

Chapter 6

The Status Of Introduced Carp Species In Asia¹

Belen O. Acosta² and Modadugu V. Gupta²

6.1 Introduction

Cyprinids are the most important group in aquaculture in Asia, accounting for 49 per cent of the total aquaculture production Asia in 1999 (FAO 2001a), and they also account for a large number of the introductions of tropical/subtropical finfish in the region (de Silva 1989). Introduction is defined as the act of intentionally or accidentally transporting and releasing an organism into an environment outside its present range (ICES 1988). In fish, the main reasons for deliberate introductions include increased production, employment, generation of foreign exchange, biological control and recreation (FAO 1996). While tremendous benefits can be and have been derived from fish introductions, there are also indications that movement of alien cyprinid species, both across international borders and across watersheds, has led to negative effects in natural ecosystems. The available information on species introductions, however, reports mainly on movements across country boundaries and very seldom on movements across zoogeographical boundaries or watersheds.

The Asian countries, in particular Bangladesh, China, India, Indonesia, Thailand and Vietnam, have vast carp genetic resources that are an important element of their aquaculture production systems. Hence, in recent years, the governments of these countries have been recognizing the need to exercise a precautionary approach in the introduction of any aquatic organism, including carps.

Information on the introduced species is a prerequisite for implementing programs aimed at

the conservation of genetic resources. This chapter discusses the status of introductions of cyprinid species across international borders in Asia. The data used were derived mainly from the FishBase³ records of fish introductions, the Food and Agriculture Organization (FAO) of the United Nations database on species introductions, the International Network on Genetics in Aquaculture (INGA)⁴ records on germplasm transfer and reports from INGA member countries. These include each instance in which a non-native species is moved into a recipient country, even if the species has already been moved into that recipient country before.

6.2 Species introduced and sources

A total of 259 introductions of cyprinid species have been recorded in the 27 countries of Asia. Of these, 72 per cent (186 records) were from countries within Asia, 10 per cent (26 records) were from countries outside Asia and another 18 per cent (47 records) were from “unknown” countries (Annex 6.1). The available records indicate introductions of forty-two cyprinid species. Fig. 1 shows the top five most often introduced cyprinid species based on the number of records. Common carp (*Cyprinus carpio*) was the most often introduced species in the region (52 records), followed by the grass carp (*Ctenopharyngodon idella*) (29 records), silver carp (*Hypophthalmichthys molitrix*) (28 records), bighead carp (*Aristichthys nobilis*) (20 records) and goldfish (*Carassius auratus auratus*) (15 records). The high frequency of introductions of *C. carpio* could be the result of this species having the longest history of culture and domestication among the cyprinids. It is believed that the species has been farmed in China for over 2000 years.

¹ WorldFish Center Contribution No. 1731.

² WorldFish Center, Jalan Batu Maung, Batu Maung, 11960 Bayan Lepas, Penang, Malaysia.

³ FishBase is an information system with key data on the biology of all fish. It has been developed by the WorldFish Center (formerly ICLARM) in collaboration with the Food and Agriculture Organization (FAO) of the United Nations and many other partners (Froese and Pauly 2002). Information on fish introductions in FishBase is an updated version of the original of Welcomme (1988) and has been expanded to include records of FAO, INGA and literature searches (Casal and Bartley 2000).

⁴ INGA is a global forum for applied fish breeding and genetics. It plays an important role in national, regional and international genetics research aimed at improving productions from aquaculture operations and conservation of aquatic genetic resources. It has a membership of 13 countries from Asia, the Pacific and Africa and 12 advanced scientific institutions, international and regional organizations, with the WorldFish Center as the member coordinator (Gupta and Acosta 2001).

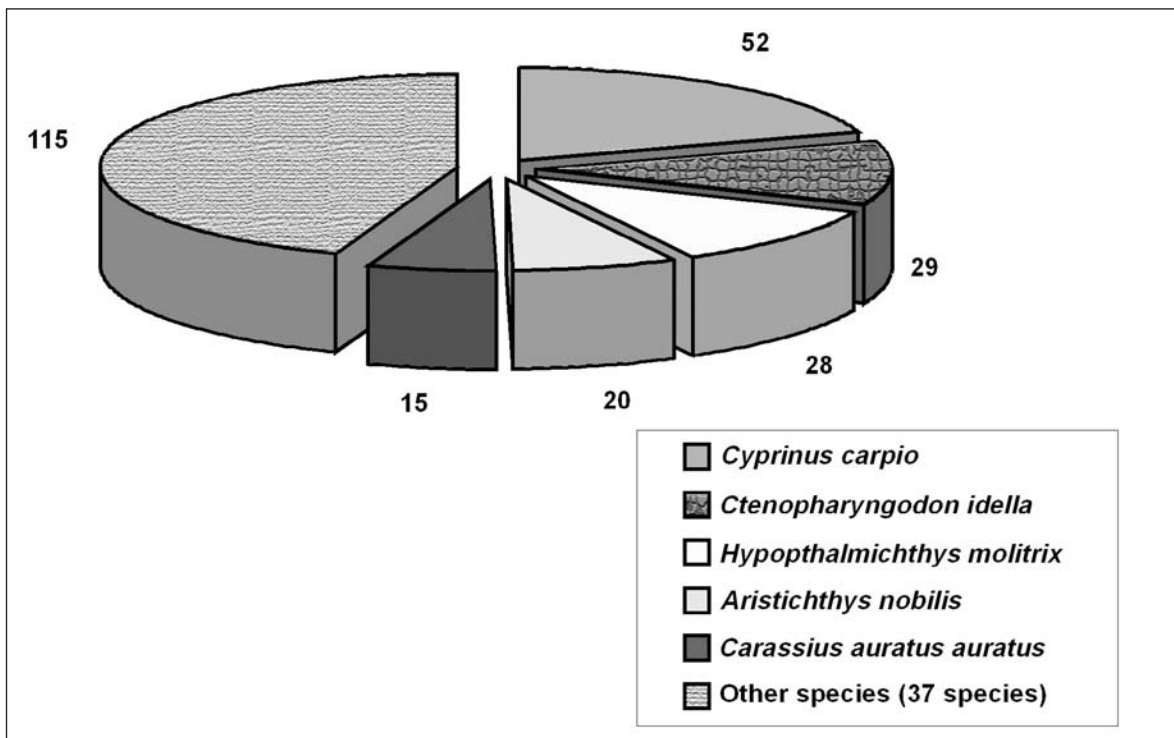


Fig. 6.1. Most commonly introduced cyprinid species based on the number of records (data based on the table in Annex 6.1)

6.3 Dates of introductions

Fig. 6.2 summarizes the number of cyprinid species introduced into the countries in Asia over time. Some of these introductions were made before the 18th century, with 38 records (or 14.7 per cent of the total) before 1950. *C. carpio* was the most frequent species among these early introductions. Apart from common carp, the Chinese carps were also introduced from the Pearl and Yangtze rivers to different provinces of China, Thailand, Singapore and Malaysia. The 4-5 cm fry were transported in wooden tubs on board ships until at least 1948, when fry were successfully transported by air for the first time (Lin 1949).

Subsequent introductions took place in the 1950s but the number of records for this period is only 11, or 4.2 per cent. During the 1960s, the frequency of introductions was at its highest (20 per cent or 52 records). The success of induced breeding through hypophysation, that improved fry supply, probably explains the increase of introductions during this decade. Over the next two decades, introductions became less frequent. Only 29 (11 per cent) and 31 (12 per cent) introductions were recorded in the 1970s and 1980s, respectively. From the 1990s to 2001, there was a further reduction in the recorded frequency of introductions (6.6 per cent or 17 records),

probably because: (i) most of the non-native species that are good candidates for aquaculture had already been introduced in many countries; (ii) heightened awareness of the risks involved in introductions in terms of impact on the environment, biodiversity and introductions of pathogens; and (iii) there is now greater focus in the countries to improve the genetic quality of their native carp stocks. About 31.3 per cent (81 records) of cyprinid introductions have no indications of the period or year the fish were brought into the country. The period of introduction was listed in FishBase as either “unknown” or left blank. The relatively high number of unknown time of transfer and unrecorded transfer of carps in the region may also be a reflection of accidental introductions or deliberate introductions without authorization from governments. In India, for instance, *A. nobilis*, *Cirrhinus molitorella* and *Mylopharyngodon piceus* have been introduced without authorization (Ponniah 1997).

6.4 Reasons for introductions

The earliest introductions of cyprinids in Asia were carried out mainly by the Chinese who “imported” both exotic species and culture systems into many Southeast Asian countries where they settled, rather than buying and consuming still relatively abundant local wild fish. Hence, it may

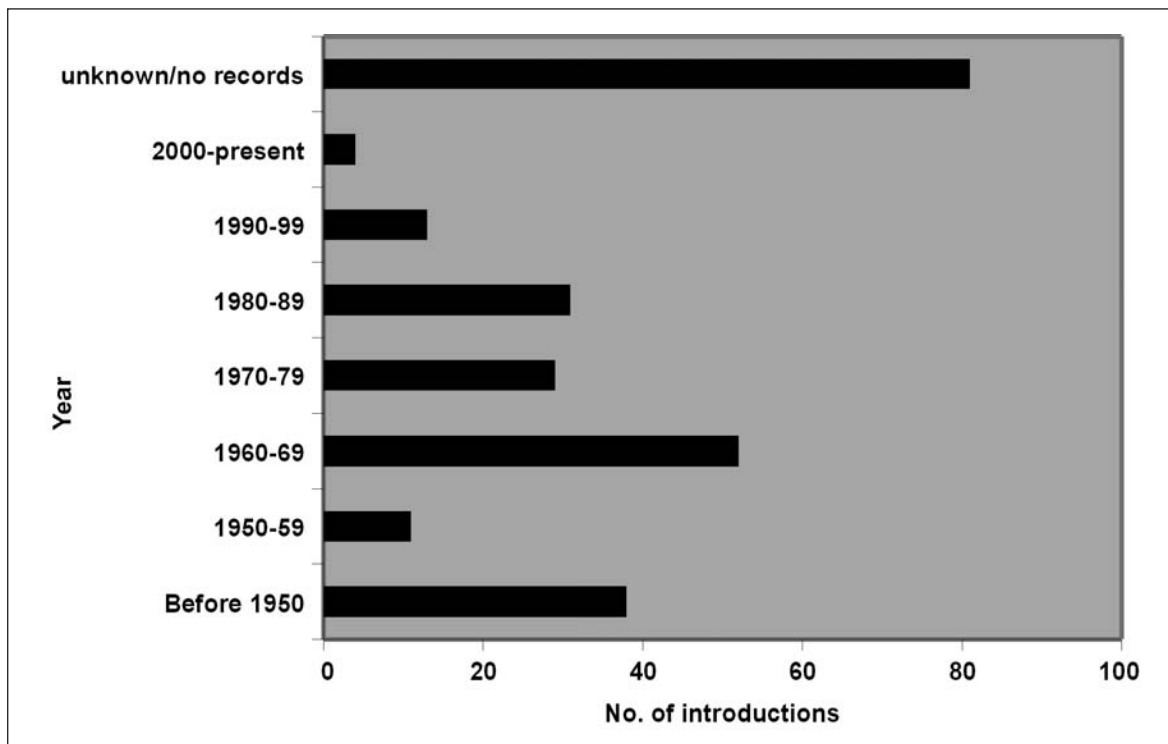


Fig. 6.2. Cyprinid introductions in Asia per decade (data based on the table in Annex 6.1)

be surmised that early introductions were due to cultural preference for Chinese carps based on nostalgia and well-established culinary tradition. Convenience may also have played a role for the predominantly urban-based Chinese in Southeast Asia, because fish culture could provide a predictable, abundant, year-round supply of fish in contrast to often seasonal capture fisheries (Edwards et al. 1997).

Subsequent to early introductions, cyprinids were introduced mainly to enhance fisheries/aquaculture production and thereby to increase the available animal protein sources. Based on FishBase records, Fig. 6.3 summarizes the reasons for introducing carps in Asia. Use in aquaculture operations was the most frequent (69 per cent or 175 records) reason for introducing carps in all countries in the region. The main reason for introduction was primarily to broaden the species spectrum in fish farming and increase yields through better utilization of trophic niches. This reflects the greater focus given by the countries in the region to aquaculture, in contrast to developed countries where fish are most often introduced to support recreational fishery activity. The other major reasons given were ornamental (10.4 per cent or 27 records) and research (9.3 per cent or 24 records). In a few instances, phytoplankton/weed control, snail control and angling/sport were also indicated as the purpose of the

introductions (1.5 per cent or 4 records). There were also several cases of accidental or unknown reasons for the introductions (9.7 per cent or 25 records).

6.5 Effects of introductions

The known effects of introducing carps in Asia are summarized in Annex 1. These are categorized as to whether they are known to have resulted in significant ecological and socioeconomic impacts.

FAO (2001b) reported that among the cyprinids, *A. nobilis*, *C. auratus*, *Catla catla*, *Labeo rohita* and *M. piceus* are the species generally viewed as "beneficial" where introduced. In terms of socioeconomic effects, the introduction of Indian and Chinese major carps in Asian countries has paved the way for the progress made in carp aquaculture. This is more evident in the six main carp producing countries in the region: Bangladesh, China, Indonesia, India, Thailand and Vietnam. In Bangladesh, where a number of exotic major carps (*H. molitrix*, *A. nobilis*, *C. idella*, *M. piceus*, *C. carpio*, *Tor putitora* and *Barbonymus gonionotus*) were introduced for aquaculture as early as the 1950s, these species (except for *T. putitora*) have become a part of aquaculture and fishery operations (Hossain 1997), for polyculture in ponds or for stocking in floodplains, rivers and

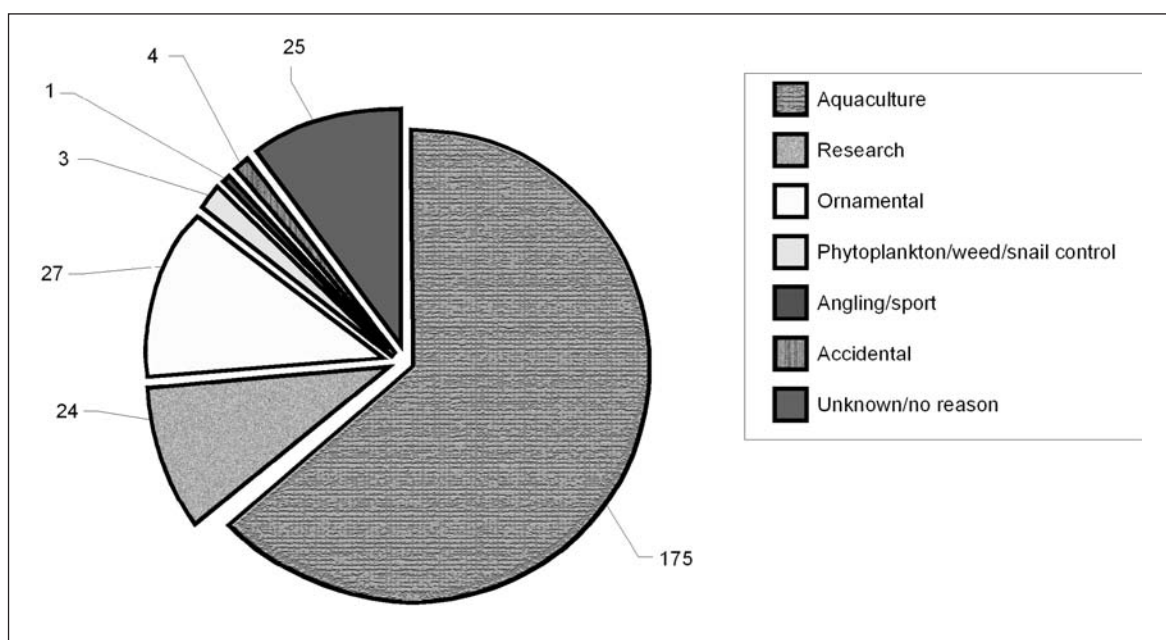


Fig. 6.3. Reasons for introduction of cyprinids based on a number of records

reservoirs to enhance natural fisheries (Gupta et al. 1997). In India, *H. molitrix* and *C. idella*, which occupy two important ecological niches hitherto vacant in the traditional polyculture system, have played a significant role in the country's aquaculture ever since their introduction in 1959 (Tripathi 1989). *H. molitrix*, *C. idella* and different strains of *C. carpio* that have been introduced into India form an important component of polyculture of indigenous and exotic species. In Indonesia, *C. carpio*, which was believed to be the first species introduced in the country, has become the most common fish cultured in freshwater ponds, cages and running water systems (Eidman 1989). In Thailand and Vietnam, the introduced *C. carpio*, *L. rohita*, and *C. cirrhosus* are used for aquaculture. For example, in northern Vietnam, *C. carpio* has been sustained because the species is bred at the household level and rice/*C. carpio* culture has been carried out locally for generations and been adapted to local circumstances (Edwards et al. 2000). Apart from *C. carpio*, the Indian major carps, *L. rohita* and *C. cirrhosus* have also become economically important cultured species in Vietnam as they are easy to breed in hatcheries and grow fast in different culture systems (Thien and Dan 1997).

While the introduction of major carp species has proven to be a boon in aquaculture and optimized the yield in ponds, the accidental and deliberate stocking of these in open waters has, in a few instances, resulted in negative ecological effects.

The introduction of *C. auratus*, *C. idella*, *C. carpio* and *H. molitrix* in India is viewed as controversial in that they have created ecological problems of various kinds but are, at the same time, perceived as being extremely useful socioeconomically (FAO 2001a; FAO 2001c). These species have made a substantial contribution to food production but have also been implicated in threatening endemic species in the country. This has been the case in India where *H. molitrix* introduced in Gobindsagar Reservoir reportedly resulted in a sharp decline of the dominant native species *C. catla* due to overlapping feeding habits and habitat. Production of *H. molitrix* in the reservoir increased from 0.60 tonnes to 334 tonnes in 10 years (from 1977-78 to 1987-88), while *C. catla* production, which was 210 tonnes in 1977-78, declined to 36.7 tonnes in 1987-88. Similarly, in Kalgarhi Reservoir the *C. catla* population declined as a result of competition with *H. molitrix* (Das 1997).

In Girna and Krishnarajasagar reservoirs (India), the introduction of *C. carpio* has resulted in the decline of *Cirrhinus* sp. *C. carpio*, because of its habit of stirring up the bottom while feeding, has the reputation of muddying the waters it occupies. This shades out macrophytes, chokes benthic invertebrates, and through the more rapid recycling of phosphate contributes to accelerated eutrophication. As a result, the composition and abundance of the native fish fauna are affected (FAO 2001b).

6.6 Need for and development of a precautionary approach

Global efforts through fisheries regulations, conventions, treaties and agreements are now emerging to protect biodiversity and minimize the risks caused by human actions and development activities.

One of the risks associated with species introductions is the spread of disease. International codes of practice, technical guidelines which describe, at least in part, standardized protocols for minimizing the risks of disease associated with movements of aquatic animals are currently available (Subasinghe et al. 2001). Examples of these are the International Council for Exploration of the Sea (ICES) Code of Practice on the Introductions and Transfer of Marine Organisms (ICES 1995) and the European Inland Fisheries Advisory Commission (EIFAC) Codes of Practice and Manual of Procedures for Consideration of Introductions and Transfer of Marine and Freshwater Organisms (Turner 1988). Within the Asia-Pacific region, the Network of Aquaculture Centres in the Asia-Pacific (NACA), in cooperation with the Office International des Epizooties (OIE) and FAO have initiated measures to minimize disease risks caused by the transboundary movement of aquatic organisms. These include, among others, the establishment of a disease surveillance and reporting system in the region (Subasinghe et al. 2001) and production of a set of technical guidelines on health management for the responsible movement of live aquatic animals in Asia (FAO and NACA 2000, 2001). These efforts complemented the existing FAO Code of Conduct for Responsible Fisheries that provides a global framework for the sustainable use and conservation of biological diversity (FAO 1995).

Naylor (1994) stressed the importance of institutionalizing quarantine programs in developing countries to minimize the risks of disease and other factors that may contribute to loss of biodiversity and damage to ecosystems as a result of species introductions. Although existing agreements, international codes of practice and guidelines have placed emphasis on precautionary measures such as quarantine, these are still left to the responsibility of individual countries. Hence, in many instances of species introductions, these measures have not been fully

implemented. International cooperation is one mechanism to ensure effective implementation of these regulatory measures. The INGA, which the WorldFish Center has been coordinating since 1993, provides assistance to 13 developing member countries (9 are from Asia) in the exchange of fish germplasm, for evaluation, direct use in aquaculture or utilization in breeding programs. Protocols and quarantine procedures formulated by the network based on international codes of practice and the Material Transfer Agreement are being followed in the transfer of germplasm through the network (Gupta and Acosta 2001). To avoid the risk of contaminating wild gene pools through interbreeding, it has been the policy of INGA not to transfer species that are endemic to potential recipient countries. INGA has also not made any new introductions, i.e. brood stock exchange has only been supported where a non-endemic species has previously been introduced into the recipient country.

Globally, governments and the international community have recognized that one of the major threats today to native biodiversity is the impact of alien invasive species.⁵ In response to this, the IUCN has drawn up guidelines for the prevention of biodiversity loss caused by such species. Its intention is to assist all governments and management agencies to give effect to Article 8 (h) of the Convention on Biological Diversity, which states that: "Each Contracting Party 'shall, as far as possible and as appropriate: ... (h) prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species'" (IUCN 2001). The Conference of the Parties to the Convention on Biological Diversity elaborated this during discussions at the Sixth Meeting of the Subsidiary Body on Scientific, Technical and Technological Advice in April 2002 and this version states that "no first-time intentional introduction of an alien species should take place without the authorization from a competent authority unless it is known that an alien species poses no threat to biological diversity. A science-based risk assessment, including environmental impact assessment, should be carried out as part of the evaluation process before coming to a decision on whether or not to authorize a proposed introduction. States should make all efforts to knowingly permit only those species that are unlikely to cause unacceptable harm to ecosystems, habitats or species" (UNEP/CBD/COP 2001).

⁵ Alien invasive species means an alien species that becomes established in natural or semi-natural ecosystems or habitat, is an agent of change, and threatens native biological diversity (IUCN 2001).

The WorldFish Center addresses research and policy issues that have impacts on aquatic biodiversity through its contributions to the work of the Convention on Biological Diversity, FAO, IUCN and other international bodies/organizations (ICLARM 1999). In line with this effort and prompted by the need to promote public awareness and strict implementation of conservation measures, the WorldFish Center, in collaboration with its partners, held expert consultation meetings on ecological risk assessment of introductions of genetically improved and modified aquatic organisms and conservation of biodiversity (Gupta et al. 2004; WorldFish Center 2002, 2003). The meeting, organized in Bangladesh in 2003 (WorldFish Center 2003), recognized that existing institutional mechanisms, policies and legal frameworks related to introductions do not adequately cover issues posed by improved strains and suggested that effective institutional frameworks, monitoring and enforcement mechanisms be established at national and local levels as appropriate. The meeting also suggested that transparent, objective and practical methodologies be adopted and promoted for assessment of risks associated with the dissemination of improved strains of fish (WorldFish Center 2003).

6.7 Conclusion

The benefits derived from introductions of cyprinid species in the region are evident in terms of improving overall fish yields through aquaculture. The introductions of this group of fish for aquaculture has resulted in significant contributions to improve human nutrition and alleviate rural poverty. The development of world aquaculture has been mostly in freshwater environments (58.7 per cent) and mainly in Asia (FAO 2000). The freshwater aquaculture production in this region is dominated by finfish, particularly the major carp species.

Although problems have been reported in a few cases, none of the carp species introduced has been regarded as a pest,⁶ nor have any carps caused major negative environmental impacts. However, the many cases of “unknown” introductions of carp species in the region that are probably unauthorized by the governments, as evidenced by the incomplete entries in some of the FishBase records, and the few reported

negative effects of alien cyprinid species on endemic species still merit attention. This indicates that stringent regulatory measures are still lacking in many of these countries and careful assessment of the risks was probably not done when the exotic carp species were introduced. This affirms the need for implementation of control measures on movements across international boundaries and across watersheds, of any aquatic organism, even if previous introductions of such a species have been generally perceived as beneficial.

References

- Alikunhi, K.H. 1966. Synopsis of biological data on common carp, *Cyprinus carpio* (Linnaeus), 1758 (Asia and the Far East). FAO Fish. Synop. (31.2). 39 p.
- Ang, K.J., R. Gopinath and T.E. Chua. 1989. The status of introduced fish species in Malaysia, p. 71-82. In S.S. de Silva (ed.). Exotic aquatic organisms in Asia. Proceeding of the Workshop on Introduction of Exotic Aquatic Organisms in Asia. Asian Fish. Soc. Spec. Publ. 3. Asian Fisheries Society, Manila, Philippines. 154 p.
- Aquarium Science of the Philippines Inc. (ASAP). 1996. Aquarium species in the Philippines. ASAP Philippines Aquarist Database Report. Quezon City, Philippines. 9 p.
- Casal, M.C. and D. Bartley. 2000. The introductions table. In R. Froese and D. Pauly (eds). FishBase 2000: Concepts, design and data sources. ICLARM, Los Baños, Laguna, Philippines. 344 p. (also available in http://www.fishbase.org/manual/FishbaseThe_Introductions_Table.htm).
- Chiba, K., Y. Taki, K. Sakai and Y. Oozeki. 1989. Present status of aquatic organisms introduced into Japan, p. 63-70. In S.S. de Silva (ed.). Exotic aquatic organisms in Asia. Proceedings of the Workshop on Introduction of Exotic Aquatic Organisms in Asia. Asian Fish. Soc. Spec. Publ. 3, Asian. Fisheries Society. 154 p.
- Coad, B.W. 1996. Exotic fish species in the Tigris-Euphrates basin. Zoology in the Middle East 13:71-83.
- Csavas, I. 1983. Establishment of a National Warmwater Fish Seed Production Centre, Gayleghug, Bhutan. FAO FI:DP/BHU/80/007/ Field Document 2. 21 p.
- Das, P. 1997. Country paper - India. In J. Humphrey, J.R. Arthur, R. P. Subasinghe and M.J. Phillips. Aquatic animal quarantine and health certification in Asia. Proceedings of the Regional Workshop on Health and Quarantine Guidelines for the Responsible Movement (Introduction and Transfer) of Aquatic Organisms, Bangkok, Thailand, 28 January 1996.
- Davidson, A. 1975. Fish and fish dishes of Laos. Imprimerie Nationale Vientiane. 202 p.
- De Silva, S.S. 1989. Exotics – a global perspective with special reference to finfish introductions to Asia, p. 1-

⁶ A pest is defined as an introduced species whose behavior makes it useless for anything but forage for other fish and causes a disproportionate amount of environmental nuisance (FAO 2001b).

6. In S.S. De Silva (ed.). Exotic Aquatic Organisms in Asia. Proceedings of the Workshop on Introduction of Exotic Aquatic Organisms in Asia. Asian Fish. Soc. Spec. Publ. 3. Asian Fisheries Society, Manila, Philippines. 154 p.
- De Zylva, E.R.A. 1994. The development of aquaculture in Sri Lanka. Paper distributed at the Infotech-Aquatech '94 Conference. (Unpublished).
- Edwards, P., D.C. Little and A. Yakupitiyage. 1997. A comparison of traditional and modified inland artisanal aquaculture systems. *Aquaculture Research*. 28(10):777-788.
- Edwards, P., D.D. Hiep, P.M. Anh and G. Mair. 2000. Traditional culture of indigenous common carp in rice fields in Northern Vietnam. *World Aquaculture*. 31(4):34-40.
- Eidman, H.M. 1989. Exotic aquatic species introduction into Indonesia, p. 57-62. In S.S. De Silva (ed.). Exotic Aquatic Organisms in Asia. Proceedings of the Workshop on Introduction of Exotic Aquatic organisms in Asia: Asian Fish. Soc. Spec. Publ. 3. Asian Fisheries Society, Manila, Philippines. 154 p.
- FAO. 1995. Code of Conduct for Responsible Fisheries. Food and Agriculture Organization of the United Nations, Rome. 41 p. (<http://www.fao.org/fi/>).
- FAO. 1996. Precautionary approach to capture fisheries and species introductions. FAO Technical Guidelines for Responsible Fisheries 2. FAO, Rome 1996.
- FAO. 1997. FAO Database on introduced aquatic species. FAO Database on Introduced Aquatic Species, FAO, Rome.
- FAO. 2000. The state of world fisheries and aquaculture. FAO Fisheries Department. 142 p.
- FAO. 2001a. Fishery statistics – aquaculture production. Vol. 88(2).
- FAO 2001b. Evaluation of introduction (<http://www.fao.org/docrep/x5628/x5628e.06.htm>).
- FAO 2001c. *Cyprinus carpio* L.: Cyprinidae. Register of international introductions of inland aquatic species (<http://www.fao.org/docrep/x5628e09.htm>).
- FAO and NACA 2000. Asia regional technical guidelines on health management for the responsible movement of live aquatic animals and the Beijing Consensus and implementation strategy, FAO Fisheries Technical Paper. No. 402. Rome, FAO. 53 p.
- FAO and NACA. 2001. Manual of procedures for the implementation of the Asia Regional technical guidelines on health management for the responsible movement of live aquatic animals. FAO Fisheries Technical Paper. No. 402, Suppl. 1. Rome, FAO. 106 p.
- Froese, R. and D. Pauly. Editors. 2002. Fish Base. World Wide Web Electronic Publication. www.fishbase.org. 21 October 2002.
- Golani, D. and D. Mires, 2000. Introduction of fishes to the freshwater system of Israel. *Isr. J. Aquacult. Bamidgeh* 52(2):47-60.
- Gupta, M.V. and B.O. Acosta. 2001. Networking in aquaculture genetics research, p.1-5. In M.V. Gupta and B.O. Acosta (eds). Fish genetics research in member countries and institutions of the International Network on Genetics in Aquaculture. ICLARM Conf. Proc. 64, 179 p.
- Gupta, M.V., M.M. Dey, R. Dunham and G. Bimbao, Editors. 1997. Proceedings of the collaborative research and training on genetic improvement of carp species in Asia, 26-29 July 1997. Central Institute of Freshwater Aquaculture, Bhubaneswar, India. ICLARM Work. Doc. 1, 24 p.
- Gupta, M.V., D. Bartley and B.O. Acosta. 2004. Use of genetically improved and alien species for aquaculture and conservation of aquatic biodiversity in Africa. *WorldFish Conf. Proc.* 68 (In press).
- Hossain, M.A. 1997. Country paper – Bangladesh. In J. Humphrey, J.R. Arthur, R. P. Subasinghe and M.J. Phillips (eds). Aquatic animal quarantine and health certification in Asia. Proceedings of the Regional Workshop on Health and Quarantine Guidelines for the Responsible Movement (Introduction and Transfer) of Aquatic Organisms, Bangkok, Thailand, 28 January 1996. FAO Fish. Tech. Paper. No. 373.
- Hussain, M.G. and M.A. Mazid. 1997. Carp genetic resources in Bangladesh. In M.V. Gupta, M.M. Dey, R. Dunham and G. Bimbao (eds.) Proceedings of the Collaborative Research and Training on Genetic Improvement of Carp Species in Asia, 26-29 July 1997. Central Institute of Freshwater Aquaculture, Bhubaneswar, India. ICLARM Work. Doc. 1. (Unpublished).
- ICES. 1988. Codes of practice and manual of procedures for consideration of introductions and transfers of marine and freshwater organisms. ICES Cooperative Research Report No. 159. 44 p.
- ICES. 1995. ICES Code of practice on the introductions and transfers of marine organisms – 1994. ICES Co-op. Res. Rep. No. 204.
- ICLARM. 1999. Operational plan. International Center for Living Aquatic Resources Management. Manila, Philippines. 102 p.
- INGA. 2002. Record of fish germplasm transfer under the International Network on Genetics in Aquaculture. 4 p. (Unpublished).
- Interim Committee for Coordination of Investigations of the Lower Mekong Basin. 1981. Mekong aquacultural achievements in the Lao PDR through projects support by the Netherlands. Report by the Secretariat, MKG/91, 16 p.
- IUCN. 2001. IUCN guidelines for the prevention of biodiversity loss caused by alien invasive species (<http://www.iucn.org/themes/ssc/pubs/policy/invasiveEng.htm>).
- Juliano, R.O., R. Guerrero III and I. Ronquillo. 1989. The introduction of exotic aquatic species in the Philippines, p. 83-90. In S.S. De Silva (ed.). Proceedings of the Workshop on Introduction of Exotic Aquatic Organisms in Asia. Asian Fish. Soc. Spec. Publ. 3. Asian Fisheries Society, Manila, Philippines. 154 p.
- Kottelat, M. and T. Whitten. 1996. Freshwater biodiversity in Asia, with special reference to fish. *World Bank Tech. Pap.* 343. 59 p.
- Krupp, F. and W. Schneider. 1989. The fishes of the Jordan River drainage basin and the Azraq Oasis, p. 347-416. In *Fauna of Saudi Arabia*. vol. 10.
- Lever, C. 1996. Naturalized fishes of the world. Academic Press. California, USA. 408 p.
- Lin, S.Y. 1949. Notes on fry industry of China. *Proc. Indo-*

- Pacific Fish. Coun. 1:65-71.
- Man, S.H. and I.J. Hodgkiss. 1981. Hong Kong freshwater fishes. Urban Council. Wishing Printing Co. Hong Kong. 75 p.
- Manandhar, H.N. 1995. Letter sent to FAO. Ministry of Agriculture, Department of Agriculture Development, Fisheries Development Division, Kathmandu, Nepal.
- Naylor, R. 1994. Socio-economic aspects of biological invasion, a case study: the golden apple snail (<http://www.gcario.org/ASPEN/science/eoc94/EOC3/EOC3-18.html>).
- Piyakarnchana, T. 1989. Exotic aquatic species in Thailand, p. 119-124. *In* S.S. De Silva (ed.). Proceeding of the Workshop on Introduction of Exotic Aquatic Organisms in Asia. Asian Fish. Soc. Spec. Publ. 3. Asian Fisheries Society, Manila, Philippines. 154 p.
- Ponniiah, A.G. 1997. Conservation of carp genetic resources of India. *In* M.V. Gupta, M.M. Dey, R. Dunham and G. Bimbao (eds). Proceedings of the Collaborative Research and Training on Genetic Improvement of Carp Species in Asia, 26-29 July 1997. Central Institute of Freshwater Aquaculture, Bhubaneswar, India. ICLARM Work. Doc. 1.
- Rahman, A.K.A. 1989. Freshwater fishes of Bangladesh. Zoological Society of Bangladesh. Department of Zoology, University of Dhaka. 364 p.
- Rainboth, W.J. 1996. Fishes of the Cambodian Mekong. FAO Species Identification Field Guide for Fishery Purposes. FAO, Rome. 265 p.
- Roberts, T.R. 1997. Systematic revision of the tropical Asian labeon cyprinid fish genus *Cirrhinus*, with description of new species and biological observations on *C. lobatus*. *Nat. Hist. Bull. Siam Soc.* 45:171-203.
- Schuster, W.H. 1950. Comment on importation and transplantation of different species of fish into Indonesia. *Contributions General Agriculture* 111. 31 p.
- Shen, S.C., Editor. 1993. Fishes of Taiwan. Department of Zoology, National Taiwan University, Taipei. 960 p.
- Shetty, H.P., M.C. Nandeesha and A.G. Jhingran. 1989. Impact of exotic species in Indian waters, p. 45-55. *In* S.S. De Silva (ed.). Exotic aquatic organisms in Asia. Proceeding of the Workshop on Introduction of Exotic Aquatic Organisms in Asia. Asian Fish. Soc. Spec. Publ. 3. Asian Fisheries Society, Manila, Philippines. 154 p.
- Shireman, J.V. and C.R. Smith. 1983. Synopsis of biological data on the grass carp, *Ctenopharyngodon idella* (Cuvier and Valenciennes 1884). *FAO Fish. Synop.* (135):86 p.
- Shrestha, J. 1994. Fishes, fishing implements and methods of Nepal. Smt. M. Gupta, Lalitpur Colony, Lashkar (Gwalior), India. 150 p.
- Subasinghe, R.P., M.G. Bondad-Reantaso and S.E. McGladdery. 2001. Aquaculture development, health and wealth. *In* R.P. Subasinghe, P.B. Bueno, M.J. Philips, C. Hough, S.E. McGladdery and J.R. Arthur (eds). NACA/FAO. Aquaculture in the Third Millenium. Technical Proceedings of the Conference on Aquaculture in the Third Millenium, Bangkok, Thailand. 20-25 February 2000. NACA, Bangkok and FAO, Rome. 471 p.
- Tan Y-J. and Tong H-Y. 1989. The status of exotic aquatic organisms in China, p. 35-43. *In* S.S. De Silva (ed.). Exotic Aquatic Organisms in Asia. Proceedings of the Workshop on Introduction of Exotic Aquatic organisms in Asia: Asian Fish. Soc. Spec. Publ. 3. Asian Fisheries Society, Manila, Philippines. 154 p.
- Thien, T.M. and N.C. Dan. 1997. Carp genetic resources in Vietnam. *In* M.V. Gupta, M.M. Dey, R. Dunham and G. Bimbao (eds). Proceedings of the Collaborative Research and Training on Genetic Improvement of Carp Species in Asia, 26-29 July 1997. Central Institute of Freshwater Aquaculture, Bhubaneswar, India. ICLARM Work. Doc. 1.
- Tripathi, S.D. 1989. *Hypophthalmichthys molitrix* and *Ctenopharyngodon idella* – exotic elements in freshwater carp polyculture in India. Paper Presented at Workshop on Exotic Aquatic Species in India, Mangalore (India), 25-26 April 1988.
- Turner, G.E. 1988. Codes of practice and manual of procedures for consideration of introductions and transfers of marine and freshwater organisms. EIFAC Occas. Pap. No. 23, FAO, Rome, Italy.
- UNEP/CBD/COP. 2001. Report of the Sixth Meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (<http://www.biodiv.org>).
- Welcomme, R.L. 1988. International introductions of inland aquatic species. *FAO Fish. Tech. Pap.* 294. 318 p.
- WorldFish Center. 2002. Nairobi declaration: Conservation of aquatic biodiversity and use of genetically improved and alien species for aquaculture in Africa. WorldFish Center, Penang, Malaysia. 13 p.
- WorldFish Center. 2003. Dhaka declaration on ecological risk assessment of genetically improved fish. WorldFish Center, Penang, Malaysia. 18 p.

Annex 6.1

History of carp introductions in Asia

Country	Species	English name	Source	Year introduced	Reason for introduction	Significant ecological effects	Significant socioeconomic effects	Reference
Afghanistan	<i>Ctenopharyngodon idella</i> <i>Cyprinus carpio</i>	Grass carp Common carp	China China	- Unknown (1970-79)	Aquaculture Aquaculture	- -	Yes-beneficial -	Welcome 1988 Welcome 1988
Bangladesh	<i>Aristichthys nobilis</i> <i>Barbomymus gonionotus</i>	Bighead carp Silver barb	Nepal Thailand	1981 1977	Aquaculture Aquaculture	- -	- Yes-beneficial	Hussain and Mazid 1997 Rahman 1989 Hussain and Mazid 1997
	<i>C. idella</i>	Grass carp	Hong Kong	1987, 1994 1994	Research Research	-	-	Hussain and Mazid 1997 Hussain and Mazid 1997
				1966	Aquaculture	-	-	Hussain and Mazid (this volume)
			Hong Kong	1969	Aquaculture	-	-	Welcome 1988
			Japan	1970	Aquaculture	-	-	Hussain and Mazid 1997
			Nepal	1979	Aquaculture	-	-	Hussain and Mazid 1997
	<i>C. carpio</i>	Common carp	China	1960	Aquaculture	-	-	Hussain and Mazid (this volume)
			Hungary	1982, 1996	Aquaculture	-	-	Hussain and Mazid (this volume)
			Vietnam	1995	Research	-	-	INGA 2002
	<i>C. carpio</i>	Mirror carp	Nepal	1979	Aquaculture	-	-	Hussain and Mazid 1997
	<i>Hypophthalmichthys molitrix</i>	Silver carp	Hong Kong	1969	-	-	-	Hussain and Mazid (this volume)
	<i>Mylopharyngodon piceus</i>	Black carp	China	1983	Aquaculture	-	-	Hussain and Mazid (this volume)
	<i>Tor putitora</i>	Putitor Mahseer	Nepal	1991	Unknown	Unknown	Unknown	FAO 1997; Hussain and Mazid (this volume)
Bhutan	<i>A. nobilis</i> <i>Cirrhinus cirrhosus</i> <i>C. idella</i>	Bighead carp Mirgal Grass carp	Nepal Unknown Nepal	1983 1985 1983	Aquaculture Aquaculture Aquaculture	- - -	- - -	Csavas 1983 Welcome 1988 Csavas 1983

	<i>C. carpio</i>	Common carp	Nepal	1983	Aquaculture	-	-	Csavas 1983
	<i>H. molitrix</i>	Silver carp	Unknown	1984	-	No	-	Welcomme 1988
	<i>Labeo rohita</i>	Rohu	India	1985	Aquaculture	-	-	FAO 1997
	<i>T. putitora</i>	Putitor mahseer	India	1969	Ornamental	Unknown	Unknown	FAO 1996
Brunei	<i>C. carpio</i>	Common carp	Unknown	-	Aquaculture	-	Yes-beneficial	Davidson 1975
Cambodia	<i>C. idella</i>	Grass carp	Unknown	-	Aquaculture	-	-	Alikunhi 1966
	<i>C. carpio</i>	Common carp	Unknown	-	Aquaculture	-	-	
China	<i>A. nobilis</i>	Bighead carp	Hong Kong	Unknown	Aquaculture	-	Yes-beneficial	Welcomme 1988
	<i>B. gonionotus</i>	Silver barb	Thailand	1986	Aquaculture	-	Yes-beneficial	Welcomme 1988
	<i>Carassius auratus</i>	Goldfish	Japan	1976	Aquaculture	-	-	Tan, Y. and H.E. Tong 1989
	<i>C. cuvieri</i>	-	Japan	1976	Aquaculture	-	-	FAO 1997
	<i>Catla catla</i>	Catla	India	1973	Aquaculture	Probably no-undecided	Unknown	Tan, Y. and H.E. Tong 1989
	<i>C. carpio</i>	Common carp	Bangladesh	1973	Aquaculture	Probably no-undecided	Unknown	Tan Jo-Jun and Tong He-Yi 1989
	<i>L. rohita</i>	Rohu	F. Germany	1982	-	-	-	FAO 1997
	<i>Orthodon microlepidotus</i>	Sacramento blackfish	USA	1982	Aquaculture	-	Probably no-beneficial	Welcomme 1988
	<i>Pseudorasbora parva</i>	Stone moroko	Unknown	Unknown (1970-79)	Accidental	Yes-adverse	-	Kottelat and Whitten 1996
Hong Kong	<i>C. molitorella</i>	Mud carp	Unknown	-	Aquaculture	-	-	Roberts 1997
	<i>C. idella</i>	Grass carp	China	Unknown	Aquaculture	-	-	Shireman and Smith 1983
	<i>C. carpio</i>	Common carp	Unknown	-	Aquaculture	-	-	Man. and Hodgkiss 1981
	<i>Opsariichthys bidens</i>	-	China	1994	Aquaculture	Probably no-undecided	Unknown	FAO 1997
India	<i>A. nobilis</i>	Bighead carp	Bangladesh	1987	Aquaculture	Probably yes-undecided	Probably no-undecided	FAO 1997
	<i>B. gonionotus</i>	Silver barb	Indonesia	1972	Aquaculture	Probably yes-undecided	Probably no-undecided	FAO 1997
	<i>C. auratus</i>	Goldfish	Japan	Unknown	Ornamental	Yes-undecided	Probably no-undecided	Shetty, Nandeesha and Jhingran 1989
	<i>C. carassius</i>	Crucian carp	UK	1870	Ornamental	Probably yes-adverse	Probably yes-undecided	FAO 1997

<i>C. idella</i>	Grass carp	Hong Kong	1959	Aquaculture	Probably no-beneficial	Yes-beneficial	FAO 1997
Indonesia	<i>C. carpio</i> (German strain) (Bangkok strain)	Sri Lanka	1939	Aquaculture	Yes-adverse	Yes-beneficial	Jhingran 1991; FAO 1997
	(wild Amur carp)	Thailand	1957	Aquaculture	-	-	Jhingran 1991
		Vietnam	1995	Research	-	-	INGA 2002
		Hungary	2000	Research	-	-	INGA 2002
		Hungary	2000	Research	-	-	INGA 2002
		Indonesia	2001	Research	-	-	INGA 2002
	<i>H. molitrix</i>	Silver carp	Japan	1959	Aquaculture	Probably yes-adverse	Shetty et al. 1989
	<i>H. molitrix</i>	Silver carp	Hong Kong	1959	Aquaculture	Probably yes-adverse	Shetty et al. 1989
	<i>Puntius lateristriga</i>	Spanner barb	Malaysia	-	Unknown; ornamental	Probably no-undecided	FAO 1997
	<i>P. oligolepis</i>	Checkered barb	Indonesia	-	Ornamental	Probably no-undecided	FAO 1997
	<i>P. semifasciolatus</i>	Chinese barb	Japan	-	Ornamental	Probably no-undecided	FAO 1997
	<i>P. tetrazona</i>	Sumatra barb	Unknown	-	Ornamental	Probably no-undecided	FAO 1997
	<i>Tinca tinca</i>	Tench	UK	1870	Phytoplankton control	-	Welcomme 1988
	<i>A. nobilis</i>	Bighead carp	Taiwan	1969	Aquaculture	-	Eidman 1989
<i>B. gonionotus</i>	Java barb	Unknown	1963	Aquaculture	-	Welcomme 1988	
<i>C. auratus</i>	Goldfish	China	Unknown	Aquaculture	-	Eidman 1989	
<i>C. chinensis</i>	Goldfish	Taiwan	1987	Research	-	Eidman 1989	
	Chinese mud carp	Taiwan	1969	Aquaculture	-	Roberts 1997	
<i>C. idella</i>	Grass carp	Unknown	-	Aquaculture	-	-	Welcomme 1988
		Singapore	1915	Research	-	-	Welcomme 1988
		Thailand	1915	Research	-	-	Welcomme 1988
	Japan	1915	Research	-	-	Welcomme 1988	
	Malaysia	1915	Research	-	-	Welcomme 1988	
<i>C. carpio</i>	Common carp	China	-	Aquaculture	Yes-beneficial	Welcomme 1988	
<i>H. molitrix</i>	Silver carp	Netherlands	1927	Aquaculture	-	Yes-beneficial	Welcomme 1988
		Taiwan		Aquaculture	-	-	Eidman 1989
		Japan		Research	-	-	Schuster 1950
		Germany		Research	-	-	Schuster 1950
		China, Japan		Research	-	-	Schuster 1950
							Eidman 1989
							Eidman 1989
							Eidman 1989
							Eidman 1989
							Eidman 1989

	<i>C. molitorella</i>	Mud carp	Taiwan	1967	-	-	-	Eidman 1989
	<i>Osteochilus hasseltii</i>	Silver sharkminnow	Malaysia and Singapore	1915	Aquaculture	-	-	Eidman 1989
Iran	<i>T. tinca</i>	Tench	Indonesia	1937	Unknown	-	-	Welcomme 1988
	<i>A. nobilis</i>	Bighead carp	Netherlands	1927	Unknown	-	-	Welcomme 1988
	<i>C. auratus</i>	Goldfish	unknown	-	Aquaculture	-	-	Coad 1996
	<i>C. carpio</i>	Common carp	unknown	-	Aquaculture	-	-	Coad 1996
	<i>H. molitrix</i>	Silver carp	USA	-	Aquaculture	-	Yes-beneficial	Coad 1996
Iraq	<i>C. auratus</i>	Goldfish	Unknown	-	Fisheries	Probably no	-	Coad 1996
	<i>C. idella</i>	Grass carp	Unknown	-	Aquaculture	Probably yes-beneficial	Unknown	FAO 1997
Israel	<i>C. idella</i>	Grass carp	Japan	1968	Aquaculture	-	-	Shireman and Smith 1983
	<i>H. molitrix</i>	Silver carp	Unknown	1966-69	-	Yes	Probably no	Golani and Mires 2000
	<i>A. nobilis</i>	Bighead carp	Germany	1973	Aquaculture	-	-	Golani and Mires 2000
	<i>C. auratus</i>	Goldfish	Germany	1985	Ornamental	-	-	Golani and Mires 2000
	<i>C. carassius</i>	Crucian carp	Unknown	-	Angling/sport	-	-	Welcomme 1988
	<i>C. catla</i>	Catla	India	1953	Aquaculture	-	-	Golani and Mires 2000
	<i>C. idella</i>	Grass carp	China	1965	Weed control	-	-	Golani and Mires 2000
	<i>C. carpio</i>	Common carp	Yugoslavia	1927-28	Aquaculture	-	Yes-beneficial	Golani and Mires 2000
	<i>H. molitrix</i>	Silver carp	Japan	1966	Aquaculture	-	Yes-beneficial	Golani and Mires 2000
	<i>M. piceus</i>	Black carp	Unknown	-	Snail control	-	-	Golani and Mires 2000
	<i>A. nobilis</i>	Bighead carp	China	Unknown	Aquaculture	-	-	Welcomme 1988
	Japan	<i>C. catla</i>	Catla	India	1960	Aquaculture	-	-
<i>C. chinensis</i>		Chinese mud carp	Pakistan	1960	Aquaculture	-	-	Welcomme 1988
<i>C. cirrhosus</i>		Mirgal	China	1965	Aquaculture	-	-	Welcomme 1988
<i>C. idella</i>		Grass carp	India	1960	Aquaculture	-	-	Chiba et al. 1989
<i>C. carpio</i>		Common carp	China	1878	Fisheries	-	-	Chiba et al. 1989
<i>H. molitrix</i>		Silver carp	Germany	1905	-	-	-	Chiba et al. 1989
			Nepal	1967	Unknown	Unknown	Unknown	Unknown
			China	1878-1940	Accidental	-	-	Chiba et al. 1989
			India	1960	Aquaculture	-	-	Welcomme 1988
			China	1970	Accidental	-	-	Welcomme 1988
			Netherlands	1961	Unknown	-	-	-
Jordan		<i>A. nobilis</i>	Bighead carp	Germany	1973	Aquaculture	-	-

	<i>C. auratus</i>	Goldfish	Unknown	-	Unknown	-	Krupp and Schneider 1989
	<i>C. catla</i>	Catla	Unknown	-	Unknown	-	Krupp and Schneider 1989
	<i>C. idella</i>	Grass carp	Japan	1965	Unknown	-	Krupp and Schneider 1989
	<i>C. carpio</i>	Common carp	Yugoslavia	Unknown (1931-34)	Aquaculture	Yes-beneficial	Krupp and Schneider 1989
	<i>H. molitrix</i>	Silver carp	Japan	1966	-	-	Krupp and Schneider 1989
	<i>M. piceus</i>	Black carp	Unknown	-	Unknown	-	Krupp and Schneider 1989
Korea	<i>A. nobilis</i>	Bighead carp	Taiwan	1963	Aquaculture	-	Welcomme 1988
	<i>C. auratus</i>	Goldfish	Japan	1972	Aquaculture	Yes-beneficial	Welcomme 1988
	<i>C. idella</i>	Grass carp	Japan	1963	Aquaculture	-	Welcomme 1988
	<i>C. carpio</i>	Common carp	Israel	1973	Aquaculture	-	Welcomme 1988
	<i>H. molitrix</i>	Silver carp	Japan	1963	Aquaculture	-	Welcomme 1988
Lao PDR	<i>C. catla</i>	Catla	Thailand	1977	Aquaculture	-	ICCLMB 1981*
	<i>C. cirrhosus</i>	Mirgal	India	1977	Aquaculture	-	ICCLMB 1981
	<i>C. idella</i>	Grass carp	Thailand	1977	Aquaculture	-	ICCLMB 1981
	<i>C. carpio</i>	Common carp	Unknown	-	Aquaculture	-	Davidson 1975
	<i>C. carpio (Hungarian)</i>	Common carp	India	1977	Aquaculture	-	ICCLMB 1981
	<i>L. rohita</i>	Rohu	Thailand	1977	Aquaculture	-	ICCLMB 1981
	<i>A. nobilis</i>	Bighead carp	Vietnam	1996, 1998	Aquaculture	-	INGA 2002
	<i>B. gonionotus</i>	Silver barb	India	1977	Aquaculture	-	Welcomme 1988
	<i>C. catla</i>	Catla	China	19 th century	Aquaculture	Yes-beneficial	Welcomme 1988
	<i>C. chinensis</i>	Chinese mud carp	Indonesia	1958	Aquaculture (polyculture in ponds)	-	Ang et al. 1989
	<i>C. cirrhosus</i>	Mirgal	China	1960	Aquaculture	-	Welcomme 1988
	<i>C. idella</i>	Grass carp	India	-	Aquaculture	-	Welcomme 1988
	<i>C. carpio</i>	Common carp	China	1960	Aquaculture	-	Welcomme 1988
	<i>H. molitrix</i>	Silver carp	China	Unknown (18 th century)	Aquaculture	-	Welcomme 1988
	<i>L. rohita</i>	Rohu	India	Unknown (18 th century)	Aquaculture	Yes-beneficial	Welcomme 1988
			China	18 th century	Aquaculture	Yes-beneficial	FAO 1997
			India	1960	Aquaculture	-	Welcomme 1988

Myanmar	<i>C. idella</i>	Grass carp	India	1969	Aquaculture	-	-	Shireman and Smith 1983
	<i>C. carpio</i>	Common carp	Unknown	-	Aquaculture	-	-	Alkunhi 1966
Nepal	<i>Devario malabaricus</i>	Malabar danio	Unknown	-	Ornamental	-	-	Welcomme 1988
	<i>A. nobilis</i>	Bighead carp	Hungary	1971	Aquaculture	Unknown	Probably yes-beneficial	FAO 1997
	<i>C. carassius</i>	Crucian carp	Unknown	-	Aquaculture	-	Yes-beneficial	Shrestha 1994
	<i>C. idella</i>	Grass carp	India	1965	Aquaculture	Unknown	Probably no-beneficial	FAO 1997
	<i>C. carpio</i>	Common carp	India	1956	Aquaculture	Unknown	Probably yes-beneficial	FAO 1997
	<i>H. molitrix</i>	Silver carp	India	1965	Aquaculture	Unknown	Probably yes-beneficial	FAO 1997
Pakistan	<i>A. obilis</i>	Bighead carp	Japan	1967	Aquaculture	Unknown	Probably beneficial	Manandhar 1995
	<i>C. catla</i>	Catla	China	Unknown	Unknown	-	-	Welcomme 1988
	<i>C. cirrhosus</i>	Mirgal	India	Unknown	Aquaculture	-	-	Welcomme 1988
	<i>C. idella</i>	Grass carp	India	1964	Aquaculture, weed control	Probably no	Probably yes-beneficial	FAO 1997
	<i>C. carpio</i>	Common carp	UK	1964	Aquaculture	Unknown	Yes-beneficial	FAO 1997
	<i>H. molitrix</i>	Silver carp	Thailand	1964	Aquaculture	Unknown	Yes-beneficial	FAO 1997
	<i>L. rohita</i>	Rohu	China	1982-83	Aquaculture	Yes	Probably no	FAO 1997
Philippines	<i>A. nobilis</i>	Bighead carp	Nepal	1982-83	Aquaculture	Yes	Probably no	FAO 1997
	<i>Balantiocheilos melanopterus</i>	Tricolor sharkminnow	India	-	Aquaculture	-	-	Welcomme 1988
	<i>Danio albolineatus</i>	-	Taiwan	1968	Aquaculture	-	-	Juliano et al. 1989
	<i>B. gonionotus</i>	Silver barb	Unknown	Unknown (1970-79)	Ornamental	-	-	Juliano et al. 1989
	<i>Barbonyms schwanenfeldii</i>	Tinfoil barb	Unknown	Unknown	Aquaculture (introduced as pituitary donor)	-	-	Aquarium Science Association of the Phil., Inc. (ASAP) 1996
	<i>C. auratus</i>	Goldfish	Unknown	Unknown	Ornamental	-	-	Juliano et al. 1989
	<i>C. carassius</i>	Crucian carp	Unknown	1964	Aquaculture	-	Yes-beneficial	ASAP 1996
	<i>C. catla</i>	Catla	India	1967	Aquaculture	-	-	ASAP 1996
	<i>C. cirrhosus</i>	Mirgal	India	1967	Aquaculture	-	Yes-beneficial	Welcomme 1988
			India	1967	Aquaculture	-	Yes-beneficial	Juliano et al. 1989
			India	1967	Aquaculture	-	Yes-beneficial	Welcomme 1988

<i>C. idella</i>	Grass carp	China	1964	Aquaculture	-	Probably yes-beneficial	Welcomme 1988
<i>C. carpio</i>	Common carp	Hong Kong	1915	Aquaculture	-	Yes-beneficial	Juliano et al. 1989
<i>Devario aequipinnatus</i>	Giant danio	Vietnam	1995	Research	-	-	INGA 2002
<i>D. devario</i>	Sind danio	Unknown	Unknown	Ornamental	-	-	ASAP 1996
<i>D. malabaricus</i>	Malabar danio	Unknown	-	Ornamental	-	-	ASAP 1996
<i>D. rerio</i>	Zebra danio	Unknown	Unknown	Ornamental	-	-	ASAP 1996
<i>H. molitrix</i>	Silver carp	China	1964	Aquaculture	-	-	ASAP 1996
<i>L. rohita</i>	Rohu	Taiwan	1964	Aquaculture	-	-	Welcomme 1988
<i>Leptobarbus hoevenii</i>	Mad barb	India	1964	Aquaculture	-	-	Welcomme 1988
<i>O. hasseltii</i>	Silver sharkminnow	Unknown	(1980-89)	Ornamental	-	-	ASAP 1996
<i>P. conchoniui</i>	Rosy barb	Indonesia	1957	Unknown	-	-	Juliano et al. 1989
<i>P. lateristriga</i>	Spanner barb	Unknown	-	Ornamental	-	-	ASAP 1996
<i>P. tetrazona</i>	Sumatra barb	Unknown	-	Ornamental	-	-	ASAP 1996
<i>P. titteya</i>	Cherry barb	Unknown	(1970-79)	Ornamental	-	-	ASAP 1996
<i>Rasbora caudimaculata</i>	Greater scissortail	Unknown	-	Ornamental	-	-	ASAP 1996
<i>R. dorsiocellata</i>	Eyespot rasbora	Unknown	-	Ornamental	-	-	ASAP 1996
<i>R. elegans</i>	Twospot rasbora	Unknown	-	Ornamental	-	-	ASAP 1996
<i>Tanichthys albonubes</i>	White cloud mountain minnow	Unknown	-	Ornamental	-	-	ASAP 1996
<i>A. nobilis</i>	Bighead carp	China	Unknown	Aquaculture	Probably yes-beneficial	Probably yes-beneficial	FAO 1997
<i>C. auratus</i>	Goldfish	Japan	Unknown (1900-97)	Ornamental	Probably yes-beneficial	Probably yes-beneficial	FAO 1997
<i>C. chinensis</i>	Chinese mud carp	China	Unknown	Aquaculture	-	-	Welcomme 1988
<i>C. idella</i>	Grass carp	Unknown	Unknown	Aquaculture	-	-	Roberts 1997
<i>C. carpio</i>	Common carp	China	Unknown	Aquaculture	-	-	Welcomme 1988
<i>P. semifasciolatus</i>	Chinese barb	China	Unknown	Aquaculture	-	-	Welcomme 1988
<i>H. molitrix</i>	Silver carp	China	Unknown	Accidental	-	-	Lever 1996
<i>A. nobilis</i>	Bighead carp	China	1948	-	No	-	
<i>B. gonionotus</i>	Silver barb	Indonesia	1968	Aquaculture	-	-	Welcomme 1988
<i>C. carassius</i>	Crucian carp	Europe	1915	Unknown	-	-	Welcomme 1988
<i>C. catla</i>	Catla	India	1942	Aquaculture	Unknown	Probably yes-beneficial	FAO 1997

Singapore

Sri Lanka

	<i>C. cirrhosus</i>	Mirgal	India	1981	Aquaculture	Unknown	-	Welcomme 1988
	<i>C. idella</i>	Grass carp	China	1948	Aquaculture; weed control	Unknown	Unknown	FAO 1997
	<i>C. carpio</i>	Common carp	Europe	1915	Aquaculture	Unknown	Unknown	FAO 1997
	<i>H. molitrix</i>	Silver carp	China	1948	Aquaculture	Unknown	Unknown	De Zylva 1994
	<i>L. rohita</i>	Rohu	India	1981	Aquaculture	-	-	Welcomme 1988
Syria	<i>C. carpio</i>	Common carp	Unknown	Unknown	Aquaculture	-	-	Welcomme 1988
Taiwan	<i>A. nobilis</i>	Bighead carp	China	Unknown	Aquaculture	-	Yes-beneficial	Welcomme 1988
	<i>C. auratus</i>	Goldfish	China	Unknown	Aquaculture	-	-	Shen (ed.) 1993
	<i>C. cuvieri</i>	-	Japan	-	Aquaculture	-	Yes-beneficial	Welcomme 1988
	<i>C. chinensis</i>	Chinese mud carp	China	-	Aquaculture	-	-	Roberts 1997
	<i>C. molitorella</i>	Mud carp	Unknown	-	Aquaculture	-	-	Roberts 1997
	<i>C. idella</i>	Grass carp	China	Unknown	Aquaculture	-	Yes-beneficial	Welcomme 1988
	<i>C. carpio</i>	Common carp	Japan	Unknown	Aquaculture	-	Yes-beneficial	Welcomme 1988
	<i>L. hoevenii</i>	Mad barb	Indonesia	1979	Research	-	-	Welcomme 1988
	<i>M. piceus</i>	Black carp	China	-	Aquaculture	-	Yes-beneficial	Welcomme 1988
	<i>H. molitrix</i>	Silver carp	China	Pre-18 th century	Aquaculture	-	No	Welcomme 1988
Thailand	<i>A. nobilis</i>	Bighead carp	China	1932	Aquaculture	-	No	Welcomme 1988
	<i>C. auratus</i>	Goldfish	China	Unknown	Ornamental	-	-	Welcomme 1988
	<i>C. carassius</i>	Crucian carp	Japan	1980	Aquaculture	-	-	Welcomme 1988
	<i>C. catla</i>	Catla	Bangladesh	1979	Aquaculture	-	-	Welcomme 1988
	<i>C. chinensis</i>	Chinese mud carp	China	-	Aquaculture	Unknown	-	Welcomme 1988; Rainboth 1996
	<i>C. cirrhosus</i>	Mirgal	Japan	1980	Aquaculture	-	-	Piyakarnchana 1989
			Bangladesh	1980	Aquaculture	-	-	
			Lao PDR	1982	Aquaculture	-	-	
			China	1922	Aquaculture	-	-	
			China	1932	Aquaculture	No	-	Welcomme 1988
			Hong Kong	1932	Aquaculture	No	-	Welcomme 1988
			China	1912, 1913	Aquaculture	-	Yes-beneficial	Welcomme 1988
			Germany	1913	Aquaculture	-	Yes-beneficial	Welcomme, 1988
			Japan	1913	Aquaculture	-	Yes-beneficial	Welcomme 1988
			Japan	1964, 1971	Aquaculture	-	-	
			Germany	1970	Aquaculture	-	-	

