

RECENT INVERTEBRATE INVASIONS AND ITS CONSEQUENCES ON AGRICULTURE AND BIODIVERSITY IN SRI LANKA

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ABSTRACT

The rate of anthropogenic introductions of species has increased with the process of globalization resulting to some species becoming invasive in new geographic areas. These invasive species have increased the cost of agricultural production, threatened human health and biodiversity. During the last two decades at least ten alien invertebrate species have invaded agroecosystems in Sri Lanka which include the nematodes *Globodera rostochiensis*, *Meloidogyne graminicola*; insects, *Aleurodicus dispersus*, *Liriomyza huidobrensis*, *Liriomyza sativae*; slugs and snail, *Derocerus reticulatum*, *Derocerus caruanae*, *Pomacea bridgesi* and a mite *Aceria guerreronis*. A bumblebee *Bombus terrestris* which had been introduced for crop pollination did not establish itself. The measures taken to control these invasive species have been inadequate at times.

INTRODUCTION

Bioinvasions have attracted attention of biologists and policy makers alike during the recent past. Change of the geographical range of species is a natural process that has been occurring over many million years. This natural process however, is very slow compared to human assisted (anthropogenic) introduction of species. In particular, the dramatic changes in international trade and transportation during the past few decades have made the rate of planned and inadvertent introductions of species unprecedented. Being an active partner in the globalization process Sri Lanka also has received a share of bioinvasions. The terms that have been used for the concept of an organism 'out of place' include Invasive, Exotic, Non-native, Alien, Introduced, Non-indigenous, Noxious and Naturalized. Definitions of these terms reflect social, political and

economic stand points of those who use the term and the threats posed to natives and ecosystems by the referred organisms. The purpose of this paper is to document the status of invertebrate invasions during the recent past and discuss their effect on agriculture and biodiversity. It also draws attention to the actions taken to control alien species.

Invasive Species

Invasive species is defined as an organism that has the potential to substantially alter the structure and function of natural ecosystems at a landscape spatial scale. An invasive species competes with native organism for nutrient, space and other resources, potentially displacing the native species or alters the composition or function of an ecosystem such that native species fail to sustain their populations. Anthropogenic introduction of a species does not necessarily result to a species becoming invasive. The introduced species to be able to survive in its new environment, it is necessary to have a close match between environmental conditions of original environment and the environment to which a species is introduced. In addition, to establish a viable population alien species should be able to out compete or displace the native species. The absence of natural enemies and lack of adaptations of native species to restrict competition enhance success of invasiveness by the invaders.

Consequences of Bioinvasions

Consequences of bioinvasions are ecological and economic. Ecological changes involve weakening or loss of species in ecosystems leading to proliferation of other species, diminished biodiversity at genetic, species and ecosystem levels and demographic changes in plant cover that may lead to loss of soil. The direct economic consequences are more prominent in the field of agriculture and human health whilst the indirect economic consequences would be through loss of biodiversity. Introduced species requires to be controlled chemically, biologically or mechanically. All control

measures involve expenditure of time and resources in addition to losses in agriculture and human health. Some estimates suggest that the United States of America alone spend tens of billions of dollars annually to control invasive species (Schmitz and Simberloff, 1997). First step in controlling invasive species involves stabilization of the environment in its invaded state preventing further introductions of non-natives and additional loss of natives.

Alien Invertebrates of Sri Lanka identified during last two decades

All the species documented below have established themselves in the local ecosystems, except the bumblebee. However, given the lack of empirical knowledge on the interrelations, especially among invertebrates, in ecosystems of Sri Lanka it is not possible to determine whether these alien species are invasive in the strict sense of the definitions.

1. Potato Cyst Nematode / Golden Cyst Nematode *Globodera rostochiensis*

This notorious pest was first observed in a seed potato consignment from Scotland in 1984 (Ekanayake, 1990). Since then it has established in the Nuwara Eliya area. In addition to the increased cost of applying Nematicides this pest has caused the fallowing of potato lands and yield reduction. Further millions of rupees have been spent on research and administrative activities on controlling it. The Department of Agriculture (DOA) has been successful in containing the spread of the species.

2. The Spiraling Whitefly *Aleurodicus dispersus* (Homoptera: Aleyrodidae)

This polyphagous whitefly was first recorded in April 1989 and it spread throughout the country at an alarming rate killing valuable plants like guava. The DOA took prompt action including screening of safe and effective insecticides to control the pest (Wijesekara and

Kudagamage, 1990). Subsequent studies revealed that two native natural enemies, an egg predator *Axinocymnus pullarufrachi* Kapur and Manshi and a parasitoid *Encarsia transvena* (Timberlake) were able to contain this pest species to an economically insignificant level. Although this species is non- significant in agriculture anymore, its effect on the ecosystem is not known. At present large populations of this species can be observed on *Manihot glaziovii* plants.

3. Rice root knot nematode *Meloidogyne graminicola*

The presence of this species was first suspected in 1990 in Hambantota District (Senanayake, 1995) and its occurrence was confirmed later (Ekanayake and Toida, 1997). At the beginning the pest was very localized and control measures were recommended. No action was taken to eradicate or contain it. At present this species is invasively spreading into other parts of the country. It has been most recently detected in Pollonnaruwa district which, is a major rice-producing area of the country. The DOA has launched a control program for containing the spread of this species.

4. Tomato leafminer *Liriomyza sativae* (Diptera: Agromyzidae)

This polyphagous pest species was first documented in 1993 (Abyawarne and Wijegunasekara, 1993). However, it is more likely that this species would have entered into the country few years before 1993. Initially it was identified as *Lirimyza trifolii* but subsequent investigations showed that the species involved is *L. sativae* (Wijesekara, 1997). No attempt was made for eradication of this species but control programs were recommended. At present this species is a serious pest on cucurbits and tomatoes in various parts of the country and allegations of pesticide resistance are abound.

5. Beet leafminer *Liriomyza huidobrensis*

This highly polyphagous pest was first recorded in 1997 from Nuwara Eliya area. It was probably introduced to Sri Lanka through the floriculture trade. By the time this species was identified, it

already had spread to a level beyond eradication. However, the DOA introduced chemical, biological and mechanical measures to control the pest. For biological control commercially available parasitoid (non-native) *Diglypus isea* (Hymenoptera: Eulophidae) was introduced and it has established in Sri Lanka. However, the level of parasitism is much less than desired. *L. huidobrensis* has established in Sri Lanka as a serious pest of beet and potato in Nuwara Eliya area where *L. sativae* occurs sympatrically. So far it has not spread to other parts of the country. The control of this pest is very difficult and resistance to insecticides has already been recorded. Irrespective of the control measures, which have added significantly to cost of cultivation, this pest still causes substantial yield loss in beet and potato.

6. Bumble Bees *Bombus terrestris* (Hymenoptera: Apidae)

An experimental introduction of this species as a crop pollinator was made into protected agriculture systems in the year 2000, amid protests from some scientists and environmentalists. The bees did not survive and the effort was abandoned. Although the species did not survive it is recorded here, as *B. terrestris* used as pollinators under similar situations is known to have established in foreign environments elsewhere in the world (Wijesekara, 2000).

7. Gray Garden Slug *Derocerus reticulatum* (Satyrommatophora: Limacidae)

This species has been recorded from Sri Lanka only in the year 2000 (Naggs and Raheem, 2000). However, farmers in the upcountry vegetable growing areas where this species is abundant, alleged that it has been in Sri Lanka since early 1980s. It is gradually spreading in vegetable growing areas of the country. No action has been taken to eradicate or contain the spread of this species. It has already become an important pest of vegetable nurseries and young carrot seedlings. The only chemical recommended for control of snails in Sri Lanka is Metaldehyde and it is not effective under high moisture conditions. Farmers are using substantial amounts of the molluscicide which add

to their cost of cultivation. In addition variety of soil amendments like salt, lime, and wood ash are used indiscriminately for control of this pest. This may lead to problems in soil fertility unless steps are taken to manage this pest properly. It is an irony that the name of this species is included in the threaten species list of Sri Lanka (IUCN, 2000).

8. *Deroceras caruanae* (Pollonera)

This slug has been identified from Nuwara Eliya area occurring sympatrically with *D. reticulatum* (K.B. Ranawana, personal communications). Its habits are similar to that of *D. reticulatum*.

9. Coconut Flower and Nut Mite *Aceria guerreronis*

This serious pest of coconut was first recorded from Sri Lanka in 1999 (J. Gunatilake, personal communications). The Coconut Research Institute has taken necessary action to make the scientific community aware about the presence of this species and a control program for containing its spread has been implemented.

10. Apple Snail *Pomacea bridgsi*

Apple snails have been brought to Sri Lanka to be used in aquariums. Many aquarium owners have thrown out the snails due to their prolific breeding. *P. bridgsi* of which the species identity was confirmed recently (L. Nugaliyadda and K.B. Ranawana, personal communications) has established in many water ways in Sri Lanka most probably since late 1980s.

Effects on Agriculture and Biodiversity

The effect of the recent invertebrate invaders on agriculture is firstly the increase in cost of cultivation due to adoption of control measures and secondly the damage cause by the pests resulting crop yield reduction even with substantial control measures used.

However, the effect of these species on biodiversity is not obvious. The possible effects could only be suggested. One important reason for such dismal understanding is lack of research on taxonomy and ecosystem interactions. Knowledge on the invertebrate organisms in Sri Lanka is inadequate to understand the complex ecosystems. The largest fraction of invertebrates in any terrestrial ecosystem, the insects, is probably the least researched group in Sri Lanka.

Following are some of the potential threats to biodiversity that could be suggested. The apple snail *Pomacea bridgesi* is a prolific breeder with high capability of surviving in adverse conditions. The native comparable snail *Phila* inhabits a similar niche in streams and waterways in Sri Lanka. When compared the populations of the two species in habitats in Sri Lanka it can be safely assumed that *Pomacea* could easily drive *Phila* to extinction. *Pomacea bridgesi* has already threatened natural forest habitats of the country. Similarly both *Liriomyza* species being highly polyphagous could survive on range of crop plants and it could also threaten the survival of some weed species in agricultural fields. Weed species *Emilia sonchifolia* (L) is usually heavily attacked by *Liriomyza* species. Although weeds are nuisances within the agroecosystem their extinction from an ecosystem could lead to unexpected problems like threatening the survival of some parasitoids and predators.

Both agriculture and biodiversity are being threatened heavily by habitat destruction and the threats of bioinvasions are no less important. Well known biologist E.O. Wilson says "Extinction by habitat destruction is like death in an automobile accident: easy to see and assess. Extinction by the invasion of exotic species is like death by disease: gradual insidious, requiring scientific methods to diagnose".

These recent animal invaders, direct attention to important aspects of managing invasive species. This documentation shows the need of methodical and coordinated effort of responsible agencies for the control of invasive species. There are at least 12 government agencies responsible for the management of agroecosystem diversity

of Sri Lanka (Ministry of Forestry and Environment, 1998). But there is minimal coordination among them.

The environmentalist lobby should be acknowledged for their concern on biodiversity related issues in Sri Lanka. However, the apple snail problem questions its objectivity. Substantial amount of information on *Pomacea caniculata* were fed by environmentalists to the public criticizing the government agencies for not taking action to control this notorious rice pest. However, no concerned party tried to confirm the identity of the apple snail. When the Department of Agriculture and University of Peradeniya finally got this species identified it turned out to be *Pomacea bridgsi*, which is not a pest of rice. Since it is not a significant pest of any crop the DOA has no interest in controlling it. However, this species, could be a bigger threat to biodiversity than some of the recently introduced pest species. The introduced species that are documented here have got attention of the scientists and the public, as they are pests of crops. But many more species seemingly harmless may have invaded ecosystems and the identification of such and control seemingly has not been assigned to any organization.

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