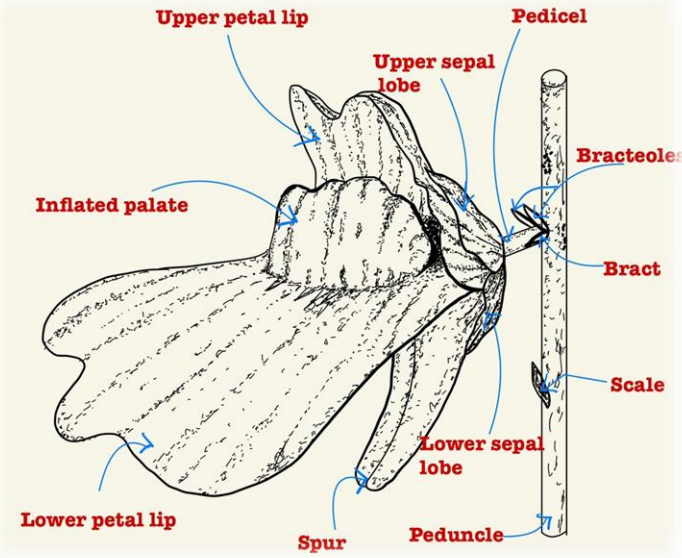
LENTIBULLARIACEAE

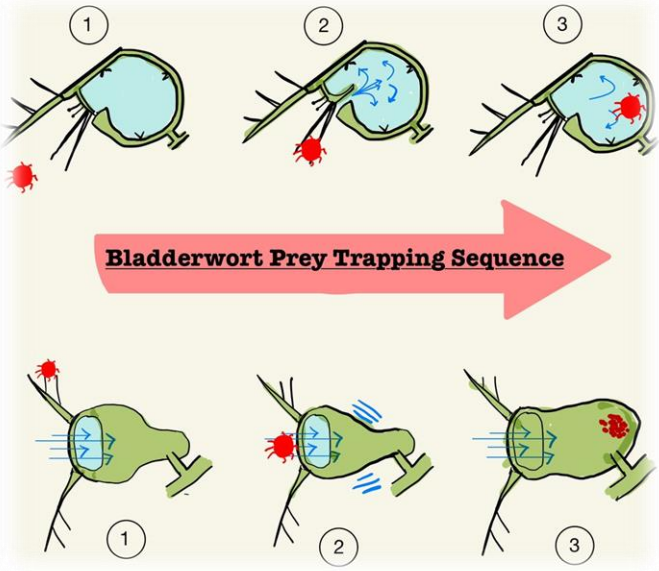
Genlisea (Corkscrew plant), *Pinguicula* (Butterworts), and *Utricularia* (bladderworts) make up the three genera, which are part of a distinctive

bladderwort family known as Lentibulariaceae that belongs to the order Lamiales. There are about 250 species in this genus, whereas the majority originate in tropical regions. This genus is viewed as cosmopolitan due to its global distribution, which includes subarctic regions, tropical rain forests, oases in the desert, and oceanic islands. This makes *Drosera* the second-largest genus in the carnivorous plant groups.

Utricularia is a very captivating carnivorous plant, but it always unnoticed due to its smaller size. Sometimes people won't even notice that there might be a *Utricularia* in their backyard or ditches near their housing area. *Utricularia* is a unique family where the common name for this plant is bladderwort.







Why? Because they have traps beneath the inflorescence that are shaped like a bladder (tiny traps with seemingly no roots). The word "*Utricularia*" is derived from the Latin word "*Utriculus*," which can imply a variety of things but is most frequently used to refer to a wine flask, a leather bottle, or a piper.

The foliar structures known as the traps, or utricles, are formed like little vesicles and function to gather prey and conceal hydrolytic enzymes to break down small animals. the little traps that catch rotifers and protozoa swimming in water-soaked soil as their food. Some species of *Utricularia* with larger bladders can eat larger prey including water fleas, nematodes, and even mosquito larvae and early tadpoles. The prey is drawn into the bladder along with the surrounding water when the trapdoor's hairs are reflexively triggered. The bladder traps are rare, very unique, and one of the most complex structures found in the plant kingdom.

NEPENTHACEAE

Peculiar, unique, attractive, beautiful, gorgeous, magnificent, spectacular, wonderful, striking, and elegant are the best words to describe the plants in the family Nepenthaceae. Their odd appearance and diverse morphological characteristics had fascinated billions of people in the world, including plant enthusiast, horticulturists and of course, the botanist, to find, collect, study, cultivate, and even legally sell or buy these plants.

Nepenthaceae is a monotypic family in the order Caryophylalles, which consists of only one genus named *Nepenthes.* The romantic name *Nepenthes* was given and cited in Hortus Cliffortianus (1737) by Carl Linnaeus, a famous Swedish botanist who was the first to name the pitcher plant according to the standard binomial nomenclature system. *Nepenthes* was a Greek word that referred to a scene in Homer's Odyssey in which Helen threw the drug 'Nepenthe,' a medicinal herb used to help her guests forget their sorrows and pain. Linnaeus was

very interested in and amazed by the tropical pitcher plants, but surprisingly, he did not believe in the carnivorous syndrome of the plants and thought that the digestive fluid inside the pitcher is just rainwater.

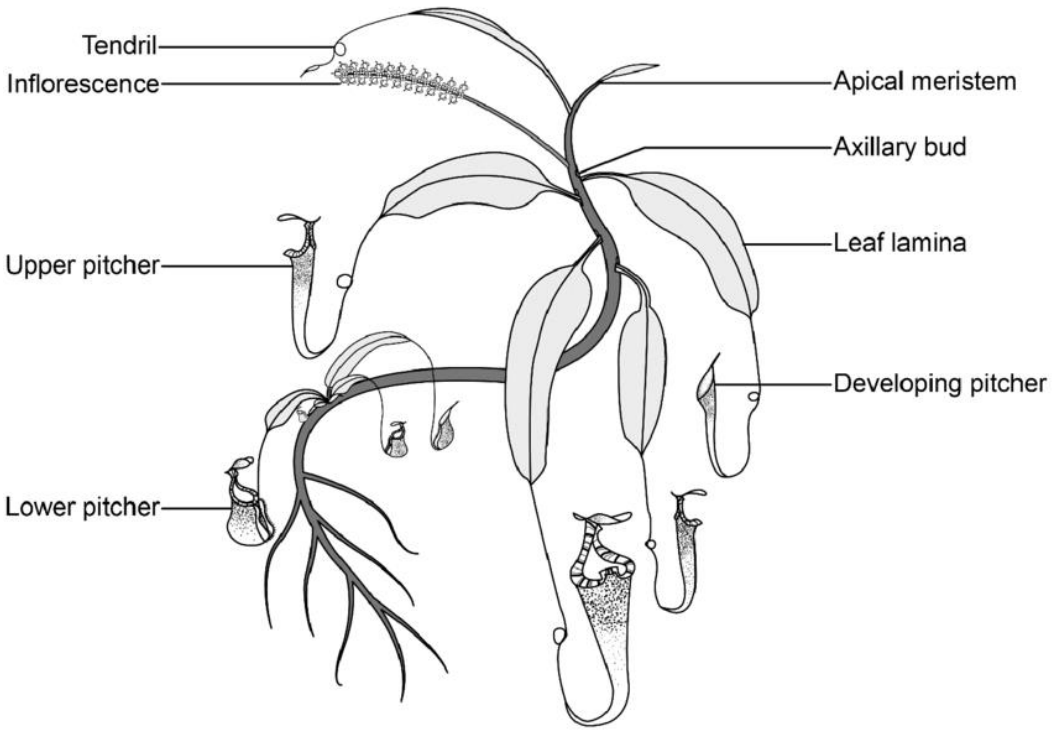
Despite this, the early history of *Nepenthes* dates back to 1658, a long time ago. This year, Etienne de Flacourt, a Governor of the then French Colony of Madagascar, found and described the very first *Nepenthes* species in the genus from Madagascar, called *Anramitaco*, a local name. His descriptions were not complete, as Falcourt was not a botanist, and he did not realize the leafy nature of the pitchers at that time. However, this species was described completely and given the name *N. madagascariensis* by Poiret in 1797, following the Linnaean binomial system.

The second species that was described and recorded is from Sri Lanka; *Nepenthes distillatoria.* This species was the first species formally described by Linnaeus after he established the name *Nepenthes* in 1737. Also known as the Sinhalese pitcher plant, this species was known by several names before, such as *Miranda herba* (1677), which meant Marvellous Herb by Thomas Bartholin, *Bandura zingalensium* (1680) by Dutch Merchant Jcob Breyn and *Planta Mirabilis distillatoria* (1683), which meant Miraculous Distilling Plant by Swedish Doctor Grimm. Meanwhile, the third *Nepenthes* species described is *Nepenthes mirabilis* from the Indonesian islands, which was initially known as *Cantherifera, which* means tankard bearer and was described by Georg Everhard Rumph around 1747. In the year 1790, Father Joalo Loureiro, a Portuguese priest, discovered a plant in Veitnam that resembled Rumphius' Cantherifera and named it *Phyllamphora*

mirabilis. However, both of these plants, by Rumphius and Loureiro, were finally treated as synonyms of *N. mirabilis.*

The genus *Nepenthes* is mostly found un the Malay Archipelago, with Borneo, Sumatra, and the Philippines being the most diverse. So far, about 160–180 *Nepenthes species* have been discovered worldwide. The exact number of *Nepenthes* species is difficult to know as the number is rapidly increasing with many new species being discovered and described each year. Borneo Island has the highest number of *Nepenthes* species with Sarawak (34 spp.), Sabah (28 spp.) and Sumatra (?).

Genus *Nepenthes* was famously known for their high dimorphism, or heterophylly, which produced lower and upper pitchers that are distinct in their morphology. The pitcher plant entices its prey, primarily insects, by producing nectar glands at the mouth and peristome area to lure the prey into the trap. The pitcher contains digestive fluid that can absorb nutrients from the prey once they fall into the pitcher and drown in the liquid.


Tendril
Inflorescence
Apical meristem
Axillary bud
Leaf lamina
Upper pitcher
Developing pitcher
Lower pitcher


THE SPECIES

***DROSERA BURMANNII* VAHL**

Synonym*: D. burmanni* var. *dietrichiana* Diels*; D. dietrichiana* Rchb.f.*; D. indica var. dietrichiana* (Rchb.f.) Diels

Vernacular name: The tropical sundew

Taxonomic History: Paul Hermann wrote the first concise description of the species, which William Sherard published in the *Museum Zeylanicum* after Hermann's death. Johannes Burman provided a more thorough description of it in his work 1737 on the flora of Ceylon. Burman used the polynomial "*Ros solis foliis circa radicem in orbem dispositi*" but the species was not formally published. In 1794, Martin Vahl published and named it in honour of Burman as *Drosera burmanni* (the species epithet is usually orthographically corrected to *burmannii*). In 1871, new species was described by Heinrich Gustav Reichenbach which was *D. dietrichiana*. This species was named after its discoverer Amalie Dietrich. Ludwig Diels considered this species to be a subspecies of *D. burmannii* in his 1906 monograph on the Droseraceae. The variety and *D. dietrichiana* are now regarded as synonyms of *D. burmannii*.

Habitat: This species is a terrestrial insectivorous herb. Usually can be found in grassland and wetlands (inland) on open humid, sandy soil. In Sarawak, this species can be found in Mount Serapi, Kuching in open areas with direct sunlight at the elevation of 911 m.

General Description: This plant has no visible stem (acaulescent) and is unbranched. The leaves that formed are usually flat and in the form of a rosette, subsessile or petiolate, sometimes the petiole is short or absent; the leaves are usually yellow-green or red to reddish violet; usually, the ones found in Kubah NP are reddish violet; shape cuneate, the adaxial have glandular trichomes, apex fimbriate. Inflorescence raceme 1 or 2, the glands are usually white or red to reddish violet glands, *ca*. 2-6 flowered; petals usually 5, white to light red to reddish obovate.

Distribution: Australia (Western Australia, Queensland, Northern Territory); Bangladesh; Bhutan; Cambodia; China; India; Indonesia (Sulawesi, Bali, Sumatera); Japan; Myanmar; Philippines; Sri Lanka; Taiwan, Province of China (Taiwan, Province of China (main island)); Vietnam. In Sarawak, this species can be found in Kubah NP.

Status: *Drosera burmannii* has most recently been evaluated for the IUCN Red list of threatened species in 2010. Currently, it is listed as Least Concern (LC).

Uses: In Ayurveda, *D. burmanni* has been regarded as a potent rubefacient. Ayurveda is an alternative medicine system with historical roots in the Indian subcontinent. This natural system of medicine has been originated in India more than 3,000 years ago. This idea is not

based on science but in India and Nepal, 80% of the population reports using it and widely being practised

Notes: This species is popular among carnivorous enthusiasts.

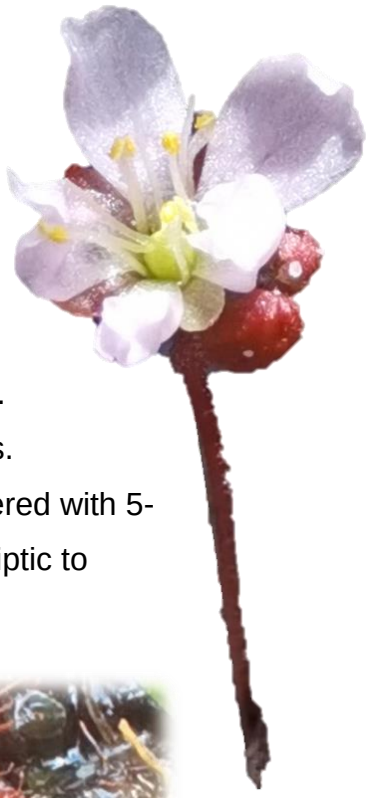
DROSERA SPATULATA VAR. BAKOENSIS
A. FLEISCHM. & CHI.C.LEE

Synonym: *D. spatulata* Labill.

Vernacular name: The vernacular name for this species is the spoon-leaved sundew but this variety can only be found in Bako NP (endemic).

Taxonomic History: *Drosera spatulata* comes from the Latin term “spatula shaped” and refers to the shaped of the leaves in the specific epithet. Jacques-Julien Labillardière identified *D. spatulata* in 1804 in his book Novae Hollandiae Plantarum specimen from a plant taken in 1793 by the d'Entrecasteaux expedition near Southport, Tasmania. *D. spatulata* var. *bakoensis* was identified and described in 2009 from Bako National Park in Sarawak.

Habitat: *Drosera spatulata* var. *bakoensis* is widespread on the Bako Plateau in the Bako National Park. It grows in open sheath areas in pure white quartz sand, occasionally mixed with clay, but is never found in organic soils. This sundew is only found where it is consistently very wet, next to small creeks or seepages on the embankment



General description: This plant has no visible stem (acaulescent) and is unbranched. The leaves are rosette, petiolate, shape spatulate in outline and have 3-nerved. The adaxial is covered with carnivorous glands while the marginal gland extends. abaxial covered with translucent short-stalked glands. Inflorescence 1-2, 1-sided racemes, scape, 1-2 flowered with 5-6 petals. petals 5-6, translucent white to soft pink, elliptic to narrowly obovate, apex rounded.

Distribution: This species is endemic to Bako National Park specifically on the Lintang trail. This species was only found within the area of Bako sandstone plateau

Status: No data on the IUCN Red list

Uses: *Drosera bakoensis* plant extracts have been utilized for treating respiratory illnesses such as whooping cough, bronchitis, asthma and pulmonary ailments since ancient times

Notes: Although Gunung Santubong is competent in the same formation as Bako, the adjoining is steeper and devoid of a plateau, making it an unsuitable habitat for *Drosera*.

NEPENTHES ALBOMARGINATA T. LOBB *EX* LINDL.

Synonym names:

N. albocincta Hort. *ex* Macfarl

N. albocincta var. *rubra* Hort. *ex* Macfarl

N. albomarginata var. *rubra* Macfarl

N. albomarginata var. *typica* Beck

N. albomarginata var. *villosa* Hook *f.*

N. laevis C. Morren

N. tomentella Miq.

Vernacular name: White-collared pitcher plant.

Taxonomy History: This species was first collected by a British botanist and a plant collector from nursery firm Messrs Veitch & Sons of Exeter, Thomas Lobb in 1848, but then was formally described by John Lindley a year later in 1849. The epithet name *albomarginata* is derived from two Latin words: *albus* = white and *marginatus* = margin which refers to the white band. This species also was named once as a white-collared pitcher plant and mentioned by Jebb and Cheek (1996).

Descriptions: This species ***is*** easily distinguished from others by its velvety white band that is noticeably present on the pitcher body underneath the peristome. The band is made up of short stellate trichomes. This species develops two types of pitcher which are the lower pitcher plant and the upper pitcher plant. The upper pitcher usually stifles and hangs onto the other plants to support them. The pitcher formed a cylindrical and slender shape with a height of up to 15 cm with colours from lime green, and yellowish green to dark purple. The leaves are coriaceous (leathery texture), lanceolate shape, slender and sessile at the base and they can develop up to 25 cm long.

Distribution: Native to Peninsular Malaysia, Borneo, and Sumatra. *Nepenthes albomarginata* recorded from lowland *Kerangas* forest, peat swamp forest, exposed-ridge tops or limestone, sand stone, and occasionally at mossy forests. This species considered as lowland species because it can be found at the altitudinal range between 50 m to 1000 m elevations.

Notes: *S*ometimes can be confused with *N. gracilis* by its cylindrical and slightly slender pitchers, but readily distinguished by its white band under the peristome.

NEPENTHES AMPULLARIA JACK

Synonym:

N. ampullacea H. Low

N. ampullacea H. Low *ex* W.H.Baxter

N. ampullaria f. vittata Hort. *ex* Beck

N. ampullaria var. *geelvinkiana* Becc.

N. ampullaria var. *guttata* Moore

N. ampullaria var. *longicarpa* Becc.

N. ampullaria var. *microsepala* Macfarl.

N. ampullaria var. *racemosa* J.H. Adam & Wilcock

N. ampullaria var. *vittata* André

N. ampullaria var. *vittata major* Mast.

Vernacular names: Flask-shaped pitcher plant.

Taxonomy History: This species was described by a Scottish botanist and a medical practitioner named William Jack in 1835. The epithet name "*ampullaria"* is a Latin word, that means flask, referring to the shape of the pitcher.

Descriptions: *Nepenthes ampullaria* develop an urceolate (urn-shape) pitcher 'that comes in a variety of colours and sometimes blotches with red to dark-purple colours. The peristome and the mouth are wider with smaller lid sizes that

reflexed away from the mouth. Two fringe wings are present on the front of the pitcher's body.

Distribution: This species is one of the most common species in Borneo and often thrives in a shady and damp forest.

Notes: Most plants produce lower pitcher plants with rosette leaves. Most of the upper pitcher plants do not produce pitcher. Collect leaf litter.

***NEPENTHES BICALCRATA* HOOK. F.**

Synonym: *N. dyak* S. Moore

Vernacular names: Fanged pitcher-plant, Periuk kera, Entuyut

Taxonomy History: Described by Joseph Dalton Hooker in 1873 (Monograph: Nepenthaceae) based on specimens collected by Hugh Low and Odoardo Beccari near the Lawas River.

Descriptions: Climbing species to over 10 m in the forest with the support of huge vines that can reach up to 4 cm thick. The pitchers can be found in bulbous shape for lower pitcher plants and smaller size in

upper pitcher plants with funnel-shaped in the bottom half. There are two fangs or sharp spines protruding at the neck of the peristome under the lid. Those two fangs produce a profuse amount of nectar fed upon by insects.

Distribution: Endemic to Borneo. This can be found grow in peat swamp forest, edge of *Kerangas* forest

Notes: *Nepenthes bicalcarata* is classified as a Vulnerable (VU) species according to the IUCN Red List.


HoB Carnivorous Plants: 26

***NEPENTHES CHANIANA* C. CLARKE, CHI. C. LEE & S. McPHERSON**

Taxonomy history: *Nepenthes chaniana* was named to give honour to the Malaysia amateur naturalist, Datuk Chan Chew Lun who has extensively worked on promoting the biodiversity of Borneo through his works and publications. This species was previously misidentified as *N. pillosa.* However, after a thorough observation and morphological review were done intensively, this species was formally described and published by Charles Clarke, Chien C. Lee, and Stewart McPherson as *Nepenthes chaniana* in the year 2006.

Descriptions: A terrestrial or epiphytic climber that can reach up to 8 m high. Leaves thickly coriaceous and petiolate with wings. The leaves

can be observed in a heart-shape spathulate with the presence of hairs on the lower surface, while the upper surface is glabrous. Lower pitchers are narrowly cylindrical with a tendril laterally in a narrow arc while upper pitchers are as lower pitchers but elongated and taller than the lower. There is a prominent hook-shaped appendage presence on the lower surface of the lids. The colour of pitchers is usually light green, yellow-green or golden yellow.

Habitat and Distribution: Grow in mossy forest or sandstone in the montane habitat of northern Sarawak and Sabah. A highland species that grow in an altitude range between 1100 – 1800 m.

Notes: *Nepenthes chaniana* is closely related to two other species which are *N. pillosa* and *N. glandulifera.* Also, so far no lower pitcher plant from the wild has been recorded.

NEPENTHES FAIZALIANA H.J. ADAM & WILCOCK

Vernacular name: Periuk kera

Taxonomic History: This species was described by Jumaat Haji Adam and Wilcock in 1991 based on specimens collected by Julaihi Lai and Jugah on Batu Panjang in Mulu National Park. The epithet name was given after Muhammad Khairul Faizal, the son of Jumaat Haji Adam. This species is closed related to *N. boschiana,* and also been reduced to synonym of *N. stenophylla* by Jebb and Cheek (1997) and Philipps and Lamb (1996).

Descriptions: A terrestrial shrub or climber that can reach up to 4 m tall in its habitat. Lower pitcher sub-cylindrical, ellipsoid shape at the lower half, and there is presence of fringed wings. Lower pitchers are uncommon as they are less produced. It is slightly different from the upper pitchers that can be observed in narrow infundibuliform and lacking in fringed wings. The pitchers have colour range from pale green or yellowish white speckles with deep red or dark purple.

Photo: Mulu National Park – home of Nepenthes faizaliana

Habitat and Distribution: The species is considered as a typical calcareous (calcicolous) species, which occur only on the limestone habitat, at altitude of 400 to 1600 m above sea level. The species occurs both as terrestrial and as an epiphyte on limestone exposed ridge tops. Endemic to limestone in Mount Mulu National Park and nearby areas. Commonly encountered at the famous Pinnacle Trail of Mount Mulu National Park. Endemic to Borneo (Sarawak – Mulu National Park)

Notes: *Nepenthes faizaliana* looks similar with the *N. stenophylla,* however it can be differentiated by its pronounced swollen base of pitcher, wider and colourful peristome as well as single borne flower on each pedicel.

NEPENTHES FUSCA DANSER

Synonym:

N. curtisii ssp. *zakriana* J.H. Adam & Wilcock

N. fusca ssp. *kostermansiana* J.H. Adam & Wilcock *ex* Jebb & Cheek

N. zakriana (J.H. Adam & Wilcock) J.H. Adam & Hafiza

Vernacular Name: The Dusky Pitcher Plant

Taxonomy History: *Nepenthes fusca* was formally described and published by Benedictus Hubertus Danser in his revision of the genus *Nepenthes,* The Nepenthaceae of the Netherlands Indies, 1928. The first collection of this species was made by a Dutch botanist, Frederick Endert during his expedition in the year 1927 to central Borneo organized by the Forest Research Institute of Bogor. The type specimen of *N. fusca* is deposited in the Herbarium Bogoriensis (BO) AT Bogor Botanical Garden. The specific epithet name *fusca* originated from a Latin word, *fuscus*, dark brown or dusky.

Descriptions: An epiphytic or shrub or terrestrial climber species. The pitcher is cylindrical (a lower pitcher) with two fringed wings and narrowly funnel-shaped or broadly infundibuliform and smaller (an upper pitcher). Both forms have a lid that is triangular-lanceolate in shape with nectar glands scattered or sometimes absent on the lower surface of leaves. Peristome cylindrical to flattened with inconspicuous and lack of teeth at the inner edge. The colour of the lower pitcher is purplish dark or dark red or black that slightly blotches with cream colour, meanwhile upper pitcher is yellow to orange, or pale green spotted with few red spots.

Peristome usually has yellow to light green colours striped with dark-purplish.

Habitat and Distribution: A highland species that grows in an altitude between 800 – 1500 m, sometimes can reach up to 2500 m elevations in a shady montane forest, and on the ridgetops. This species is endemic to Borneo and distributed widely across Sabah, Sarawak, Brunei and Sumatera.

Notes: Closely similar with *N. faizaliana, N. pilosa, N. stenophylla, N. veitchii* and *N. vogelii.* Even so, it can be distinguished by the characteristic of the lid which is sickle or triangular with an involute margin.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***NEPENTHES GRACILIS* KORTH.**

Synonym:

N. angustifolia Mast.

N. gracilis var. *arenaria* Ridl. *ex* Macfarl.

N. gracilis var. *elongata* Blume

N. gracilis var. *longinodis* Beck

N. gracilis var. *teysmanniana* (Miq.) Beck

N. korthalsiana Miq.

N. laevis Korth. *ex* Hook. *f.*

N. laevis Lindl.

N. teysmanniana Miq.

N. tupmanniana Bonstedt

Vernacular names: Slender pitcher plant

Taxonomy History: *Nepenthes gracilis* was formally described in 1839 by Pieter Williams Korthal, an official Dutch botanist under the Dutch East India Service. This species was included in his work, a monograph entitled 'Over het geslacht *Nepenthes'.* The epithet name, *gracilis* is derived from the Latin word that means thin and slender which refers to the shape of leaves and the pitcher body.

Descriptions: Commonly found scrambling horizontally on the ground, climbing up to 5 m and hanging onto the other plants. The leaves are shiny green, chartaceous (papery) and sessile at the base. The pitchers are developed with a pair of fringe wings, small in size, cylindrical shape with slightly constricted or slender at the middle, and can be observed in various colours from light green and often, dark purple. The peristome is cylindrical in section, small in width with its inner edge minutely toothed. The lid is narrowly ovate with few nectar glands scattered on the lower surface.

Habitat and Distribution: A common lowland species that grows in *Kerangas* forest, damp peat forest, roadsides, and disturbed forested areas. Usually, this species co-occurs with other *Nepenthes species* such as *N. ampulalria, N. mirabilis, N, rafflesiana* and occasionally with *N. bicalcarata* and *N. albomarginata. Nepenthes gracilis* is widespread and has been recorded in Peninsular Malaysia, Borneo, Sumatra, Singapore, Thailand and Sulawesi.

Notes: *N. gracilis* almost similar to *N. albomarginata* and *N. reindwardtiana,* but can be distinguished by its slender shape and lack

of white band under the peristome and eye spots on the interior surface of the pitcher.

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***NEPENTHES HIRSUTA* HOOK. F.**

Synonym:

N. hirsuta var. *glabrata* Macfarl.

N. hirsuta var. *typica* Macfarl.

N. leptochila Danser

Vernacular names: Hairy-Pitcher Plant, Trambuo (Bidayuh)

Taxonomy History: This species was described by Sir Joseph Dalton Hook in the year 1873. The epithet name *hirsuta* is derived from a Latin word, *hirsutes* means hairy or bristly.

Descriptions: Climber, with woody stems and indumentum stems. The leaves are coriaceous, lanceolate in shape for lower pitchers and narrowly ovate for upper pitchers. Brown hairs or indumentum are densely present on the lower surface of leaves and tendrils. The lower pitcher can be observed as an ovoid or ellipsoid shape while upper pitchers are in cylindrical, or ovoid–cylindrical or infundibuliform cylindrical. A pair of fringe wings are present on both forms of pitchers. Peristome cylindrical to slightly flattened with minute teeth on the inner edge. The mouth of the pitcher ovate in shape and slanted obliquely towards the lid throughout. The lid is usually ovate or ovate-oblong in shape. The colour of pitchers is commonly visible in light green colour spotted with red to purple or sometimes in red colour.

Habitat and Distribution: Grows in a shady area of *Kerangas* and hill-top forest and also often can be found in sandstone in an altitudinal range of sea level to 1100 m. *Nepenthes hirsuta* is endemic to Borneo.

***NEPENTHES HISPIDA* BECK.**

Vernacular names: Hairy-bristles pitcher plant

Taxonomy History: The epithet name *hispida* (Latin: *hispidus* “bristly”) was given by an Austrian botanist, Sir Günther Ritter Beck von Mannagetta und Lerchenau in the year 1895. This species was closely related to two other *Nepenthes* species which are *N. hirsuta* and *N. macrovulgaris.* In 1928, Benedict Hubertus Danser reduced *N. hispida* as a synonym of *N. hirsuta* in his monograph entitled “*The Nepenthaceae of the Netherland Indies*”, and supported by Jan Schaleur, who considered this species as a heterotypic synonym of *N. hirsuta.* However, the *N. hispida* has been restored to species status by Matthew Jebb and Martin Cheek in 1997.

Descriptions: The pitchers are mostly similar to those upper pitchers in *N. hirsuta*, however, they can be distinguished by the characteristics of the leaves which is amplexicaul-decurrent leaf based and also the presence of dense purplish indumentum on purplish grey stems. The morphological characteristics of pitchers between these two species are somewhat confusing and it is sometimes not useful to differentiate the species.

Distribution: An endemic to Borneo. Generally, grows in the kerangas forest at a lowland altitude between 100 – 800 m elevations.

***NEPENTHES LOWII* HOOK. F.**

Vernacular names: Low's pitcher plant, the Toilet Pitcher Plant.

Taxonomy History: *Nepenthes lowii* was discovered and collected by Sir Hugh low, a British colonial administrator and naturalist in his first

expedition to Mount Kinabalu, Sabah in the year 1851. The type specimen is deposited in the herbarium of the Royal Botanic Gardens, Kew (K). In later several years, this species was discovered and recorded from Bukit Batu Lawi and Mount Murud in Sarawak, Borneo.

Descriptions: Grows as an epiphyte or climbs over 10 m tall. The pitchers can be observed in two forms which are lower pitcher plant and upper pitcher plant. Generally, the pitcher can be visible as gourd-shaped for the upper pitcher plant, meanwhile sub-cylindrical shaped in the lower pitcher plant. The upper pitcher plant has a thick wall of pitcher or sub-woody in texture and is often visible in green colour at the outer surface of the pitcher's body and red mahogany on the inner surface of the pitcher. The colour of the lower pitcher is usually brownish-red at the inner and outer surfaces of the pitcher. The lid is smaller than the mouth of the pitcher The lower surface of the lid has dense longer and slender bristles or hair-like structures that secrete white resin and contains white sugar substances to attract small birds and mammals.

Distributions: Endemic to Borneo. Specifically, on isolated peaks of Borneo (Mount Kinabalu, Mount Tambuyukon, Mount Alab, Mount Trusmadi, Hose Mountain, Batu Lawi, Mount Murud, Mount Mulu, Bario and Tama Abu Range, Bukit Pagon and Mount Kemul).

Notes: This species is perhaps the most uncommon in the genus, being characterized by its strongly constricted upper pitcher, which bears a reduced peristome and a reflexed lid with numerous bristles on its lower surface.

NEPENTHES MIRABILIS (LOUR.) DRUCE

Synonym:

N. albolineata F.M.Bailey
N. alicae F.M.Bailey
N. armbrustae F.M.Bailey
N. bernaysii F.M.Bailey
N. cholmondeleyi F.M.Bailey
N. fimbriata Bl.
N. fimbriata var. *leptostachya* Bl.
N. garrawayae F.M.Bailey
N. jardinei F.M.Bailey
N. kennedyana F.Muell.
N. macrostachya Bl.
N. moluccensis Oken
N. moorei F.M.Bailey
N. obrieniana Linden & Rodigas
N. pascoensis F.M.Bailey
N. phyllamphora Willd.
N. phyllamphora var. *macrantha* Hook.*f.*
N. phyllamphora var. *pediculata* Lecomte
N. phyllamphora var. platyphylla Bl.
N. tubulosa Macfarl.
Phyllamphora mirabilis Lour.

Vernacular names: Common-swamp pitcher plant, tropical pitcher plant

Taxonomic History: Formally described by a Portuguese botanist, João de Loureiro in the year 1869. The given name *mirabilis* means wonderful.

Descriptions: The leaves of *Nepenthes mirabilis* are thinly chartaceous (papery) with a fimbriate margin and it is petiolate at the base. The leaves are commonly seen in light green colour but sometimes can be visible in red colour when grown in

highly exposed sunlight areas. The midrib at the upper surface of the leave usually can be spotted with red-pink colours. The pitcher. The pitchers generally can be visible in sub-cylindrical shape, slightly laterally flattened, ovoid shape in the lower half (a lower pitcher), slightly infundibuliform (an upper pitcher) with a 'hipped' point at the middle. The colours of pitches commonly can be found in green or green suffused with red colours.

Habitat and Distribution: Occur abundantly in a swampy forest, *Kerangas* forest, forest margin, and disturbed areas such as roadsides with an altitudinal range up to 200 m, but sometimes can occur up to 1000 m and rarely on 1500 m a.s.l. *Nepenthes mirabilis* is the most widespread species in the genus *Nepenthes* with its distribution recorded throughout the Malesia regions which included Borneo, and Sumatra. Thailand, Sulawesi, Maluku, New Guinea, and the Philippines, except a few places such as eastern Nusa Tenggara (East Java, Bali to Lombok) in Indonesia, and northern Philippines (Luzon and Palawan). Also, distributed widely from Indochina to Micronesia (Palau) and Australia.

Notes: Categorized as Least Concern (LC) species as it is the most widespread species in the world.


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***NEPENTHES MIRABILIS VAR. ECHINOSTOMA* J.H. ADAM & WILCOCK**

Synonym: *N. echinostoma* Hook. *f.*

Taxonomy History: This variety was initially described as *N. echinostoma* by Joseph Dalton Hooker in 1873 after its discovery by other botanists, Beccari a decade before. Adam and Wilcock reduced it to a variety of *N. mirabilis.*

Descriptions: Most of the characteristics of the plant are similar to the *Nepenthes mirabilis.* The difference can be seen in its unique peristome with wide spiny or long peristome teeth that are developing from the inner side.

Distributions: Most of the population is distributed and exists in part of Sarawak and Brunei, Borneo.

Notes: A botanist traveller described and mentioned the peculiar characteristics of the peristome of *N. mirabilis* var. *echinostoma* remind him of the deflexed teeth of some gigantic moss from the Hypnoid section.

***NEPENTHES MOLLIS* DANSER**

Taxonomy history: This *Nepenthes* species recognized and described by Benedict Hubertus Danser in his publish “The Nepenthaceae” in

Netherland Indies 1928. This species was initially discovered and collected by a Dutch botanist named, Frederick Endert during a botanical expedition with the Forest Research Institute of Bogor at Kemul Massif, Kalimantan in 1900. *Nepenthes mollis* was among the 65 Nepenthes species discovered in Kemul Massif, North Central Kalimantan. But, during the collection, the pitchers of this species were unknown. Neither upper nor lower pitchers were discovered. Fortunately, complete parts of the plant of *N. mollis* with its pitchers were rediscovered in an expedition led by Stewart McPherson in 2008. A revised taxonomy of *Nepenthes mollis* and its full morphology descriptions were described and published by Robinson et al (2019).

Descriptions: A terrestrial climbing plant but initially an epiphyte with leathery leaves that are sessile at the base and observed in oblanceolate or oblanceolate-spathulate in shape. Lower pitchers are sub-cylindrical with a pair of fringe wings and intermediate pitchers are slightly different which is sub-cylindrical to slightly infundibuliform with two fringed wings soon the upper half of the pitcher's body. The lid is smaller than the mouth in a ovate (lower pitcher) or triangular-ovate in shape (an intermediate pitcher). The colour of pitchers is visible in green

to yellowish green speckled with deep red to purple. Brown hairs or indumentum densely covered on both surface of leaves.

Habitat and distribution: Occurs in humus or mossy banks, a high montane forest at 1840 – 2054 m a.s.l. The species has been recorded from Kemul Massif (Outside the North-central of Kalimantan), Brunei, southwestern Sabah, and northeastern Sarawak.

Notes: *Nepenthes mollis* has been recognised as *N. hurreliana* because of their similar morphological characteristics. But, after thorough observation and taxonomy revision, the difference between *N. mollis* and *N. hurreliana* are identified by the decency of the leaves base, and the bracts of pedicels of male inflorescence.

***NEPENTHES MURUDENSIS* CULHAM *EX* JEBB & CHEEK**

Synonym: *N. murudensis* Culham *ex* Phillipps & A.L. Lamb

Taxonomy history: *Nepenthes murudensis* was first collected in 1982 based on the information of holotype specimen deposited in the herbarium of the Royal Botanic Garden, Kew. However, the epithet name *murudensis* which refers to the origin place of the species was informally given by Alastair Culham in 1994 in the preparation of its manuscript. Despite that, the species was finally fully described and published by Matthew Jebb and Martin Cheek in their 1997 monograph entitled A Skeletal Revision of *Nepenthes*.

Descriptions: A terrestrial climber that can reach up to 3 m tall with a slightly flexuous, thin and angular stem. Leaves thinly coriaceous, sessile at the base, clasping the stem, glabrous and shiny green, sometimes purplish. The pitchers are glabrous and large with a pair of narrow fringed wings that are present in the lower pitcher while absent in the upper pitcher. Lower pitcher broadly ovate in the lower half, gradually constricted at the middle, cylindrical at the upper half with a slight expansion beneath the mouth area. Upper pitchers are more elongated than lower pitchers, sub-cylindrical, ellipsoid or swollen at the base. The lid lack of filiform appendages on the upper surface but is densely packed with large glands along the midrib. The colours of pitchers are uniformly green colour or green suffused sparsely with inconspicuous red to dark purple, the peristome usually pale yellow-green or purplish, sometimes striped with slightly dark purple.

Habitat and Distribution: Occurs in stunted shrubby vegetation in montane scrub on sandstone ridges or moss forest at an altitude range between 1750-2400 m. *Nepenthes murudensis* is endemic to Borneo and has been recorded to grow in Mount Murud, Mount Mulu, Batu lawi, and Tama Abu Range.

Notes: The upper pitcher plant of *Nepenthes murudensis* was misidentified with *N. tentaculata* as the similarity of its morphological characteristics between these two species is somewhat confusing.


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NEPENTHES RAFFLESIANA JACK

Synonym name:

N. hookeriana H.Low ex Becc.

N. rafflesiana var. *alata* J.H.Adam & Wilcock

N. rafflesiana var. *ambigua* Beck

N. rafflesiana var. *glaberrima* Hook. *f.*

N. rafflesiana var. *insignis* Mast.

N. rafflesiana var. *minor* Becc.

N. rafflesiana var. *nigro-purpurea* Mast.

N. rafflesiana var. *nivea* Hook. *f.*

N. rafflesiana var. *typica* Beck

N. raflesea Hort.

N. sanderiana Burb.

Vernacular name: Raffles's pitcher plant

Taxonomy History: Dr William Jack discovered the largest known species in the genus, *N. rafflesiana* in 1819. The discovery of this species has been formally described in 1835 and was given the epithet name *rafflesiana* in honour of Sir Stamford Raffles, a British statesman who served as Lieutenant-governor in Singapore.

Descriptions: This species is a terrestrial climber that can reach up to 6 m tall. The leaves are large and long up to 30 cm, chartaceous and petiolate. The pitchers are varied in shape, size and colours. Lower pitchers are large, usually squat on the ground with a broadly ovate shape in the basal part of the pitcher and gradually narrower in the upper

part. Broad fringe wings are presence. Upper pitchers are funnel-shaped, longer than the lower pitchers with its peristome distinctly raised at the front. The peristome of both pitchers elongated at the back forming a neck. The large lids are in ovate size in both forms with numerous glands on the lower surface. The colour of lower pitchers is usually pale green or white strongly mottled with dark purple or red, while upper pitchers, have pale green blotches or are suffused with red or purple.

Habitat and Distribution: A lowland species that occur in *Kerangas* forest peat swamp forest, disturbed areas such as roadsides embankments. This species can be found in shady or sun-exposed areas at below 1000 m altitude a.s.l. *Nepenthes rafflesiana* is widely distributed in Peninsular Malaysia, Borneo, Sumatra, and Singapore.

Notes: *Nepenthes rafflesiana* has high dimorphism and the morphological characteristics of the lower pitcher and upper pitcher plants are very distinct. Moreover, this species was identified as the most collected *Nepenthes* species in western Sarawak.




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***NEPENTHES REINWARDTIANA* MIQ.**

Synonym name:

N. naquiyuddinii J.H. Adam & Hafiza

N. reinwardtiana var. *samarindaiensis* J.H. Adam & Wilcock

N. reinwardtii Hook. f.

Vernacular names: Reinwadt's pitcher plant.

Taxonomy History: The epithet name *reinwardtiana* was given to honour a Prussian botanist named, Caspar Georg Carl Reinwardt. This species was described by Friedrich Anton Wilhelm Miquel in 1852.

Descriptions: An epiphytic or climbing species to over 10 m and usually grows in the sun-exposed area on the tree branches. The narrow and slender leaves are lack petioles and sometimes sessile at the base with a triangular stem. The pitchers can be distinguished by the presence of two-eyed spots (absence of wax coating) on the interior surface of the pitcher. The pitchers are subcylindrical at the upper half, slightly constricted at the middle, and swollen at the base but slightly ventricose for the upper pitcher. The colour of the pitcher is often glaucous on the inner side and light green on the outer or sometimes slightly green suffused or spotted with a reddish-brown colour.

Habitat and Distribution: A lowland and highland species that can grow from sea level to over 1600 m in lowland forest, steep rocky cliffs, sometimes near the ocean and disturbed sites such as road banks. This species is distributed in Borneo and Sumatra.

Notes: Closely related to *N. gracilis, N. macrovulgaris* and *N. reinwardtiana.* These species can be differentiated by the presence of eye spots in *N. reinwardtiana* and other characteristics in peristomes and flowers.

***NEPENTHES STENOPHYLLA* MAST.**

Synonym:

N. boschiana var. *lowii* Hook. *f.*

N. fallax Beck

N. fusca ssp. *apoensis* J.H. Adam & Wilcock *ex* Jebb & Cheek

N. maxima var. *lowii* (Hook. *f.*) Becc.

N. sandakanensis J.H. Adam & Wilcock

N. sandakanensis var. *eglandulosa* J.H. Adam & Wilcock

N. sandakanensis var. *ferruginea* J.H. Adam & Wilcock

Vernacular name: The narrowed-leaves pitcher plant

Taxonomy History: The specific epithet name *stenophylla* was derived from two Greek words, *stenos* (narrow) and *phyllon* (leaf) referring to the leaves character of the species. This name was given by Maxwell Tylden Masters in his publication in 1890. The first collection of this species in Borneo was made by Charles Curtis in 1883.

Descriptions: A terrestrial climber to 10 m tall. The leaves are petiolate and hairy along the margin of the lower surface. The lower pitchers are cylindrical and slightly waisted and narrowing from the base with two fringed wings and the upper pitchers are slightly distinct in funnel-shaped with two ridges which lack fringed wings. The pitchers can be seen visible in yellow to light green colour, sometimes slightly or densely blotches with dark purple or black, peristome in pale yellow or red striped with red colours.

Habitat and Distribution: A common highland species that grows above 1000 m altitudes in open sub-montane and montane cloud forests, usually on the ridge top, steep rocky areas among shrubs or sometimes in kerangas forest. This species is endemic to Borneo.

Notes: *N. stenophylla* was misidentified with a latter species, *N. fallax* as they have similar morphological characteristics in most parts of the plant. There are many arguments between botanists and difficult to conclude whether to consider these two species as separate species or belong to the same species. *Nepenthes fallax* was treated as a heterotypic synonym of *N. stenophylla,* however, many taxonomists prefer that these species be reinstated back to its own.

***NEPENTHES TENTACULATA* HOOK. F.**

Synonym name:

N. tentaculata var. imberbis Becc.

N. tentaculata var. tomentosa Macfarl.

Vernacular name: Fringed pitcher plant

Descriptions: A botanical description of *Nepenthes tentaculata* was provided by Sir Joseph Dalton Hooker in 1873 based on a type specimen collected by Thomass Lobb in the year 1853.

Taxonomy History: *Nepenthes tentaculata* was formally described by a botanist, Josep Dalton Hooker in 1873 after 20 years of its collection by Thomas Lobb. The name *tentaculata* was originated from the Latin word, "*tentacula",* meaning tentacles which refers to the tentacle-like bristles that presence on the upper surface of leaves.

Descriptions: The pitchers are small and delicate, usually growing up to 15 cm in length, with the presence of fringed wings at the frontal pitcher of both forms. The lower pitcher ovoid or broadly sub-cylindrical, meanwhile, the upper pitcher is cylindrical or narrowly ovoid at the base part of the pitcher. The upper surface of the lids bears the tentacles which are thick multicellular simple hairs. The colour of pitchers usually

can be seen in brownish or dusky purple, sometimes freckled with dark purple or lime green suffused with purple colour.

Habitat and Distributions: A most widespread highland *Nepenthes* species that occurs in a mossy forest on mountain summits and ridges. Distributed in Borneo and Sulawesi.

Notes: A close related species to *N. muluensis* as the species has slightly similar bristles on the upper surface of the lid.


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NEPENTHES VEITCHII HOOK. F.

Synonym name:

N. lanata Hort. *ex* Linden

N. lanata Hort. *ex* Mast.

N. lanata Mast.

N. veitchii var. *striata* Veitch

Vernacular name: Veitch's pitcher plant

Taxonomy History: Veitch's pitcher plant was named after James Veitch, a nursery man who owns the famous Veitch's Nursery in Chelsea. This species was discovered by Thomas Lobb in 1856 before it was formally described by Sir Joseph Hooker in 1859.

Descriptions: A highland plant that robustly grows epiphytically or with a unique climbing habit on the tree. Despite having short tendrils compared to the other *Nepenthes* species, this species ascends the tree vertically and use its stem instead of coiled tendrils to clasp the tree trunks to gain support. The leaves are coriaceous, broad at the apex and narrow towards the base, petiolate and can be seen in glossy dark green colour. The pitchers are large, broadly cylindrical, with the presence of a pair of fringed wings at the frontal part, and densely indumentum with brown hairs. The colour of the pitchers can range from golden yellow or green, sometimes splashed with red. The peristome is broad and flared with its wavy margin and golden yellow colour striped with red.

Habitat and Distribution: It can be found growing on trees along the rivers in the lowlands, sub-montane areas, *Kerangas* forest, thick stunted mossy forest, and limestone mountains. Endemic to Borneo (Sabah, Sarawak, and Kalimantan).

Notes: This species is one of most adorable among all pitcher plant species by having adapted to their surroundings harmlessly hugging and climbing the tree trunk as an epiphyte. This behaviour rationally to supports the heavy plant with large pitchers.

NEPENTHES* x *HOOKERIANA LINDL.

Synonym: *N. hookeri* Alphand; *N. hookeri* Alphand *ex* Hook. *f.*; *N. hookeriana* H. Low *ex* Lindl.; *N. hookeriana* H. Low *ex* W.H. Baxter; *N. loddigesii* W.H. Baxter; *N. rafflesiana* var. *excelsior* (Lindl.) Beck; *N. rafflesiana* var. *hookeriana* (Lindl.) Beck; *N. x excelsior* B.S. Williams

Vernacular name: Hooker's pitcher plant

Taxonomy History: This taxon was recognized as a natural hybrid by John Lindley in 1908. The epithet name was given after Sir William Hooker who was at the Royal Botanic Gardens in Kew from 1841 until 1865. At first, Lindley believed that this hybrid was a species, *N. hookeriana* until Macfarlane suggested that this pitcher plant was a hybrid and formally described it.

Descriptions: A common natural hybrid between *N. ampullaria* and *N. rafflesiana.* The shape of the pitcher looks the same as *N. rafflesiana,* however, the difference in its morphological characteristics can be noticed by thorough observation. The characteristic of the parent plant, *N. ampullaria* can be seen in the urceolate shape pitcher with broad wings and its broad, rounded peristome. Meanwhile the parent plant, *N. rafflesiana* can be noticed in the upper pitcher plant that developed funnel-shaped without the elongated neck and raised breastplate section at the frontal part of the peristome. The characteristic of its

peristome is intermediate between *N. ampullaria* and *N. rafflesiana,* which is not too large and not too small.

Habitat and Distribution: Occurs with both parents; *N. ampulallaria* and *N. rafflesiana* in *Kerangas* forest, peat swamp forest a disturbed site such as roadsides embankment. This species is distributed in Borneo, Peninsular Malaysia, Sumatra, and Singapore.

Notes: This species was once thought to be a variety of *N. rafflesiana* but later was described as a natural hybrid.

NEPENTHES X KUCHINGENSIS SH. KURATA

Synonym: *N. cutinensis* Hort. *ex* Lauffenburger (1995) nom. nud.

Taxonomy History: Described by Shigeo Kurata in 1982, based on the specimens collected from Kuching, Sarawak (as the epithet name was given).

Descriptions: The pitcher plant has a short sub-cylindrical shape with a slightly swollen base like *N. mirabilis* and a wider peristome like *N. ampullaria.* The morphological characteristics of these natural hybrids are intermediate between the parent plants involved.

Habitat and Distribution: Frequently found in areas where the parent plants grow. This natural hybrid prefers to occur in the disturbed *Kerangas* forest and degraded areas along the roadsides. Mostly distributed in Borneo specifically at the Kuching division in western Sarawak.

***NEPENTHES X TRICHOCARPA* MIQ.**

Synonym: *N. trichocarpa* var. *erythrosticta* Miq.

Taxonomy History: This natural hybrid was described by Friedrich Anton Wilhelm Miquel, in 1858 based on a specimen collected in 1856 by a former gardener of Governor-General van den Bosch and a curator of the Botanic Gardens at Buitenzoirg (currently known as Bogor at Indonesia). The name *trichocarpa* (Greek word; *tricho*= hairy, *carpus*=fruit) was given referring to the hairy ripe fruits of this plant.

Descriptions: As its name, this natural hybrid has hairy inflorescences which are densely covered along the margin of the tepals and also, the fruit capsules. The leaves are sessile as the *N. gracilis* but develop hairs, texture and venation similar to *N. ampullaria.* The pitcher characteristics are intermediate between the parent plants, *N. ampullaria* and *N. gracilis.* The lower pitcher portrays a more cylindrical shape with a pair of fringed wings, a narrower lid and a wider lid than the *N. ampullaria.* Meanwhile, the upper pitcher is slightly larger than the lower, tubular in shape, lacks of fringes wings and wider peristome. The colours of pitchers can be found in wholly light green or light green suffused with red to dark purple.

Habitat and Distribution: Have been recorded in Borneo, Peninsular Malaysia, Singapore and Sumatra.

***UTRICULARIA AUREA* LOUR.**

Synonym: *Askofake recurva* (Lour.) Raf.; *Nelipus bifida* (L.) Raf.; *Philydrum cavaleriei* H. Lev.; *Utricularia alata* Banj.; *U. antirrhinoides* Wall.; *U. brevicaulis* Benj.; *U. humilis* Vahl; *U. recurva* Lour; *U. wallichiana* Benj.

Vernacular name: Rumpai ekor kucing, Lumut ekor kucing, lumut ekor kuning, Golden floating bladderwort

Taxanomic History:

Joao de Loureiro first characterized *U. aurea* in 1790. The Royal Portuguese Academy of Sciences funded the publication of Flora Cochinchinensis by Joao de Loureiro in 1790. The Latin word “aurea” (which relates to the hue of the petals) means ‘golden’.

Habitat: This species most often can be found at a low level but increasing to 1700 m, in shallow to relatively deep, motionless or slow-moving water in lakes, pools, river backwaters, rice paddies, drainage near oil palm plantations and lakes.

General Description: Medium to large emergent free-floating aquatic herbs. Flowers are open usually from the late morning until afternoon. This is one of the common *Utricularia* aquatic plants found widespread. Rhizoids are usually present at the base or shortly above the base of the peduncle. Stolon - base is divided into 3-4 primary filiform segments. Leaves numerous; Traps usually few to many; Inflorescence erect, emergent, simple, ca. 10-20 cm long. The flowers 2-4, are pale yellow with reddish-brown nerves.

Distribution: Australia; Bangladesh; Cambodia; China; Hong Kong; Pakistan; Nepal; Bangladesh; Ceylon; Burma; Korea; India; Indonesia; Japan; Lao People's Democratic Republic; Malaysia; Myanmar; Philippines; Sri Lanka; Taiwan, Province of China; Thailand; Vietnam; Sumatra; Java; New Guinea

Status: In the IUCN Red list this species is considered as LC (least concern)

Uses: This plant is considered a nuisance aquatic weed that can also be utilized to improve the water quality of fish ponds.

Notes: The largest synonym, *U. aurea*, is simply a reflection of the relatively large number of countries in which it has been documented in the absence of knowledge of the earlier names from other places. *Utricularia aurea* is the most widespread Asian suspended aquatic

***UTRICULARIA BIFIDA* L.**

Synonym: *Askofake recurva* (Lour.) Raf.; *Nelipus bifida* (L.) Raf.; *Philydrum cavaleriei* H. Lev.; *Utricularia alata* Benj.; *U. antirrhinoides* Wall.; *U. brevicaulis* Benj.; *U. humilis* Vahl; *U. recurva* Lour; *U. wallichiana* Benj.; *U. ramosa* Vahl; *U. biflora* Wallich; *Philydrum cavaleriei* Leveille; *Utricularia biflora* Hayata; *U. capillacea* Willd.; *Trixapias capillacea* Raf.

Vernacular name: Bifid Bladderwort

Taxonomic History:

In Latin, the word “bifida” implies “split”. Carl Linnaeus first identified and documented U. bifida in 1753. He was a Swedish botanist, zoologist, taxonomist, and doctor who is credited with developing the contemporary technique of identifying species, binomial nomenclature. He devised a precise and effective two-word, or binomial, system for naming plants in 1753 with the publication of the two-volume work Species Plantarum. This system forms the basis of modern plant taxonomy

Habitat:

This species can be found in low- to medium-altitude grassland and wetland areas such as rice agriculture, damp soil, and rocks

General Description: The size of the plant is ca. 5-40 cm, rhizoids and stolons are capillary and branched. The bladders (traps) are on stolons and leaves. Leaves are arising from stolon, rosette. Inflorescence erect,

2-8 flowered, peduncle rounded. Flower yellow, upper petal rounded, lower petal widely divergent, curved and apex acute. The spur is the slender, slightly curved and the same length as the lower petal.

Distribution: Australia; Bangladesh; Cambodia; China; Guam; Hong Kong; India; Indonesia; Japan; Korea, Democratic People's Republic of; Lao People's Democratic Republic; Malaysia; Myanmar; Palau; Papua New Guinea; Philippines; Taiwan, Province of China; Thailand; Vietnam

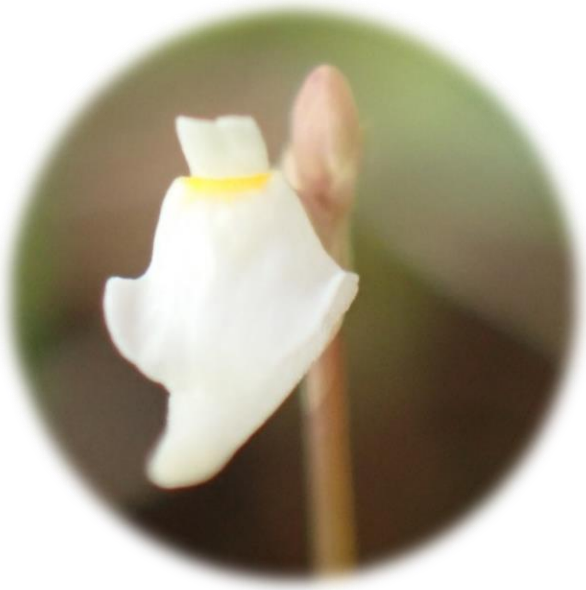
Status: In the IUCN Red list this species is least concern (LC) but it was listed as threatened in 2010

Uses: The species is used in traditional medicine to treat urinary diseases

Notes: Potential as an environmental indicator. The presence of common pioneer species (*U. bifida*) indicates a past disturbance in a habitat

UTRICULARIA CAERULEA L.

Synonym: *Calpidisca takenakae* Nakai; *Pelidnia caerulea* (L.) Barnh.; *Utricularia albina* Ridl.; *U. caerulea* L. var. *filicaulis* (Wall. *ex* A. DC) Haines; *U. campestris* Miq. *ex* C.B. Cl.; *U. cavalierii* Stapf.; *U. charnleyensis* W.V. Fitzg.; *U. complanata* Wall. ex. C.B. Cl.; *U. conferta* Wight; *U. filicaulis* Wall. *ex* A. DC.; *U. filicaulis* Wall. *ex* A. DC. var. *papillosa* Pellegr.; *U. kerrii* Craib; *U. nivea* Vahl; *U. nivea* Vahl var. *caerulea* (L.) Voigt; *U. nivea* Vahl var. *rosea* (Edgew.) Trimen; *U. nivea* Vahl var. *wallichiana* A. DC.; *U. obscura* R. Br.; *U. obtusiloba* Benj.; *U. ophirensis* Ridl.; *U. paucifolia* Benj.; *U. racemosa* Wall. *ex* Walp.; *U. racemosa* Wall. *ex* Walp. var. *filicaulis* (Wall. *ex* A. DC.) C.B. Cl.; *U. racemosa* Wall. *ex* Walp. f. *leucantha* Komiya; *U. racemosa* Wall. *ex* Walp. var. *rosea* (Edgew.) Thw.; *U. rosa-pupurea* Fyson; *U. rosea* Edgew.; *U. rosea-purpurea* Stapf. Ex Gamble; *U. sampathii* K. Subramanyam & S.N. Yoganarasimhan; *U. sootepensis* Craib; *U. squamosal* Wight.



Vernacular name: Blue bladderwort

Taxanomic history:

In Latin, the word “caerulea” implies “blue” which refers to the corolla of the species. Carl Linnaeus first identified and documented *U. caerulea* in 1753. He was a Swedish botanist, zoologist, taxonomist, and doctor who is credited with developing the contemporary technique of identifying species, binomial nomenclature.

Habitat: This plant grows as a terrestrial plant in open ecosystems, typically at lower elevations but ascending to as high as 2100 m, on moist shallow soils over rock, wet meadows, or near streams.

General Description: Very small to medium-sized. Rhizoids and stolons capillary, branched. The traps are on stolons and leaves. The leaves are numerous, from peduncle base and stolon nodes, shape of the leaves is linear and apex rounded. Inflorescence erect ca. 10 –20 cm, 1-5 flowered; peduncle sometimes branched. Flower colour is sometimes violet, pink or white which is marked with yellow on the lower petal. The upper petal apex is usually retuse and the shape is oblong. The lower petal apex is subacute. The spur is usually longer than the lower petal.

Distribution: Madagascar, Western India to Japan and Northern New South Wales; Bangladesh; Burma; Ceylon; Nepal; Thailand; Indo china; China; Korea; Japan;

Malaysia; Sumatra; Java; Philippines; New Guinea; Palau; Guam; Australia.

Status: No data in the IUCN Red list
Uses: Some *Utricularia* species are utilized as traditional medicines are diuretics and moderate astringents. *Utricularia caerulea* is used as treating wounds.

Notes: Considering *U. caerulea* is a widely distributed and very variable species, there are many synonyms for it.

***UTRICULARIA GIBBA* L.**

Synonym: *Megopiza fornicata* Raf.; *Megopiza integra* Raf.; *Megopiza longirostris* Raf.; *Megozipa fornicata* (Leconte) Raf.; *Megozipa integra* (Leconte) Raf.; *Megozipa longirostris* (Leconte ex Elliott) Raf.; *Plesisa bipartita* Raf.; *Trilobulina crenata* Raf.; *Trilobulina fibrosa* Raf.; *Utricularia fibrosa* Raf.; *Utricularia alba* Hoffmanns. ex Link; *Utricularia ambigua* A. DC.; *Utricularia anomala* A. St. –Hill. & Girard; *U. aphylla* Ruiz & Pav.; *U. bifidocalcar* R. D. Good; *U. biflora* Lam.*; U. bipartita* Elliott; *U. crenata* Vahl; *U. diantha* Schult.; *U. diflora* Roxb.; *U. elegans* Wall.; *U. emarginata* Benj.; *U. exoleta* R. Br.; *U. exoleta* var. l*usitanica* Kamienski; U*. fibrosa* Walter; *U. fornicate* Leconte; *U. furcate* Pers.; *U. gayana* A. DC.; *U. gibba* f. *natans* Komiya; *U. gibba* subsp. *exoleta* (R. Br.) P. Taylor; *U. gibba* subsp. *gibba*; *U. gibbosa* Hill; *U. gracilis* Kunth; *U. integra* Leconte; *U. kalmaloensis* A. Chev.; *U. khasiana* J. Joseph & J. Mani; *U. longirostris* Leconte*; U. macrorhyncha* Barnhart; *U. nagurai* Makino*; U. natans* Salzm. ex A.St.-Hill. & Girard; *U. obtusa* Sw.; *U. pallens* var. *natans* Warm.; *U. parkeriana* A. DC.; *U. pauciflora* Blume; *U. pterosperma* Edgew.; *U. pumila* Walter; *U. riccioides* A. Chev.; *U. roxburghii* Spreng.; *U. saharunporensis* Royle ex Oliv.; *U. secunda* Benj.; *U. spirandra* C. Wright ex Griseb.; *U. sumatrana* Miq.; *U. tenuifolia* Benj.; *U. tenuis* Cav.; *U. tenuis* var. *poeppigii* A. DC.; *U. tricrenata* Baker ex Hiern; *Vesiculina gibba* Raf.

Vernacular name: Humped Bladderwort

Taxonomic History: The specific epithet "*gibba*" refers to the enlarged base of the lower lip corolla, which is Latin for "hump" or "swelling". Carl Linnaeus first described and published this species in 1753

Habitat: This species can be found in mud or ditches, pools, lakes, river backwaters, bogs, swamps, and marshes, as well as shallow still or slowly flowing water. Although they can grow in deep water often, they cannot flower unless they are supported by floating mats of living or dead vegetation. *U. gibba* is usually at low altitudes, but capable of climbing to heights of 2600 m.

General Description: True aquatic. Rhizoids are sometimes present or absent, filiform and branched. The stolons filiform usually mat-forming. Leaves numerous on stolons. Inflorescences erect, 1-2 flowered. The petals are yellow, the lower petals are slightly smaller than the upper petals. The lower petal has a rounded apex. The spur is shorter than the lower petal.

Distribution: Pan tropical, extending northwards into eastern and western Canada and the USA, Spain and

Portugal North Africa, Israel, China and Japan and southwards to Argentina, S. Africa, Australia and New Zealand, also as an occasional introduction into other European countries and a common weed of aquaria and botanic gardens throughout the world. America, Mexico, Europe, Africa, India, Nepal, Ceylon, Burma, Thailand, Vietnam, Malaysia, Sumatra, Java, Borneo Philippines, Sulawesi, New Guinea, China, Japan, Australia, New Zealand and New Caledonia.

Status: This species has most recently been assessed for the IUCN Red list of threatened sp. in 2018 and currently is listed as Least Concern (LC).

Uses: This species is very widely grown for the horticultural trade

Notes: *Utricularia gibba* is considered a common species of bladderworts in Malaysia.

UTRICULARIA HIRTA KLEIN *EX* LINK

Synonym*: Utricularia capillacea* Vahl; *U. setacea* Wallich*; U. hirta* Klein ex Link var. *elongata* Pellegrin*; U. tayloriana* Joseph & Mani

Taxonomic history: Jacob Theodor Klein gave the first name for *U. hirta*, and Johann Heinrich Friedrich Link formally described and published it in 1820

Habitat: This species is a terrestrial plant that can be found in freshwater, grassland and wetlands which strive in wet, open grassy places, such as marshes and deciduous woodland from near sea level to 1000 m altitude.

General Description: Small, the plant size ca. 6-15 cm. Rhizoids capillary, stolon capillary. The traps are usually on rhizoids, stolons, and leaves. Leaves shaped are narrowly obovate with 1-veined and few from stolons, apex rounded. Inflorescences are erect, and densely covered with hairs. Flowers found in Bako National Park are only violet the lower petal is sub-circular with a rounded 3-lobed at the apex while the upper petal with oblong, apex emarginated and smaller than the lower petal. The spur is subulate and much longer than the lower petal.

Distribution: Bangladesh; Cambodia; China; India; Lao People's Democratic Republic; Malaysia; Sri Lanka; Thailand; Vietnam

Status: In the IUCN Red list this species is in the category of Least Concern (LC) but was considered threatened in 2016 currently there is no data update hence that is why it is considered LC

Notes: In Sarawak, this species can only be found in Bako National Park, Kuching. It often looks allied to *U. minutissima* but the difference is *U. hirta* is a larger and well-developed covering of hair which extends to the calyx.

UTRICULARIA MINUTISSIMA
VAHL.

Synonym: *Meionula parviflora* Raf.; *Utricularia brevilabris* Lace; *U. brevilabris* var. *parviflora* Pellegr.; *U. calliphysa* Stapf; *U. evrardii* Pellegr.; *U. Lilliput* Pellegr; *U. minutissima* f. *albiflora* (Komiya) Komiya & Shibata; *U. nigricaulis* Ridl.; U. nipponica Makino; U. pygmaea R.Br.; *U. siamensis* Ostenf.; *Vesiculina pygmaea* (R. Br.) Raf.

Vernacular name: Minute bladderwort

Taxonomic History: Martin Vahl first wrote about and published this species in 1804; however, Banks and Solander provided the illustrations. The name of the epithet is taken from Latin words that imply very little

Habitat: This species is usually found in wet, sandy soil or mud in open, grassy areas. This plant grows as a terrestrial plant at elevations between sea level to 2100 m in open, humid places with muddy or sandy soil.

Description: Very small annual terrestrial or sometimes freshwater 2.5-6.0 cm tall. Rhizoids are many, capillary, simple and a few mm long. Stolons few, capillary, sparsely branched. Leaves few which grow from the peduncle base and the stolons, leaves shaped that is narrowly obovate to a linear and single nerve. Traps (bladder) are numerous on the rhizoids, stolon and petioles. Inflorescence erect, solitary ca 5 cm long; Flowers usually 1-3. The petals are usually violet or mauve; the upper petal is narrowly oblong-elliptic to obovate, with the apex emarginated; the lower petal limb is 3-lobed rounded at the apical margin. The spur subulate from a conical base, straight or slightly curved, slightly longer than or twice as long as the lower petal.

Distribution: India; Japan; Australia; India; Ceylon; Burma; Thailand; Indochina; China; Japan; Malaysia; Sumatra; Philippines; New Guinea; Australia

Status: According to the IUCN list this species is Least Concern (LC) and its habitat is 33.3% freshwater (Inland water), 33.3% terrestrial and 33.3% terrestrial and freshwater (Inland water)

Uses: *Utricularia minutissima* has been reported to be edible and abundant in nutrients, it has the potential as a medicinal crop. The species is frequently widespread locally and serves as pioneers of open disturbed wetland indicators.

Notes: *U. minutissima* and *U. hirta* are often confused. To distinguish between these two species is the variable in stature and the peduncle can be quite glabrous to distinctly hispid, but the hairs never extend to the calyx lobes as in *U. hirta. Utricularia minutissima* is also the most common species in Malaysia.

Utricularia minutissima and *U. bifida are* frequently found growing together in grassland.

UTRICULARIA SUBULATA

Synonym: *Utricularia pumila* Walter; *U. setacea* Michx; *U. filiformis* Roemer & Schultes; *U. capillaris* Hoffsg. Ex Roemer & Schultes; *U. pusilla* Sm.; *U. media* Salzmann ex A. St. Hil. & Girard; Vesiculina setacea (Michx) Raf.; U. perpusilla A. DC.; U. subulata L. var. inaequalis A.DC.; U. nervosa Weber ex Banj.; U oligocista Benj.; U. subulata L. var. cleistogama A. Gray; U. cleistogama (A. Gray) Britton; U. angolensis Kamienski; U. multiflora Afz. Ex Kamienski; U. subulata L. var minuta Kamienski; Setiscapella subulata (L.) Barnhart; S. cleistogama (A. Gray) Barnhart; Enetophyton cleistogamum (A. Gray) Nieuwl.; Utricularia tenuiscapa Pilger; U. subulata L. forma cleistogama (A. Gray) Fernald; U. triloba Good; Vesiculina setacea (Michx.) Raf.

Vernacular name: The zig-zag bladderwort

Taxonomic history: The Latin term ‘subulata’ means ‘subverted’ in English. *Utricularia caerulea* was originally recognized and recorded by Carl Linnaeus in 1753.

Habitat: Between sea level and 2600 m above sea level, *U. subulata* can be found in sandy savanna, wet shallow soil over

rocks, ditches, streams, pool edges, and damp regions often in low open vegetation

General Description:

Small to very small, the rhizoids are filiform with branches, stolons numerous, capillary, and branched. Leaves are usually numerous, linear in shape with apex subacute with 1-nerved. Traps are numerous on the stolons and leaves. Inflorescence erect, solitary, simple and at times branched, *ca*. 9-20 cm. Flowers 1-3 or more sometimes, petals usually yellow. The upper corolla has a rounded apex. The lower petal rhombic and the apex are deeply 3-lobed. The spur is subulate and slightly longer than or shorter than the lower petals.

Distribution: Portugal; Tropical Africa; Madagascar; India; Thailand; Malaysia; Australia; Canada; U.S.A; Mexico; Bahamas

Status: *Utricularia subulata* is in the least concern (LC) category but in 2015 it was justified as threatened now no data update hence considered in the LC category

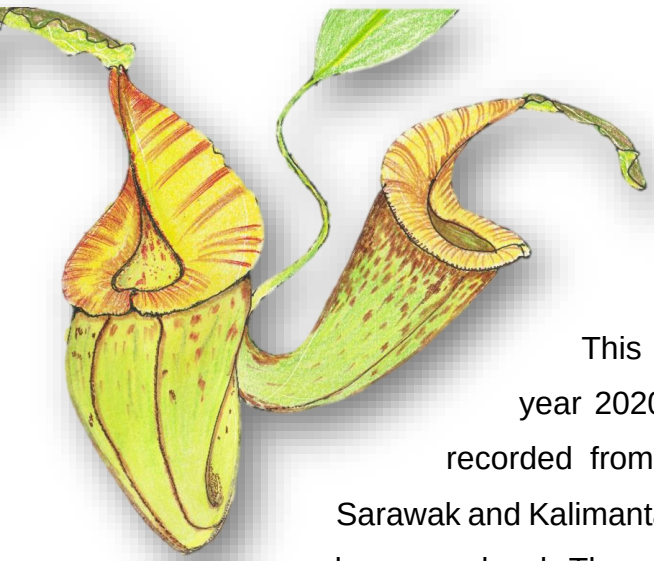
Notes: In Sarawak, this species can only be found Bako National Park, Kuching where specifically on the Lintang trail.

OTHER SPECIES

The number of carnivorous plants discussed in this book is not complete. Many species still need further information. These species are included in this section despite having very little information.

NEPENTHES CAMPANULATA SH. KURATA

Known as “the bell-shaped pitcher plant” this species is native to Borneo (also Palawan?). In the year 1983, this species was thought to be extinct when the type location (the only known locality) was destroyed by a forest fire. However, it was rediscovered in 1997 in the Mulu National Park, Sarawak.



NEPENTHES FRACTIFLEXA GOLOS, A.S. ROB & BARER

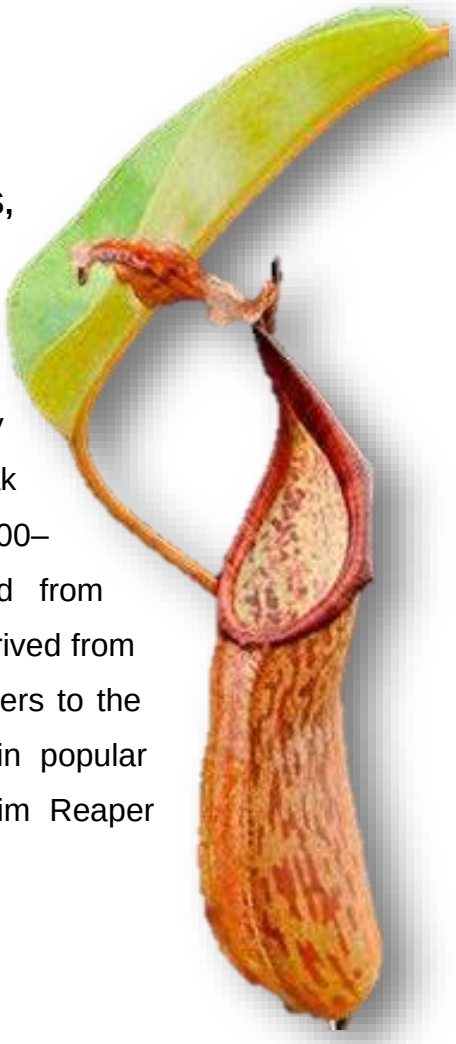
This species was recently described in the year 2020, and it is endemic to Borneo. It was recorded from a small number of localities across Sarawak and Kalimantan at elevations of 1,400 – 2150 meters above sea level. The species epithet *fractiflexa,* formed from the Latin *fractus* and *flexus,* refers to the characteristics of distichous vining stems of this species which bend alternately at the nodes in a zig-zag fashion (Golos et al. 2020).

***NEPENTHES VOGELII* SCHUIT. & VOGEL**

This species was described based on a specimen cultivated in the Hortus Botanicus Leiden. The origin of the type locality was Kelabit Highland, Sarawak. *Nepenthes vogelii* is considered a highland species. It was collected from the mossy kerangas forest at elevations more than 1,000 meters above sea level. The epithet name was given after Mr Art Vogel, greenhouse manager of the Hortus Botanicus Leiden, also the co-discovery of the species.

***NEPENTHES PLATYCHILA* CHI. C. LEE**

Nepenthes platychila was described by Chi Chen Lee in 2002. This species is uniques to the Hose Mountain of central Sarawak. It is considered a highland species, recorded at elevations 900–1,300 meters above sea level. The most unusual feature was the peristome of the upper pitchers, which was flattened and very broad (Lee, 2002).



***NEPENTHES DACTYLIFERA* A.S. ROB., GOLOS, S. McPHERSON & BARER**

This species was described in 2019 based on a specimen from Bukit Belalong, Temburong, Brunei Darussalam. This species is widely distributed across the central highlands of Sarawak (Bukit Bangai, Gunung Murud, etc.) at elevations 800–1,300 meters above sea level. Also recorded from Kalimantan, Indonesia. The name *dactylifera* is derived from the Greek word and the Latin suffix-fer, which refers to the species' extremely long and narrow lid, which in popular culture resembles the arched fingers of the Grim Reaper (Robison et al. 2019).

***NEPENTHES EPHIPPIATA* DANSER**

This species was described by B.H. Danser in 1928 in his monograph, “The Nepenthaceae of the Netherlands Indies” based only on part of a stem and an infructescence. *Nepenthes ephippiata* is endemic to Borneo (Sarawak and Kalimantan). Considered a highland species, it grows in montane forests from 1,000 to 1,900-meter elevation. The epithet name from the Latin, *ephippium,* means saddle cloth, which refers to the leaf. Also known as “saddle-leaved pitcher-plant”.

COROLLARY

The carnivorous plant groups are very fascinating with their beautiful alteration of plant parts to gather supplement nutrients for their survival. This unique adaptation is an example of a complex relationship in the tropical forest. It is not surprising that the number of carnivorous plant species in Sarawak is tremendous. However, besides the well-known genus *Nepenthes,* others genera (*Drosera* and *Utricularia*) are being disregarded for many years. There is still a lot to be learnt about the carnivorous plants in Sarawak, particularly on their diversity. The possibility of discovering new species is high, as many areas are still unexplored. It is hoped that this monograph will inspire a new generation to study this amazing group of plants which is very important for the ecological system.

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GLOSSARY

Abaxial - the surface of an organ facing away from the organ's axis e.g. the lower surface of a lateral organ such as a leaf or petal

Adaxial - the surface of an organ facing toward the organ's axis, e.g. the upper surface of a lateral organ such as a leaf or petal.

Circinate - Spirally coiled with the tip innermost, for example, circinate vernation of the developing fronds of most ferns.

Elliptic - Also ***elliptical***. Planar, shaped like a flattened circle, symmetrical about both the long and the short axis, tapering equally both to the tip and the base; oval.

foliar

Mucilage - a polysaccharide substance extracted as a viscous or gelatinous solution from plant roots, seeds, etc.

Obovate - (of a leaf) Having a length about 1.5 times the width, and widest above the centre.

Petiolate - (of a leaf) Having a petiole. Contrast *sessile*.

Raceme - adj. ***racemose***, An indeterminate inflorescence in which the main axis produces a series of flowers on lateral stalks, the oldest at the base and the youngest at the top.

Compare spike. **racemiform** or **racemoid** - having the form of a raceme

Rhizoids - a filamentous outgrowth or root hair on the underside of the thallus in some lower plants, especially mosses and liverworts, serving both to anchor the plant and (in terrestrial forms) to conduct water.

Scape - adj. ***scapose***

stem-like flowering stalk of a plant with radical leaves.

Sessile - Attached without a stalk, e.g. of a leaf without a petiole or a stigma, when the style is absent.

Stolons - *Also **runner**.* A slender, prostrate or trailing stem, produces roots and sometimes erect shoots at its nodes. See also rhizome.

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