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# Impact of Changes in the Microclimatic Conditions on Species Diversity of Insectivorous Plants at Karungalagudi, (TN) India

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## ABSTRACT

A study on the interrelationship between the factors influencing vegetation change and composition of insectivorous plant community was carried out at Karungalagudi, India. Anthropogenic intervention at this site due to industrial development, agro-industrial pollution, mining, quarrying has accelerated the pace by which the microclimatic and environmental conditions have shown ever-changing temporal and special variation. This has resulted in alteration in community composition of insectivorous plants at this consortium. Anthropogenic activities along with changes in ecological process have altered the microclimatic conditions conducive for the sustenance of the tiny plant association among the members of insectivorous (Droseraceae, Lentibulariaceae), non insectivorous (Eriocaulaceae, Polygalaceae and Scrophulariaceae) and other lower plants. Changes in the environmental condition are reflected by the decline in species diversity, count of a single species and dynamics of community composition at the site. Understanding of the impact on the future changes has been hampered by the inability to disentangle conflicting, forcing factors that regulate the dynamic environment and vegetation composition of carnivorous and associated plants.

## INTRODUCTION

The expansion of humans across the earth has caused a long string of species extinctions. Unfortunately, all of these past extinctions pale in comparison to the projected effects of recent and anticipated human habitat destruction. Human conversion of natural ecosystems into managed ecosystems or into roads, rights of way, housing, and industry continues at an astounding rate. Already, about 43% of earth's terrestrial ecosystem area is directly harnessed for human benefit with some ecosystem types, especially those with fertile soils or favorable climates, much more heavily exploited (Tillman et al., 1997). The impact of anthropogenic activities on the natural environment had occurred at a variety of temporal and special scales (Tillman et al., 1994; Gallagher and Carpenter, 1997; Dobson et al., 1997). Habitat conversion from forest to cropland and then to degraded barren land is the single largest factor in the present day biodiversity crisis (Tillman et al., 2001; Seabloom et al., 2001). The industrial demand for raw materials in production of value added products ranks second (Srinivasan et al., 2008). The ever-changing climatic conditions are forcing a great threat to biodiversity. Accelerated conversion of natural habitat into cropland and deforestation for commercial development occur conically over a larger area especially in the tropical regions. It has been reported the tropical rain forest alone encodes for 60-70% of biodiversity. Reports and data from various continents show that tropical rain forest being destroyed at the annual rate of 1-4% (Reid, 1992). The development in this belt during the second half of last century has been detrimental to the vulnerable species and results in the reduction of genetic diversity. The impact of slow and longer habitat conversion due to human intervention has threatened individual species which over a period of time eventually may go extinct. Since composition and diversity of plant commune has a grater impact on the ecosystem process, disruption in composition of the ecosystem community that occurs as a species in a consortium will worsen the accumulated extinction debt (Tillman et al., 1994; Hooper and Vitousek 1997). The magnitude of distributions is often comparable with the natural disaster from which an ecosystem usually recovers over a period of time thus gradual elimination of a given species and habitat destruction in an endemic region is unrecoverable and eventually the biological diversity gets erode off due to resulting ecosystem instability (Tilman, 1996). Restoration ecology is an emerging approach to combat this crisis that encompasses the study of native habitat taking into account all the factors that regulate the substance of the species. The casual key factor affecting the decline in the genetic diversity and its decline has to be checked to recover the natural habitat and more wide spread anthropogenic changes need to be speeded up (Dobson et al., 1997).

Atmospheric transport and deposition of nutrients, is a global environmental problem with well-documented consequences for ecosystem dynamics. However, monitoring changes in the mineral content is relatively expensive and therefore predicted impacts of mineral eco-dynamics are currently derived from spatial modeling and interpolation of limited data. Ombrotrophic (“rain-fed”) bogs are nutrient-poor ecosystems that are especially sensitive to increasing nutrient input, and carnivorous plants, which are characteristic of these widespread ecosystem types and sensitive indicators of N deposition. In general distribution of carnivorous plants is restricted to sunny, moist, nutrient-poor habitats (Givnish et al., 1984). Botanical carnivory is thought to have evolved in nutrient-poor and well-lit habitats such as bogs because the marginal benefits accruing fromcarnivory exceed the marginal photosynthetic costs associated with the maintenance of carnivorous organs (Ellison and Gotelli, 2002). However, the production of carnivorous organs can be a phenotypically plastic trait. Insectivorous plants like members of Droseraceae and Lentibulariaceae have gained economic importance for the production of digestive enzymes and fluids (Gadhgil, 1997). The key factor thus identified and analyses in detail for the present study the microclimate in the native natural habitat and loss of diversity due to the changes over a period time in the microhabitat at Karungalagudi, Tamilnadu, India. The parameters that regulate the unique association are emphasized in the present study.

## MATERIALS AND METHODS

The study was conducted at Karungalagudi, located about 50kms away from Madurai, an isolated pocket in the Natham range of Dindigul Dist. TN, India. The mean annual rain fall in the area ranges from 100 - 120±20mm. The mean annual temperature varies between 35±5 . The species diversity in the area was determined by employing quadrant method in an area of 1 x1 m randomly selected at different points, maintaining a minimum distance of about 50m among the quadrates. The study was conducted over a period of 10 years, further the occurrence of insectivorous plant species in the site is more seasonal therefore the studies were conducted at the site only in the months of Oct – Dec every year. Other parameters, viz. relative humidity, temperature, light intensity, were recorded using hygrometer, thermometer and lux meter respectively. Soil sample collected from the site were analyzed in the lab following standard protocols as described by (Jebaraj and Jayakumararaj, 1998) for various parameters such as soil macro and micro nutrients, pH, salinity including the physical parameters such as texture of the soil, size of the soil particles.

## RESULTS AND DISCUSSION

It has been well established that the diversity of plant communities are governed by a-wide-array of intricate environmental factors with in the population level (Grime, 1997; Hooper and Vitousek, 1997). This implicates that habitat preference which in turn is due to the apt micro climatic conditions is the key factor that sustains the unique composition of species diversity of insectivorous plants in an endemic consortium (Jebaraj and Jayakumararaj, 1998). It has been periodically observed that the seeds and spores of the plants in the consortium germinate with a week's time after the downpour during the on set of monsoon as the site being ombrotrophic area. The diversity of the plant communities at the site was recorded as the maximum during the months of Oct to Dec. The composition of the insectivorous plants and its associated plants in the study site has been presented in Table 1.

It was observed that most species of carnivorous plants in the site are localized in nutrient-poor environments, therefore growth and flowering transition probabilities can by-and-large be affected by nutrient availability. It has been observed that the germination of the seeds and spores of associated plants dependent on the abiotic parameters are driven the community dynamics. Ellison and Gotelli (2002) pointed out that nitrogen content of the soil determines species diversity of the insectivorous plants and the community composition on a whole in an endemic region. However, it has to be stressed that very existence of the endemic species composition at the site is determined by the composition of the soil and uncontaminated rain water. Furthermore, the site is free from other source of agro industrial pollutants such as chemical fertilizers and pesticides.

The quarrying activities and installation of a granite industry in this site led to the destruction of the plant communities in this consortium with the decline in number of insectivorous plant species (JohnJebaraj and Jayakumararaj, 1998). The process of elimination of sensitive and venerable insectivorous plant species from the site was however related to the mining work. Industrialization in particular the process of mining has resulted in pollution and degradation of the preferential habitat. In long run over a period of time quarrying degraded the ecosystem and as now it reached a stage from where it is hardly possible to recover the endemic diversity of the insectivorous plant community. The ecophysiological mechanism underlying this biological indicator also suggests that other carnivorous plants could be used as biological indicators of nutrient accumulation and utilization (Ellison and Gotelli 2001; 2003) .Givnish et al (1984) pointed out that the cost–benefit model for the evolution of carnivory predicted that carnivory will not be favored when there is an excess supply of nutrients in the environment.

Quarrying resulted immobilization of native soil nutrients and removal of rock from the site affected the community dynamics, but the association was still successful in colonizing the surrounding but later with the functioning of the industry, the transport of the stones and related problems added to the reduction in the diversity of the plants and the count of plants belonging to a single species (*Uticularia*) (Tilman et al., 1997). Besides the crushing industry produces very fine dust particles of the rocks that are carried to distant area by mild wind. This ultimately destroys the whole plant association through destabilization of the auto regulating mechanism which is very slow and operates in a mild dynamic state (Jebaraj and Jayakumaraj, 1998). The deposition of silicon introduces changes in the parameters of the microclimate like humidity and the exposure of the plants to the sun light. The deposition of the sand particles reduces the water holding capacity of the soil. Further, changes in the soil surface temperature and accelerated percolating rate the growth of BGA and mosses is drastically affected. The deposition of dust promotes a drying effect on the tentacles of the leaves thus the insect feeding mode of nutrition of the insectivorous plants in the site is significantly affected. However, remedy to circumvent the problem is not possible on a large scale. Analysis of the soil properties and microclimatic conditions reveals that the shift of soil pH to alkalinity failed to support the growth of the insectivorous and its associated plants (Jebaraj and Jayakumararaj, 1998). Further, it was observed that the mobilization of the nutrients was significantly reduced as the deterioration process got arrested due to change in soil property. The plant species were however found to grow in isolated places due to dispersal by anthropogenic activities. This can be taken as an example of primary succession. However, conservation of the incredible plant species at this site is possible only if appropriate management technology is applied through eco-modeling and reconstruction of the affected plant community structure. If not now we will have to pay for the loss in the diversity of the insectivorous plant species at the unique endemic site.

## CONCLUSION

Because endemic ecological conditions can cause severe and long-lasting environmental damage with large economic costs, ecologists must identify possible environmental regime shifts and pro-actively guide ecosystem management. An integrated understanding of the changes relationship between the components and the interaction between the biotic and abiotic factors is essential for the conservation of the rare and endemic plant species at this site. Insights into the ecological community structure, dynamics and the ecosystem function provide vital information for habitat conservation and reconstruction of the distracted habitat to sustain the incredible biodiversity.

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**Table 1**. Species diversity of insectivorous/ associated plants at Karungalagudi.

| Insectivorous plants | Non insectivorous plants | Lower plant groups |
|---|---|---|
| **Droseraceae** | **Eriocaulaceae** | **Algae** |
| ***Drosera*** | ***Eriocaulon*** | |
| *Drosera burmannii* Vahl | *Eriocaulon dianae* | Blue green algae |
| *D. indica* L. | *Eriocaulon decangulare* | Green algae |
| *D. brevifolia* Pursh | *Eriocaulon quinquagulare* | |
| | | |
| **Lentibulariaceae** | **Scrophulariaceae** | **Bryophytes** |
| ***Utricularia*** | ***Striga*** | Hepaticopsida |
| *U. bifida* L. | *Striga gesnerioides* | Bryopsida |
| *U. hirta* Klein ex Link | *Striga angustifolia* | |
| *U. minutissima* Vahl | *Striga asiatica* | |
| *U. polygaloides* Edgew. | | |
| *U. minor* L. | **Polygalaceae** | **Pteridophytes** |
| *U. resupinata* Green | ***Polygala*** | *Isoetales* |
| *U. uniflora* R.Br. | *Polygala telephioides* | |
| | | |
| | **Lytharaceae** | |
| | *Rotala verticillaris* | |