

An insight into the world of plants that eat animals – Carnivorous Plants

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Nature has always being a subject of curiosity to human beings owing to its vivid and colourful live forms. Most of us are aware of its infinite diversity ranging from a micro organism of just few micrometers in length to the huge dinosaurs that roamed the Earth. Nature is a plethora of Surprises. Many of its creations have created ripples even in the scientific world and scientists are still trying to understand and find an explanation for several unconventional forms. Amongst many such unsolved mysteries, there lies a group of plants that are not conventional plants. Known by the name of their source of nutrition, insectivorous plants form a unique group of plants that differ from other plants not just in their nutrition but also in the habitats they are found in as well as in their appearance. These can be referred to as the ‘carnivores’ of plant kingdom!! Let us peep into the world of some of the most strange and fascinating members of Plant Kingdom.

This group of strange plants are also sometimes called by the name of the carnivorous plants owing to their tendency to eat animals . A long time back, these insect-trapping plants had managed to attract the interest of some people and created a curiosity about these plants. In 1790 Thomas Jefferson collected the Venus flytrap near Charleston, South Carolina, for study. These group of plants even made the author of “Origin of Species”, even had Charles Darwin fascinated. He said that the Venus’s Fly trap was one of the most wonderful plants in the world. He also planned and performed various experiments to study the motions of this plant’s leaves in response to the slightest of sensations, by a human hair let alone the sensation created by insects. He was astonished when leaves of this plant did not respond

huge water droplets falling from the sky as rain. He extensively studied many species of insectivorous plants. He recorded his findings and experiments in a book entitled “Insectivorous Plants”, in 1875. One of his interesting findings was how the hair-trigger speed of the Venus Flytrap’s snap shutting itself in just one-tenth of a second, close to the muscle contraction of animals. This behaviour is, remarkable as plants lack muscles and nerves, leaving us with the mind-boggling question - “Then how do they act like animals?”.

However, not all were so thrilled and captivated by these strange members of plant kingdom. The great Swedish naturalist Carl Linnaeus, on knowing about insect trapping by Venus Flytrap declared the act, “against the order of nature as willed by the God”.

Now, insectivorous plants actually are tiny insect-trapping plants that dwell in nutrient poor soils, and certainly not in the curious dense and dark swamps and forests of the movies! By definition, plants that attract, catch, digest and absorb body juices of animals are generally grouped as Carnivorous Plants. Due to their fondness for trapping insects plants such as the Venus Flytrap are referred to as Insectivorous Plants.

It is interesting to note that although many plants use their colourful petals to attract insects that transport their pollen, Insectivorous plants, however, do not sport such petals for pollen, but for obtaining their food – the insects themselves! Insectivorous plants include a wide range of plants such as sundews, pitcher plants, butterworts, bladderworts and Venus flytraps. The victims of these plants also fall in a broad range comprising of almost 150 species of insects, arachnids including mainly spiders and mites, molluscs like snails and slugs, sometimes earthworms and also small vertebrates like small fishes, frogs, reptiles, rodents and birds. The largest of all the victims till date was reported to be a rat!

Discussing about the habitats and nutrition of the Insectivorous plants, it is quite interesting to note that, these plants grow in regions that are low in nitrogen, phosphorus and potassium concentrations. Furthermore, these plants die even if doses of garden fertilisers (rich in NPK) normal for common garden plants are applied on them. Going against the common norms, these absorb nutrition from animal juices to fulfil their needs for nitrogen and phosphorous.

Carnivorous plants have fascinated evolutionary ecologists, botanists and horticulturists for centuries. There are above one million flowering plant species known worldwide among which over 400 are known to be carnivorous. In the evolutionary history of plants, carnivory has come much later - what could be the possible reason of their shift towards carnivory? Ecologists suggest the role of nutrition - environmental stress and the lack of resources - for the development of possible carnivory in this group of plants. It has been studied that these plants have evolved independently over six times within different angiosperm subclasses including both monocotyledons and eudicotyledons. By opening up a new venture of extracting chemical energy from insects, these plants have opened a new niche defined by a new energy source.

Diversity has always proved to be an important factor for establishment of any group of similar organisms. Similarly, insectivorous plants too have many classes in which they are divided. This would be easier to be viewed in a tabular form as in Figure 1.

	<p><i>Sarracenia</i> (Trumpet pitcher plant)</p> <ul style="list-style-type: none"> • Approximately 10 species known • Generally found in South-eastern United States, with one species extending across Canada
	<p><i>Darlingtonia</i> (California pitcher plant)</p> <ul style="list-style-type: none"> • Single species known • Found in Northern California and adjacent Oregon
	<p><i>Heliamphora</i> (South American pitcher plant)</p> <ul style="list-style-type: none"> • Approximately 5 species known • Generally found in Venezuela, Guyana, Brazil
	<p><i>Nepenthes</i> (Tropical pitcher plant)</p> <ul style="list-style-type: none"> • About 75 species are known • Generally found in Southeast Asian tropics, Australia, Malaysia, and India to Madagascar
	<p><i>Cephalotus</i> (Australian pitcher plant)</p> <ul style="list-style-type: none"> • Single species known • Found in Western Australia
	<p><i>Drosera</i> (Sundew)</p> <ul style="list-style-type: none"> • About 100 species • Found worldwide, especially South Africa and Australia
	<p><i>Dionaea</i> (Venus' flytrap)</p> <ul style="list-style-type: none"> • Single species • Found in South-eastern North Carolina and adjacent South Carolina
	<p><i>Pinguicula</i> (Butterwort)</p> <ul style="list-style-type: none"> • About 60 species known • Found mostly in northern hemisphere
	<p><i>Utricularia</i> (Bladderwort)</p> <ul style="list-style-type: none"> • About 200 species known • Found worldwide

Source: www.wikipedia.org

Carnivorous plants in India

As can be totalled from the table above approximately 460 different species of carnivorous plants are there on this planet concentrating mainly in the tropical areas including

North America, South Asia and Australia. In India, carnivorous plants found include species of the genera of *Drosera* (sundews), *Pinguicula* (butterworts), *Nepenthes* (pitcher plants), and *Urticularia* (bladderworts). From published records we know that at least 3 species of *Drosera*, 1 species of *Pinguicula*, 1 species of *Nepenthes* and 35 species of *Urticularia* are found within the geographical limits of our country. They grow in a range of habitats – *Drosera* in the crop fields in the plains to *Pinguicula* species in the altitudes of the Himalayas.

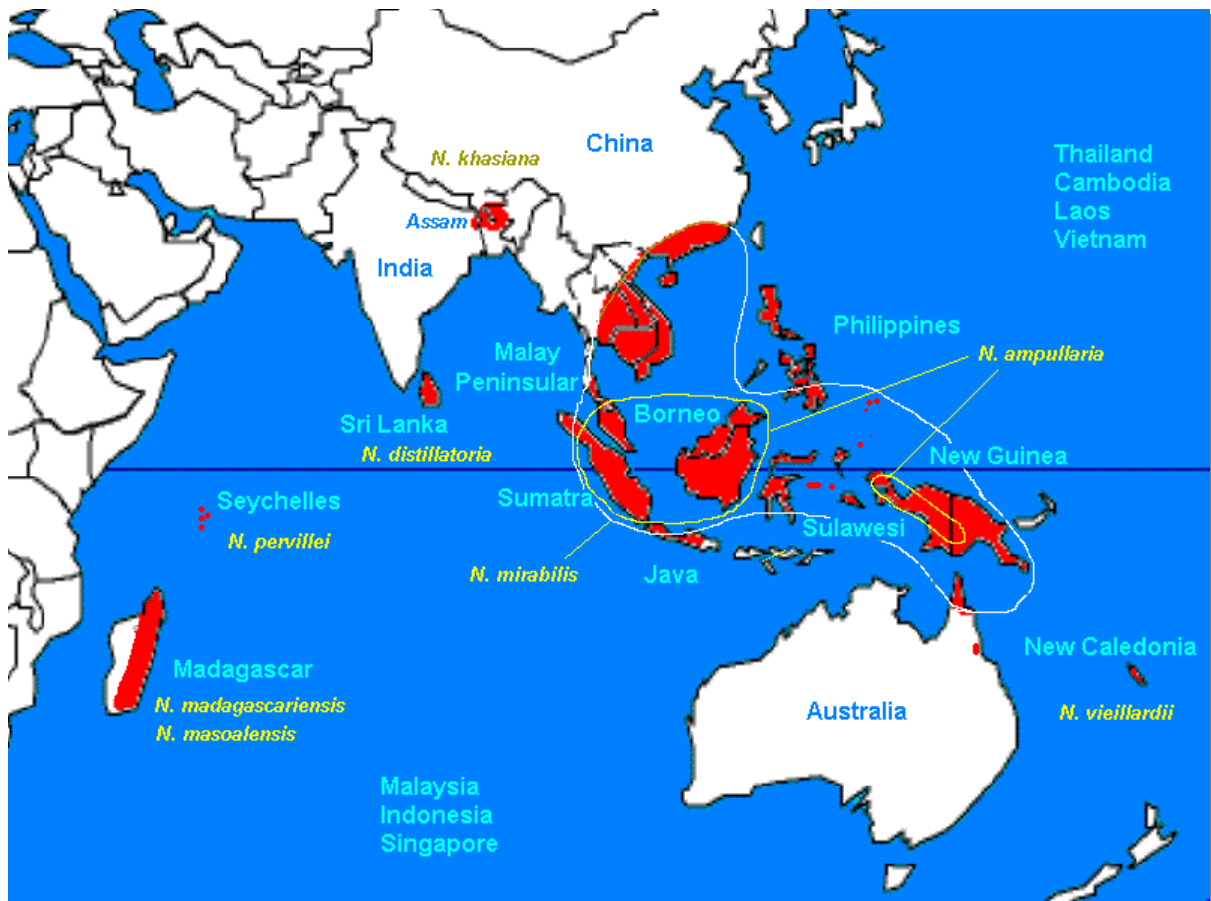


The wild variety of *Nepenthes khasiana* plant growing outside a house in Nagaland,

India

The Genus *Nepenthes*

Let us find out a little more about the genus *Nepenthes* as it is notably spectacular owing to the enormous traps that undoubtedly fit to our conventional picture of a dangerous carnivorous plant (their traps can reach 10"-12" in size). It is the only genus in the family Nepenthaceae. It was the Governor of a French colony Etienne de Flacourt in 1658 who first recorded observations on *Nepenthes*. The name of the genus was coined by Linnaeus recalling the narcotic (nepenthe) used by the Helen of the Troy to intoxicate her guests. Plants belonging to this genus are climbers. They are also called by names such as 'tropical pitcher plant' owing to the shape of their traps, or 'monkey cups' as some have observed monkeys drinking rain water from their 'pitchers'. *Nepenthes* has a geographic distribution ranging from Southeast Asia which constitutes its centre of diversity, and then westwards into Seychellas and eastern Madagascar and south to Australia (refer map). More than a 100 species are known to fall in this genus. They vary in the structure of the pitcher, positioning of pitcher traps on the plant (lower pitchers, upper pitchers) and the elevation at which they are found (lowland species, highland species). However, some of the more common species in the South East Asia have been highlighted in the figure below that denotes the distribution of the particular species of the genus *Nepenthes*.



Source: http://www.honda-e.com/A02_World%20Maps/WorldMap_NepenDetail.htm

The distribution of different species of *Nepenthes* genus in South East Asia

Some of the species along with their distinct character of pitchers are detailed below:



N. albomarginata

N. ampullaria

N. burbidgeae

N. mirabilis

N. distillatoria

N. madagascariensis

N. vieillardii

Source: The International Carnivorous Plant Society

Different species of Genus *Nepenthes* found in South East Asia

Some *Nepenthes* species found in South East Asia

Nepenthes khasiana is an endangered species of genus *Nepenthes*, this species is the only species of carnivorous plants endemic to India. It is thought to attract prey through blue

fluorescence. The pitchers emit a blue glow that is visible to animals that can see UV light, including many insects. Found in Khasi hills of Meghalaya it has been named *tiew-rakot* by the local people, meaning demon flower or devouring-plant. It is the only known species of pitcher plants in India and is reported to be critically endangered.

The pitcher of *Nepenthes albomarginata* has a white band around the opening that has hair like structures. Termites are attracted to feed on these structures and fall into the pitcher of the plant. This species therefore specializes in a particular kind of prey.

Nepenthes ampullaria is a species that has evolved to become quite different from its congeners. The lid of the pitcher of this plant does not shield the opening, leaving it left open for dead leaves and twigs to fall inside. This species is unique in that it in addition to feeding on insects, it is also detritivorous – feeding on nutrients from plant matter that falls into it and decays.

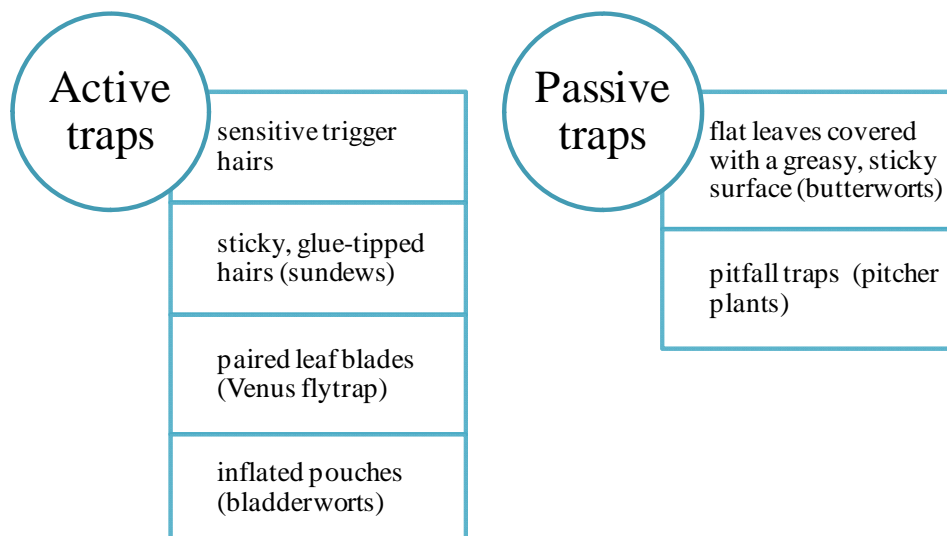
Nepenthes mirabilis: The most widely ranging species with flimsy leaves. It is distinct owing to its broad and flat peristome.

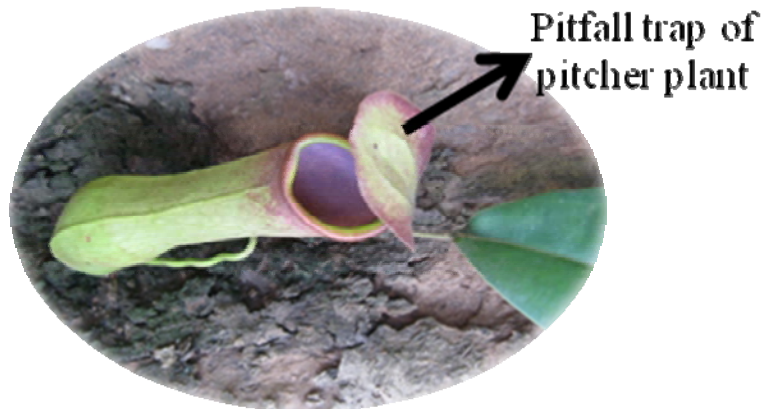
Nepenthes distillatoria: It is the first species in the genus to be named according to the Linnaean system of taxonomy and hence is the type species for this genus. This species is endemic to Sri Lanka.

Open and sunny wet habitats favour the establishment of insectivorous plants, especially areas having nutrient scarcity and acidic pH. It is the uniqueness of this group that they thrive well in nutrient poor. Wet meadows and peat bog moss have been reported to be common habitats for these plants, however, some have been found in the still fresh water ponds, and further some are also found to be clinging on to wet, seeping rock cliff. Going to

the extremes, some are also reported to be found on wet sands and also on places that generally have periodic fires.

Now, just as we humans can be categorised on the basis of the skills we excel in, carnivorous plants are grouped on the basis of the traps they specialize in for catching their prey. Sometimes, even their names give the hint of the kind of traps that group uses. For example, when we say bladderworts, there are small inflated pouches (bladders) which trap microscopic organisms and insects as their prey. However, it is interesting to note that all the kinds of traps these plants use; they all are actually modifications of their leaves. Also, two types, active and passive traps have been reported on the basis of their effectiveness to the prey. The following chart shows different traps of carnivorous plants:





Different class of traps found in insectivorous plants. The passive trap used by pitcher plants to catch insects. Note the deep pitcher that act as death well for insects.

There has been a great deal of curiosity about the mode of nutrition, the secret behind their traps and their habitat . Following a series of experiment Charles Darwin, has suggested that there lies a system akin to the nervous system in animals which sense prey movement that results in a cascade of impulses from cell to cell, through the trap that finally stops at the complete closing of the leaves trapping the fluttering prey inside. Alexander Volkov, a plant physiologist has even mentioned Venus's fly trap as an "electrical plant". Experiments showed that the hairs of a living insect are more effective in triggering the impulse for closing the leaves, than a dead insect. Volkov's experiments further revealed that once an insect has been sensed by a leaf, they close because of a charge or impulse that flows down through the leaf in fluid filled tunnels that open pores in cell membranes. Movement of water in an outward manner from cells on inner side to cells on outer side makes the leaves to curl up and close trapping the insect inside.

Many carnivorous plants have special glands that secrete enzymes capable of digesting hard exoskeleton of the insects, example pitcher plants. The specially equipped pitchers have a mixture of secreted enzymes and nectar, that at first attract the insects and

then due to the leaf's/pitcher's slippery surface falls into the death trap. In some species, the lid of the pitcher closes after a prey falls in, sealing their fate. The plants derive nitrogen, phosphorous and other elements from the bodies of the insects by devoting complex machinery to obtain nutrition than the normal plants which use the solar energy to produce their food. However, surviving in a limiting environment with low quantities of nitrogen and phosphorous, these have developed an efficient alternate mode of nutrition, yet expensive in terms of energy utilised in their traps.

At this point it becomes necessary to include that apart from obtaining nutrition through digesting the insects or prey that fall into their traps, these plants are also capable of photosynthesizing. However, they do not have flat leaves like other plants to capture sunlight efficiently. Hence, it could be said that insectivorous plants may not so efficient in converting solar energy into chemical energy. The investment of most of their accumulated energy in putting together their equipments required to catch animals like the enzymes, the traps, the sticky tentacles and so on, means that they invest less energy in the assemblage for gathering energy to photosynthesize. But still, in nutrient poor soils, these plants are at an advantage over normal plants in acquiring nutrition in a more efficient manner which cannot be obtained through conventional means. Also, in bogs, sunlight is found abundantly, so even a less capable carnivorous plant can survive by photosynthesizing and catching prey. Actually, these plants have made up for the shortage of nutrients in their habitat by trapping and digesting insects that act as supplement to their diet.

So, how do carnivorous plants reproduce? Some reproduce asexually, and other sexually. Now, this brings out yet another question about the sexually reproducing carnivorous plants that are insect pollinated (and most seem to be have flower traits that indicate that they are pollinated by insect visitors)- how do they differentiate the insects that

help them to pollinate and those that provide them with nutrition! Well, it looks like they are not always successful in doing so – in some species pollinators do get trapped as food. However, some of them seem to have their own way to deal with this problem – flowers and traps are located in different parts of the plant so that visitors to the flowers, potential pollinators, are not in immediate danger of become food for the plant. There has been some speculation that some carnivorous plants emit odour to attract prey and pollinators at different times – flowers and traps do not emit attractive odours at the same time. Perhaps in plants that trap pollinators, the positive effects on the growth of the plant outweighs the loss of some pollination.

Nowadays, carnivorous plants are cultivated and promoted as decorative plants in various parts of the world. Special soil preparations are used for their proper development with special temperature and humidity conditions. Interestingly, with an increasing interest in the gardening of uncommon plants in India, special nurseries are available which provide carnivorous plants for decorating in houses and working places. In India, , *Nepenthes khasiana* can now be propagated by tissue culture and is being promoted and sold as decorative plants in houses of the north eastern region of the country.



**Pitcher plants cultivated at the campus of Nagaland University, School of Agricultural
Sciences and Rural Development Campus, Medziphema,
Nagaland, India**

The tribal groups along with the localities of the Khasi, Jaintia and Garo hills of Meghalaya, the area to which the species is endemic, prefer to grow this plant around their houses so as to prevent the rise in the number of insects. If we look at this practice in another angle, it will not be an exaggeration to use the term “biological control” by using natural means to control insects in the surroundings. Generally, we use this term for controlling plant pathogens in agricultural fields in order to reduce the crop losses by them. Isn't it will be interesting to explore the possibility of using insectivorous plants in areas with suitable temperature and humidity for their growth, to control the outbreak of disease-causing insects. Onepot with an insectivorous plant each in the windows of a house and in gardens around the house may prove fatal for the deadly disease causing insects!!

Inspite of being a wonder in themselves, and regardless of their potential utility as insect controlling agents, some carnivorous plants are at risk – they are endangered and need protection. Environmental changes have not left this group of plants unaffected. Release of industrial wastes in bogs has extensively increased the nitrogen content which is proving fatal for the survival of the carnivorous plants. Also human interference such as poaching for commercial purposes has threatened the mere existence of these plants, so much so that botanists now keep the location of rare species a secret. Development of residential areas by removing or filling bogs and meadows has also resulted in sharp fall in the number of carnivorous plants.

A step taken by CSIR- National Botanical Research Institute (NBRI) Lucknow, India, signifies the role of the scientific community in creating general awareness among students and children, the future of our country towards conservation of our diversity. They have very beautifully set dustbins in shape of pitcher plants in the NBRI garden to attract the attention of the viewers and also to serve their motto of general awareness. These extraordinary plants contribute to our biological diversity not just by adding to the number of species but also in terms of the way they obtain energy.



It is our responsibility to protect the diversity of “Nature”

Photographs: Prof. H. B. Singh

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