Working Paper No. 8
(July 1998)

Indigenous Freshwater Fish Resources of Karnataka State and their Potential for Aquaculture

Aquaculture in Small-scale Farmer-managed Irrigation Systems
Funded by DFID Aquaculture Research Programme

Institute of Aquaculture
University of Stirling
Scotland, UK

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List of Working Papers

Project Summary Report
1. Raichur District: Site for a Study of Aquaculture Development in the Semi-arid Tropics
2. Methods for Participatory Information Gathering and Analysis
3. Socio-economic Analysis of Villages in Relation to Aquaculture Potential in Raichur District, Karnataka, India
4. Investigation of Gender Issues in Relation to Aquaculture Potential in Raichur District, Karnataka, India
5. On-farm Resources for Small-scale Farmer-managed Aquaculture in Raichur District, Karnataka, India
6. Inland Fisheries Resources and the Current Status of Aquaculture in Raichur District and Karnataka State, India
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8. Indigenous Freshwater Fish Resources of Karnataka State and their Potential for Aquaculture
9. Institutional Linkages of Relevance to Small-scale Aquaculture Development in Karnataka State, India
10. Fisheries Marketing, Demand and Credit in Raichur District, Karnataka, India

Project background

The arid and semi-arid tropics are areas in urgent need of development. As a home to a large proportion of the world's poor these regions face a future of scarcity of food and insufficient water for consumption and irrigation of crops. It has been predicted that India and Sri Lanka will face a fresh-water crisis in the near future, and as much water is currently wasted due to inadequate management and conservation practices there is a need for more integrated approaches to water management. The majority of India's surface water bodies are used primarily for irrigation. Although large-scale irrigation systems cover more surface area and supply a greater area of farmland, more farmers are dependent on small-scale systems for their daily livelihood. Irrigation systems are often very inefficient water distribution systems, and studies suggest that the efficiency of water use could be improved. The integration of aquaculture (which can be non-consumptive in terms of water use) has the potential to increase food production and improve the efficiency of the use of small-scale irrigation water resource.

These Working Papers are the first stage of the research project 'Small-scale farmer-managed aquaculture in engineered water systems' (DFID project R7064). The project aims to investigate the potential for integration of aquaculture into small-scale farmer-managed irrigation systems in arid and semi-arid regions of India and Sri Lanka. Intended beneficiaries include the rural poor, which in India belong to the Scheduled Castes (SCs)[1] and Scheduled Tribes (STs)[2]. This part of the project focuses on Karnataka State on the south west of the Indian peninsular.

During the research, the economic and technical feasibility and the social acceptability of the production of fish in such systems of arid and semi-arid regions of Karnataka were investigated. Field research took place from 6 April to 21 May 1998 and included a 'Rapid Rural Appraisal' of four villages in Raichur District, Karnataka, and semi-structured interviews with representatives from the Government Department of Fisheries, marketing organisations, academics and other relevant institutional sectors within the state.

All fieldwork was undertaken in collaboration with the NGO Samuha, an organisation undertaking wide-ranging activities in the arid and semi-arid areas of Karnataka State. Samuha has extensive experience within participatory development and its initiatives range across health, disabilities, women's development, HIV/AIDS, education, animal husbandry, drinking water and sanitation, irrigation and watershed development (Pradeep, 1994). The majority of the work of Samuha is carried out in the districts of Koppal and Raichur with a smaller project in Bangalore. The activities of Samuha are supported by a number of bodies: ActionAid; OXFAM; the Swiss Development Cooperation; the Government of Karnataka and the Government of India as well as individual donors.

The results and analysis are presented in the ten Working Papers listed above. For an overview of the content of each of the Working Papers, see the Summary Report. This series of working papers have been produced principally as a resource for a stakeholder workshop to be held in Coimbatore, 19th - 20th November 1998. Conclusions and the research agenda are therefore preliminary.

[1] SCs: lower castes identified by the Indian government as a means of classifying castes for the allocation of benefits.
[2] STs: all tribals. SCs and STs together constitute the 'socially and educationally backward classes of citizens'. The terms form the basis for policies of protection and positive discrimination.

Glossary

CIFA	Central Institute for Freshwater Aquaculture
DFID	Department for International Development (formerly ODA)
DoF	Department of Fisheries
NGO	Non-governmental Organisation
ODA	Overseas Development Agency (now DFID)
PAD	Peninsular Aquaculture Division
Rs	Indian unit of currency
1ha	2.4 acres

Summary

1. One of the key constraints to aquaculture in remote rural areas is seed costs and availability. Wild sourcing of indigenous species offers one potential solution to this problem. This is a low cost option for farmers with limited resources. Such fish are sometimes slower growing than commercial species and outputs may be more suitable for improving food security rather than for retail purposes.

2. Field research took place in Shimoga District, on a three-day field trip conducted with representatives from the Peninsular Aquaculture Division (PAD) of the Central Institute for Freshwater Aquaculture (CIFA). During the trip fish were caught by PAD fishermen, and reservoir landing sites and local markets were visited. The aim of the trip was to produce an indigenous species inventory, containing photographs of males and females of the different species along with details on their local and scientific names, characteristics, growth patterns, distribution and other information relevant to aquaculture. During subsequent market research, additional information and local names were collected.

3. The use of indigenous species is consistent with Indian bio-diversity conservation initiatives. Such resources have traditionally been managed by rural communities in a sustainable fashion and used to diversify their livelihood options (and thus improve their food security). The abundance of many indigenous species is falling dangerously low, and some Indian authorities blame over-exploitation by capture fisheries and pollution. The culture of such species could help to reduce this pressure.

4. Twenty-one indigenous species were logged during a resource inventory trip in Shimoga District, Karnataka (mostly from visits to fish markets). It was found the use of indigenous names alone was insufficient for identification, as these could vary on at a very local scale (such names often rely on generic features, which could be shared by several species). The resolution with which people could accurately identify different species tended to be best in larger organised markets and a Bengali rehabilitation camp in Raichur (where there is a strong tradition of fish culture and consumption).

5. Potential cultivable species in small-scale water bodies includes catfish and other air breathing species and Peninsular carps including, *Cirrinhus cirrhosa*, *C. reba*, *Puntius pulchellus*, *P. carnatacus*, *Labeo fimbriatus*, *L. kontius* and *L. calabasu*. *Labeo* spp. were identified to have the best potential for low input culture in small-scale water bodies. As a consequence of their feeding habits *L. fimbriatus* and *L. kontius* were identified as having the bests potential for culture in open wells and *L. calabasu* in farm ponds and check dams.

6. The natural spawning time of the peninsular carps are incompatible for short season harvesting options. Several possible options to overcome this constraint are suggested in Working Paper No. 6. This includes the possible introduction of transportable mini-hatchery technology (*P. puntius* has been successfully hypophysed). Other researchable constraints to the use of indigenous species were the relative accessibility of project villages to suitable water bodies (often located in upper catchment areas) and the technical difficulties associated with collecting, identifying and transporting wild seed.

Indigenous Freshwater Fish Resources of Karnataka State and their Potential for Aquaculture

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1 Introduction

Seed availability is often one the key constraints to the uptake of aquaculture. The key objective of this Working Paper is to identify indigenous species that may have potential for small-scale culture and could be obtained from the wild by farmers at minimal cost. Marginal farmers attempt to produce limited outputs with scarce resources, which they use in diverse ways to limit risk. The use of indigenous fish species would reduce the input required, and thereby the associated risk, for aquaculture. Because indigenous species grow slower than commercially grown carps, these species would be more suitable for household consumption than retail. The use of indigenous fish species could also help to preserve existing bio-diversity.

In this paper the indigenous freshwater fish resources of Karnataka State are assessed in terms of their potential for aquaculture. The initial aim of this Working Paper was to present a photographic record of male and female specimens of each species, with scientific and local names and information on distribution and life history along with an assessment of their potential for aquaculture. Although not all species found could be reliably identified, this Working Paper represents a useful log of indigenous fish species of the region.

2 Methodology

A three-day field trip to Shimoga district (see Figure 1) was undertaken with Dr. Kumariah, Director of the Peninsula Aquaculture Division (PAD) of the Central Institute for Freshwater Aquaculture (CIFA). This district straddles the Western Ghats and contains considerable water resources, including the Thunga and Bhadra rivers (both dammed), which later join with other rivers in Dharwad and Chitradurga before flowing into the TB dam. As part of their research program, PAD are evaluating the potential of indigenous peninsular species for aquaculture and the potential for fish culture in irrigation tanks. A visit was made to their new site at Hesseraghatta lake, on the outskirts of Bangalore (due to be completed this year) where they were in the process of collecting candidate species especially the carps *Puntius pulchellus, Labeo calabasu* and *L. fimbriatus*. Very little is known about the performance and breeding potential of these fish under culture conditions. Further specimens were caught during the trip. Scientific names were provided by reference to Francis Day's guide to the Fishes of India (1885) and by Dr Kumariah from PAD. To assist with future identification, local names were collected in the field for as many species as possible. Further species were logged during subsequent market visits in the company of officials from the Department of Fisheries (DoF). Information on spawning times of peninsular carps was supplied by Dr Kumariah.

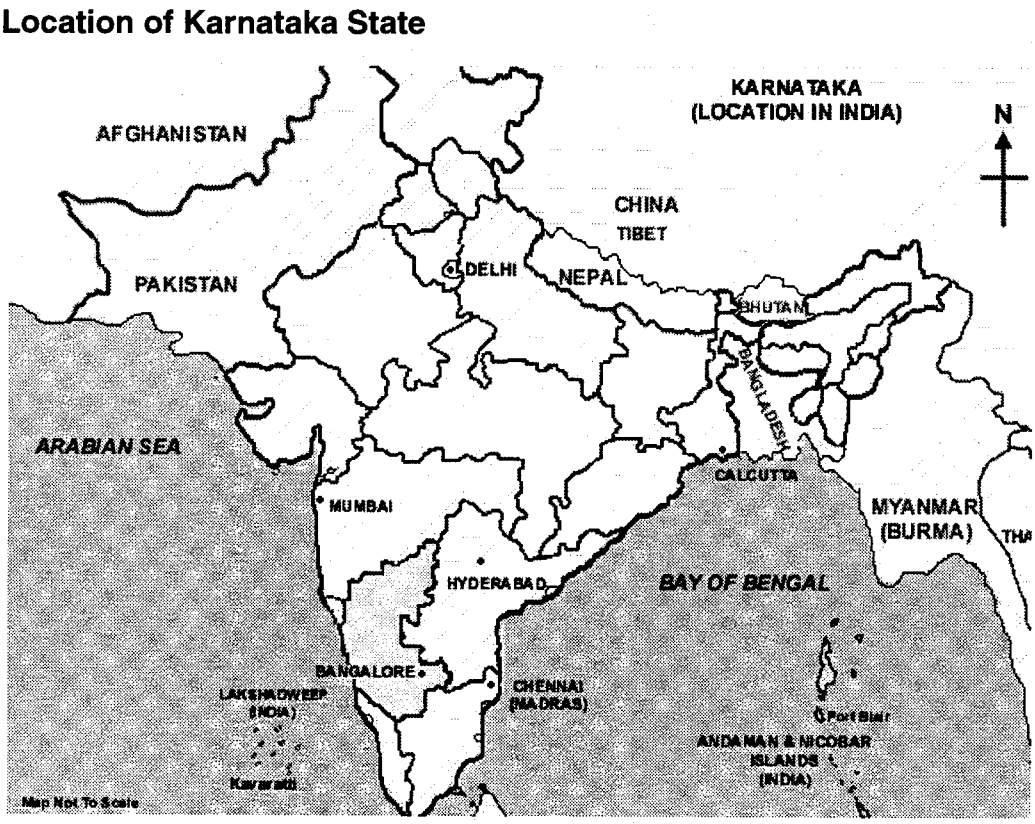
Fish investigated were from three sources:

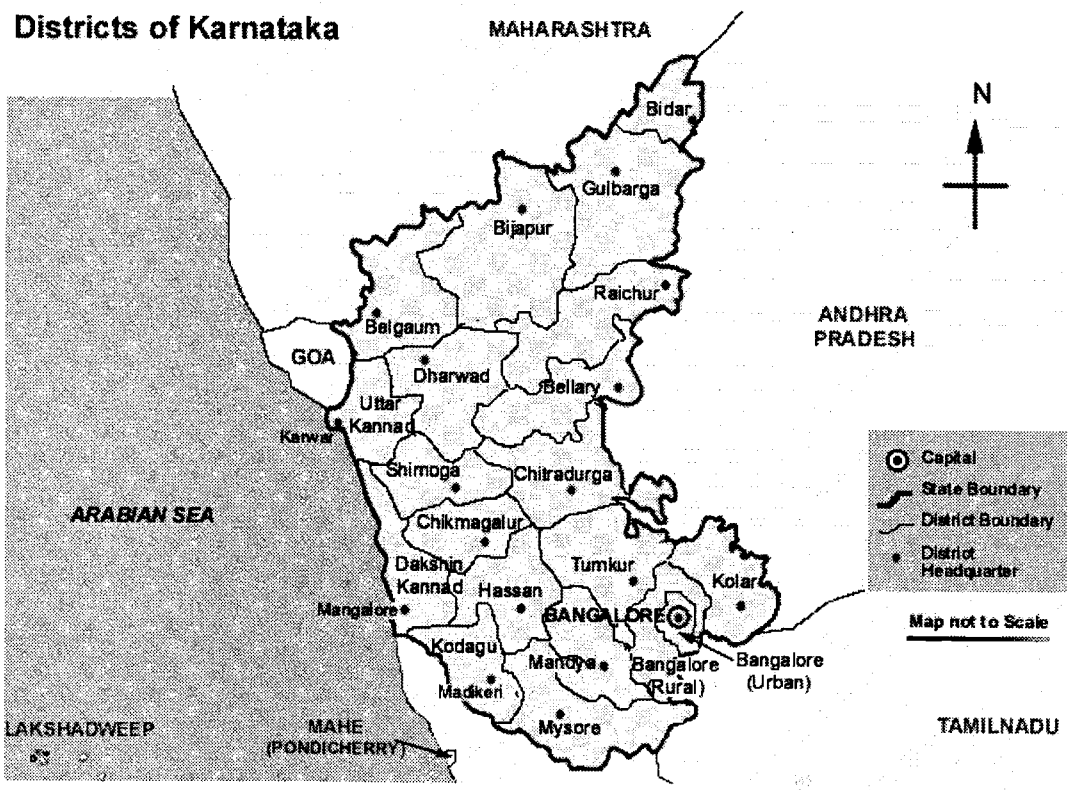
- Cast netted from rivers by PAD fishermen.
- Observed at reservoir landing sites of native fishermen.
- Observed at local markets, or being sold by street vendors.

Two of the prospective fishing sites investigated were large river pools adjoining Hindu temples. These were the Ganesh temple on the Thunga river at Chippalgudde (near Thirthahalli), and Sringeri monastery on the Bhadra river (in neighbouring Chickmagalur district). As such the waters were sacred, and pilgrims were accustomed to feeding the fish puffed rice as part of their worship. Consequently a dense shoal of large fish (principally *L. calabasu*, *P. pulchellus* and *Tor khudree* (mahseer)) were in permanent attendance at the foot of the temple steps (see section 3). Unfortunately, permission to fish these waters could not be obtained from appropriate bodies (the local DoF Fisheries Officer and the abbot of the temple). Cast netting was attempted on the Thunga River near Shimoga, but only four small specimens of *L. fimbriatus* were caught and further attempts abandoned.

It was not possible to view fish being landed, which meant that only specimens being sold by vendors could be examined. Several roadside markets (3-4 vendors) were investigated near Shimoga, as well as the

Figure 1: Location of Karnataka in India and districts of Karnataka. Source: Compare Infobase (1998).





organised fish market in Shimoga (this also had a substantial dry (marine) fish market). On these markets the fish sold came from the river Tunghra or the Tunghra Reservoir.

Species registration continued during subsequent visits to markets in Raichur District whilst investigating the marketing chain. However, during these visits it was often not possible to identify the scientific name of new species encountered.

3 Bio-diversity and aquaculture

A number of endemic species of fish dominate the lotic water bodies of the region, whilst the three major rivers of the peninsular, the Godavari, the Krishna and the Cauvery, contain a diverse and unique indigenous fauna. These species are gradually being depleted primarily due to pollution, indiscriminate exploitation of fisheries, reservoir formation and the depletion of water bodies (CIFA, 1996). Depletion of water bodies occurs as a result of reclamation, encroachment and siltation. Indiscriminate stocking of Indian major carps (IMC) has contributed to the loss of species bio-diversity in reservoirs and tanks. The species: *Tor spp.* (mahseer), *Puntius pulchellus, P. carnaticus, P. dubius* and *Cirrhinus cirrhosa* are fast dwindling within the region (CIFA, 1996), while others are on the verge of extinction. Therefore there is a pressing need to conserve such stocks which could have future potential for aquaculture.

In India there is great awareness of the importance of the conservation of bio-diversity. The systems that need to be conserved are extremely complex. Centralised plant and animal management and conservation efforts tend to concentrate on a few individual species in an *ad hoc* manner with limited skills and local knowledge for effective management. A large proportion of India's population depends on natural living resources for fishing, fuel wood, medicinal plants and natural vegetation for habitation.

Box 1. Legal protection of wild fisheries

Under the 1901 Mysore Game and Fish Act (established by the Maharaja of Mysore to protect game fish), the DoF had limited power to enforce conservation measures. The Karnataka Inland Fisheries Conservation Development and Regulation Bill, 1996, is currently being passed. This should provide a uniform legislation to allow protection of indigenous species in the recently integrated districts of Karnataka.

Traditionally communities, depended on bio-diversity as a means of increasing their survival strategies, and therefore conserved it in a sustainable manner. Such practices are often integrated with other cultural activities, for instance through the designation of sacred groves in forests. In Karnataka some of the richest reserves of indigenous species were found in the sacred waters surrounding temples. However, rising population inevitably exerts pressure on these natural resources and this pressure is accompanied by a loss of indigenous knowledge. The Government has commonly responded with a 'hands off' approach e.g. through the designation of national parks. Unfortunately this has often lead to a lack of local support. A new initiative from the Government is a People's Bio-diversity Register, which aims to make indigenous wisdom an important base for monitoring and protecting bio-diversity. The State Government wishes to develop such registers into a decentralised and participatory conservation initiative. 60 registers have been completed in nine states including three in Karnataka.
For aquaculture a sustainable approach should investigate the potential of using indigenous species to augment the current dominance of exotic carp culture for the following reasons:

- To preserve and propagate species that are in danger of becoming extinct
- To overcome potential seed availability constraints in semi-arid areas at low cost to poor farmers
- Indigenous species may have more suitable characteristics for survival and growth under the conditions found in different small water bodies
- To increase the production strategies of farmers in Complex Diverse Risk-prone (CDR) areas
- Sustainable use of these natural resources is consistent with watershed development policies and bio-diversity initiatives in the region

4 Local names

Having logged 21 indigenous species on the 'fishing trip' to Shimoga, it soon became apparent that names could vary significantly on a local basis (even within a single taluk). This is indicative of the isolation of many artisanal fishing activities, and the poor fish-retailing infrastructure in the region.

The accuracy with which local people could distinguish different species varied from place to place. Resolution was good in the larger organised markets (and a Bengali re-habilitation camp in Raichur) and poorer in smaller markets. Here, generic names based on the traits of similar species were often used e.g. at Tintinni Bridge, Raichur, 'Mise' (meaning moustache, and referring to the presence of long barbels) was applied to various Mystus species catfish.

5 Results of indigenous species inventory

A summary of species logged is shown in Table 1. Plates of these species are shown in section 8.
Potential cultivable species for small-scale water bodies would include many of the catfish and air-breathing species. These species are often very distinctive and (with limited experience) much easier to distinguish than the many species of peninsular carps (only two of which, *Labeo fimbriatus* and *L. calabasu*, are easily identified with certainty).

Table 1: Inventory of indigenous species encountered with local names. Meenu, means 'fish' in Kannada (the local language of Karnataka). U.P.: Uttar Pradesh; M.P.:Madhya Pradesh.

Scientific name	Local name	Site location	Indian distribution
Cyprinidae			
Labeo fimbriatus	Khemmeenu, Kemmu	Shimoga and Raichur.	Peninsular India, Orissa to Bengal and Sind (Pakistan)
Labeo pobail	Argaleamoss	Shimoga	Peninsular India
Labeo bata	Kolchumeenu, Bata	Shimoga	Assam, Darjeeling, Bengal, Orissa, M.P, Kristna and Godavery.
Labeo kontius		Shimoga	Rivers of the Neilgherries, the Cauvery and the Coleroon
Labeo calabasu	Kage, Kagi, kalbasu	Shimoga and Raichur	Peninsular India, Orissa to Bengal, Burma and Sind (Pakistan)Peninsular India, Orissa to Bengal
Labeo gonius		Shimoga	
Heteropneustes fossilis		Shimoga	Freshwaters throughout India, Sri Lanka

Table 1 continued:

Scientific name	Local name	Site location	Indian distribution
Puntius kolus	Kolsu (*Puti*)	Shimoga	Central provinces Deccan, Kistna, Tamboodra and Gogavery rivers
Puntius pulchellus	Hargi	Shimoga	South Karnara inland streams
Rohtee cotio	Battegarea	Shimoga	Throughout India except the Malabar coast and Kistna
Tor kudree (mahseer)	Yellu	Shimoga & Raichur	U.P, Orissa and Peninsular India
Oxygaster bacaila	Manchu	Shimoga & Raichur	Throughout India except Malabar, Mysore and Madras and parts of the Deccan.
Cirrinhus reba		Shimoga	Throughout India and Pakistan
Cirrinhus cirrhosa	Arja	Raichur	Godavery, Krishna and Cauvery.
Mastacembelidae			
Mastacembelus armatus (spiny eel)	Avu	Shimoga & Raichur	
Bagridae			
Mystus cavasius	Jella / girleu	Shimoga & Raichur	Sind throughout India, Assam and Burma
Mystus aor	Surgi, Aar, *(Air)*	Shimoga & Raichur	Punjab, U.P, Bihar, W. Bengal, Assam, Orissa, M.P.
Mystus seenghala	Thorwi	Shimoga & Raichur	Punjab, Darjeeling, Bengal, Assam, MP Deccan down to Krishna River.
Notopteras notopteras (feather back)	Chapli	Shimoga & Raichur	Fresh and brackish waters from India to the Malaya archipelago.
Rita rita		Shimoga	U.P, Darjeeling, Bihar, Bengal.
Siluridae			
Ompok bimaculatus	Pabda Godli	Raichur & Shimoga	E.Punjab, Bihar, Manipur, Assam, W.Bengal, Mysore, Deccan
Wallago attu (freshwater shark)	Bale	Shimoga & Raichur	
Chanidae			
Chana striatus	Common Murrel	Shimoga	
Channa marulius	Murrel / Snakehead	Shimoga & Raichur	W.Bengal, Deccan, Mysore, Ahmadabad
Channa punctatus	Murrel	Shimoga	Freshwaters throughout India, Pakistan
Pangasiidae			
Pangasius Pangasius	Polgoker	Raichur	Punjab, Darjeeling, Bengal, Assam, MP Deccan Peninsular
Claridae			
Clarius batrachus (Indian magur)	Magur	Shimoga & Raichur	Fresh and brackish waters on Indian plains
Clarius gariapenus (African magur)	Magur	Raichur (hybrid)	Exotic introduction

Source: Semi-structured interviews with fishermen and vendors as well as personal communication with Dr. Kumaraiah, PAD, CIFA.

6 Aquaculture characteristics of indigenous species

Table 2 compares production characteristics of indigenous fish species with those of the commercially available exotic carps.

Table 2 continued.

Species	Common name	Food	Feeding habit	Annual growth	Max growth	Breeding time
Air breathers Chanidae						
Chana marulius	Large murrel	Insects, fry,fish	Highly predacious			Feb-June river Feb-Nov. tanks
Chana striatus	Common murrel	Insects, fry, fish	Bottom, highly predacious			Feb-June river Feb-Nov. tanks
Chana punctatus	Murrel (snakehead)	Insects, fry, fish carnivorous	Highly predacious			Feb-June river Feb-Nov. tanks
Airbreathers Claridae						
Clarias batrachus	Magur	Ostracods worms, fish, detritus	Bottom, highly predacious			
Heteropneustes fossilis	Singhi (murrel)	Ostracods worms, fish, detritus. Carnivorous	Bottom omnivore			
Pangasiidae						
Pangasius pangasius	Pangas	Insects, fry	predacious			
Ompok sp.	Pabda, Godli					
Bagridae						
Mystus seenghala		Insects, fry, fish	Highly predacious			
Mystus aor	Aar	Insects, fry, fish	Highly predacious			
Siluridae						
Wallago attu	Wallago	Insects, fry, fish	Highly predacious			

Source: CIFA (1996), Jhingran, (1982), M. Doddamani, Tungabhadra Dam, pers. com., (1998).

In this scheme fish are classified according to their trophic niche i.e. column, surface or bottom, and their diet i.e. herbivores, omnivores, carnivores (of invertebrates) and predators (of fish). *Cirrhinus cirrhosa, Puntius dubius, P. carnatacus, P. pulchellus, Labeo kontius* and *L. calabasu* are the most important peninsular carps. Attempts to culture these species have been scanty due to lack of knowledge about their seed production and biology. This is due in part to their slow growth rate in comparison to the exotic carps. However, successful hypophysation of *L. calabasu* and *L. fimbriatus* has been carried out in the last decade (CIFA, 1996). The Peninsular Aquaculture Division (PAD) of CIFA are currently evaluating the potential of these two species for aquaculture, and the possibility of *P. pulchellus* as a future substitute for grass carp for weed control. *Labeo calabasu* is already extensively cultured in Bangladesh as an indigenous species.

Air-breathing fishes have many desirable properties: they can be marketed live; are reputed to have excellent nutritive and therapeutic properties during convalescence (Jhingran, 1982); have few bones and fetch a higher price than carp to which they are often preferred. Magur can be stocked at high density and is tolerant of high temperatures and poor water quality. Zeol culture in Bangladesh involves harvesting wild seed during floods by connecting ponds to drainage ditches. Snakehead and magur are widely

cultured using this system (O'Riordan, 1993). However, their predacious nature and requirement for supplementary feed makes them poor candidates for small-scale extensive culture. They are also difficult to harvest in water bodies that cannot be drained, as they tend to bury themselves in the sediment. Furthermore, where food security and the availability of cheap protein at local markets is of primary importance, the culture of high value species might be avoided. Many projects based on this premise have found that most of the fish produced is converted into income instead of being consumed.

7 Indigenous species with potential for aquaculture

This section should be read in conjunction with the commercial seed availability and short term harvesting options section in Working Paper 7.

To assess the suitability of indigenous species, one must consider their culture characteristics, consumer preferences and both the regional and seasonal seed availability. (Table 2 shows growth characteristics of some of these fish). Of the project villages, only Pai Doddi, situated 4km from the river Krishna, had close proximity to a perennial capture fishery resource. Fish on sale at the local market included catfish (*Ompok bimaculatus*, and *Mystus aor*) peninsular carps (only *Labeo fimbriatus* and *L. calabasu* were identified with certainty) and major carps (catla, rohu and mrigal). Local markets near the other villages stocked only exotic carps from tank fisheries. Perennial water bodies are scarce in the district and, in the other three villages, villagers would have to travel from 20-35km to find wild fish.

Box 2: Important commercial catfish species contributing to inland fishery production in India and South Asia (after CIFA 1996).

Aorichthys aor, A. seenghala, Mystus cavasius, M. gulio, Rita rita, Wallago attu, Ompok bimaculatus, Heteropneustes fossilis, Clarias batrachus, Silonia silondia, Pangasias pangasias.

Although catfish including *Wallago attu, Ompok bimaculatus* and *Pangasius pangasius* have been successfully reared, the carnivorous nature of these species make them unsuitable for small-scale culture. In addition, high value species may be sold rather than consumed. Because of their ability to exploit natural productivity (with resulting lower requirements for feed inputs) the peninsular carps are the species with the best potential. Plankton feeders such as *Labeo fimbriatus* and *L. kontius* may be more suitable for open wells, whilst *L. calabasu*, an omnivorous bottom-feeder, would be more suited to silt-laden farm ponds and check dams. These all have good consumption characteristics and fetch intermediate prices at local markets.

All the peninsular carps spawn from June to December (Table 2), which makes them less suitable than many of the exotic carps that can be induced earlier, or predatory catfish. These omnivorous fish spawn from February to take advantage of the later-spawning prey species, and may be good candidates for short season harvesting options. A reliance on wild seed is unlikely to lead to widespread or sustained adaption. Potential difficulties are associated with the collection and identification of wild juvenile spawn. Mixed juveniles may be collected, but the identification and transport of larger juveniles would involve a lot of labour and be less practical for villages located some distance from capture sources.

The risk of disease introduction would also be enhanced if wild seed were introduced. Carps *(L. fimbriatus)* infected with Epizootic Ulcerative Syndrome (EUS) were observed in Shimoga district during the field visit. A final problem lies with the lack of technical knowledge that exists regarding the culture of many of these species (and extension services' lack of familiarity with knowledge that does exist). Although considerable effort has gone into researching the culture of air breathing fishes (CIFA 1996), husbandry techniques are technically more demanding than carp culture and survival rates are often disappointing. Research into the culture characteristics of *P. pulchellus* by the peninsular division of CIFA promises good potential, but is still in its infancy. Small-scale culture of *Labeo calabasu* is widely practiced in Bangladesh and the applicability of Bangladeshi indigenous knowledge to conditions in Raichur should be investigated.

Table 3:Key characteristics of important fish species for aquaculture in Karnataka. >: more than; <: less than.

Species	Name		Diet		Growth		Max size	Breeding times	Fecundity	Flesh quality
	Common	Local	Juvenile	Mature	Year 1	Annual average				
Labeo rohita	Rohu			Plankton, plants, detritus		250-400 g	92 cm in length	Mid May – Late Sep.		Popular culture fish
Catla catla	Catla			Phyto- & zooplankton, detritus	50 g advanced fry reach 450-500 g in 4 months	500-750 g	> 183 cm in length	Mid April – mid July		Important food fish
Cirrhinus mrigala	Mrigal			Detritus, algae, mud		250-400 g	92 cm in length	March – Sep.		Important culture fish
Cyprinus carpio	Common carp			Plankton, detritus	50 g advanced fry may reach 300 g in 4 months	500-750 g		Jan. – April		
Puntius pulchellus		Hargi	Pre-fingerlings: phytoplankton and zooplankton	Submerged rooted macrophytes, marginal grasses, forest leaves & grasses, Ipomea.	700 – 850 g	20 – 25 cm	10 kg or 50 cm	Aug. - Dec. (Sept. - Nov in rivers)	< 100,000 kg^{-1} body wt	Popular food fish
Puntius kolus		Kolsu, Puti			250 – 300 g		> 31 cm in length	Sep. – Nov.	Low	Popular food fish
Puntius serrana				Insect larvae, small molluscs, mosquito larvae and detritus	500 – 600 g			Locally from June to Aug. in rivers only	Low (ca. 500-1,000 eggs kg^{-1} body wt.)	
Labeo fimbriatus	Kemmu	Khemmeenu. Kemmu		Detritus, specialist algae	500 g	30 - 45 cm	5 kg or 60 cm in length	June - Sep.	100,000 eggs kg^{-1} body wt	Popular food species
Labeo bata		Kolchumeenu, Bata					About 31 cm in length			
Labeo calabasu	Kalabasu	Kage, Kagi, Kalbasu		Omnivorous	Up to 700 g	25 – 30 cm	5 kg or 92 cm in length	June - Sep.		Important food and game fish
Rothee cotio		Battegarea								Very unpopular as food fish. Usually dried and used as fish meal component of poultry feeds
Oxygaster bacaila		Manchu			Approx. 40-50 g		100 g or > 18 cm in length			Typically sundried

Source: Dr. Kumariah, Peninsular Aquaculture Division (PAD), CIFA (Central Institute for Freshwater Aquaculture, India), fishermen and salesmen from Karnataka State, India.

Table 3 presents a summary of the main characteristics of the indigenous species with the greatest potential for aquaculture.

8 Photographic log of indigenous fish inventory

CLUPEIFORMES, NOTOPTERIDAE:

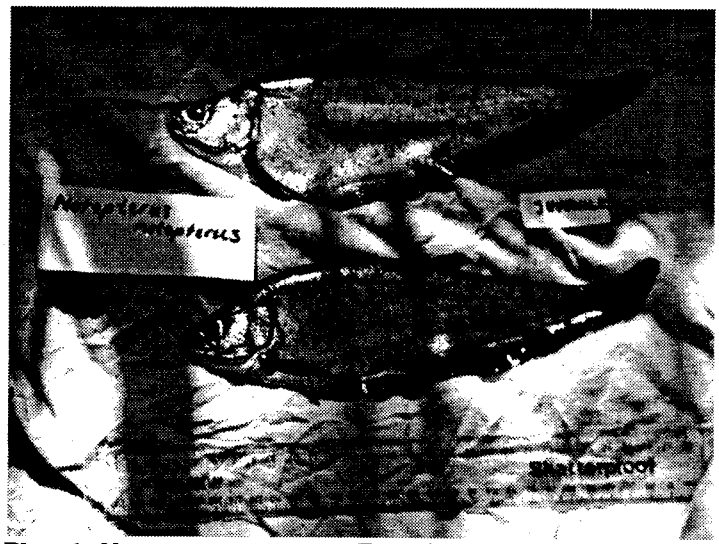


Plate 1: ***Notopterus notopterus*** **(Pallas) juveniles**

Notopterus notopterus **(Pallas)**
Characteristics: Dorsal profile not as convex as ventral. Maxilla reaches to mid-orbit. Preorbital serrated. Small dorsal in the caudal region, its origin midway between snout and caudal end, far behind the pelvic origin. Anal and caudal united. Scales on opercle larger than those on body; about 225 in the lateral line. Silvery becoming greyish on back; with some gloss of yellow on head; many fine greyish spots all over; eyes golden.
Distribution India: Ponds, fresh and brackish waters of E. Punjab, Uttar Pradesh., W. Bengal, Assam, Chilka Lake, Orissa, Madras, Deccan Deolali Karnataka, Poona, Malabar;
Remarks: Grows to 609 mm or more in length.

CYPRINIFORMES, CYPRINIDAE:

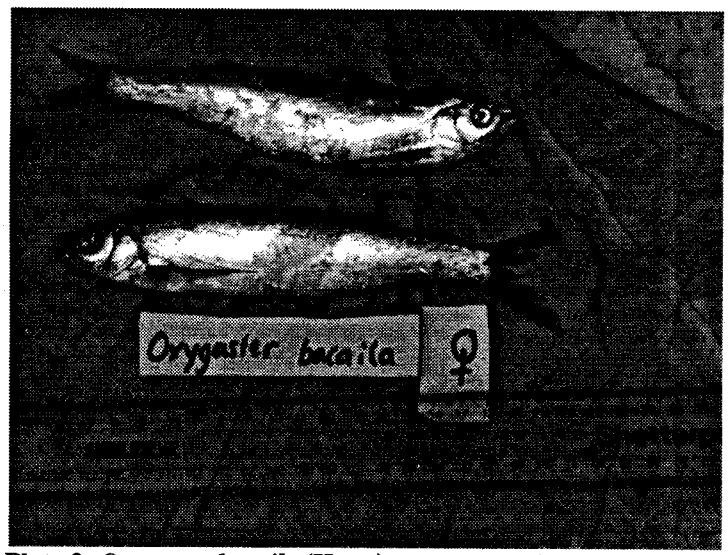


Plate 2: ***Oxygaster bacaila*** **(Ham.)**

Oxygaster bacaila **(Ham.)**
Characteristics: Snout longer then eye. Cleft of mouth reaches to below first fourth of eye. Keeled portion of ventral profile commences opposite pectoral fin. Sub orbital ring of bones broad, nearly covering cheek. Anal rays 13-15. Lateral lines scales 86-100; lateral transverse scale 17-19/6-10. Uniform silvery colour.
Distribution India: Freshwaters of Assam, W. Bengal, Punjab (I), Uttar Pradesh., Bihar, Orissa, Boroda, Nepal state or throughout India, except Malabar, Travencore-Cochin, Mysore and Madras.
Remarks: Grows 400 – 500 mm in year 1. Attains at least 177 mm in length. Typically eaten sundried.

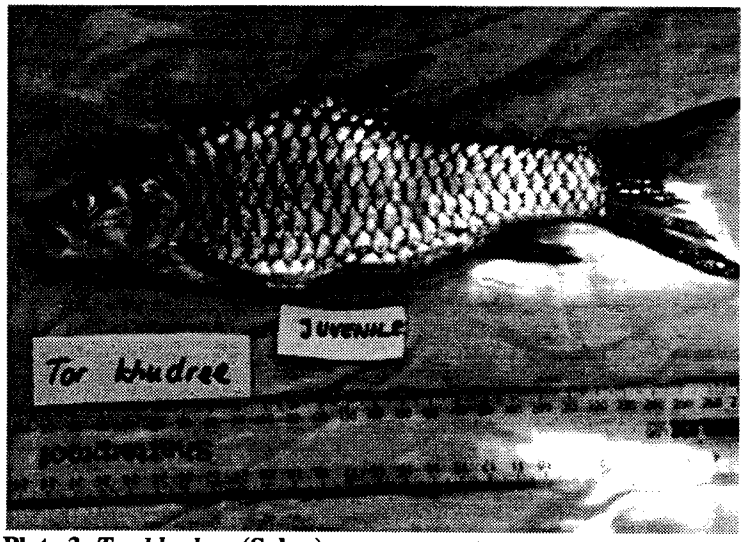


Plate 3: ***Tor khudree*** **(Sykes)**

Tor khudree **(Sykes)**

Characteristics: Eyes in the anterior half of the head. Sides of snout and suborbital region tuberculated. Lips thick, with labial fold continuous. Two pairs of barbels, reaching beyond eye. Dorsal origin opposite to pelvic origin; dorsal spine strong, smooth, about as long as head without snout. Lateral line scales 25-27; 3-4 rows between lateral line and pelvic base. Colour Dark olive superiorly becoming creamy, yellowish white below; fins bluish grey, often tipped yellowish pink.

Distribution India: freshwaters of Uttar Pradesh, Orissa and Peninsular India.

Remarks: Game fish growing to 1,447 mm in length

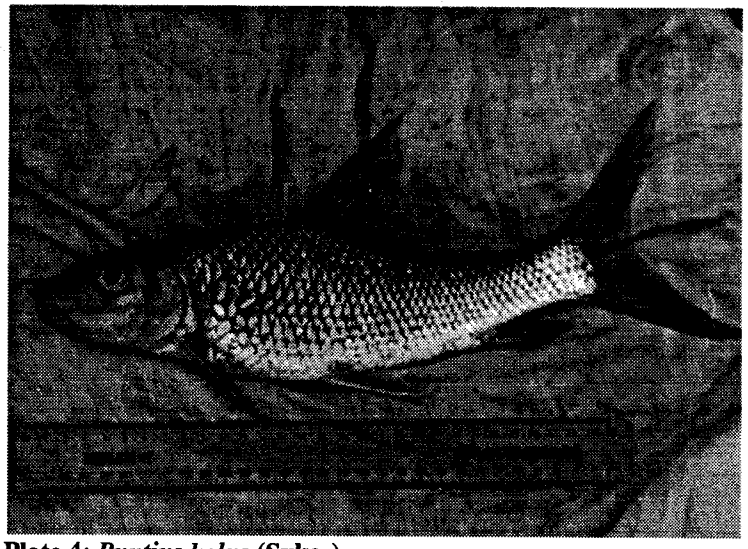


Plate 4: ***Puntius kolus*** **(Sykes)**

Puntius kolus **(Sykes)**

Characteristics: Interorbital flat. Dorsal profiles sharply arched from occiput to commencement of dorsal fin. Barbels 2, reaching beyond midorbit. Dorsal origin in advance of pelvic origin, nearer to snout than to caudal base. Lateral line complete, with 40-43 scales in the longitudinal series; 4 to 5 rows between it and pelvic base. Silvery shot with yellow; dorsal, caudal and anal tipped grey.

Distribution India: Freshwaters of Madhya Pradesh, Deolali, Decan and throughout the Krishna, Tungabhadra and Godavari rivers.

Remarks: Grows 250 – 300 g in first year. Attains 304 mm upward in length. Breeds in Sep. – Nov. Low fecundity. Popular food fish.

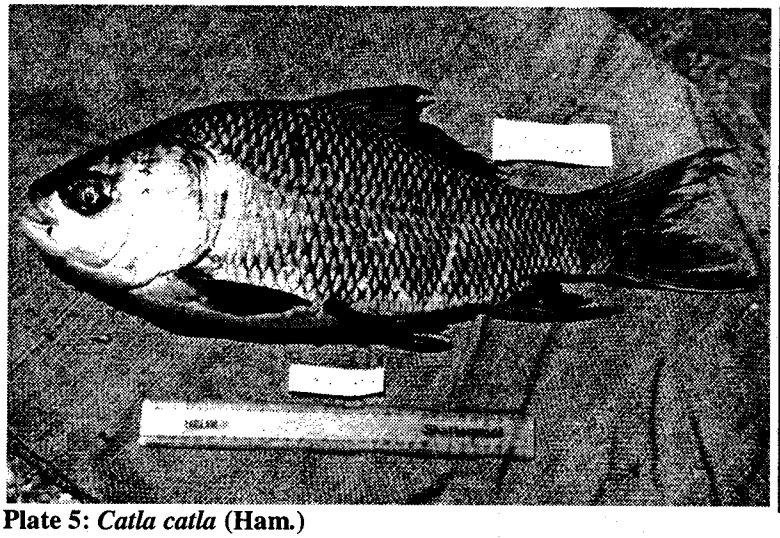


Plate 5: ***Catla catla*** **(Ham.)**

Catla catla **(Ham.)**

Characteristics: Eyes in front half of head. Dorsal profile more convex than that of ventral. Dorsal origin before pelvic, 17-19 rays. Anal shorter than dorsal, 8 rays. All fins rather elongated. Lateral line with 40-43 scales in the longitudinal series; 5 ½ to 6 ½ rows between it and pelvic base. Greyish above, silvery on flanks and belly; fins dark.

Distribution India: Freshwaters throughout India south to the Krishna River.

Remarks: Important food fish attaining at least 1,828 mm in length, widely cultured throughout India, especially Bengal. Diet: phyto- and zooplankton, detritus. Annual average growth: 500 – 750 g. Breeding times: mid-April to mid-July.

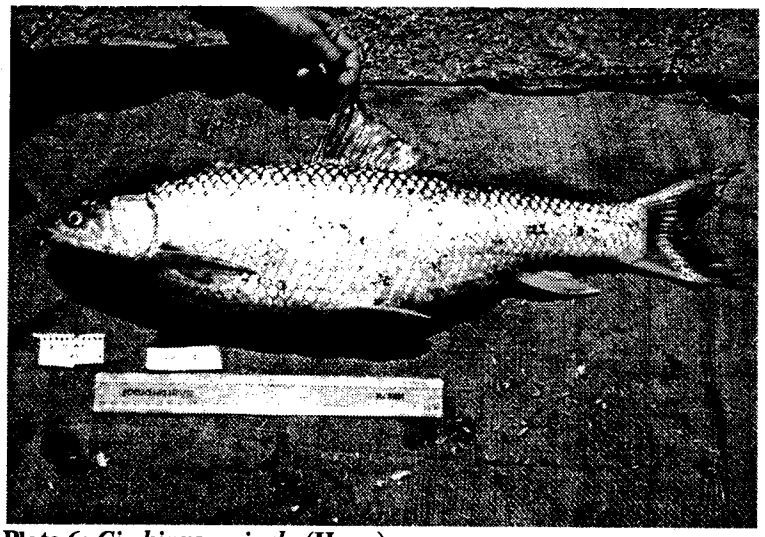


Plate 6: ***Cirrhinus mrigala*** **(Ham.)**

Cirrhinus mrigala **(Ham.)**

Characteristics: Eyes in head the anterior half of head. Dorsal profile slightly more convex then ventral profile. Upper lip entire. Barbels 2, one short rostral. Dorsal nearly as high as body, with 15-16 rays; origin much in front of pelvic origin, nearer to snout than to caudal base. 4 1/2 to 6 rows of scales between lateral line and pelvic base; 40-45 scales in the longitudinal series. Dark grey with a coppery tinge along back, becoming silvery below; pectoral, pelvic and anal orange, tinted with black, eye golden.

Distribution India: Rivers and tanks in W. Bengal, Darjeeling Dt., Eastern Himalayas, E. Punjab, Uttar Pradesh, Western Himalayas, Madras, Deccan Karnataka, Bombay, Ahamedabad.

Remarks: Important culture (and game) fish; grows to 914 mm in length. Diet: detritus, algae, mud. Annual average growth: 250 – 400 g. Breeds March – Sep.

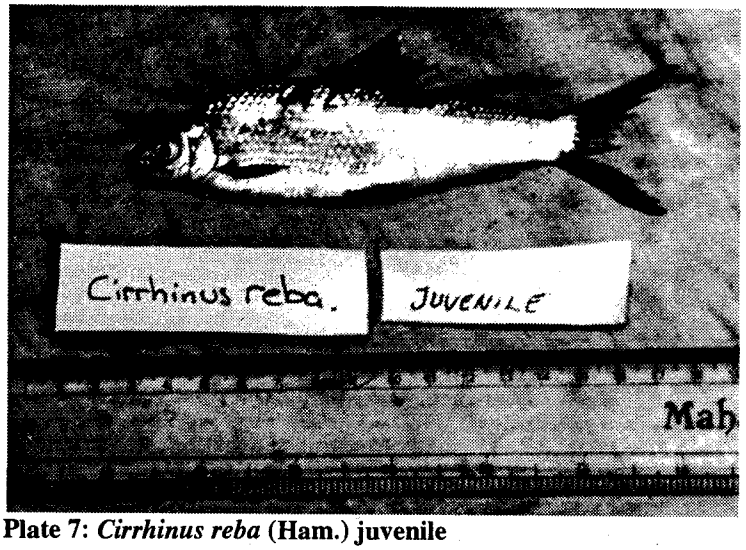


Plate 7: ***Cirrhinus reba*** **(Ham.) juvenile**

Cirrhinus reba

Characteristics: Dorsal profile slightly more convex than ventral profile. Upper lip fringed in the young, often entire in adult; a thin cartilaginous layer covering lower jaw. Barbels, a pair of short rostral, or none. Dorsal with 10-11 rays; origin anterior to pelvic origin, nearer to snout than to caudal base. Scales hexagonal; 35-38 along lateral line in the longitudinal series, 7/9 in transverse series. Silvery; scales darkest at their edges, forming bluish longitudinal bands above lateral line, young often with a leaden coloured lateral band.

Distribution: Freshwaters throughout **India** and **Pakistan.**

Remarks: Grows to about 304 mm in length.

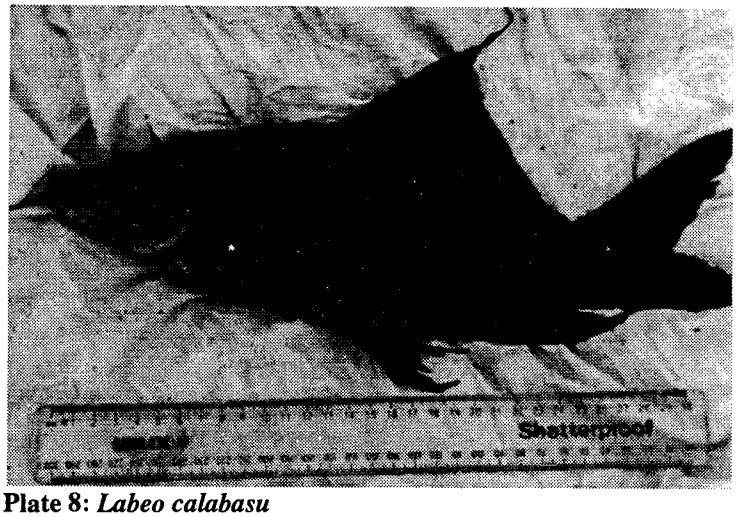


Plate 8: ***Labeo calabasu***

Labeo calabasu

Characteristics: Dorsal and ventral profiles about equally convex. Lips thick, fringed, lower one more so. Snout obtuse, with pores. Barbels 4, rostrals the longer, nearly equal to eye. Dorsal with 16-18 rays; origin ahead of pelvic origin, midway between snout and caudal base. Lateral line with 40-44 scales in the longitudinal and 7/8 in the transverse series. Blackish green becoming lighter below; fins black, upper tip of caudal usually edged white.

Distribution India: Freshwaters of E. Punjab, Uttar Pradesh, Bihar, Darjeeling, Assam, W. Bengal, Orissa, Ahmedabad, and south to the Krishna river, Madras.

Remarks: An important food and game fish attaining 914 mm in length. Widely stocked in tanks. Omnivorous. Grows up to 700 g in year 1, annual average 250 – 300 mm. Breeds June – Sep.

Labeo fimbriatus **(Bl.)**

Characteristics: Dorsal profile more arched than ventral profile. Lips thick, continuous and fringed; lower jaw with a horney covering inside. Snout obtuse, somewhat swollen and studded with pores. Barbles 4, short. Dorsal with 19-22 rays; origin nearer to snout than to caudal base. Lateral line scales 44-47 in the longitudinal and 9-10/8 in the transverse series. Silvery along back, lighter on sides and below; fins stained black, often, a diffused dusky blotch at the caudal base.

Distribution India Freshwaters of E. Punjab, Uttar Pradesh., Orissa, Madhya Pradesh, Madras, Deccan, Deolali, Poona, Ahmedabad

Remarks: Attains 457 mm in length and is good eating. Diet: detritus & specialist algae. Max growth year 1: 500 g, average annual 300 – 450 mm. Breeds June – Sep., about 100,000 eggs kg^{-1} body wt.

Labeo bata **(Ham.)**

Characteristics: Dorsal profile more convex than ventral profile. Lips thin, continuous; a tubercle inside lower jaw above symphysis; no horny covering inside jaws. A pair of very short maxillary barbels. Dorsal with 11-12 rays; origin nearer to snout end than to caudal base. Lateral line with 37-40 scales in the longitudinal, 7/6-7 in transverse series. Grey above and silvery below with lower fins tinted orange Young often with 3 or 4 small, lateral black spots.

Distribution India: Freshwaters of Assam, Darjeeling Dt., W. Bengal, Orissa, Madhya Pradesh, and in Krishna and Godavari;

Distribution in Pakistan: Freshwaters of E. Pakistan.

Remarks: Attains 304 mm in length.

Rohtee ogilbii **(Sykes)**

Characteristics: Dorsal profile more convex than ventral profile. Lower jaw shoret. Barbels absent. Dorsal origin midway between snout and caudal base dorsal spine strong, serrated. Anal with 16 rays. Lateral line scales 55; lateral transverse scales 13/11. Purplish silvery superiorly becoming silvery white below; young with 4 or 5 lateral bands.

Distribution India: Freshwaters of Deccan, Deolali, Poona, Mysore.

Remarks: Attains at least 152 mm in length.

Cirrhinus cirrhosa **(Bl.)**

Characteristics: Dorsal profile more convex than ventral profile. Upper lip entire. Barbels 4, maxillary reaches one third of way to eye, rostral a little longer. Dorsal as high as body, with 17-19 rays; origin considerably in front of pelvic origin, midway between snout and hind end of anal base; first few rays often elongated. 5 ½ to 6 ½ rows of scales between lateral line and pelvic base; 42-44 in the longitudinal series. Silvery, every scale with a red centre except along the belly which is a dull yellowish white; fins tinted grey.

Distribution India: In the Godavari, Krishna and Cauvery

Remarks: Grows to 457 mm in length.

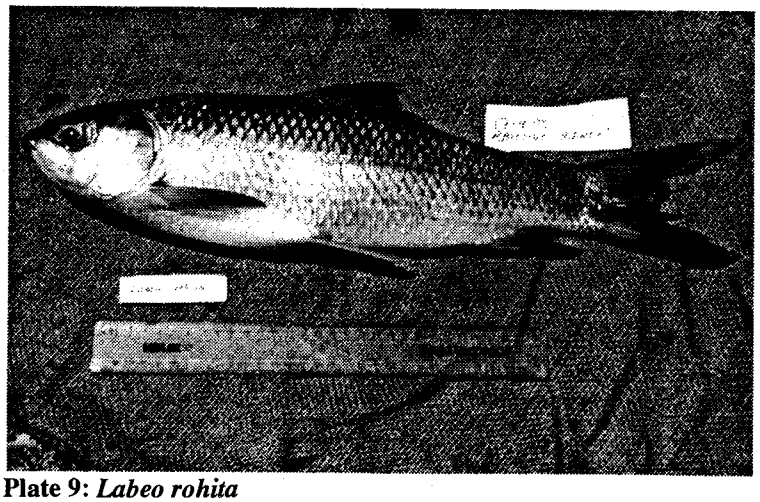


Plate 9: ***Labeo rohita***

Labeo rohita

Characteristics: Dorsal profile more arched than ventral profile. Lips thick, fringed. Snout obtuse, depressed. Barbels, a short thin maxillary pair; a rostral pair rarely present. Dorsal with 15-16 rays; origin midway between snout and caudal base with pelvic origin below the third or fourth ray. Lateral line with 40-42 scales in the longitudinal and 6/9 in the transverse series. Bluish or brownish along back, becoming silvery on sides and belly; fins sometimes black.

Distribution India: Freshwaters of E. Punjab, Uttar Pradesh, Bihar, Darjeeling, W. Bengal, Assam, Orissa, Madhya Pradesh, Ahmedabad. Bombay;

Distribution Pakistan: freshwaters of W. Punjab, E. Pakistan.-Burma.

Remarks: Attains 914 mm in length. Widely stocked in tanks

CYPRINIFORMES, SILURIDAE:

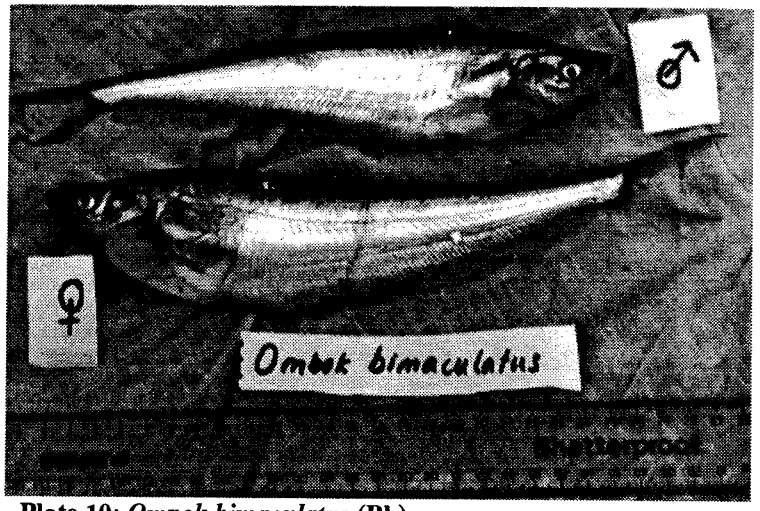


Plate 10: ***Ompok bimaculatus*** **(Bl.)**

Ompok bimaculatus **(Bl.)**
Characteristics: Lower jaw prominent. Width of gape of mouth equals post orbital length of head. Barbels 4 or 2, the mendibular pair rudimentary; maxillary pair reaches middle of pectoral or commencement of anal. Teeth in two small patches on either sides of vomer. Dorsal short, without spine (and rarely absent); origin of pelvic much nearer to snout end and than to caudal base. Pectoral with a strong spine, serrated or entire. Pelvic with 8 rays. Anal very long, with 54 to 73 rays. Silvery, short with purple; a black spot on shoulder and often one or two faint, black, lateral bands on upper part of body.
Distribution India: Freshwaters of Kashmir, E. Punjab, Uttar Pradesh, Bihar, Manipur, Assam, W. Bengal, Orissa, Madhya Pradesh, Madras, Bombay, Malabar, Mysore, Deccan;
Remarks: Attains at least 304 mm in length.

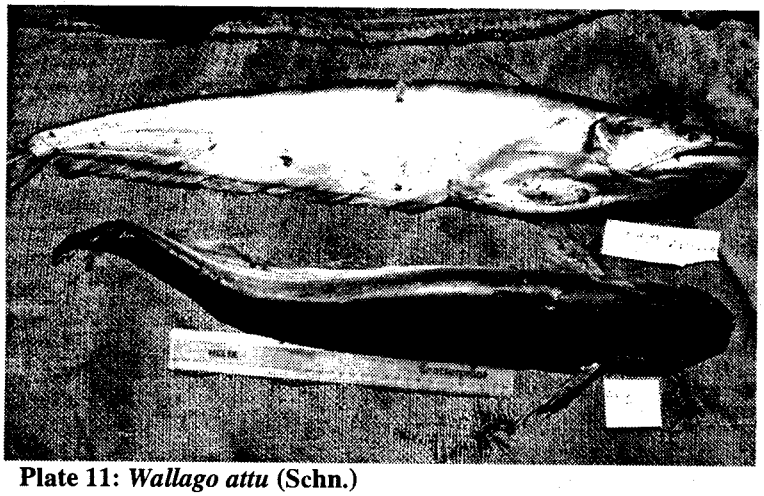


Plate 11: ***Wallago attu*** **(Schn.)**

Wallago attu **(Schn.)**
Characteristics: Dorsal profile nearly straight. Width of head a little less than its length and half its height. Cleft of mouth extends to nearly an eye diameter behind orbit; lower jaw more prominent. Barbels 4, maxillary twice as long as head, mandibular barbels of the same length as snout. Teeth numerous, cardiform in both jaws; an oblique patch on either side of vomer.Dorsal short, spineless; origin above or a little in front of pelvic origin. Pectoral spine moderately strong and finely serrated. Caudal forked not united with anal. Uniform silvery grey becoming lighter below.
Distribution India: Freshwaters of E. Punjab, Uttar Pradesh, Bihar, Darjeeling Dt., W. Bengal, Manipur, Assam, Orissa, Deolali, Madras, Ahmedabad, Bombay, Malabar,
Remarks: Attains 1,828 mm in length and is often found in tidal rivers.

CYPRINIFORMES, SCHILBEIDAE

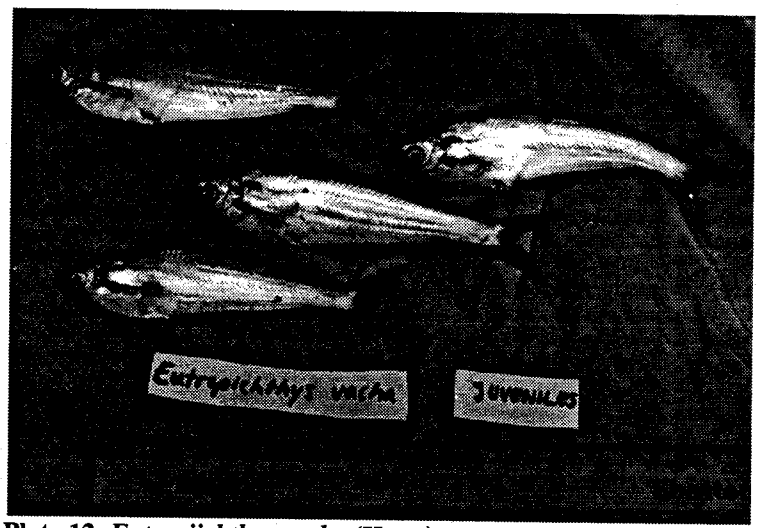


Plate 12: ***Eutropiichthys vacha*** **(Ham.)**

Eutropiichthys vacha **(Ham.)**
Characteristics: Eyes with broad adipose lids. Cleft of mouth oblique reaching beyond midorbit. Snout compressed, pointed. Upper jaw slightly longer. Barbels 8, maxillaries reaching end of preopercle or even as long as head, nasal reaching just behind the head. Teeth in a pyriform band on palatin. Dorsal spine thin, serrated, as long as head without snout. Pectoral spine serrated, as long as dorsal spine. Anal with 44 to 51 rays. Greyish silvery, darkest along back; pectoral and caudal edged black.
Distribution India: freshwaters of E. Punjab, Uttar Pradesh, Bihar, Darjelling, W.Bengal, Calcutta, Orissa, Madhya Pradesh, Nepal;.
Remarks: Attains upward of 304 mm in length and is good eating.

Pengasius pangasius **(Ham.)**
Characteristics: Eyes in the anterior half of head, partly on the lower surface. Upper jaw longer. Cleft of mouth reaches opposite centre of front edge of eye. Barbels 4, maxillary pair extending to pectoral base. Palatine teeth in a crescentic row, vomerine patches separate from or nearly confluent with those on palate. Dorsal spine serrated, moderately strong, as long as head behind mouth. Pectoral spine serrated, strong, as long as dorsal spine or head. Anal with 31-34 rays. Silvery, darkest superiorly, shot with purple on sides; cheeks and under surface of head golden.
Distribution India: Freshwaters of Uttar Pradesh, Bihar, Darjeeling Dt., W.Bengal, Assam, Orissa, Madhya Pradesh, Madras;
Distribution Pakistan: freshwaters of E. Pakistan.
Remarks: Attains 1,219 mm in length and is a foul feeder. Descends tidal rivers and estuaries

Heteropneustes fossilis **(Bl.)**
Characteristics: Barbels 8, maxillary reaching middle of pectoral or even to pelvic base. Vomerine teeth in a pyriforme patch on either side, converging anteriorly and diverging posteriorly. Dorsal short, spineless, origin anterior third of body. Pelvic origin below dorsal origin. Pectoral spine serrated, from 2/3 to 3/4 as long as head. Anal long, with 60-79 rays. Leaden, often with two lateral, yellowish band; young sometimes reddish brown.
Distribution India: freshwaters throughout India;
Distribution Pakistan: freshwaters of E. and W. Pakistan.
Remarks: Attains 304 mm in length or more.

CYPRINIFORMES, CLARIDAE:

Plate 13: ***Clarius batrachus*** **(L.)**

Clarias batrachus **(L.)**
Characteristics: Upper jaw longer, width of gape of mouth about half of head length. Two depressions on head, an oblong one more or less behind eyes, another oval one towards the nape. Occipital process rounded behind, its width at the base being more than twice its length. Barbels 8, maxillary reaching base or middle of pectoral. Vomerine teeth villiform, in an uninterrupted band. Pectoral spine finally serrated. Dorsal long, spineless with 62-76 rays. Anal rays 45-58. Caudal free. Dirty green or dark brown above, lighter beneath; vertical fins often with reddish margin.
Distribution India: Fresh and brackish waters of the plains of India
Remarks: Attains 457 mm in length.

CYPRINIFORMES, BAGRIDAE:

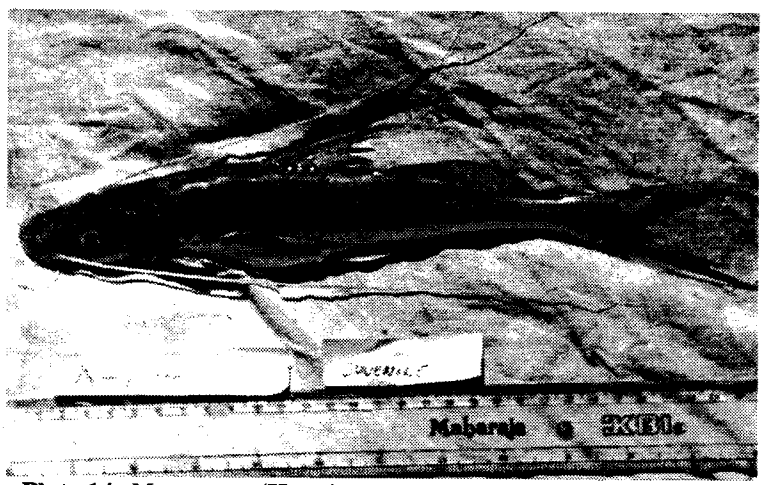


Plate 14: ***Mystus aor*** **(Ham.)**

Mystus aor **(Ham.)**
Characteristics: Snout broad, depressed. Width of gape less than half head length. Upper jaw longer. The median longitudinal furrow on head extends to base of occipital process. Palatine teeth in an uninterrupted, semi-lunar, transverse and. Pectoral spine rugose, stronger than dorsal. Base of adipose dorsal equal that of rayed dorsal or even more. Pelvic origin below last dorsal rays. Anal ray 12-13. Bluish leaden above, becoming white on abdomen; fins yellowish, tinted gray, a black spot on adipose dorsal.
Distribution India: Freshwaters of E. Punjab, Uttar Pradesh, Bihar, W.Bengal,Assam, Orissa, Madhya Pradesh.
Remarks: Attains 1,828 mm in length.

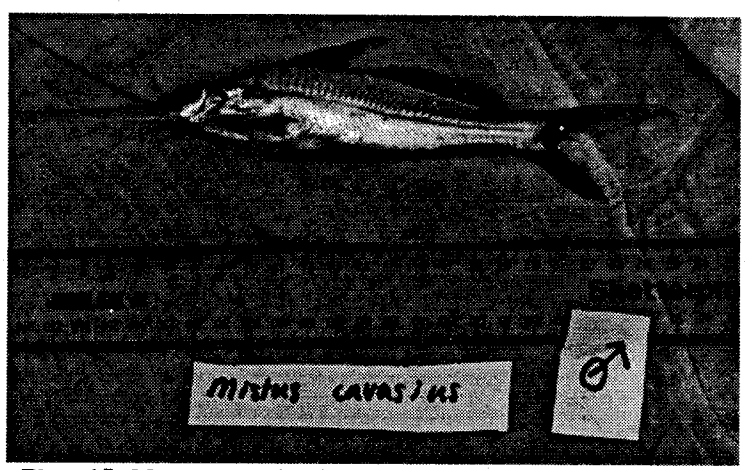


Plate 15: ***Mystus cavasius*** **(Ham.)**

Mystus cavasius **(Ham.)**
Characteristics: Snout somewhat obtuse. Upper jaw longer. Width of gape of mouth less than half of head length. Cleft of mouth extends to below orbit. The median longitudinal groove wide, extending to base of occipital process. Occipital process with a shallow, narrow groove along its posterior half. Barbels 8,maxillary pair extending beyond caudal base. Palatine teeth in a continuous, crescenting band. Pectoral spine serrated, as long as, but stronger than dorsal spine. Adipose dorsal arises just behind rayed dorsal. Anal rays 11-13. Leaden above and yellowish on abdomen and cheeks, often with a bluish band along the lateral line; pectoral, pelvics and anal dull white.
Distribution India: Freshwaters of E. Punjab, Uttar Pradesh, Bihar, Darjeeling Dt W. Bengal, Assam, Orissa, M.P., Madras, Mysore, Ahmedabad, Boroda, Bombay.
Remarks: Attains about 457 mm in length.

Mystus seenghala (Sykes)
Characteristics: Upper jaw longer. Cleft of mouth shallow. Width of gape of mouth equals 1/3 of head length. The median longitudinal groove on head extends to base of occipital process. Occipital process twice as long as wide at its base, separated from basal bone of dorsal by an intermediate, internal shild from 4 times as long as broad in the young, to half that width in the adult. Barbels 8, maxillary pairs reaching to middle or just beyond rayed dorsal. Palatine teeth in continuous, crescentic band. Dorsal spine weak, extending to snout. Pectoral spine stronger than dorsal spine, serrated, half as long as head. Pelvic origin behind last ray of dorsal. Base of adipose dorsal equals or slightly exceeds that of rayed dorsal. Anal rays 11-12. Brownish grey superiorly and silvery on sides and abdomen; a black spot on hind end of base of adipose dorsal.
Distribution India: Freshwaters of E. Punjab, Uttar Pradesh, Darjeeling Dt., W. Bengal, Assam, Madhya Pradesh, Ahmedabad, Poona, Deccan, down south to Krishna river.-Yunnan.
Remarks: Attains at least 381 mm in length.

Plate 16: ***Rita rita***

Rita rita
Characteristics: Upper jaw longer. Width of mouth nearly half of head length. The occipital process about as long as wide at its base, notched in front to accommodate basal bone of dorsal. Cubito-humeral process about 3/4 of head, granulated. Barbels 6, nasal very short, mandibular extending to end of head. Teeth villiform in upper jaw and in the anterior part of lower jaw; internally 2 or 3 rows of rounded teeth; palatine teeth rounded, in two elliptical patches. Dorsal spine very strong, serrated. Pectoral spine serrated shorter than dorsal spine. Greenish grey above becoming lighter below.
Distribution India: Freshwaters of Uttar Pradesh, Bihar, Darjeeling Dt., W.Bengal;
Remarks: Attains at least 1,219 mm in length.

OPHIOCEPHALIFORMES, OPHIOCEPHALIUDAE:

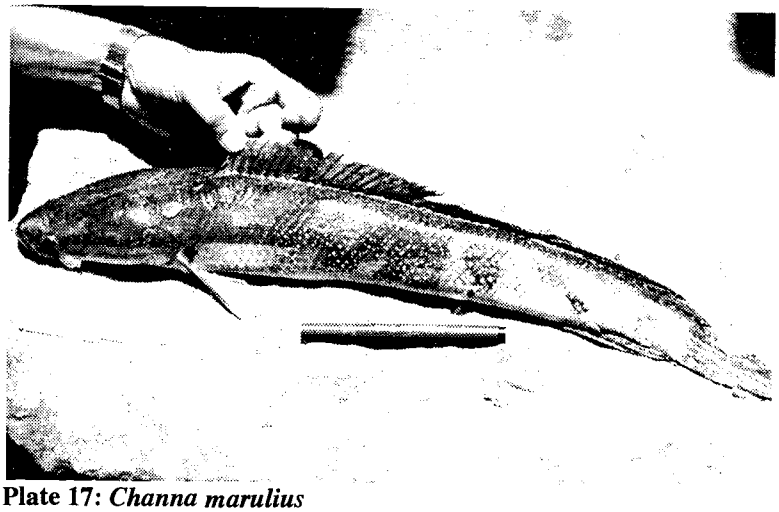


Plate 17: ***Channa marulius***

Channa marulius
Characteristics:: Maxilla extend half eye diameter behind orbit. Teeth villiform. Pelvics two-thirds as long as pectoral. 10 rows of scales between orbit and angle of preopercle; predorsal scales 16; lateral line scales 60-70.Cephalic pits multiple. Colour varies with environment; a large black ocellus at upper part of the base of caudal.
Distribution India: Freshwaters of W. Bengal, Deccan, Mysore, Traven-coachin, Ahmadabad;
Remarks: Attains as much as 1,219 mm in length. Takes live bait.

Channa punctatus (Bl.)
Characteristics: Lower-jaw longer, maxillary reaching below or behind border of eye. Teeth conical in jaws, cardiform on palatines 9 rows of scales between eye and angle of preopercle; predorsal scales 18-20; lateral line scales 50-57. Cepalic pits multiple. Dark greyish to black above, dirty white below; band of grey or black from sides to abdomen; fins greyish.
Distribution: Freshwaters through out **India** and **Pakistan.** Burma, Malaya, Siam, China, Philippines, Honolulu
Remarks: Attains 914 mm or more in length. Takes bait readily, especially frogs.

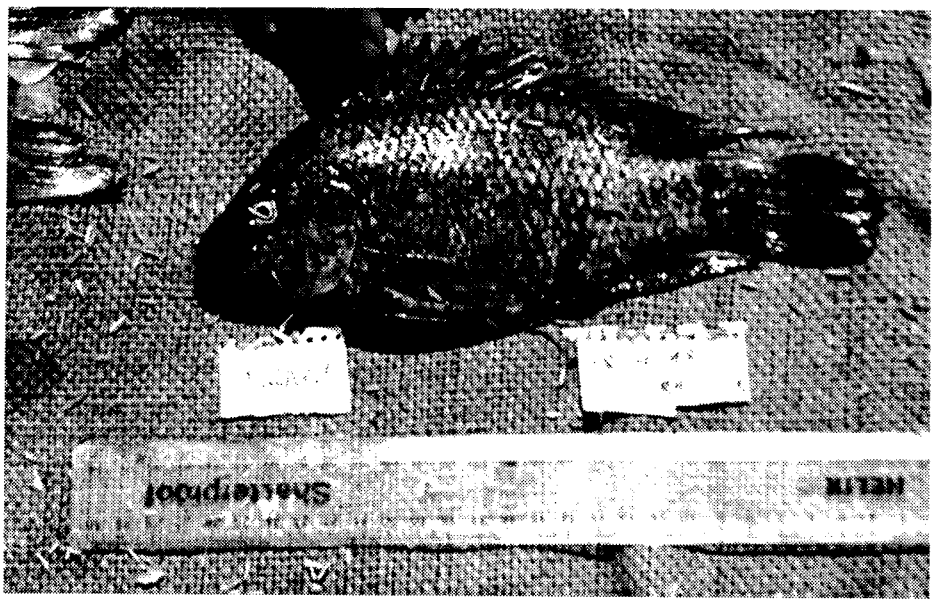


Plate 18: ***Oreochromis mossambicus*****, Mavina Kerry, Raichur. Exotic introduction responsible for decimating the fishery**

Plate 19: Hybrid magur (*C.gariepinus* x *C. bariatrachus*) Exotic introduction, Bengali Rehabilitation camp, Sindhnur, Raichur

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Appendix 1: Other sites visited during inventory

Tunghra Dam seed-rearing farm (the largest in state).

Department of Fisheries (DoF) office in Shimoga.