THE STATUS AND IMPLICATIONS OF ALIEN INVASIVE SPECIES IN SRI LANKA

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Abstract

Alien invasive species (AIS) is one among the various threats to the biodiversity of Sri Lanka. A survey was carried out to establish the present status of AIS in Sri Lanka. Wetland and terrestrial ecosystems of different climatic zones were surveyed randomly for the presence of AIS and their threats. Among the 59 AIS identified, 10 species of fauna and 13 species of flora are included in the list of 100 of the world's worst AIS. The alien invasive fauna of Sri Lanka includes 15 vertebrates and 5 invertebrates. The paper discusses the impact of alien invasive fauna and flora on the native species and stresses the need for a proper management strategy.

Keywords

Alien invasive species, Sri Lanka, status, impacts

Introduction

Sri Lanka, though being a small island of 65,610 km^2, a wide range of topographic and climatic variations have resulted in a multitude of ecosystems. These ecosystems have in turn contributed to an extremely high level of species diversity, which is known to be higher than in most other tropical Asian countries, when measured per unit area. Furthermore, isolation from the Indian subcontinent since the late miocene has led to the evolution of many endemic species. While the island has been recognized as one of the 25 biodiversity hotspots of global significance by conservation biologists, it is also one of the eight hottest hotspots in terms of habitat loss. The latter aspect is of serious concern and several anthropogenic factors have contributed to the degradation and deterioration of natural habitats and ecosystems, and thereby resulting in harmful consequences on species which inhabit them. Besides the harmful factors related to human population growth in Sri Lanka, there is yet another danger to the island's biological diversity – the growing threat of alien invasive species (AIS) (Bambaradeniya, 2000).

An alien invasive species is defined as "a species introduced into a habitat and whose establishment and spread threatens the ecosystem, habitat or species with economic or environmental harm" (McNeely, 2001). It has been well documented that AIS have resulted in massive and rapid losses of biodiversity, especially in island communities (Clout, 1995). Sri Lanka, being a small island with a rich biodiversity, the vast array of wetland and terrestrial ecosystems of the island are inhabited by several species of alien biota, hence causing a threat to native biodiversity. This paper intends to discuss the present status of AIS in Sri Lanka, based on observations made during the past six years.

Methodology

The survey was commenced in May 1995 and random field visits were made to wetland and terrestrial ecosystems in the different bioclimatic zones of Sri Lanka (excluding North and East), to document the presence of AIS. The threats of the different alien invasives on native biodiversity were also recorded during the field surveys, supplemented with published sources. The current major contributors to the introduction of alien invaders were also identified.

Results and discussion

AIS in Sri Lanka and contributory sources

Observations made during the six years have led to the documentation of 20 species of alien invasive fauna and 39 species of alien invasive flora spreading in natural and semi-natural ecosystems in the different bioclimatic zones of Sri Lanka. The alien invasive fauna includes 15 species of vertebrates (9 freshwater fish, 1 reptile, 5 mammals) and five species of invertebrates (molluscs) (Table 1). The alien invasive flora includes two pteridophytes, two monocots and 35 dicots (Table 2). Among the total AIS documented in Sri Lanka, 10 species of fauna and 13 species of flora are included in the list of 100 of the world's worst AIS (IUCN ISSG, 2001). At present, the ornamental fish trade and the ornamental plant/horticulture

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trade are two major contributory sources to the introduction of AIS in Sri Lanka.

Impacts of AIS on the biodiversity of Sri Lanka

The major impacts of AIS can be summarised under the following categories: Direct exploitation or destruction of native species; superior competitors for resources; hybridization with native biota; agricultural pests and other impacts.

Direct exploitation or destruction of native species:

This is the biggest threat posed by AIS on native organisms. Most IAS destroy or deplete native biota by being active predators or herbivores. In addition, alien invasive fauna can also function as vectors which transmit diseases to vulnerable native species. Among the alien invasive fish in Sri Lanka, five species (*Oncorhynchus mykiss, Chitala chitala, Poecilia reticulata, Gambusia affinis and Clarias batrachus*) are active predators of native aquatic fauna. The Rainbow Trout (*Oncorhynchus mykiss*) occurs in cold streams of the montane zone, mainly in the Horton Plains National Park, which is also known to be the sole locality of the endemic shrimp *Caridina singhalensis* (Pethiyagoda, 1991). As the trout is known to feed on aquatic organisms such as crabs, shrimps, insects and other fish, it is possible that it has effected the populations of the above endemic shrimp as well as other endemic crabs (ie., *Ceylonthelphusa sorror*) in the montane zone streams. The Clown-knife Fish (*Chitala chitala*) is a large voraceous carnivore which feeds on slow-moving native fish. As it multiplies and spreads rapidly in streams, rivers, ponds and marshes of the wet zone, it might have already affected the populations of the endemic fish which are mainly distributed in this zone. The Guppy (*Poecilia reticulata*), which is a prolific breeder distributed in aquatic habitats throughout Sri Lanka, has been observed to feed on the eggs of native amphibians (de Silva, 1996). The recently introduced Red-eared Slider (*Trachemys scripta*) is a carnivorous turtle that can pose a serious threat to native aquatic vertebrate fauna. The domestic/ feral cat (*Felis catus*) is a serious threat to native reptiles, birds and small mammals, as it is a stealthy predator. The domestic/ feral dogs also pose a similar threat to native vertebrates. It has been documented that domestic/feral dogs avidly search and feed on the eggs of marine turtles, in coastal areas in Sri Lanka (de Silva, 1999; Ilangakoon, 2000). It is quite possible that some of the alien invasive fish and molluscs also function as vectors of various diseases that affect native fauna.

Superior competitors for resources:

All alien invasive fauna act as superior competitors of resources and thereby displace native biota. For instance, among the alien freshwater fish species, the Tilapia (*Oreochromis mossambicus*) is non-selective in its diet and breeds prolifically, enabling it to colonize tanks, reservoirs and slow-flowing rivers, while displacing some of the native inhabitants such as *Labeo lankae* and *Labeo dussumieri* (Pethiyagoda, 2000), of which the former is considered highly threatened endemic species in Sri Lanka (IUCN Sri Lanka, 2000). The feral buffalo and cattle pose a threat to native large herbivores such as deer, sambar and elephant by competing for limited food resources, especially in the dry zone habitats (Bopitiya *et al.*, 1998). The wallowing habit of buffalloes in water makes the aquatic habitats muddy, thereby deterring other animals such as elephants from visiting water holes. The feral buffaloes have also contributed to changes in vegetation communities in natural ecosystems.

The alien invasive plants form thickets and shade out native vegetation thereby displacing them gradually. Typical examples in the island include Mesquite (*Prosopis juliflora*) and the Prickly Pear Cactus (*Opuntia stricta*) that has formed uniform stands in the arid zone scrubland, and the Pond Apple (*Annona glabra*) that has invaded the coastal marshes of Sri Lanka. At the extreme level, alien invasive plants may entirely modify the structure and function of an ecosystem, which could occur in many ways. For instance, an invasive plant species can produce substances that are toxic to other native plant species (allelopathic substances) and thereby make the soil unsuitable for the native plant communities. The aquatic alien invasive plants that form dense mats, e.g. Water Hyacinth (*Eichhornia crassipes)* and Salvinia (*Salvinia molesta*), tend to accumulate greater amount of sediment. This, coupled with high loss of water through increased transpiration ultimately converts wetlands into terrestrial habitats. The final outcome of such uniform stands of alien invasive plants is the narrowing down of native biological diversity in a particular locality.

Hybridization with native species:

The two species of exotic mammals (*Rattus rattus* and *Bubalus bubalis*) have become agents of hybridization, where they have interbred with indigenous subspecies. Three subspecies of the house rat (*R. r. rattus*, *R. r. alexandrianus*, and *R. r. rufescens*) have been accidentally introduced to Sri Lanka by ships. These have now interbred with the two local subspecies (*R. r. kandianus and R. r. kelaarti*) to form mixed populations (Phillips, 1980). Similarly, the domestic buffalo has interbred with the native wild water buffalo (*B. bubalis*) to form feral populations.

Agricultural pests:

Several species of alien invasive fauna function as agricultural pests throughout the island. The ship rat (*Rattus rattus*) and the house mouse (*Mus musculus*) are major grain feeding pests of rice. The Giant African Snail (*Achatina fulica*) and slug (*Laevicaulis alte*) are pests of agricultural / horticultural crops. The two recently introduced garden slugs – *Deroceras reticulatum* and *Deroceras caruanae* are posing a serious threat to vegetable cultivations in the Nuwara-Eliya District (K.B. Ranawana, pers. comm.). It is also reported that farmers use

substantial doses of pesticides to control these garden slug species, without much success (Wijesekera, 2001). The feral buffalo also cause damage to various agricultural crops, mainly in the dry zone of Sri Lanka. The introduced aquatic snail belonging to the genus *Pomacea*, commonly called the Golden Apple Snail was imported to Sri Lanka during the early 1980s by the ornamental fish traders. Today, it is rapidly spreading in aquatic ecosystems throughout Sri Lanka, as it is a prolific breeder. Recently, the Department of Agriculture was able to identify one specimen of Apple Snail as *Pomacea bridgsi* (Wijesekera, 2001). However, based on external morphological features, there seems to be two species of *Pomacea* that are currently spreading in Sri Lanka, and taxonomic work is in progress now (K.B. Ranawana, pers. comm.). It would be interesting to know whether *Pomacea cannaliculata* is present in Sri Lanka, as this species is considered to be a serious pest of rice, causing severe economic damage especially in the Southeast Asian region (Naylor, 1996).

Among the alien invasive flora in Sri Lanka, some species function as weeds in agricultural ecosystems, and thereby result in economic losses to farmers. These include *Parthenium hysterophorus, Eichhornia crassipes, Salvinia molesta, Chromolaena odorata, Lantana camara, Mikania micrantha, Imperata cylindrica, Panicum maximum, Tithonia diversifolia, Mimosa invisa* and *Clidemia hirta*.

Other impacts of alien invasives:

Some alien invasives facilitate the establishment and spread of another alien invader or contribute to other environmental disasters. For instance, the feral buffalo and cattle feed on the pods of Mesquite (*Prosopis juliflora*) and hence facilitate the spread of the latter in the arid zone of Sri Lanka. Furthermore, the disturbances to natural habitats caused by feral buffalo, cattle and unmanaged domestic pigs facilitate the establishment of alien invasive plants. Some alien invasive plants such as *Lantana camara* and *Chromalaena odorata* facilitate the spread of forest fires as well, causing severe damage to native ecosystems and species. Certain alien invasive animals function as vectors of diseases that affect man and livestock. For instance, the ship rat (*Rattus rattus*) functions as a vector of Leptospirosis virus, while the feral cats (*Felis catus*) and dogs (*Canis familiaris*) are vectors of the rabies virus.

Some beneficial attributes of alien invasives to native biodiversity

Not all alien invasives are entirely bad. Some alien invasive plants provide food and cover for native fauna. For instance, the thick Gorse (*Ulex europaeus*) stands in the Horton Plains area serve as a good habitat for the endemic Black-lipped Lizard (*Calotes nigrilabris*) and several amphibians, providing them with food (ie., insects attracted to flowers) and cover. It is also a nesting habitat of birds. The alien invasive shrub *Eupatorium riparium* in the montane region serves as a browsing plant for Sambar. The berries of *Lantana camara* are fed upon by several species of birds. The fruits of Strawberry Guava (*Psidium littorale*) and Cactus (*Opuntia stricta*) are eaten by langurs and monkeys. Therefore, when considering management options for alien invasives, land management should be given high priority in order to encompass such beneficial attributes.

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Table 1. Alien invasive fauna in natural ecosystems of the different bioclimatic zones of Sri Lanka

Common name	Scientific name	Mode;source; purpose	Distribution	Affected habitats / ecosystems
Rainbow Trout *	*Oncorhynchus mykiss*	Deliberate; British planters; sport fishery	Montane zone	Streams
Clown Knife Fish	*Chitala chitala*	Negligence; aquarists;ornamental fish trade	Lowland wet zone	Tanks, ponds, slow-flowing rivers, marshes
Plectosomus Catfish	*Hypostomus plecostomus*	Negligence; aquarists;ornamental fish trade	Lowland wet zone	Tanks, ponds, slow-flowing rivers, marshes
Walking Catfish *	*Clarias batrachus*	Negligence; aquarists; ornamental fish trade	Lowland wet zone	Marshes, streams, canals
Guppy	*Poecilia reticulata*	Deliberate; state; mosquito control Ornamental fish trade	Island wide	Tanks, ponds, slow-flowing rivers, marshes, streams
Western Mosquito Fish *	*Gambusia affinis*	Deliberate; state; mosquito control	Lowland wet zone	Marshes, streams and canals
Mozambique Tilapia *	*Oreochromis mossambicus*	Deliberate; state; commercial fishery	Island-wide	Tanks, reservoirs, slow-flowing rivers, marshes
Carp *	*Cyprinus carpio*	Deliberate; state; commercial fishery	Island-wide	Tanks, reservoirs
Snake-skin Gouramy	*Trichogaster pectoralis*	Deliberate; state; commercial fishery	Dry and intermediate zones	Tanks, reservoirs, marshes, streams
Red-eared Slider Turtle *	*Trachemys scripta*	Negligence; aquarists; ornamental fish trade	Lowland wet zone	Marshes, steams and canals
Golden Apple Snail	*Pomacea bridgsi*	Negligence; aquarists; ornamental fish trade	Lowland and upland wet zone	Tanks, ponds, marshes
Giant African Snail *	*Achatina fulica*	Negligence; British planter; research/ hobby	Island-wide	Natural and managed terrestrial habitats
Slug	*Laevicaulis alte*	Accidental; horticulturists	Island-wide	Natural and managed terrestrial habitats
Garden Slug	*Deroceras reticulatum*	Accidental; horticulturists	Wet zone and intermediate zone	Disturbed and managed terrestrial habitats
Garden Slug	*Deroceras caruanae*	Accidental; horticulturists	Wet zone and intermediate zone	Disturbed and managed terrestrial habitats
House Mouse *	*Mus musculus*	Accidental; ships	Island-wide	Natural and managed terrestrial habitats
Ship Rat *	*Rattus rattus*	Accidental; ships	Island-wide	Natural and managed terrestrial habitats
Domestic / Feral Cat *	*Felis catus*	Deliberate; pet trade	Island-wide	Natural and managed terrestrial habitats
Domestic / Feral Dog	*Canis familiaris*	Deliberate; pet trade	Island-wide	Natural and managed terrestrial habitats
Domestic / Feral Buffalo	*Bubalus bubalis*	Deliberate; state and farmers; animal husbandry	Island-wide	Forests

* Species included in the list of 100 of the world's worst invasive alien species (IUCN ISSG, 2001)

Table 2. Alien invasive flora in natural ecosystems of the different bioclimatic zones of Sri Lanka

Scientific name	Common name (habit)	Mode; source; purpose	Distribution	Affected habitats / ecosystems
Eichhornia crassipes *	Water Hyacinth (Floating)	Negligence/ deliberate; ornamental plant	Island-wide	Tanks, ponds, marshes, streams
Salvinia molesta	Salvinia (Floating)	Negligence/ deliberate; ornamental plant	Island-wide	Tanks, ponds, marshes, streams
Pistia stratiotes	Water Lettuce (Floating)	Unknown	Island-wide	Tanks and marshes
Hydrilla verticillata	Hydrilla (submerged plant)	Negligence; aquarists; ornamental fish trade	Island-wide	Tanks, ponds, streams, canals
Egiria densa	Canadian Pondweed or LeafyElodia (submerged plant)	Negligence; aquarists; ornamental fish trade	Lowland wet zone	Tanks, ponds, streams, canals, marshes
Najas marina	Pond Weed (submerged plant)	Unknown	Coastal areas	Coastal aquatic habitats
Alocasia macrorhiza	Unknown	Island wide	Marshes, riparian areas	
Colocasia esculenta	Unknown	Island wide	Marshes, riparian areas	
Typha angustifolia	Reed Cattail	Unknown	Coastal areas	Estuaries, tanks and marshes
Phragmites karka	Reed	Unknown	Coastal areas	Marshes, riverbanks
Annona glabra	Pond Apple (small tree / shrub)	Unknown	Lowland wet zone	Coastal lagoons, marshes, riverbanks, streambanks
Xanthium indicum	Cocklebur (shrub)	Unknown	Lowland dry zone	Marshes, villus and tank margins
Dillenia suffruticosa	*'Diyapara'* (small tree)	Negligence; horticulturists; ornamental plant	Lowland wet zone	Marshes, streambanks, riverbanks
Mimosa pigra *	Giant Sensitive Plant (small tree/ shrub)	Accidental; soil – moving machinary	Intermediate zone	Riverbanks
Alternanthera philoxeroides	Alligator Weed (runner)	Deliberate; horticulturists; food	Island-wide	Fallow fields, marshy/riparian areas
Lantana camara *	Prickly Lantana (shrub)	Negligence; horticulturists; ornamental plant	Island-wide	Scrubland, degraded open forests
Ulex europaeus *	Gorse (shrub)	Negligence; horticulturists; ornamental plant	Montane zone	Montane forests, wet pathana grasslands
Eupatorium riparium	Mistflower (shrub)	Negligence; horticulturists; ornamental plant	Montane zone	Montane forests
Chromolaena odorata	Siam Weed (shrub)	Negligence; horticulturists; ornamental plant	Lowland dry and wet zones	Forest edge and pathways
Cestrum aurantium	(shrub)	Negligence; horticulturists; ornamental plant	Montane zone,	Montane forests
Prosopis juliflora *	Mesquite (small tree)	Deliberate	Arid zone	Thorn scrublands
Opuntia stricta *	Erect Pricklypear Cactus (shrub)	Negligence; horticulturists; ornamental plant	Arid zone	Thorn scrublands
Clidemia hirta *	Hairy Clidemia / Koster's curse (shrub)	Unknown	Lowland wet zone	Rainforests
Swietenia macrophylla	Mahogany (large tree)	Deliberate; state; forestry / timber	Lowland wet zone	Disturbed forests

Scientific name	Common name (lifeform)	Mode; source; purpose	Distribution	Affected habitats / ecosystems
Mimosa invisa	(Creeper)	Unknown	Lowland wet zone	Disturbed forests
Leucaena leucocephala *	Leucaena (shrub)	Deliberate; state; fodder plant / soil rehabilitation	Intermediate zone	Dry-mixed evergreen forests
Clusia rosea	*'Gal Goraka'* (shrub)	Negligence; horticulturists; ornamental plant	Sub-montane zone	Rocky outcrop forests
Parthenium hysterophorus	Congress Weed (shrub)	Accidental; imported goats	Dry and intermediate	Fallow fields, marshy areas
Wedelia trilobata *	Wedelia (runner)	Negligence; horticulturists; ornamental plant	Wet and intermediate	Forest edge
Myroxylon balsamum	*'Kattakumanjal'* (tree)	Deliberate; state; forestry	Wet and intermediate	Dry-mixed evergreen forests
Miconia calvescens *	Velvet Plant (shrub)	Negligence; horticulturists; ornamental plant	Sub-montane zone	Disturbed forests
Tithonia diversifolia	*'Naththasooriya'* (shrub)	Negligence; horticulturists; ornamental plant	Island-wide	Secondary forests
Mikania micrantha *	Mile-a-minute Weed (vine)	Negligence; horticulturists; ornamental plant	Island-wide	Disturbed forests, scrubland
Psidium littorale *	Strawberry Guava (treelet)	Negligence; horticulturists; ornamental plant	Montane zone	Montane forests
Alstonia macrophylla	'Hawarinuga' (Tree)	Deliberate; state; forestry / timber	Island-wide	Secondary forests
Millingtonia hortensis	(shrub)	Negligence; horticulturists; ornamental plant	Southern dry, intermediate zone	Disturbed forests, scrubland
Imperata cylindrica *	'Illuk' – Cogon Grass (grass)	Unknown	Island-wide	Disturbed forests, scrubland
Panicum maximum	Guinea Grass (grass)	Unknown	Island-wide	Disturbed forests, scrubland
Pteridium aquilinum	(Fern)	Negligence; horticulturists; ornamental plant	Montane zone	Disturbed montane forests, wet grasslands

* Species included in the list of 100 of the world's worst invasive alien species (IUCN ISSG, 2001)