Chapter 1

Importance of Carp Genetic Resources[1]

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Fish and fisheries play an important role in the economies of developing countries, contributing to animal protein intake, employment generation, household incomes and foreign exchange earnings. Surveys conducted by the WorldFish Center and FAO show that fish has become an increasingly important source of protein over the last decade in most of the developing countries. Countries with low per capita gross domestic product tend to have a higher share of fish protein in their animal protein consumption (Kent 1997). Studies indicated that demand for fish increases as expenditure/income rises and that higher income groups tend to consume more fish than lower income groups. However, the share of fish (as protein) and the share of fish to the total food expenditure are higher among lower income groups, suggesting that lower income groups are the most dependent on fish (Dey et al. 2004; FAO 1999a; Dey 2000; Dey et al. 2000a; ICLARM 2000). This result is also consistent with the generalization that although less developed countries are not the biggest consumers of fish, they are the most dependent on aquatic resources (FAO 1993; Kent 1997; FAO 1999b), indicating the importance of fish as a primary source of protein among relatively poorer households in these countries. No wonder it is regarded as "poor man's protein" (Williams 1996).

In Asia, on average, almost 30 per cent of the total animal protein intake is derived from fish. Among the Southeast Asian countries, fish protein provides 45 per cent of the total protein consumed (Prein and Ahmed 2000). Although Japan, the European Union and USA have higher per capita consumption of fish and fish products, the share of fish protein in terms of the total animal protein consumption is far less than that in many developing countries.

World fish production in 1999 was estimated at 130 million t, of which only 97 million t was for human consumption (FAO 2003). FAO (1999a) estimated that by the year 2010, demand for food fish will have increased by 13.5-18 per cent or to about 105-110 million t. Against this demand, production from capture fisheries is declining as most of the world's fish stocks have been exploited to their maximum potential or over exploited, indicating it might be difficult to increase yields from capture fisheries in the near future (Williams 1996). During the 1950s and 1960s capture fish production increased by an average of 6 per cent per annum and this declined to 2 per cent during the 1970s and 1980s, falling almost to zero during the 1990s (FAO 2000).

In contrast to declining growth in capture fisheries, aquaculture has been growing at a fast rate, by about 5 per cent per year during the 1950s and 1960s to about 8 per cent during the 1970s and 1980s and over 10 per cent since 1990 (FAO 2000). Aquaculture production has increased from 3.2 per cent of the total fish production in 1950 to 32 per cent in 2000. Aquaculture has become the world's fastest growing food-producing sector, with production more than doubling during 1990-2000, from 13.1 million t in 1990 to 35.6 million t in 2000 (FAO 2003).

Of the total aquaculture production of 45.7 million t in 2000, 45 per cent was contributed by freshwater aquaculture. Production increased from 7.9 million t in 1991 to 20.6 million t in 2000. Asia produces about 91 per cent of the world's freshwater aquaculture production, with China contributing 74 per cent of this (Fig.1). Other major producers of freshwater aquaculture are India (9.89 per cent), Bangladesh (2.77 per cent), Vietnam (1.85 per cent), Indonesia (1.76 per cent), Thailand (1.29 per cent) and the Philippines (0.54 per cent). Growth in freshwater aquaculture in the last decade among these countries differs: Vietnam had the highest growth

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of 14.54 per cent per annum during 1990-2000, followed by China (13.6 per cent), Bangladesh (12.94 per cent), Thailand (9.38 per cent) and Indonesia (5.65 per cent).

With this remarkable increase in production, relatively low prices and limited international markets, freshwater fish are expected to become an increasingly important source of animal protein, particularly for those in medium and lower income groups in developing countries, especially in Asia (Dey et al. 2004).

About 242 species of freshwater finfish are cultured globally and of these, carps (Cyprinidae) are the dominant species, especially in Asia. While production of cultured carps is on the increase the amount from capture fisheries from rivers and other natural waters is on the decline due to the shrinking of areas for spawning, over fishing and other human induced habitat degradation. Production of carps from culture has increased from 5.6 million t in 1990 to 16.4 million t in 2001, while the yield from capture fisheries has declined from 0.75 million t in 1990 to 0.54 million t in 2001 (Table 1.1). These human induced changes are leading to threats to the existence of some of the species (Acosta and Gupta, Chapter 7, this vol.). In Asia, aquaculture production increased from 10.8 million t in 1990 to 29.48 million t in 2001, while carp production increased from 5.07 million t in 1990 to 16.42 million t in 2001 (Fig. 1.1).

Table 1.1. Carp production (million t) from capture fisheries and culture during 1990-2001

Year	Production from culture (million t)	Production from capture fisheries(million t)	Total (million t)
1990	5.07	0.47	5.54
1991	5.27	0.54	5.81
1992	6.08	0.39	6.47
1993	7.18	0.45	7.63
1994	8.50	0.51	9,01
1995	9.93	0.55	10.48
1996	11.48	0.43	11,90
1997	12.94	0.38	13.32
1998	13.60	0.38	13.98
1999	14.63	0.38	15.01
2000	15.14	0.33	15.47
2001	16.00	0.31	16.31
Growth rate (%)	11.16%	-2.60	10.44%

Source: FAO 2003. Fisheries Statistics (on line) available at www.fao.org/fi/statist/FISOFT/FISHPLUS.asp [June 2003].

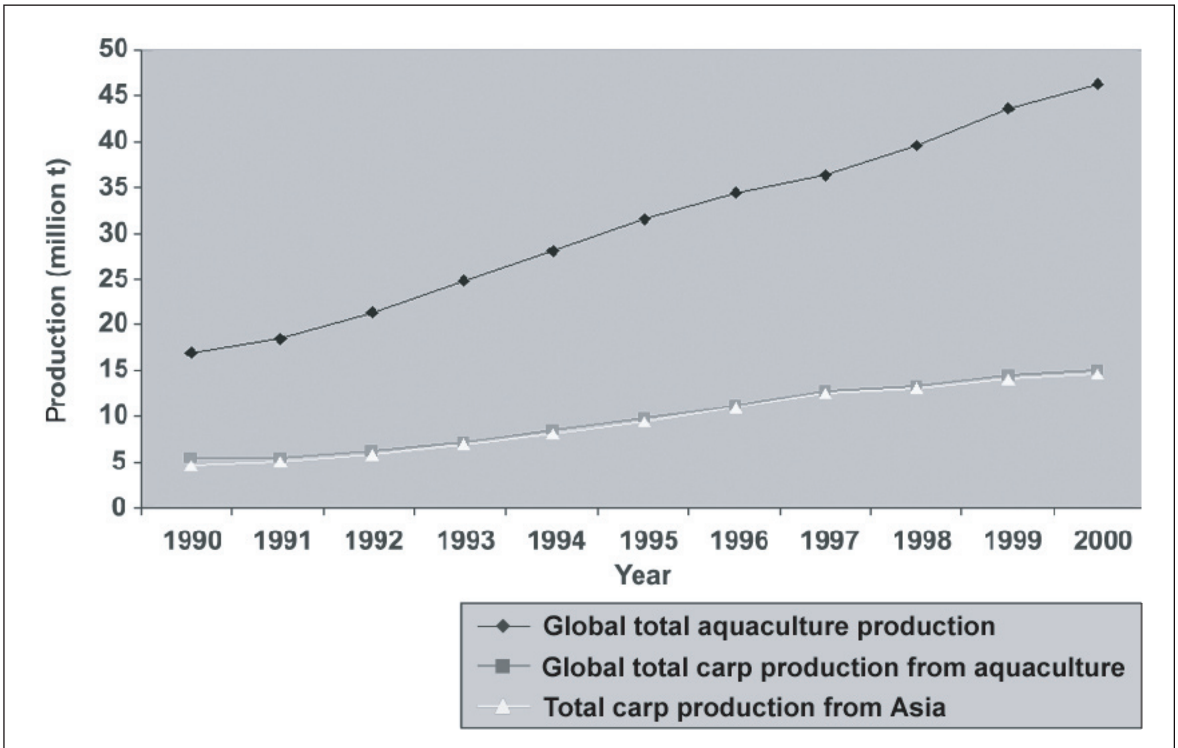

Fig. 1.1. Trends in world aquaculture and carp production (million t) from aquaculture globally and from Asia

Table 1.2. Prominent Cyprinid species used for aquaculture in Asia

Species	Production (t) in 2001[a]
Hypopthalmichthys molitrix	3 546 285
Ctenopharyngodon idella	3 636 367
Cyprinus carpio	2 849 492
Aristichthys nobilis	1 663 499
Carassius carassius	1 527 058
Labeo rohita	833 816
Catla catla	870 085
Cirrhinus cirrhosus	589 841
Parabramis pekinensis	541 115
Mylopharyngodon piceus	190 707
Cirrhinus molitorella	220 118
Barbonymus gonionotus[b]	53 563
Puntius javanicus[b]	26 251
Osteochilus hasseltii	15 319
Leptobarbus hoevenii	1 111
Other cyprinid species	56 440
TOTAL	16 621 067

[a] Represents production of carp from aquaculture in 23 countries of Asia.
[b] *Puntius gonionotus* and *Puntius javanicus* are the same species, now described as *Barbonymus* (*Barbodes*) *gonionotus* by FishBase (2003) [available on line at: www/fishbase.org].
Source: FAO 2003. Fishery statistics: Aquaculture production. Vol. 92/2

Over 99 per cent of the total carp production was contributed by 15 species among which Chinese carps [silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*), bighead carp (*Aristichthys nobilis*), crucian carp (*Carassius carassius*) and common carp (*Cyprinus carpio*)] and Indian carps [rohu (*Labeo rohita*), catla (*Catla catla*) and mrigal (*Cirrhinus cirrhosus*)] are the dominant species (Table 1.2 and Fig. 1.2).

Although aquaculture has a long history in Asia, dating back over 2000 years in China, until recently aquaculture has not been subject to the same intensive development of its genetic base as has been the case with terrestrial agriculture. Genetic improvement of fish is estimated to lag behind advances in livestock by nearly 50 years (Eknath et al. 1991). In fact until the 1960s, the aquaculture industry was dependent on seed of carps collected from the wild, but with successful hypophysation of carps in the late 1950s, much of the seed is presently being produced in hatcheries. With this development, there is increasing concern that the genetic bases of many culture species are deteriorating to the extent of lowering the growth (Eknath and Doyle 1990) and the most common stocks used in aquaculture may not be the best performers (e.g. Nile tilapia in the Philippines, Eknath et al. 1993; Dey et al. 2000b; Dey and Gupta 2000). Evidence of inbreeding and unintentional selection among hatchery-based and established farm stocks have been observed (Pullin and Capilli 1988; McAndrew et al. 1993; Eknath 1995).

While remarkable progress has been made in improving the productivity of crops and livestock in the last three to four decades through breeding and selection, it is only in recent years that efforts have been made to harness the benefits of genetic enhancement (e.g. salmon and Nile tilapia). Selective breeding of Nile tilapia (*Oreochromis niloticus*) over five generations has resulted in an

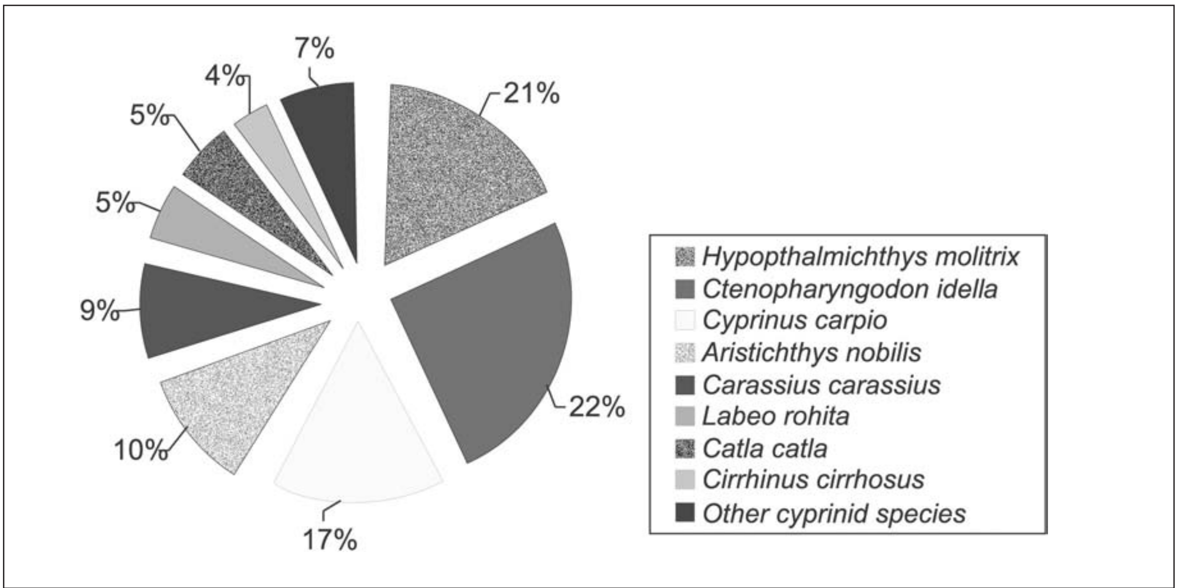

Fig. 1.2. Percentage of contribution of major carp species to the total carp production from aquaculture in Asia during 2001

improved strain, the GIFT strain that has shown 85 per cent higher growth as compared to the existing stocks in the Philippines (Eknath and Acosta 1998). Furthermore, testing of the GIFT strain through on-station and on-farm trials indicated the GIFT strain's faster growth as compared to the existing strains in Bangladesh, China, Thailand and Vietnam (Dey et al. 2000b). This has created interest among a number of major aquaculture producing countries in Asia and research is in progress for genetic improvement of *C. carpio, L. rohita,* silver barb (*B. gonionotus*) and Blunt snout bream (*Megalobrama amblycephala*), besides others, with funding support from the Asian Development Bank (WorldFish Center 2001). While most of these genetic improvement programs have as yet had little impact on aquaculture, there are some examples that demonstrate the kind of impact that can hopefully be expected to become much more widespread in the near future. Over one million tonnes of the Jian strain of common carp is produced each year in China, and several other improved varieties are cultured on a significant scale in China. Genetically improved varieties of several other cyprinid species have been developed and in some cases disseminated in several Asian countries.

In view of the significant growth of aquaculture and the need for increased production, there is a tendency among farmers and government agencies to introduce exotic species. The available records indicate that 259 introductions comprising 42 cyprinid species have taken place in 27 countries of Asia (Acosta and Gupta, Chapter 7, this vol.). In most cases these new species have led to improved aquaculture production, while in some cases they have also resulted in adverse impacts on the aquatic ecosystem.

Conservation and proper utilization of germplasm is a prerequisite for the sustainable management of and increased production from aquatic resources. In view of this, several major carp producing countries in Asia (Bangladesh, China, India, Indonesia, Thailand and Vietnam) have been involved in genetic improvement of carps under a project funded by the Asian Development Bank. As part of this, a review of the carp genetic resources in these countries was undertaken. The results of this are detailed in Chapter 3. The publication also includes a review of progress of genetics research in carps, introductions of carps and their impacts.

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