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Alien Flora into the Fragile Ecosystem of Andaman and Nicobar Islands - A Major Concern

The Andaman and Nicobar group of (A and N) Islands epitomize a diverse bio-geographic zone characterized by rich heritage of biological wealth. 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 A and N Islands consisting of about 2574 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. There are 316 indigenous plant species (Pandey and Diwakar, 2008), out of which 130 species were entered in the red data book (Rao *et al.*, 2003). Therefore utmost care should be taken to save these from invasive plant species. There are many wild relatives of horticulturally important species, out of which 12 species are found endemic. Tribes of these Islands also use around 231 plant species as flock medicines.

The A and N 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 (Mac Arthur and Wilson, 1967) the number and nature of species in an Island ecosystem depends upon its area and distance from the mainland. Smaller animals and small seeded plant species mainly dominate islands far away from mainland, while larger animals and plant species dominate Islands closer to mainland. However exact form of species area relationship can be accurately described by formula given by Mac Arthur and Wilson (1967).

$S = CAZ$

Where S = Number of species on an Island, A = Area of Island, C and Z = Constants

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 to and from ports or 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.

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.

All the literature available of Flora of A and N Islands were scrutinized for introduced species time to time. 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. These were classified as number of available herbs, shrubs, trees and climbers in each family. 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.

It has been observed (Pandey and Diwakar, 2008; Mohanraj, *et al.*, 1999; Dagar and Singh, 1999; Awasthi and Jacob, 1987; Balakrishnan and Rao, 1984) that maximum number of genera (30) of family Poaceae followed by genera (24) of family Fabaceae, genera (21) of family Asteraceae and genera (13) of family Acanthaceae are introduced into these Islands. Maximum 41 number of species of the family Poaceae, followed by 37 species of family Fabaceae, 31 species of family Euphorbiaceae, 25 species of family Araceae, 24 species of family Asteraceae were introduced.

Forty-one herbs of family Poaceae followed by 21 herbs of family Asteraceae and Fabaceae and 16 herbs of family Araceae were the largest among the introduced herbs. Maximum 16 shrubs of family Euphorbiaceae followed by 12 shrubs of family Acanthaceae and 11 shrubs of family Rubiaceae are introduced. In the tree category, 13 trees of family Caesalpiniaceae, followed by 12 trees of family Arecaceae is the largest number. Among the climbers as there are large number of vegetables, 12 climbers of family Cucurbitaceae followed by 9 climbers of family Fabaceae and 7 climbers of Araceae and Convolvulaceae are introduced into these Islands.

The insular nature of territory of A and N Islands, chiefly characterized by high humidity and rainfall around eight months of a year. Due to very highly humidity and rainfall this Island is immensevely rich in genetic diversity of tropical flora and fauna. Out of 572 Islands only flora of south Andaman and Car Nicobar have been studied in great details. However in other parts of A and N Island 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 and occupies some prime areas and may affect the local tropical palms. Increasing rate of human travel, natural calamities etc. 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 (interbreeding with other individuals of the same species, as opposed to self pollination) 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. Introduced species carrying the inoculum of the disease or the insect pests will be always present in the microenvironment and may cause damage to the local species. The bird population which affect the dispersal of forests flora seeds is also getting reduced because of indiscriminate pesticide use and other natural disaster like *Tsunami*. Most of the extinction of birds during the last 350 years have occurred on Islands (King, 1985) and at least 90% 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. 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 (Spielman, *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. The highest species extinction rates during historic times have occurred on Island ecosystems as reported by IUCN, 1998, Reid and Miller, 1989. 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 puddling 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. 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.

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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