

Early Warning Systems for Forest Invasive Species in Bangladesh

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Introduction

Bangladesh is located between 20° 34' and 26°38' North and 88° 01' and 92°42' East, with an area of 147,570km². Geographically, the country is located at the transition of Indo-Gangetic and Indo-Malaya sub-regions between the Himalayas and the Bay of Bengal. Bangladesh is characterized by a sub-tropical monsoonal climate with fairly marked seasonal variations of precipitation and a mild winter from December to February. The country has 2.53m hectares of forest land, covering 17.49% of its total landmass. Aside from ranges of hills along the Burmese and Indian borders (to the southeast and northeast), the entire country is an enormous deltaic plain flanked by the river Ganges (Padma), Brahmaputra (Jamuna), and Meghna rivers. These rivers are among the largest in the world, and along with their floodplains and tributaries that crisscross the country forming a myriad of meandering channels, lakes, ox-bows and water meadows,

they form an intricate network of waterways flowing into the Bay of Bengal. Additional temporary bodies of water are formed when a large part of the country becomes submerged for 3-4 months during the monsoon season. Bangladesh Forest is exceptionally rich in biodiversity. The country has approximately 113 species of mammals, more than 628 species of birds, 126 species of reptiles, and 22 species of amphibians. In marine and aquatic systems, there are approximately 442 species of marine fish, 266 species of freshwater fish, 15 species of crabs, 56 species of shrimp/prawns, 362 species of mollusks, and 66 species of corals. Approximately 5000 species of angiosperms have been identified, of which 300 species are cultivated. Published records document approximately 2493 species of insects, 19 species of mites, 164 species of algae/seaweed, and 4 species of echinoderms (Alam 1967, Khan 1991, Ahmed and Ali 1996, Anonymous 2000a, 2000b). Resource managers have identified 224 species of timber yielding plants (Mia and Haque 1986), While Khan and Mia (1984) report 130 species of indigenous fiber plants.

Numerous species are known to be threatened by various land uses and other environmental changes. These include 54 species of inland fish, 8 amphibians, 58 reptiles, 41 resident birds, and 40 mammals. Among the marine and migratory species of animals in particular, 4 fish, 5 reptiles, 6 birds, 3 mammals, and 96 seed-bearing plant species are threatened (Anonymous 2000a, 2000b). As in many other countries of South Asia, hundreds of alien species have entered Bangladesh, intentionally and unintentionally . The remainder of this paper addresses the status of invasive alien species (IAS) in Bangladesh and what is being done to address the problem.

Invasive alien species in Bangladesh

Bangladesh has a long history of introduction of alien species of plants and animals, especially those which were found to be productive elsewhere and

offered potential economic benefits to Bangladesh. Early introductions were associated with importation of exotic goods from almost every nation of Asia. Some alien species have entered the country unintentionally. For example, it is believed that many IAS were indiscriminately introduced from India with floodwaters and rapidly spread to the wetlands in Bangladesh as a sort of 'biological explosive'. Unfortunately, no consideration was made of the likely adverse effects of introduction of any alien species to Bangladesh. Quarantine measures adopted during import of alien species were weak, and as a result they were introduced into the country without proper documentation. Information such as published lists of harmful, invasive or pest alien species, and published scientific data on the ecological and economic impacts of such species are not available. Despite the absence of studies, it is believed that a growing number of IAS are causing significant economic and environmental impacts in Bangladesh. These species include fish, insects, weeds, nematodes, crustaceans, microbial pathogens, and vascular plants. Of the hundreds of alien species introduced to Bangladesh, some have naturalized to such an extent that it is very difficult to recognize them as aliens. Some of the alien species have become invasive.

Invasive alien plants

It is very difficult to give a complete list of alien species of plants introduced into Bangladesh, as published literature is not available on this aspect. However, a list of IAS of plants introduced into Bangladesh is given in **Table2**.

Invasive alien weeds

Introduction of alien species of weeds has a long history in Bangladesh. A condensed list of alien weeds with available information on country of origin, area of spread, and the damage caused by these species is presented in Table3.

Bangladesh forestry mostly uses the clear felling system, which creates wide gaps that support the growth of disturbance-tolerant species, including weeds. Certain kinds of agricultural practices, including some that have been used from a long time ago, also support the growth of IAS. It has been observed that most invasive weeds grow luxuriantly at the advent of rain and continue growing until the onset of winter. Weeds prefer to grow in areas with sunlight, while the growth of most is retarded under conditions of shade leading to their eventual death. They all bear the unique character of suppressing regeneration of cultivated plants unless there is some kind of human interference. Perhaps the first widely introduced IAS in Bangladesh is the water hyacinth, *Eichhornia crassipes*, which was brought from Brazil during the British colonial period. British ladies were fond of its attractive flowers and used them for hairstyling and decorative purposes. Now almost all the wetlands of Bangladesh are covered by this water hyacinth (Ameen, 1990), and it is a very serious invasive, replacing indigenous aquatic species such as *Enhydra fluctuans*, *Ipomoea aquatica* and *Dodonaea viscosa*. Other most invasive alien weeds are: *Alternanthera philoxeroides*, *Argemone mexicana*, *Chylocalyx* sp., *Enhydra fluctuans*, *Mikania cordata*, and *Parthenium hysterophorus*. Though they are not measured scientifically, visually significant economic damage is caused by these introduced weeds. The impacts of alien species of weeds and resultant changes to local ecosystems have not yet been studied in Bangladesh. Following are brief accounts of some species of major alien weeds with their recorded impacts. *Mikania scandens*, a luxuriantly growing climber which grows on wet soil with sufficient sunlight, has perennial rootstocks and rootlet climbers that grow very rapidly on the ground and also on other plants. The perennial rootstock makes it very hard to eradicate except by completely pulling it out of the ground. It is found covering entire crowns of the trees in plantations, and arrests the growth of these trees if sufficient care is not taken during establishment of the plantations. It is also a menace in the high forests. This creeper has proven itself very difficult to eradicate, and is spreading

gradually into the adjacent areas of forests as well. This species most likely invaded the country after the major cyclone of the 1960s. Sometime in the mid 1960s, *Ipomea fistula* was introduced to the coastal areas of Bangladesh. This plant accumulates salt in its tissues, which does it no harm, but when it dies, the salt is released into the soil, rendering the area unfit for much of the native vegetation. *Mimosa pudica*, a perennial, prickly, bristly, and creeping weed of roadsides and fallow lands, is also commonly found on the hills. It grows all over the country and is considered to have been introduced to Bangladesh more than 200 years ago. The thick layers of this species prevent growth and development of many native species including the natural germination of many valuable forest species, such as *Dipterocarpus* spp. and *Syzygium* spp., which it does by largely by preventing the seeds from reaching the soil. *Mimosa intsia*, another IAS, is found spreading in the northeastern part of the country, usually following tea cultivation. The invasive grass *Imperata cylindrica* has overrun woodland margins in the country. This grass is highly flammable, and regenerates quickly after burning. Its most damaging impacts are hindering tree growth in plantations and virgin forests, and destruction of soil fertility by its greater adaptability to dry open areas. It is very difficult to eradicate this from plantations, since it is gregarious in nature, with a strongly spreading root system. Some other alien weeds are listed below: *Cleome hassleriana* is growing dominantly in marshy areas of the northeastern part of the country, where it was introduced as long ago as 200 years or so, following tea cultivation. *Croton bonplandianus* is a common branched perennial herb with watery juices. Known as a common weed of road sides and waste lands of the eastern part of the country, this plant was introduced from Brazil during the 1890s. *Croton lobata*, a perennial under-shrub, is a weed of waterlands and roadsides mostly found in the eastern part of Bangladesh. The plant has been growing in this region since 1940s. *Panicum repens*, another aggressive grass, is found invariably in the coastal region of Bangladesh, and was introduced over a hundred years ago.

Lantana camara var. *aculata*, which is prickly and difficult to pull out, grows mostly in the hilly regions. This species was introduced to Bangladesh around 200 years ago. A scrambler, it is a menace to the seedlings used for artificial regeneration in forest areas. *Chromolaena* (*Eupatorium*) *odorata*, introduced in the mid 1940s, is a coarse straggling under-shrub species, growing as a bush. It has displaced virtually all other vegetation from some places in the hill regions. This species is more destructive whenever vegetation clearing is done. Unless quick remedial measures are taken, the area becomes covered with this invasive within a period of about three years, forming an impenetrable thicket. *Ageratum conyzoides* (Introduced to Bangladesh during the 1940s) does great damage by precluding natural regeneration, covering crowns of trees, and killing the foliage of existing crops. *Opuntia dillenii*, a well-known cactus invasive and a native of South America, was introduced to coastal Bangladesh some time in the past. *Parthenium* sp. (*hysterophorus*?) is present in Bangladesh for the past 15 years, and is known to cause serious allergic reactions to its pollen. Alien plants grown for forestry Valuable timber species such as teak (*Tectona grandis*), Mahogany (*Swietenia mahagonii* or *S. macrophylla*), and fast growing alien tree species such as *Eucalyptus camaldulensis*, *Acacia mangium*, *Acacia auriculiformis* and *Leucaena leucocephala*, have been introduced for development of forestry. Some of them are now well acclimatized to the country. Several species from the two genera, *Acacia* and *Eucalyptus* from Australia and eastern Malaysia, have been introduced into Bangladesh, mostly during the 1980s. Plantations of fast growing eucalypts, *A. auriculiformis* and *A. mangium* from Australia, are a common choice for pulp and fuelwood in Bangladesh. All these species have proven to be rivals to endemic flora, eventually replacing indigenous forest species as well as other native wild flora. For example, *A. auriculiformis* germinates naturally in plantation forests and forms congested seedling areas, which in turn prevent natural germination of some native forest species. *Acacia* and *Eucalyptus* trees produce leaves that are not easily degradable, and thus the soil becomes less

fertile, threatening the existence of thousands of humus-dependent species including herbs and earthworms. These trees are said to absorb large amount of water and nutrients from the soil rather rapidly, and hence even the indigenous trees cannot properly grow around it. Some species of eucalyptus are therefore used for draining swamps. Furthermore, birds are observed to avoid eucalyptus plants. These trees do not support wildlife because they do not produce edible fruit or nectar for them. The monocultures of these species are lifeless, and the tall and slender stems of these species are lifeless, and the tall and slender stems of these species are not storm tolerant and cannot shelter any fauna during storms. Moreover, the spores produced by the flowers of these trees create allergic diseases in the respiratory tracts of human beings (Ameen, 1999). There are many other alien species growing in Bangladesh, such as oil palm (*Elaeis unguis*), rubber (*Hevea brasiliensis*) (introduced in 1964 and 1910 respectively), and *Pinus caribaea* and *Pinus oocarpa*, introduced in 1940 and 1970 respectively. However, we still do not have any assessment of the impact of these species on native biodiversity and gene pools. So far, only growth and spacing trials of alien forest species have been carried out. During introduction of alien species, only quarantine regulations for exclusion of insect pests intimately associated with timber, along with fungi and bacterial pathogens, are followed.

Alien ornamental plants

Ornamental plants such as Krishnachura (*Poinciana pulcherrima*), Radhachura (*Delonix regia*), and *Peltophorium ferrugineum*, and various types of cacti and orchids, have entered the country. Yet again, we have no comprehensive assessment of the impacts and status of spread of these species.

Invasive alien fish

Among the animal species, the recent introductions are mostly fish. Due to increased demand for fish resources (fish being one of the major sources of protein), caused by the human population explosion, fish species capable of producing a higher biomass in a shorter period than native species were introduced. About 15 alien species of fish, mostly carps, were introduced to Bangladesh. A list of different alien species of fish introduced into Bangladesh is given in **Table-1**. The main objective of these introductions were augmenting fish production, use of some as predators of pest insects and weeds, and some for use in aquaria and decoration. Hardly any studies on the influence of the imported species and their interactions with local species and the natural environment preceded these introductions. Some of the introduced species have been found to be competing with local species for food, to the detriment of the latter. The most disastrous invasive alien fish species are *Clarias gariepinus* (native of Africa), *Pangasius sutchi*, *P. giganticus* (naturally occurring in Southeast Asia), *Tilapia mossambica* and *Tilapia nilotica*. These fish species were brought from Thailand between 1953 and 1990 (Rahman, 1997). The predatory habits of the first three species are well known and legendary. *Clarias gariepinus* and *Pangasius* spp. eat almost everything they encounter. They not only feed on indigenous fish species and domestic ducklings, but also on snails and birds that are killed and supplied by cultivators. As a result, the vulture population of the country is also threatened, because carcasses that would have been available to them are collected and supplied to these fish species (Rahman, 1997). The last two species are not predatory species, but their fecundity and growth rate are very high, and they can breed naturally. *T. mossambica* and *T. nilotica* are competing with small native fish species, and gradually occupying their niches. In case of carps, some interesting research data have been collected. The local major carps contributed 67% of the total stock in 1967 in Sylhet-Mymensingh haor (large marshland)

basin, but rapidly declined to 50% in 1973 and only managed a 4% contribution in 1984 (Tsai and Ali, 1987).

The following are a few more examples of introductions:

- ❖ Grass Carp (*Ctenopharyngodon idella*) introduced to Bangladesh from Hong Kong in 1966;
- ❖ Silver Carp (*Hypophthalmichthys molitrix*) naturally occurring in China was introduced to Bangladesh from Hong Kong in 1969;
- ❖ The Goldfish (*Carassius auratus*) was brought from Pakistan in 1952 and is used as decorative species in aquaria and cement tanks. Many IAS were indiscriminately introduced, and rapidly spread to wetlands as a kind of 'biological explosion' along with floodwaters from India. Some of the introduced fish species were recommended only for restricted cultivation in closed ponds, but these plans were unsuccessful as closed ponds could not be maintained due to floods. The result is that 54 indigenous fish species have become threatened within a very short time, and many of them will become extinct from Bangladesh if this process continues (Islam et al., 2000).

Fish diseases

Epizootic Ulcerative Syndrome has been causing large-scale fish mortality in the floodplains. The occurrence of Epizootic Ulcerative Syndrome disease was first reported in February 1988 from Chandpur. Ali (1991) reported that the disease broke out almost all over Bangladesh causing heavy mortalities of native fish such as Snakeheads ('taki', 'shol'), eel ('baim'), perches ('Koi', 'Kholisha', 'meni'), barbs ('punti'), and gobies ('bele'). Major species of local carps and their fingerlings in floodplains and ponds were also

affected. Minkin (1988) suspected that this disease possibly entered Bangladesh through the introduction of alien fish, *Puntius gonionotus*, a carrier of the infective agent to Bangladesh. This disease has been reported from Thailand, Philippines, Myanmar, Sri Lanka, Malaysia and Laos (Minkin, 1988). The Fisheries Specialist Study in Bangladesh's 6th Flood Action Plan (FAP6, 1993) reiterates the suspicion that the disease was introduced into the country through imported alien species, and indicates that fish disease has played an important role in reducing fish production in Bangladesh.

Invasive alien insect species

This Spiralling Whitefly (*Aleurodicus dispersus*) is a serious pest of guava, *Capsicum* spp., and a number of ornamental plants. This insect pest may also infest mango leaves. This insect has not been reported in published literature even up to the 1980s as a pest of guava or any other economic plant, from India, Pakistan, and Bangladesh, but serious infestations of this insect pest have been found in guava and some ornamental plants (including 'Madhabi Lata') in Dhaka city since the early part of 1993. The Spiralling Whitefly is now a major pest of guava in most parts of the country. It is suspected that this pest species was introduced in Bangladesh through hand-carried and unchecked plant materials from other countries (Karim, 1995). The introduced multipurpose tree *Leucaena leucocephala* in Bangladesh is not free from its major pest, the psyllid bug *Heteropsylla cubana* (?) (personal communication from Karim, M.A., 2002). There is no published literature on other invasive alien insect species in Bangladesh. Absence of insect taxonomic identification services in Bangladesh is a major limiting factor in reporting any new invasive alien insects. Much more work has to be carried out on the status, and impacts of invasive alien insect species on ecosystems of Bangladesh.

Management of IAS

The following sections will provide a brief outline of the issues and options for management of biodiversity that have relevance to the topic of IAS.

Legal instruments

Following are the legal instruments of Bangladesh for management of its biodiversity, which also relate to prevention of introduction of alien organisms:

- Destructive Insects and Pest Act of 1914;
- Forest Act of 1927;
- Bangladesh Wildlife (Preservation) (Amendment) Act of 1974;

In addition, Bangladesh is signatory to the:

- International Plant Protection Convention (in 1974);
- Convention on Biological Diversity, CBD (in 1992);
- Agreement on the Network of Aquaculture Centres in Asia and the Pacific (in 1990);
- UN Framework Convention on Climate Change (in 1992);
- Ramsar Convention (in 1992);
- Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) (in 1981);
- Global Tiger Forum (in 1999).

Bangladesh, as a signatory to the CBD, has already initiated plans and programmes to fulfill its obligations to the convention. Biodiversity resources are under the management of several government agencies. They are all agencies that have the potential to manage IAS, and are listed later in this paper. The Forest Department manages 1.53 m ha forestland, approximately 10.54% of the total land area of the country. Of Bangladesh's total forested area, 0.24 million ha constitutes protected areas. Government policy is to manage its forests under two categories: productive forests and protective forests, to meet the demand for forest produce and to conserve the threatened biodiversity of the country respectively. The government of Bangladesh imposed a restriction on all tree felling in the Natural Reserve Forests until the year 2005. Since wetlands abound with biological diversity, and since Bangladesh is a Contracting Party to the Ramsar Convention, necessary steps are being taken to conserve aquatic ecosystems as Bird, Fish and Wildlife Reserves. It is obvious that besides this measure, that some sort of monitoring programme should be undertaken in wetlands to prevent and control the introduction of alien fish species.

Quarantine

The existing plant quarantine legislation, known as Destructive Insects and Pest Rules, 1966 (Plant Quarantine), were framed as per provisions of sub-section (1) of Section 3, Section 4A and 4D of the Destructive Insect and Pest Act, of 1914. The director, Plant Protection Wing of Department of Agricultural Extension under the Ministry of Agriculture, is responsible for execution and implementation of the plant quarantine legislation. Fifteen plant quarantine stations are functional at various entry points to Bangladesh. The country became a member of the Asia and Pacific Plant

Protection Commission in 1978. Bangladesh and India signed a bilateral memorandum of Understanding on quarantine issues in 1978. The Department of Livestock under the Ministry of Fisheries and Livestock executes the animal quarantine legislation. On average, 1.5 million tons of plants and plant products are imported in Bangladesh every year from different countries, under plant quarantine inspection. On the other hand, about 0.4 million tons of agricultural commodities, mainly raw jute and jute products, handicrafts, vegetables, and fruits are inspected for issuing phytosanitary certificates, for the purpose of export. A total of 2,002 fruit and flower saplings were destroyed at entry points from 1999 to 30 June, 2002 due to detection of harmful nematodes. Most of these saplings were brought from Mozambique, Ghana, Papua New Guinea, Afghanistan, UAE, Russia, Kenya, Uganda, Portugal and Poland. The detected nematode species were *Ditylenchus dipssci*, *Radopholus similes*, *Creconema* sp. And *Xiphenema* sp. One consignment of 50 metric tons of imported seed potato (*Solanum tuberosum*), from the Netherlands was intercepted and destroyed due to presence of *Erwinia atroseptica* and *Ralstonia solanacearum* infection in 1999, although the consignment of seed potatoes was accompanied by a valid phytosanitary certificate issued by the NPPO of the Netherlands. Another consignment of 1000 metric tons of tuber potatoes for consumption, imported from India in 1999, was refused entry to Bangladesh for reason of contamination with cysts of *Globodera rostochiensis* (Bulbul, 2000).

Pest management policy

Integrated Pest Management (IPM) activities, started in 1981, have already passed through several phases of research and extension. It has made an immense contribution to the reduction of pesticides in crop

production. Results show that it has the potential to increase crop production directly, with little or no adverse effects on agro-ecosystems. Considering these benefit of IPM, the government has initiated the National Integrated Pest Management Policy in 2002.

Public awareness and education

In Bangladesh, the general public is not aware of the harm caused by IAS, their potential future risks to local ecosystems and its exceptionally rich biological heritage. There are very few publications or guidelines on IAS available in Bangladesh, The need for education extends over many sectors such as policy makers, researches, extension personnel, administrators, politicians, farmers and the general public. Messages on IAS should be spread, using various media such as booklets, newspapers, radio, and television. People should be motivated to cultivate indigenous species. Both positive and negative impacts of IAS on native ecosystem need to be introduced at school, college and university level curricula, which will help create awareness among the future generation of decision makers, about the impacts of IAS, their prevention and establishment.

List of government agencies that have potential to manage IAS

1. Forest Department
2. Department of Environment
3. Department of Agricultural Extension
4. Department of Fisheries
5. Department of Livestock
6. Bangladesh Forest Research Institute (BFRI)
7. Fisheries Research Institute (FRI)

8. Bangladesh Rice Research Institute (BRRI)
9. Bangladesh Agricultural Research Institute (BARI)
10. Bangladesh Jute Research Institute (BJRI)
11. Bangladesh Tea Research Institute
12. Bangladesh Cotton Development Board
13. Sugarcane Research Institute
14. Sericulture Research Institute
15. Livestock Research Institute
16. Wheat Research Institute
17. National Herbarium
18. Botanical Garden
19. Zoological Garden
20. Mango Research Institute
21. Tourism Department
22. Customs Department
23. Seed Certification Agency
24. Bangladesh Water Development Board
25. Barind Multipurpose Development Authority

Experts associated with direct management of IAS

1. Member-Director (Crops), Bangladesh Agricultural Research Council,
Ministry
of Agriculture, Farmgate, Dhaka-1215, Bangladesh.
2. Director, Plant Protection Wing, Department of Agricultural Extension,
Ministry of Agriculture, Khamarbari, Dhaka-1215, Bangladesh.
3. Director General, Department of Livestock, Ministry of Fisheries and
Livestock, Farmgate, Dhaka-1215, Bangladesh.

4. Director General, Department of Fisheries, Ministry of Fisheries and Livestock, Matshya Bhaban, 13 Shaid Munsur Ali Sharani, Ramna, Dhaka, Bangladesh.
5. Director General, Department of Environment, Ministry of Environment and Forest, Agargaon, Dhaka, Bangladesh.
6. Director General, Bangladesh Forest Research Institute, Chittagong, Bangladesh.

Steps to be taken for IAS

The study of IAS is a completely new issue in Bangladesh. Information on IAS is therefore very scanty and not gathered systematically. A thorough study of IAS must be carried out and should consist of:

- Inventory and identification of IAS;
- Description of the natural habitat and geographic origin of each alien species, its habitat, and role in the environment;
- Mechanisms by which these organisms survive, propagate and spread;
- Establishment of clear quarantine regulations on IAS, and assessments of their effectiveness;
- International co-operation in information exchange, and on experiences gained with relevant IAS;
- Prior clearance for species of economic and/or aesthetic importance before introduction to a country, with documentation of country of origin, concerned organizations and probable ecological impact on the native species;

- Development of standardized procedures for introduction and monitoring of species;
- Political commitment through promulgation and enactment of proper legal instruments.
- Introduction of IAS in the management plan prescriptions for the existing biologically diverse forest areas has to be carefully incorporated which does not hinder existing ecosystems.

Conclusions

The IAS issue needs to be put on the national agenda in Bangladesh, and action should be taken now. Not taking action will result in substantial economic loss and damage to ecosystems and the rich biological heritage of Bangladesh. The status and impacts of existing IAS (especially internationally introduced species) in different regions of Bangladesh must be studied. These studies will improve public awareness of the impact of alien species to the national economy and ecosystems. For economic reasons, and the need for development of resources, it is essential sometimes to introduce alien species in forestry, agriculture and fisheries, but care should be taken about their nature and potential impacts. A species should only be introduced after risk assessment and environmental impact assessments. Adequate quarantine regulations should be promulgated to include the control of IAS introductions and establishment; in particular the inspection of vessels and other containers that may carry propagates. No predatory species should be introduced. Combating IAS in Bangladesh will be very difficult because of the absence of lists of identified IAS, properly carried out case studies on economic and ecological impacts, programmes on management efforts, awareness campaigns, coordination among different ministries and agencies and priorities for future work. As IAS require an integrated approach, all

relevant departments should be integrated in their approaches to address IAS by the establishment of a national focal point, and by monitoring and implementation of legal instruments. In this context, Bangladesh needs international cooperation in developing, sharing, linking and integrating IAS database and information systems, and research support for effective and prevention and management of IAS.

Table 1. List of IAS of fish introduced in Bangladesh

Name of species	Common name	Natural habitat	Country of origin	Year of introduction
<i>Trichogaster pectoralis</i>	Siamese Gourami	Thailand	Singapore	1952
<i>Carassius auratus</i>	Goldfish	Europe, Asia	Pakistan	1953
<i>Tilapia mossambica</i>	Tilapia	Africa	Thailand	1954
<i>Lebistes reticulatus</i>	Guppy	S. America	Thailand	1957
<i>Cyprinus carpio</i>	Carp	Asia, Europe	Not known	1960, 1965
<i>Ctenopharyngodon idella</i>	Grass Carp	China, Hong Kong	Japan, Nepal	1966, 1970, 1979
<i>Hypophthalmichthys molitrix</i>	Silver Carp	China, Hong Kong	Japan	1969, 1970
<i>Tilapia nilotica</i>	Nilotica	Africa	Thailand	1975
<i>Puntius gonionotus</i>	Thai	Indonesia, Thailand, Malaysia, Philippines	Thailand	1986
<i>Cyprinus carpio</i>	Sarpunti/Rajpunti	Temperate Asia, Europe	Nepal	1979
<i>Aristichthys nobilis</i>	Mirror Carp	China	Nepal	1981
<i>Mylopharyngodon piceus</i>	Black Carp/SnailCarp	China	China	1983
<i>Clarias gariepinus</i>	African Magur	Africa	Thailand	Thailand
<i>Pangasius sutchi</i>	Pangas	Thailand,	Indochina, Thailand	1990
<i>Pangasius giganticus</i>	Giant Panges	unknown	unknown	unknown

Source:

- Department of Fisheries 2001, Matshya Bhaban, 13 Shaid Munsur Ali Sharani, ramna, Dhaka.
- Insect control and experimental cultural purposes,
- Weed control & experimental cultural purposes,

- *Aquarium & decoration purposes &*
- *Experimental or cultural purposes*

Table 2. List of IAS of plants introduced in Bangladesh

Name of species	Common name	Natural habitat
<i>Acacia auriculiformis</i>	AKashmoni	Papua New Guinea, Australia, Torres Strait Island
<i>Acacia mangium</i>	Mangium	Australia, Papua New Guinea, Indonesia
<i>Paraserianthes falcataria</i>	Malacana	Papua New Guinea, Solomon Island, The Moluccas
<i>Dalbergia sissoo</i>	Sissoo	Indian subcontinent
<i>Eucalyptus brassiana</i>	Eucalyptus	Papua New Guinea, Australia
<i>Eucalyptus camaldulensis</i>	Eucalyptus	Throughout the Mediterranean
<i>Eucalyptus tereticornis</i>	Eucalyptus	Australia
<i>Leucaena leucocephala</i>	Telekadam/ Epilepil	Mexico, North Central America
<i>Pinus caribaea</i>	Caribaea pine	Nicaragua, Guatemala, Bahamas
<i>Pinus oocarpa</i>	Pine	Nicaragua Mexico, Guatemala, Honduras, El Salvador
<i>Swietenia macrophylla</i>	Mahogany	Central and South America
<i>Swietenia mahogany</i>	True mahogany	North America, Cuba, Bahamas
<i>Tectona grandis</i>	Teak	South-east Asia
<i>Xylia dolabriformis</i>	Pynkado	Myanmar, India

Source: Zabala, 1990

Table 3. List of IAS of weeds introduced in Bangladesh.

Source: Islam, 1985 and Karium and Kabir, 1995, personal communication

Name of species	Common name (Bengali name)	family	Country of origin and natural habitat	Harmful effect
<i>Alternanthera philoxeroides</i>	Alligator weed (Helencha)	Amaranthaceo us	Brazil	Weed of transplanted and deep water, in Aman, Boro and Aus rice fields, grows in shallow and stagnant water, ditches and ponds.
<i>Argemone mexicana</i>	Mexican poppy (Shialkata)	Papaveranceae	Tropical America and Mexico	Aggressive weed reduces plant diversity. Grows in wheat, sugarcane, potato, pulses and tea fields
<i>Chylocalxy</i> sp.	Not known	Polygonaceae	India	Forms mats over other plants including crops (wheat, mustard), climbs several metres onto trees. Major agricultural pest.
<i>Croton bonplandianus</i>	Not known (Banmoricha)	Euphorbiaceae	South America	Grows widely, competes with crops (corn, sugarcane, pulses).
<i>Cyperus alternifolius</i>	Mistletoe	Cyperaceae	Africa and Arabia	Grows in paddy fields.
<i>Cyperus exaltatus.</i>	Muthagrass	Cyperaceae	Topical Africa	Grows in paddy fields.
<i>Dendropthe falcata</i>	Not known	(Furulla/Bantha) Loranthaceae	India	Tropical Australia Parasitic plant can kill the host plants.
<i>Eichhornia crassipes</i>	Water hyacinth	(Kachuripana) Pontederiaceae	Brazil	Blocks waterways, damages paddy fields, creates mosquito habitat.
<i>Eleocharis dulcis</i>	Not known	Cyperaceae	Tropics	Grows profusely Stagnant and slow moving water.
<i>Enhdrya fluctuans</i>	Harkuch (Hinchashak)	Compositae	Malaysia	Problem in Aus, Aman, Boro rice, Jute and Rabi fields. Profuse growth prohibits light penetration, depleting oxygen from wetlands.
<i>Hibiscus tiliaceus</i>	Not known (Bhula)	Malvaceae	Tropics of both Hemispheres	Grows vigorously, smothers other species, makes forests and other places inaccessible to humans.
<i>Hydrolea zeylanica</i>	Not known (Bishlanguli)	Hydrophyllaceae	Trop. America and Africa	Grows in marshy places. It is also grown in irrigates rice fiels.
<i>Ipomoea aquatica</i>	Morning glory (Kalmi)	Convolvulacea e	Tropical Africa	Dense growth covers water body and may cause oxygen depletion. Grows in Aus rice and Jute fields.
<i>Macrosolen cochinchinensis</i>	Not known	Loranthaceae	China	Parasitic plant may kill the host.
<i>Mikania cordata</i>	Mikianialata (Assamlata)	Compositae	Tropical America	Serious weed of tes, rubber and forest crops.
<i>Parthenium hysterophorus</i>	Not known	Compositae	Tropical America, West Indies (Jamaica)	Poisonous, causing skin eruptions in animals. Very harmful for cattle in the dry season. Grows widely and competes with crops. Poisonous to fish.
<i>Sagittaria sagittifolia</i>	Common arrowhead (Sota Kut)	Alismataceae	North America and Europe	It grows in shallow water, ditches and lowlands. It is a problem in deep water Aman rice fields.
<i>Pistia stratiotes</i>	Water lettuce (Tupapana)	Araceae	Tropical	It grown in irrigated rice fields and in fishponds. Covers water surface and causes depletion of oxygen in water.

