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ALIEN FLORA INTO THE FRAGILE ECOSYSTEM OF ANDAMAN AND NICOBAR ISLANDS: A MAJOR CONCERN

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Abstract

The Andaman and Nicobar Islands epitomize a diverse Island biogeographic zone characterized by rich heritage of biological wealth. The Andaman and Nicobar Islands are evolved from volcanic eruptions and are continuity of Arakan Yoma mountain of Myanmar and subsequently other Islands are of coral reef origin developed. As these Islands are very far from any part of mainland and developed its own flora by evolution and also gathered flora of South East Asia. The insular flora of this archipelago consisting of about 2654 species belonging to 219 families and 1046 genus within a land area of 8249 km^2 on 572 Islands and islets is a momentous feature, making them a cynosure not only for plant taxonomists but also for conservationists. The rare and distinct flora which evolved through millions of years due to the insular nature of the territory, physical isolation between the Islands and also from the neighboring continental landmasses, is unique in India. It has been reported that there are 250 and above medicinal plants, 154 plant with edible portions mostly used by tribes and there are 44 plants which can be directly recommended for cultivation or can be used in horticultural technologies. There are many wild relatives of horticultural importance, out of which 12 plant species are found endemic. Tribes of these Islands also use around 231 plant species parts as flock medicines. All the available literature on flora of Andaman and Nicobar Islands were scrutinized and a total of 592 introduced alien plant species of agricultural importance, dangerous weeds and other flora has been discussed in this paper including their damage to the fragile ecosystem and habitat destruction of native plant species.

Keywords: Fragile Island Ecosystem, Alien Flora, Indigenous plants

INTRODUCTION

The Andaman and Nicobar Islands are about 1200 km away from the mainland of the Indian sub-continent; these Islands are also called "Bay Islands". These Islands are blessed with the influence of the south-west and north-east monsoons, they receive rains from April to December. The mean annual precipitation is around 3100 mm unevenly distributed through out the year and the temperatures vary between maximum (30^o C) and minimum (23^o C). The Andaman and Nicobar group of Islands possess an apparently uniform tropical humid and warm climate, showing considerable variation in the biodiversity and vegetation patterns. According to Island biogeography mode that is based on species-area relationship the number and nature of species in an Island ecosystem depends upon distance of Island from the mainland and area of Islands (Robert *et al.*, 1967). Islands far away from mainland are mainly dominated by smaller animals and small seeded plant species, while Islands closer to main lands are dominated chiefly by larger animals and plant species. However exact form of species area relationship can be accurately described by formula given by Robert *et al.* (1967).

The socio economic status of people of these Islands is better than those of mainland India. The population pattern starts with aboriginal tribes (Onges, Jarwas, Sentinals and Andamanese) who completely depend on forest products. The Nicobaries a Mongoloid group is a migrated population long back from Myanmar and cultivate coconut and rear pigs. The shompans who are Mongoloid and their origin confined to one Island and are completely depend on forest products. Other populations are from many states of mainland India and Myanmar, Bangladesh and Sri Lanka. All these people introduce cultivated crops of their liking. Many non-native plants have also been introduced into new territories, initially as either ornamental plants or for soil erosion control, stock feed, food, or

forestry. Whether an exotic species will become invasive was seldom understood in the beginning, and many non-native ornamentals languish in the trade for years before suddenly naturalizing and becoming invasive. By definition, a species is considered "introduced" when it is transported into an area outside of its native range is human mediated. This higher frequency of germination of introduced plants solely depends on competition with other plants species that ultimately leads to deletion of some of wild species.

Introductions of plant species by humans can be described as either intentional or accidental. Intentional introductions have been motivated by individuals or groups who believe that the newly introduced species will be in some way beneficial to humans in its new location. Unintentional or accidental introductions are most often a byproduct of human movements, and are thus unbound to human motivations. An introduced species might become invasive if it can out-compete native species for resources such as nutrients, light, physical space, water or food. Invasive species often coexist with native species for an extended time and gradually the superior competitive ability of an invasive species become apparent when its population grows larger and denser often after it adapts to its new location. Normally an introduced species must survive at low population densities before it becomes invasive in a new location. At low population densities, it is often difficult for the introduced species to reproduce and maintain it self in a new location, but often due to human actions a species might be transported to a location a number of times before it become established. Repeated patterns of human movement from one location to another, such as ships sailing from one port to another port and cars driving up and down highways, allow few species to have multiple opportunities for establishment. Ever since the time of Darwin and Wallace, Islands have been recognized as natural laboratories for the study of evolution and plant species diversity and adaptation.

In future some of the endemic species of most Islands will be known only by the specimens in museums. It is therefore both important and urgent that selected Islands biota's be thoroughly studied while there is still time. The assumption that an Island of given size can support only a limited number of species and that when this "saturation point" has been reached further colonization must be balanced by extinction of some species. Forest species which are generally highly heterozygous in nature required a specific number of plants on a given Islands to maintain its heterozygosity and vigor. If this number is affected their survival on the small Islands is doubtful.

METHODOLOGY

All the available literatures on flora of Andaman and Nicobar Islands were consulted to document the introduced species from time to time (Pandey and Diwakar, 2008; Mohanraj *et al.*, 1999; Dagar and Singh, 1999; Awasthi and Jacob, 1987; Balakrishnan and Vasudeva Rao, 1984). Important species caused damage to the indigenous species were discussed. Indirect effect of the bio-recycle of forest products, extraction of economically important species ruthlessly and their effect, cultivation of rice in reserve forest close to National Park and its effect on indigenous plants also pointed out in this paper.

RESULTS AND DISCUSSION

The present paper deals with 592 introduced or non-indigenous plant species of crops, weeds and other flora belonging to 99 families and 379 genera was introduced into this Islands. They were classified as number of available herbs, shrubs, trees and climbers in each family (Table 1). It has been observed that maximum number of genera belongs to the family Poaceae (30) followed by Fabaceae (24), Asteraceae (21) and Acanthaceae (13). Amount the introduced species, the maximum number of species belongs to the family Poaceae (41), followed by Fabaceae (37), Euphorbiaceae (31), Araceae (25) and Asteraceae (24).

Among the herbs family Poaceae (41) showed highest number followed by Asteraceae and Fabaceae (21). Maximum number of shrubs from the family Euphorbiaceae (16), followed by Acanthaceae (12) and Rubiaceae (11). From the tree category highest number of species from the family Caesalpiniaceae (13), followed by Arecaceae (12). Among the climbers as there is large number of vegetables, Cucurbitaceae (12) followed Fabaceae (9) and Araceae & Convolvulaceae (8).

Table 1. Number of introduced flora in Andaman and Nicobar Islands

Sl. No.	Families	Genera	Species	Herb	Shrub	Tree	Climber
1.	Acanthaceae	13	17	4	12	0	1
2.	Agavaceae	7	13	4	4	5	0
3.	Amaranthaceae	6	10	9	1	0	0
4.	Amaryllidaceae	3	5	5	0	0	0
5.	Anacardiaceae	2	2	0	0	2	0
6.	Annonaceae	3	5	0	0	4	1
7.	Apiaceae	7	7	7	0	0	0
8.	Apocynaceae	11	13	0	6	3	4
9.	Araceae	11	25	16	2	0	7
10.	Araliaceae	3	6	0	5	1	0
11.	Araucariaceae	1	2	0	0	2	0
12.	Arecaceae	11	12	0	0	12	0
13.	Asclepiadaceae	2	2	0	1	0	1
14.	Aspleniaceae	1	1	1	0	0	0
15.	Asteraceae	21	24	21	0	0	3
16.	Averrhoaceae	1	2	0	0	2	0
17.	Balsaminaceae	1	1	1	0	0	0
18.	Basellaceae	1	1	1	0	0	0
19.	Begoniaceae	1	6	6	0	0	0
20.	Bignoniaceae	8	9	0	2	5	2
21.	Bixaceae	1	1	0	0	1	0
22.	Bombacaceae	3	3	0	0	3	0
23.	Boraginaceae	3	5	2	1	2	0
24.	Brassicaceae	4	6	6	0	0	0
25.	Bromeliaceae	1	1	1	0	0	0
26.	Cactaceae	4	4	0	3	1	0
27.	Caesalpiniaceae	9	18	2	3	13	0
28.	Campanulaceae	1	1	1	0	0	0
29.	Cannabinaceae	1	1	1	0	0	0
30.	Cannaceae	1	1	1	0	0	0
31.	Caricaceae	1	1	0	0	1	0
32.	Caryophyllaceae	1	1	1	0	0	0
33.	Cleomaceae	2	4	4	0	0	0
34.	Clusiaceae	1	1	0	0	1	0
35.	Combretaceae	2	2	0	0	0	2
36.	Commelinaceae	4	4	4	0	0	0
37.	Convolvulaceae	4	10	2	1	0	7
38.	Crassulaceae	1	4	4	0	0	0
39.	Cucurbitaceae	10	15	3	0	0	12
40.	Cupressaceae	1	2	0	0	2	0
41.	Cyperaceae	4	7	7	0	0	0
42.	Dioscoreaceae	1	2	0	0	0	2
43.	Ebenaceae	1	1	0	0	1	0
44.	Euphorbiaceae	11	31	11	16	4	0
45.	Fabaceae	24	37	21	3	4	9
46.	Flacourtiaceae	1	1	0	1	0	0
47.	Gesneriaceae	2	4	4	0	0	0
48.	Hydrangeaceae	2	2	0	2	0	0
49.	Iridaceae	1	1	1	0	0	0

50.	Lamiaceae	7	13	12	1	0	0
51.	Lauraceae	1	2	0	0	2	0
52.	Lecythidaceae	1	1	0	0	1	0
53.	Liliaceae	6	10	7	2	0	1
54.	Lythraceae	3	5	1	2	2	0
55.	Magnoliaceae	2	2	0	0	2	0
56.	Malpighiaceae	2	2	0	2	0	1
57.	Malvaceae	6	10	1	8	1	0
58.	Marantaceae	2	6	6	0	0	0
59.	Meliaceae	4	5	0	0	5	0
60.	Mimosaceae	10	15	0	5	8	2
61.	Moraceae	2	7	0	0	7	0
62.	Moringaceae	1	1	0	0	1	0
63.	Musaceae	2	5	5	0	0	0
64.	Myristicaceae	1	1	0	0	1	0
65.	Myrtaceae	5	10	0	1	9	0
66.	Nyctaginaceae	3	6	2	0	0	4
67.	Oleaceae	2	4	0	1	1	2
68.	Onagraceae	1	2	2	0	0	0
69.	Oxalidaceae	1	1	1	0	0	0
70.	Pandanaceae	1	1	0	0	1	0
71.	Papaveraceae	1	1	1	0	0	0
72.	Passifloraceae	1	3	0	0	0	3
73.	Pedaliaceae	1	1	0	0	0	1
74.	Piperaceae	2	6	5	0	0	1
75.	Plantaginaceae	1	1	1	0	0	0
76.	Plumbaginaceae	1	2	0	2	0	0
77.	Poaceae	30	41	41	0	0	0
78.	Polygonaceae	3	3	1	0	0	2
79.	Pontederiaceae	2	2	2	0	0	0
80.	Portulacaceae	2	4	3	1	0	0
81.	Pteridaceae	1	1	1	0	0	0
82.	Punicaceae	1	1	0	0	1	0
83.	Rhamnaceae	1	1	0	0	1	0
84.	Rosaceae	1	1	1	0	0	0
85.	Rubiaceae	8	17	3	11	3	0
86.	Rutaceae	4	6	0	2	4	0
87.	Sapindaceae	2	2	0	0	1	1
88.	Sapotaceae	1	1	0	0	1	0
89.	Scrophulariaceae	3	3	2	1	0	0
90.	Solanaceae	7	13	5	8	0	0
91.	Sterculiaceae	4	4	1	0	3	0
92.	Strelitziaceae	1	1	0	0	1	0
93.	Theaceae	1	1	0	1	0	0
94.	Thunbergiaceae	1	1	0	0	0	1
95.	Tiliaceae	1	1	0	0	1	0
96.	Urticaceae	2	7	4	0	0	3
97.	Verbenaceae	12	17	4	9	3	1
98.	Vitaceae	1	1	0	0	0	1
99.	Zingiberaceae	4	6	6	0	0	0
Total		**379**	**592**	**269**	**120**	**129**	**75**

The insular nature of territory of Andaman and Nicobar Islands, chiefly characterized by high humidity and rainfall around eight months of a year. Due to very highly humidity and rainfall this Island is immensely rich in genetic diversity of tropical flora and fauna. Out of 572 Islands only few islands have been surveyed to study the flora in details. It has been reported that there are 250 and above medicinal plants, 154 plant with edible portion mostly used by tribal and there are 44 plants which can be use in horticultural technologies (Sharma *et al.*, 2010). However, in other parts of Islands flora is being studied by different botanist at different time frame.

Some species that are intentionally introduced for example agricultural crops, fodder and timber plants may escape from the captive or cultivated populations and subsequently establish independent breeding populations. Some weeds like *Parthenium hysterophorus* (congress weed), *Mikania cordata*, *Eichhornia crassipes* (water hyacinth) that was introduced as recreational flora have now become a invasive threat found growing at an alarming rate. Oil palm which was introduced in early 1960 is also spreading in these Islands (birds, rodents etc as disbursing agent) and occupies some prime areas and may affect the local tropical palms. Increasing rate of human travel, natural calamities are providing accelerating opportunities for species to be accidentally transported into areas in which they are not considered native. Abiotic factors like wind and water are equally responsible for the transport of plant seeds to distant Islands. Introduction or invasion of such large number of species into these Island ecosystems with special reference to small Islands and islets will cause genetic erosion of native species as their habitat will be populated with these introduced species. These species may also become a carrier of pest which will affect the native species, which might not have tolerance to the new pest. Root crops like *Manihot esculenta* (Tapioca), *Zingiber officinale* (Ginger), *Ipomoea batatas* (Sweet potato) were introduced into these Islands and were cultivated on hill slopes. These crops are harvested during summer and the dug out soil get eroded causing soil loss along with nutrients. One or two crops like this will make the top soil unfertile and crops and local species will also get damaged. The soil will erode along with rain water and block the coral reef area as well as other habitat of local species. Among plant species rates of out crossing appears to be higher in tropical plant species than in temperate once (**Bawa,** 1992). Higher rates of out crossing may lead to higher level of genetic variability, local adaptation and speciation. Because of these new introduced species the inaculam of the disease or the insect pest population will be always present in that micro environment and may cause damage to the local species. The bird population is also getting reduced because of indiscriminate pesticide use and other natural disaster like Tsunami that disturbed their natural well established habitat and breeding ground, which may affect the dispersal of forests flora seeds. Successful survival of a plant species in a new geographical area is affected by many factors like climatic, soil profile, competition, and genetic factors of that plant (Derek *et al.*, 2004). Among these factors competition plays very important role in the survival and success of introduced flora in the new habitat. According to Charles Darwin every organism has capability to produce maximum number of offspring's for success in competition and for survival in the nature. Thus the introduced species produces maximum number of seeds and other reproductive bodies for retaining identity of its species.

Thousands of species are going extinct as a result of human activities. Conservation biology is a new synthetic discipline to deal with unprecedented crisis. Conservation biologist and applied biologist should search approaches to prevent extinction of species, the loss of genetic variation and the destruction of biological communities. The highest species extinction rates during historic times have occurred on Island ecosystems as reported by IUCN, 1998 (Reid and Miller, 1989). Most of the extinction of birds during the last 350 years have occurred on Islands (King, 1985) and at least 90 per cent of the endemic plants of oceanic Islands are extinct or in danger of extinction. Many species of forests completely depend on birds for their seed dispersal. Important species like *Momordica cochinchinensis* requires a bird's gut passing of its seeds for germination. Wherever major extraction activities have taken place, large numbers of people were brought as forest labor got themselves settled and started cultivation of rice. The cultivation of rice starts with paddling of the land in the heavy rain period which in turn discharges large amount of soil during the heavy rains. This flows to the sea affecting coral reefs. A typical example is Rutland in South

Andaman. This Rutland Island is having most of the species suppose to be present in southern groups of Islands and because of human activities, plant and other species extinction is happening at an alarming rate. With the use of agrichemicals not only effect the chemical composition of soil but also reduce the bird population. Island species are particularly vulnerable to extinction because many of them are endemic and mainly through habitat destruction. Island species have usually evolved and undergone speciation with reduced level of competition, predation and threat of diseases.

In contrast, competition, predation and disease competitiveness in species from mainland are introduced in these Islands. They decimate the Island species which have not evolved any defense against them. Humans have radically altered this pattern by transporting species throughout the world. In pre-industrial times, people carried cultivated plants and domestic animals from place to place as they set up new farming areas and colonies. In modern times a vast array of species has been introduced deliberately and accidentally into the areas where they are not native (Mooney and Drake, 1986).

The control of introduced or invasive species can involve their eradication or their containment within a specified area. This can be done either by mechanical removal of plants or by using chemicals like herbicides to kill these invasive plants. While the former method is labor intensive and requires a large time investment, as treatments must often be applied several times to ensure success and the latter is dangerous, as the chemicals lack target specificity and kills desirable plant species. A new approach of biological control can be applied with proper research. This method is both environmentally safe and successful. Preventing the establishment of introduced or invasive species is always the best method of control. Stopping harmful species at this stage can be difficult. Many governments try to limit the entry of invasive species into their lands with thorough inspections of international shipments, customs checks, and proper quarantine regulations. The creation of a list of safe and potentially harmful species can be helpful in regulation. This has to be carried out in these Islands also. The general public can also participate in invasive species prevention by educating themselves about invasive species and by making informed decisions. Later publications on this aspect should also be taken care off. To complete the scientific understanding of ecology and evolutionary biology some large and small Islands have to be conserved without any disturbance.

Long term monitoring of ecosystem processes (temperature, rainfall, humidity, soil acidity, water quality, discharge rates of streams, soil erosion etc.), communities (species present, amount of vegetative cover, amount of biomass present at each tropic level) and population number (number of individuals present in a particular species) is necessary to protect biological diversity since it is otherwise difficult to distinguish normal year to year fluctuations from long term trends (Magnusan, 1990). For example, many amphibians, insects and annual plant populations are highly variable from year to year. So many years of data are required to know whether a particular species is actually declining in abundance over time or merely experience in a number of low population years that are increased with its regular pattern of variation. Therefore long term research sites should be established and monitored for conservation. A mega project on these lines has to be planned and executed without loosing any further time. Year marking the Islands on their floral diversity, size specific, location specific and geological factors should be taken under consideration for these studies.

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