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INVASIVE SPECIES: THEIR DEFINITIONS AND SALIENT FEATURES

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SUMMARY

The spread of alien invasive species into native ecosystems and habitats has gained increasing recognition worldwide due to their significant impact on biodiversity. The concern over the spread of such species is reflected in the Convention on Biological Diversity (CBD), to which Sri Lanka is a signatory, and in National Biodiversity Action Plans. The present paper provides information on the definitions and salient features of alien invasive species, and predicting and impact assessment of biological invasions.

INTRODUCTION

Biological invasions by alien species is acknowledged by scientists and governments as one of the major threats to indigenous or native biodiversity in almost every country in the world. They have affected fresh water and marine ecosystems, tropical and temperate forests, urban areas and roadsides, islands grasslands and even deserts. The impact of these invasive species on biodiversity is immense, irreversible and hence irreparable, yet still remains poorly understood.

For millenia, the natural barriers of oceans, mountains, rivers and deserts provided the isolation essential for unique species and ecosystems to evolve. However, in few hundred years these barriers have been rendered ineffective. Exploration of pristine wilderness areas, conversion of them to other land uses through intentional and unintentional introductions of organisms, and increased travel and trade have inadvertently ended millions of years of biological isolation and created this major threat to native and naturalized biodiversity in both developing and developed countries alike.

Invasive species are found in all taxonomic groups, and include introduced viruses, fungi, algae, mosses, ferns, higher plants, invertebrates, amphibians, reptiles, birds and mammals. They have invaded and affected native biota in virtually every ecosystem type on earth. Hundreds, probably thousands of extinction, especially on islands, have been caused by alien invasives.

The inter-mixing of flora and fauna through human agencies across bio-geographic regions, which is facilitated through disturbance and destruction of natural habitats, has been a major cause of biological extinction throughout the world. While a number of such extinction occurred during the past several centuries have been well documented, many of them have gone unrecorded due to poor understanding of the indigenous biodiversity and the severity and magnitude of their destruction. However, there is now and increasing realization of the ecological costs of biological invasions in the unrecoverable loss of indigenous biodiversity.

The threat to natural and semi-natural ecosystems by invasion of alien organisms is a lasting and pervasive threat as compared with that of exploitation or pollution. Even though the introduction of alien organisms could stop the expansion of existing aliens, the former do not disappear, but in contrast they continue to spread and colonize and hence may be called a more pervasive threat. Invasion of biological communities in many parts of the world by introduced organisms therefore, constitutes one of the most serious threats to their survival. Their ecological and economic costs are considerable.

The spread of alien invasive species into native ecosystems and habitats has gained increasing recognition over the last decade as a significant impact on biodiversity worldwide. The concern over the spread of such species is reflected in the Convention on Biological Diversity (CBD) and in National Biodiversity Action Plans including that of Sri Lanka. The Article 8 on *in-situ* Conservation under section (h) of the CBD calls for each contracting party to take measures as far as possible and appropriate, to prevent the introduction of, control or eradicate alien species that threaten ecosystems, habitats or species.

In responding to the Convention ideals, Sri Lanka has recognized the need for the development and implementation of measures such as policies, plan legislation, and programs to prevent alien species (including genetically modified organisms) from adversely affecting our biodiversity.

Definitions

In general, invasive species are those that are most often not native to a geographical region or a country and have the ability to compete with and replace native species in natural habitats. A native species occurs within its natural range and dispersal potential and is distributed within the range it occupies naturally or could occupy without direct or indirect introduction or are by humans. For the most part, invasive species are alien species, commonly referred to as exotics, introduced or non-indigenous species that have come from other geographical regions through intentional or unintentional introductions into an area or ecosystem in which it is not native. However, even the native species can sometimes become invasive, triggered by natural or human-induced habitat changes.

Most of our invasive species have come from tropical, subtropical or warm temperate regions of other continents while still others, especially those in the cooler mountains have come predominantly from temperate Europe where the climate is somewhat similar. Those alien species that are able to adapt to their new environments and extend their range beyond the initial points of introductions are considered to be naturalized species.

Naturalized species are only considered to be invasive if they possess "weedy" or "invasive" characteristics that enable them to spread rapidly and aggressively and compete with the native flora or fauna to form dense populations that interfere with the natural development of biotic communities. These species have spread rapidly and widely in different climatic regions but nowhere do they form extensive populations. They generally occur scattered throughout disturbed habitats as individuals and small groups.

Any plant or animal, including both native and alien species can be considered to be a weed or a pest if it grows or thrives where it is not wanted and becomes a nuisance due to its presence in large numbers, or because of objectionable and possibly harmful attributes. The majority of alien plant species are however, agricultural and roadside weeds. Most weeds are not invasive in their natural habitats although many have considerable economic impact on agricultural biodiversity. This results from their prolific growth and in some cases their harmful characteristics that result in injury or sickness to livestock or humans.

The spread and establishment of alien invasive species has interfered with the natural co-evolution process of indigenous biotic communities in a given ecosystem sometimes to the point of the total elimination of the latter. This is of particular significance to a small tropical island like Sri Lanka blessed with rich biodiversity and high incidence of point endemism as a consequence of geographic isolation habitat diversity and the subtle niche specialization of incumbent species. Islands, including isolated biological systems such as lakes, montane and lowland rain forest ecosystems are especially vulnerable to biological invasions.

The rare endemic species, which have evolved in isolation over a long period of time are particularly vulnerable to extinction through competition or perdition from introduced species. Invasive species, through their ability to reproduce and colonize rapidly in a new environment, may alter ecosystem processes displacing native species, sometimes hybridizing with native species, and supporting other non-native plants, animals and pathogens.

With the increased accessibility to the remotest ecosystems and wilderness areas the threats posed by alien invasive species to global, regional and national biodiversity through both intentional and unintentional introduction are considerable and ever-increasing. Prevention of further biological invasions and management of existing invasive species, which have become a conservation threat, is therefore an extremely urgent priority. In future, management of invasive species will become an important and indispensable component of conservation of indigenous biodiversity.

Salient Features of Alien Plants

There is considerable evidence to show that species that share some or all of the following characteristics are most likely to be invasive;

- Reproducing early in their life cycle.
- Produce many small seeds.
- Seed dispersal by animals
- Ability to reproduce both by seeds and vegetative growth.
- Have extended flowering and fruiting periods.
- Self-compatible breeding system.
- No special seed germination requirements.
- Ability to thrive well in nutrient-poor habitats

Predicting Invasion

Some evidence also indicates the following characteristics may be predictors of invasiveness of species;

- Self-fertility or self-compatibility (can fertilize itself).
- Species with large native ranges (well adapted to a variety of climate and soil conditions and therefore more likely to find suitable habitat in a new area).
- No close relatives among any native species.

Preliminary data from one interesting study shows that invasive species are likely to have relatively small amounts of DNA in their cell nuclei. Apparently, the cells in these plants are able to divide and multiply more rapidly and consequently the entire plant can grow faster than species with higher cellular DNA content. Some species become invasive many decades after their first introduction.

A species that rarely spreads today may turnout to be troublesome several decades later. Therefore, it is important identify a method to determine which species are most likely to become invasive to arrest their spread more efficiently. Several hypotheses have been put forward based on ecological theory to explain and predict more reliably the biological invasions, as given below (Cronck and Fuller, 1995);

- *Absence of predator hypothesis*: Invasions occur in the absence of natural pests, predators and diseases of a species.

- *Greater reproductive potential hypothesis*: Rapid invasions are made possible by the greater reproductive potential of the invading species than those in the community being invaded. Many invasive plants produce large quantities of seed, which are often retained in the soil as seed-banks and may be much larger than those of native species.

- *Chemical changes hypothesis*: Plants invasions occur after the chemical characteristics of a habitat have changed by fertilizer or sewage pollution (eutrophication) *eg.* Algal blooms.

- *Disturbance-produced gaps hypothesis*: Increased disturbance may increase the invasibility by lowering the competition for establishment.

Impact Assessment of Biological Invasions

When an alien species is spreading its likely impact should be assessed. Information should be collected to evaluate its further spread and likely effects on native organisms and ecosystem process. This impact assessment is important in deciding which species should be given priority for control, as ecosystem effects have important consequences for conservation and control. Impact assessment is also an important stage in the cost:benefit analysis involved in planning control measures, particularly biological control. Biological and ecological characteristics such as the following in both native and introduced habitats should be recorded to aid the prediction of spread and control of alien invasives:

- *Seed dispersal mechanism*: adaptations for both short- and long-distance dispersal.
- *Seed ecology*: high or low seed production (continuous or seasonal), longevity of seeds, dormancy mechanisms.
- *Breeding system*: adaptation for self-fertilization and cross- fertilization, ability to reproduce vegetatively.
- Requirements for germination and establishment.
- Rate of growth under favourable conditions.
- Ability to re-sprout after curing.
- Environmental factors: tolerance to frost, fire and shade, nutrient and water requirements, etc.
- Susceptibility to pests and diseases: generalist or specialist pests.
- Comparative ecology of the invasive species with that of other species, which are most likely to replace it after control measures have been adopted.

Potentially harmful alien species can enter a country through either unintentional or intentional (authorized or unauthorized) introductions. The former is perhaps the most difficult category of alien species to regulate and deal with. These organisms are involuntarily carried around by widespread human activities such as trade and tourism. Among the more common examples are;

- Aquatic organisms in ballast water of ships.
- Disease causing organisms and parasites brought in with unauthorized introductions.

- Involuntary movement with substrates of traded/transported items (water for fish, soil for plants, etc.).
- Insects and other terrestrial organisms on aircraft and ships.
- Aquatic organisms dispersed through canal systems.

The risk of unintentional introductions that are described as "accidental" introductions could be minimized or avoided by following proper safety guidelines as given below;

Education and awareness: Reducing the risk of unintentional introductions should be addressed by both formal and non-formal education of all sectors of society. The article 13 of the Convention of Biological Diversity entitled "Public Education and Awareness" recognizes the importance of public education and education in all aspects of biodiversity conservation including exotic biodiversity.

Trade: When international or bilateral trade agreements are developed they should incorporate safeguards to revert unintentional introductions. Mail-order companies dealing with live specimens should be strongly monitored by the government authorities in both exporting and importing countries.

Development: Where large civil engineering projects are envisaged such as canals and tunnels, which would link different bio-geographical zones, the implications of the linkage for mixing the fauna and flora of the two regions should be carefully considered. The recent proliferation of inter-basin water transfer schemes for irrigation and power generation poses a significant threat to indigenous biodiversity as many river systems have evolved unique biota.

Responsibilities of the exporters: Freight companies should be encouraged, through appropriate legislation, to become concerned about unintentional introductions in goods they transport.

The costs associated with unintentionally introduced species should be internalized through dedicated taxes that are borne by those responsible for an introduction. Movement of goods containing biological material should be registered to ensure identification of responsible parties if an unintentional introduction occurs.

REFERENCE

Cronck, Q.U.B. and Fuller, J.L. (1995): Plant Invaders. Chapman and Hall. London.