Government of the Peoples Republic of Bangladesh
Flood Action Plan

FAP 17

Fisheries Studies and Pilot Project

FINAL REPORT

(Draft)

JUNE 1994

Special study

Supporting Volume No. 26

AN ANNOTATED BIBLIOGRAPHY (1940-1992) ON THE RIVER AND FLOODPLAIN FISHERIES BIOLOGY AND PRODUCTION IN BANGLADESH AND SOUTH ASIA

ODA
Overseas Development Administration, U.K.

FAP 17

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FAP 17
FISHERIES STUDIES
AND PILOT PROJECT

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TABLE OF CONTENTS

1 OVERVIEW

This annotated bibliography was produced as part of the FAP 17 Fisheries Studies and Pilot Project to provide background information on inland fish stocks and fisheries of Bangladesh. The bibliography includes published and unpublished information on fish and prawns. Most references listed in the bibliography concern studies undertaken in Bangladesh but literature from neighbouring countries such as India, Pakistan and Sri Lanka is also included where it serves a useful comparative function.

During the compilation of the bibliography, literature searches were carried out at several libraries in Bangladesh, including university libraries. Difficulties were encountered in acquiring information not only from abroad, particularly India but also within Bangladesh. The bibliography is therefore by no means exhaustive.

The numerous research studies carried out by universities, government and non-government institutions relating to the culture of fishes in Bangladesh were not included in the bibliography, unless the results were relevant to natural conditions on the floodplains. For example, references have been included where studies on food and feeding of fish species have noted preferences for food items that occur in open waters, or where comparisons of cultured and wild fishes are presented.

The annotated bibliography is indexed using document numbers by species (including synonyms and local names) and by subject to facilitate reference to the relevant literature. It is hoped that the bibliography will provide a useful source of background information for future studies on capture fisheries of Bangladesh.

2 BIBLIOGRAPHY

1. Afroze, S. and Hossain, M.A. 1983.
The fecundity and sex ratio of the freshwater fish, *Amblypharyngodon mola*. 4th Nat. Zool. Conf. Sec. IV. Abst. 47.

150 specimens of ripe females were studied for fecundity by gravimetric method. Fecundity varied from 400 eggs (fish 75 mm in length and 3.8 g in weight) to 8,550 eggs (fish 92 mm in length and 9.5 g in weight). There were more females in the population than male, the ratio of male : female being 1: 6.7.

2. Afroze, S. and Hossain, M.A. 1990.
The reproductive cycle of the freshwater fish, *Amblypharyngodon mola*. (Hamilton). (Cypriniformes : Cyprinidae).
7th Nat. Conf. Zool. Soc., Bangladesh. Abst. 60.

A sample of 430 fish, was collected by cast net from a pond in Rajshahi town during 1977-78. 367 females were studied. The fish spawned twice a year. August was the peak breeding time. March was a secondary breeding period.

3. Aguero, M. 1986.
Bangladesh fisheries: a challenge to resource managers.
NAGA. ICLARM. Q. 9(3): 11-12.

Bangladesh's freshwater fishery resources are discussed. The method of inland fisheries production is described. Increased production through culture-based fisheries and efficient use of a wide variety of water bodies are reported. Overfishing, pollution, sedimentation, flood and tidal control projects, excessive removal of surface water for irrigation, large-scale reclamation of *haors*, *beels* and other depression areas for crop production, were listed as severe problems for inland fisheries. Long term management policies of the Ministry of Livestock and Fisheries were also addressed.

4. Aguero, M. 1989.

Inland water fisheries in Bangladesh: Management options and national interventions: *In* Aguero, M., Huq, S., Rahman, A.K.A. and Ahmed, M. (eds.). 1989. Inland fisheries management in Bangladesh. DOF and BCAS (Dhaka). ICLARM (Philippines): 1-13.

A review of the basic characteristics of inland fisheries in Bangladesh formed a background for the analysis of the main issues, problems and rationale of the New Management Policy for Inland Open-water Fisheries in Bangladesh. The socioeconomic importance of inland fisheries is highlighted and the main management problems are analyzed. The new Government strategy for licensing fishing access is discussed and guidelines are proposed. Of the current annual production of about 815,000 t, 53% originates from inland freshwaters including *beels*, rivers and floodplains. Only China, India and the former USSR produce more freshwater fish than Bangladesh. In Bangladesh inland open water provides 75% of total production. Hilsa forms 44% of the riverine catch (DOF 1987), followed by prawns, carps and catfish. Of the three countries (Bangladesh, Burma and India) in the upper Bay of Bengal region, Bangladesh secures the largest share of landings with 150,000 t per annum. The total landings in India and Burma are about 30,000 t per year (Raja 1985). The diversity of water bodies, geographical configuration and location make Bangladesh very appropriate for the production of fish by means of culture systems. Rough estimates by FAO and the World Bank indicate that through culture-based fisheries and efficient use of a wide variety of water bodies, it would be possible to obtain an increased production of about 300,000 t per year; fish farming is estimated to potentially yield an additional 120,000 t per year (FAO 1985).

5. Ahmed, A.T.A., Mustafa, G. and Alam, G.N. 1978.

Fecundity and larval development of *Tilapia nilotica* (L.).
J. Asiatic Soc. (Sc.). **4(1&2)**: 67-71.

The mean fecundity of 20 females was recorded as 1,476 eggs. The relationship of fecundity with length, weight and gonad weight was found to be linear. Different stages of larval development of the fish showed a very rapid growth. The fish attained sexual maturity within three months.

6. Ahmed, A.T.A., Mustafa, G. and Hai, A. 1980.
Food and feeding habit of the catfish, *Clarias batrachus* (L.).
Dhaka Univ. Stud.B. **XXVII (2)**: 79-84.

The stomach contents of 180 specimen of catfish, collected from the *beels* of Munshiganj by dipnets, drag nets and traps during 1977-78, were examined. The food of the adult fish predominantly consists of chironomid larvae, ostracods, copepods, algae, aquatic plants and molluscs together with debris, sand and mud. The juveniles feed on chironomid larvae, ostracods and dragon flies. The juveniles feed more actively than the adults whose feeding intensity decreases in the breeding season (March to August) when the gonads occupy the major space of the abdominal cavity.

7. Ahmed, K., Mustafa, G., Ali, S. and Shahjahan, M. 1985.
Induced spawning of magur fish, *Clarias batrachus (L.)* by stripping method in a plastic bowl hatchery.
Bangladesh j. zool. **13(1)**: 19-24.

A total of 32 pairs of *C. batrachus* was induced to spawn by injecting them with human chorionic gonadotrophin (HCG). Hatchlings were obtained in a plastic bowl hatchery. Each hatchery consisted of ten plastic bowls, each with two holes, one as inlet and the other as outlet. Each bowl had a plastic pipe connected with a water tap. Excess water was discharged through the outlet of the bowl. A constant water level was maintained. Fertilization varied from 55-95% and hatching from 20-75%.

8. Ahmed, M. 1991.
A model to determine benefits obtainable from the management of riverine fisheries in Bangladesh.
International Center for Living Aquatic Resources Management. Contribution No. **728**. 133 pp.

An operational model has been derived to analyse the performance of Bangladesh riverine fisheries under different simulated conditions of technical, economic and biological circumstances. The base model encompasses two submodels, one for bioeconomic production and the other for the market. Under optimal conditions the results of the model yield net

benefits of TK 1,383 million. The implication of the results for management is that intervention into the fisheries through control of fishing effort would produce substantial benefits from the fisheries.

9. Ahmed, M., Ali, S., Rahman, H., Ahmed, K. and Alam, A.K .M.A. 1985.
Studies on possibilities of using harvested paddy fields and ditches as nursery ponds.
Proc. 5th Nat. Conf. Zool. Soc. Bangladesh: 155-161.

An investigation to ascertain the use of harvested paddy fields and ditches as nursery pond for raising fry of carps, e.g. *Cirrhinus mrigala* (Ham.) (*mrigel*), *Hypophthalmichthys molitrix* (Valen.) (*silver carp*) and *Puntius gonionotus* (Bleeker) (*thaiputi*) was carried out at six selected water areas. The survival rate of these species was observed during a nursing period of 30 days and the rate was recorded as 54-96% for *mrigel*, 43-91% for silver carp and 49-55 % for *thaiputi*. The average growth for 30 days was 5.0 cm for *mrigel*, 3.0 cm for *silver carp* and 2.4 cm for *thaiputi*.

10. Ahmed, Q.J. 1960.
A preliminary note on the hilsa of East Pakistan.
Agriculture Pakistan. **11(1)**: 165-172.

The results of a general survey of the hilsa fishery of East Pakistan were presented. Nutritional value of fish and the gears and crafts used in the fishery were also discussed.

11. Ahmed, Q.J. 1961.
Study of the vertebral column of Hilsa with reference to its racial investigation.
Agriculture Pakistan. **12**: 65-76.

The potential racial differences of hilsa were studied through a morphometric study. Vertebrae counts from 383 fish indicated a homogeneous stock of hilsa.

12. Ahmed, S.M.J. 1988.

Availability of *Macrobrachium malcolmsonii* in western Orissa *vis-a-vis* problems and possibilities of its conservation and propagation.

Nat. Symp. Univ. of Kalyani. West Bengal. India. Abstr.# C25.

Almost all canals and rivers of western Orissa are endowed with reasonable resources of *M. malcolmsonii*. Because of the economic importance of its capture and culture, the impact of the present land use pattern and water resource development on the prawn fisheries of the rivers and reservoirs has been highlighted. Conservation and propagation of prawn fisheries to boost the rural economy were examined.

13. Ahsanullah, M. 1964.

Population dynamics of hilsa in East Pakistan.

Agriculture Pakistan. **15(3)**: 351-365.

This report presents the results of the hilsa investigations conducted between 1956 and 1962. Yields of hilsa were found to vary from year to year but showed a gradual decline. Possible causes included indiscriminate fishing of *jatka* (young hilsa) on the spawning grounds, decrease in river discharge, and the use of small mesh nets. In East Pakistan (Bangladesh) hilsa was caught all year round in variable quantities.

14. Ahsanullah, M. 1967.

A note on length, weight, and length-weight relationship of hilsa.

Agriculture Pakistan. **18(1)**: 123-135.

The data for hilsa were collected from the Padma River. In general fish between 24-54 cm migrated from the Bay of Bengal to the Padma River and other rivers. However, hilsa ranging from 33-45 cm in length and 0.32-1.25 kg were most abundant.

15. Alam, S.M.N. 1989.

Biochemical composition and some aspects of biology with special reference to fecundity of *Mystus tengara* (Hamilton-Buchanan).

M.Sc. Thesis, Dept. of Zoology, Dhaka Univ. 124 pp.

The moisture, ash, fat, protein, phosphorus, calcium and iron content of whole fishes of *M. tengara* were calculated. The average fecundity was 3,543 eggs for a fish measuring 6.9 cm in length and 4.2g in weight.

16. Ali, M. S. 1992.

Changes in global climate and it's effect on fisheries resources. Seventeenth Annual Bangladesh Science Conference, Dhaka. Section IX - Zoology, Fisheries, Entomology, Animal Husbandry, Poultry, Wildlife and Biology. Bangladesh Association for the Advancement of Science. 13 pp.

The paper is divided into sections dealing with climate change and: marine fisheries; estuarine fisheries; freshwater fisheries; and fisheries of Bangladesh. The first three sections review the literature available, particularly from North America. The final section poses arguments that the coastal areas, including the Sundarban will be engulfed in to the Bay of Bengal and that Khulna, Barisal and Patuakhali will become islands. This would effect the nursery grounds for *Penaeus spp.*, *Macrobrachium rosenbergii*, and many other commercial fish, such as *Pangasius pangasius* and *Johnius spp.* The higher salinity advancing inland would also jeopardise the habitats of freshwater fishes, consequently affecting production. The opposing argument is that the land masses in the subtropics and tropics would change little. In addition the huge quantities of silt that are deposited in the estuaries each year would minimise the risk of inundation from sea water. However, the rise in temperature may still have adverse effects on the fisheries. The paper concludes with some measures to try to minimise the possible effects, including: avoiding high evaporation rates by planting more trees; establishing fish sanctuaries in perennial wetlands; reexcavation of seasonal wetlands and effective regulations for management of open water fisheries.

17. Ali, M.Y. 1989.

Environment, conservation and fishery resources in Bangladesh: *In* Aguero, M., Huq, S., Rahman, A.K.A. and Ahmed, M. (eds.). Inland fisheries management in Bangladesh. DOF and BCAS, Dhaka. ICLARM, Philippines: 36-52.

The inland fishery production system of Bangladesh is described. The importance of the floodplain during the monsoon season in the continuation and sustenance of the stocks of a large variety of fish species is highlighted. Interference with this production system through

implementation of FCD projects and their impacts is discussed with reference to certain FCD projects. Impacts of submersible embankments on the aquatic production system and species diversity in the *haor* areas are discussed. The inland fishery resources in terms of fish and prawn species and the breeding migration requirements of some of the important species are presented. Agro-chemical pollution caused particularly by agricultural pesticides and their possible impacts on fisheries are discussed.

Conservation measures are proposed to sustain the populations and stocks of different species by (a) reducing or minimizing degradation and destruction of wetlands and (b) converting the present unregulated capture fisheries in the open waters to regulated fisheries.

18. Ali, M.Y. 1991.
Towards sustainable development: Fisheries Resource of Bangladesh.
IUCN and BARC. Dhaka. 96 pp.

The paper includes fishery production systems, and the causes and effects of resource degradation. Reduction and modification of aquatic habitats was reported to be caused by the implementation of water resource development projects in the inland open waters and as a consequence of large-scale siltation and shoaling of rivers, channels and natural depressions due to natural causes. Upto the end of the third five year plan (June, 1990), about 3.36 million ha of inundatable floodplain has been protected by flood control and drainage through the construction of 7,024 km of embankment, 3,017 km of drainage canal, 6,884 hydraulic structures, 3,888 bridges and culverts and 1,064 river closures. Embankments for flood control, drainage and irrigation reduce floodplains and obstruct fish movement and migration from rivers and *beels* to the remaining floodplains, for breeding and feeding. These also alter growth patterns and species composition.

19. Ameen, M. and Rashiduzzaman, M. 1986.
Food and feeding habit of *Puntius stigma* (Cuv.& Val.).
Dhaka Univ. Stud. E. **1(2)**: 119-126.

The stomach contents of 112 specimens of *P. stigma*, caught monthly from a dighi in Noakhali by cast net (mesh 13 mm), were examined. Food items included: phytoplankton 28%, other plant parts 12.2%, materials of animal origin including benthic nematodes

18.3%, mud and debris 4.5% and sand 37%. The fish is an omnivore, feeding throughout the water column as well as on the bottom.

20. Ameen, M.U. 1987.

Fisheries resources and opportunities in freshwater fish culture in Bangladesh. Noakhali Rural Development Project. II/Danida. Noakhali. Bangladesh. 244 pp.

The book consists of nine chapters : ecology and the basis of fish production ; limnology and freshwater habitats ; some characteristics of freshwater habitats in Bangladesh ; fisheries resources ; aquaculture practices ; fish production possibilities in freshwater habitats other than ponds in Bangladesh and some issues relevant to fish culture in Bangladesh.

21. Ameen, M.U. 1987.

Fish production possibilities in freshwater habitats other than ponds in Bangladesh. *In* Fisheries resources and opportunities in freshwater fish culture in Bangladesh. Pat. NRD-II/Danida, Noakhali. Bangladesh : 244 pp.

The Bangladesh Fisheries Resources Survey System (FRSS, 1986) estimated that Bangladesh has 2.83 million ha of seasonally flooded land where fish are produced at 71 kg/ha. The scope and production of fish in paddy fields are discussed. Possibly the fish harvest from paddy fields has been greatly reduced due to the increased use of pesticide in agriculture. The construction of embankments in many parts of the country has also contributed to the decline of fish from inundated areas because the embankments have obstructed the natural re-stocking from the rivers and canals. Paddy-cum-fish simultaneous culture is not feasible in many areas of Noakhali because of the present agronomic practices followed by the farmers. Fish culture in paddy fields was experimental and cost-benefit analysis in six inundated paddy fields was given. The average profit per acre was TK 1,104 when both fish and prawns were considered. The observations were considered incomplete. The indigenous species did better than the exotic tilapia and common carp in the paddy fields (unpublished data of Islam and Ahmed, BAU). Indigenous small fish like *puti* (*Puntius stigma*) and *darkina* (*Esomus danricus*) and live fish like *koi*, *shinghi* and *magur* are considered suitable for paddy-field stocking.

22. Anonymous. 1974.

Study on food and feeding habits and fecundity of live fishes.

Abst. Fish. Res. 1963-72. Res. Rep. Ser. **No.1**. DOF: II-8 & 9 pp.

Stomachs of *Anabas testudineus*, *Heteropneustes fossilis* and *Clarias batrachus* were examined from ponds in the Chandpur area. Insects, crustaceans, eggs and larvae, fish scales, algae and parts of higher plants and debris were found in stomachs of *A. testudineus*. Stomachs of *H. fossilis* also contained the above food materials as well as juvenile prawns and snails. Snails were absent in stomach of *C. batrachus*. The number of eggs produced varied from 12,500 to 39,687 in *A. testudineus*, 4,200 to 15,750 in *H. fossilis* and 2,340 to 13,400 in *C. batrachus*.

23. Anonymous. 1974.

Study of fish parasites and diseases of different freshwater fishes.

Abst. Fish. Res. 1963-72. Res. Rep. Ser. **No.1**. DOF: II-75 & 76 pp.

The ectoparasites and endoparasites of fish were as follows : *Argulus* sp. - a copepod on the skin, fins and gills of *Labeo rohita* and *Catla catla* ; parasitic isopoda on external surface of *Polynemus sextarius*, *Silonia silondia* and *Tetraodon* spp.; *Hemiclopsis marginata* on the skin of *Clarias batrachus*; protozoans on the skin and muscles of *Catla catla* and *H.fossilis*; gill flukes on the skin of *Barbus stigmata*; fungus on the skin of *Channa punctatus*; encysted cercaria of *Isoparorchis hypsilobagri* (Trematoda) in the muscles around coelom and liver of *Channa striatus*, *C.punctatus*, *Nandus nandus* and *Channa marulius*; digenic trematoda in *C.striatus* and *C.punctatus*; nematodes in the coelom of *C. striatus*, *C. punctatus*, *H. fossilis*, *N. nandus*, *Xenentodon cancila*, *Pama Pama*, *Mastacembelus armatus* and *Clupisoma garua*. In addition cestodes and acanthocephalans were observed in the liver, intestine, coelom and viscera of the above fishes.

24. Anonymous. 1974.

Study of fecundity, food of Hilsa from Chandpur area.

Abst. Fish. Res. 1963-72 Res. Rep. Ser. **No.1.** DOF. 171 pp.

Hilsa were caught at Balasia, Satnal and Fenchuganj from the Meghna river during 1967-1970. The fecundity varied from 334,170 eggs to 1,577,600 eggs for fishes ranging from

31.5 cm to 53.0 cm in length and from 0.39 to 1.8 kg in weight. The male to female ratio was 55.8 to 44.2. The food items primarily consisted of algae, rotifers and crustaceans.

25. Anonymous. 1976.
Food and feeding habits of fry and fingerlings of three major carps, *Labeo rohita* (Ham.), *Catla catla* (Ham.) and *Cirrhina mrigala* (Ham.).
M.Sc. Thesis. Dept.of Aquac.& Management. BAU. Mymensingh. 89 pp.

The three species were omnivorous in their food habits. Debris and plant food were preferred by *L. rohita* and *C. mrigala*. *Catla* showed feeding preference for animal food. They all fed in all levels of the water column. With increasing size *C. mrigala* showed a greater tendency for bottom feeding and *L. rohita* was more likely to feed further up the water column. When small in size *catla* was a surface feeder.

26. Anonymous. 1977.
Studies on the age and growth length-weight relationship and condition of *Catla catla* (Hamilton Buchanan, 1822).
M.Sc. Thesis. Dept. of Zool. Dhaka Univ. 113 pp.

Catla catla was studied from Karnaphuli Reservoir and Dhaka University (D.U.) pond. The length-weight (L-W) relationship and condition factors were established. Age and growth-rate of the fish were studied by the scale method. The body length/scale length relationship was linear. True rings on the scales of fish from Karnaphuli Reservoir appeared in May-July due to spawning stress (broad grooves or bands with discontinuous circuli in the groove zone). Rings were absent in immature fish. Scales from the fish of the D.U. pond carried true rings, formed in March-April every year, probably due to non-availability of food and consequent starvation (cutting over of unfinished circuli by the newly formed circulus). Highest rates of growth was always found in the first and second years of life, thereafter the growth decreased gradually. The von Bertalanffy growth equation fitted the length-at-age data well. The infinite length was 97.0 cm for fish from Karnaphuli Reservoir and 92.0 cm for pond fish.

27. Anonymous 1978.

Successful artificial breeding of hilsa. *In* B.N. Saigal (ed.). "Central Inland Fisheries Institute, Barrackpore, India". Newsletter **3(1&2)** : 1.

The results of successful propagation of hilsa at Farakka and transfer of hatchlings to ponds at Bhagalpur are reported in this newsletter. After 18 and 31 days hatchlings had grown to 9-12 cm and 23-25 cm respectively.

28. Anonymous. 1979.

On the biology and fishery of air breathing catfish, *Heteropneustes fossilis* (Bloch, 1792).

M.Sc. Thesis. Dept. of Zool. Dhaka Univ. 104 pp.

Adult *H. fossilis* could be sexed by urino-genital papilla of the male and by the bulging abdomen of female during breeding period. Males were generally smaller than females. The observed sex-ratio (of fish from Chapada *beel*, Faridpur) was 41.73 % male : 58.27 % female. The oldest fish was 5 years old. The males matured earlier (12.0 cm) than females (14.0 cm) at about 1 year age (and larger females spawned earlier than youngers). Spawning took place in August/September in jute-retting water bodies. Algae, higher plant parts, crustaceans, aquatic insects, larvae, oligochaetes, gastropods and debris were the main food items. Larger fishes were mainly carnivorous and bottom feeders.

29. Anonymous 1984.

Investing the Hilsa resource in the upper Bay of Bengal.

Bay of Bengal News. BOBP issue # **16**. 7 pp.

The paper discusses the status of knowledge on the hilsa fishery. It prepares a work plan which includes a census of craft and gear, collection of catch and effort data at three sampling stations (riverine, estuarine and marine), species separation and familiarization, sampling for length frequency data, maturity and spawning, experimental fishing with multipanelled gill nets of a graded range of mesh sizes, racial investigations through biometrics and if possible, through biochemical studies, and collection of environmental data (Sivasubramanium). The annual yield of hilsa reached 150,000 tonnes. While the availability of fish in the upper reaches of the rivers was falling, the marine catch and related effort had

increased steeply. This raised the question (Choudhury), do the riverine and marine catches originate from a single stock or do they constitute different stocks? Possible existence of three stocks, purely riverine, anadromous and purely marine made the understanding of the hilsa resource in its totality difficult and confusing. There are at least two morphologically distinguishable variants and two separate spawning runs having probably three peaks of spawning activity (Raja). Close monitoring and management of the hilsa resource, declaration of certain areas as sanctuaries, protection of brood fish, and a ban on fishing during spawning time were advocated.

30. Anonymous. 1986.
Observations on some aspects of biology of feather-back, *Notopterus notopterus* (Pallas, 1910), with special reference to its maturation and fecundity.
M.Sc. Thesis. Dept. of Zool. Univ. of Dhaka. 65 pp.

198 specimens of the fish were studied. Females were in greater numbers than males in most of the months (1984-85). Maximum value of gonado-somatic index (GSI) was obtained in July. Fecundity varied from 686 (fish length 17.30 cm) to 2,443 (fish length 29.40 cm). The length-weight relationship was estimated. The largest specimen was 37.90 cm. The fish was carnivorous, feeding on small fish (like *Puntius* spp. and *Esomus danrica*), crustaceans, annelids, molluscs, insects and their larvae.

31. Aquatic Farms, Honolulu. 1985.
Handling, marketing and processing of fish and shrimps.
Bangladesh 2nd Aquaculture Dev. Proj.: 14-20.

A total of 700,000 tonnes of fish and shrimps were consumed locally in 1984. Per capita annual fish consumption appears to have declined steadily over the past 20 years from about 12 kg in 1965 to less than 8 kg in 1985. In 1984-85 fisheries exports comprised shrimp (86%), fish (9%) and frogs legs (5%). Exports of shrimp in 1984-85 were directed to Japan (58%), USA (11%), Belgium (11%), UK (7%) and the Federal Republic of Germany (4%). Of the shrimp exports, 50% were freshwater species, 15% marine species caught by trawlers and 35% marine species caught by other gear or grown in ponds. The marine shrimp are exported principally to Japan and the freshwater shrimp to Europe and the United States. In 1985 there were an estimated 65 processing plants with a daily freezing capacity of 450

tonnes and a cold storage capacity of 12,000 tonnes. Exports of Bangladesh shrimp in 1984-85 were 12,700 tonnes. Principal species were the freshwater prawns, *Macrobrachium spp.*, black tiger prawn, *Peneaus monodon*), green tiger prawn *Peneaus semisulcatus* and white shrimp, *P. indicus* and *P. monoceros*.

32. Azad, S.A., Hertel-Wullf, J., Hossain, M.M., Huq, Q.M. and Das, N.N. 1987.
Some observations on size groups in the fishery and migration of hilsa in Bangladesh waters during 1985-86.
*BOBP, Colombo. BOBP/REP/***36**: 46-63.

This report describes the seasonal changes in mesh size of fishing gear, length frequencies of fish and mean lengths at first capture in the marine, estuarine and riverine waters of Bangladesh. Size group differences are also discussed in terms of hilsa migration.

33. Azadi, M.A. 1985.
Spawning of commercial freshwater fish and brackish and marine water shrimps of Bangladesh.
Fish. Inf. Bull. **2(2)**. BFRSS. Dhaka: 1-75.

Reports on spawning of fishes and shrimp are reviewed. Lists of commercially important species are provided. The spawning habits, spawning migrations, spawning seasons, environmental conditions, methods of hatching and rearing, spawning behaviour and life-histories of the major carps, other fishes and shrimps are discussed.

34. Azadi, M.A., Islam, M.A. and Dev, S.R. 1987.
Some aspects of the biology of *Mystus vittatus* (Bloch) : food, feeding habits and fecundity.
Proc. 12th Ann. Bangladesh Sc. Conf. BAAS. 36 pp.

Mystus vittatus was mainly a plankton feeder with preference for zooplankton. It fed mainly on copepods, cladocerans, rotifers, ostracods, insects, oligochaeta, chlorophyceae, bascillariophyceae and debris. Fecundity of the species ranged from 2,515 to 9,789 eggs (fish length from 8.9 to 11.5 cm).

35. Azadi, M.A. and Siddique, M.S. 1986.
Fecundity of catfish, *Heteropneustes fossilis* (Bloch) in Bangladesh.
Bangladesh j. zool. **14(1)** : 33-39.

Twenty females of *H. fossilis* were studied. The fecundity varied from 5,683 to 21,992 eggs. The mathematical relationships of fecundity with length, weight and ovary weight were found to be linear. The variations in the fecundity were better explained in terms of ovary weight than in length or weight.

36. Azadi, M.A., Islam, M.A. and Solaiman, S. 1988.
Food and feeding habits of *Eutropiichthys vacha* from Kaptai reservoir.
13th Ann. Sci. Conf. BAAS. Bangladesh. Sec.II. Abst. No. 62.

Gut content analysis of 129 specimens of *E. vacha* in the range 15-40 cm showed that the fish was mainly a surface feeding carnivore. The major food items consisted of insects, zooplankton, shrimp, molluscs, fishes, plant materials, debris and nematodes. The larger sizes were more piscivorous than smaller ones. Intensive feeding was found in July, September and December.

37. Azadi, M.A., Islam, M.A. and Solaiman, S. 1990.
Aspects of the reproductive biology of *Eutropiichthys vacha* (Ham.) in Kaptai lake, Bangladesh.
15th Bangladesh Sc. Conf. BAAS. Dhaka. Extended Synopsis.# 10.

Fifty species of fish including five exotic species are found in Kaptai lake. Females of *E. vacha* were more numerous than males throughout the year. The smallest ripe male and female were found at 20 cm and 15.7 cm, respectively. Five different maturity stages were observed in females on the basis of colour, shape, size of gonads and ova diameter frequency. The values of gonado-somatic index (GSI) indicated that *E. vacha* spawns once a year during May. Fecundity of twelve ripe females varied from 5,040 (for a fish 23.3 cm in length, 49.5 g in weight.) to 35,00 eggs (for a fish 49.5 cm in length, 680 g in weight).

38. Azadi, M.A, Islam, M.A. and Solaiman, S. 1991.
Food and feeding habits of Eutropiichthys vacha (Ham) from the Kaptia reservoir.
J. Asiat. Soc. Bangladesh, Sci. **17(1)**: 53-60

Gut contents of 129 *Eutropiichthys vacha* (Ham) showed that the fish is mainly a surface feeder carnivore. The major food items consist of insects, zooplankton, shrimps, molluscs, fishes plant materials and debris. The larger sized fishes were move piscivorous than smaller ones. Indices of abundance showed the importance of fish in the diet. Highest index of abundance was found in the month of December 1986 (92.63%) and lowest in the month of August 1986 (20.60%). Intensive feeding was found to occur in the months of July, September and December, 1986.

39. Azadi, M.A. 1990.
On the natural occurrence of Catla-Rui hybrid in Kaptai reservoir.
J. Asiat. Soc. Bangladesh. Sci. **16(2)**: 103-112.

Catla-rui hybrids were observed in the commercial catches in Kaptai reservoir in 1987 in the size range of 430-610 mm in length and 1,100-3,400 g in weight. The body of the hybrid was deeper than the *rui* and the head was smaller than that of *catla*. The mouth was terminal, lower lip slightly fringed and a pair of rudimentary barbels were found. The taxonomic characters and the age and growth of the hybrid are presented. In many respects the *catla-rui* hybrid was superior to its parent species. In terms of body flesh to the total weight, the hybrid was superior to *catla*. The growth rate of hybrid was faster than *rui* and very nearly that of *catla*. Taxonomic characters of the hybrid in comparison to its parent species and similar hybrids from India are tabulated.

40. Azadi, M.A., Shafi, M. and Islam. M.A. 1991.
Studies on the age and growth of Mahaseer, *Tor tor* (Ham.) from the Kaptai lake, Bangladesh.
Bangladesh j. zool. **19(1)**: 47-54.

The age and growth of mahaseer, *Tor tor* (Ham.) from the Kaptai lake have been studied using scales for ageing, during the years 1986 and 1987. The growth parameters L_∞, k and t_o have been estimated to be 84.36 cm, 0.3135 (annual) and - 0.27561 respectively. Two

phases in the growth of the fish were observed. Other characteristics, such as, coefficient of condition, length-weight relationship, growth constant and specific rate of linear growth were also studied.

41. Bailey, W.M. 1979.

Revised fisheries management plan - Chandpur Irrigation Project, Bangladesh. *In* Fishery Development in Irrigation and Flood Control Systems. Final Report: 8-1.

Bangladesh Water Development Board (BWDB) has drawn up a master plan which calls for construction and development of water control structures in specific local areas. 34 of these schemes had been completed by 1977. The Chandpur Irrigation Project was completed in 1978. The project provides irrigation water to and controls flooding in 217 square miles located southeast of Chandpur. The project area is now encircled by a dike about 67 miles long and 22 feet wide at the top. The project is equipped with regulator, pumping plant and navigation locks. Because the tidal/estuarine fishes were prevented from entering the project area, the fish fauna inside changed from a mixture of tidal/estuarine and freshwater resident species to entirely freshwater resident species. Some species benefited from the change in the ecosystem. Natural immigration of fry or fingerlings of major carps was stopped as these failed to enter the project area. Hilsa was able to migrate into the project area through the regulator during the early monsoon but in very small numbers. For several species of tidal/estuarine prawns, which were immigrants from the River Meghna, the water control structures presented a blockage to their migration.

Specifically, passage of *Macrobrachium villosimanus* and *M. mirabilis* was greatly decreased. However, this obstacle did not affect the passage of *M. malcolmsonii*, *M. rosenbergii*, *M. dayanus* and *Cardina* spp. The juveniles of these migratory prawns passed through the structures more effectively than their adults. The two freshwater resident species *M. lamarrei* and *Cardina* spp., preferred stagnant water with thick growth of aquatic weeds and benefitted by the change in the ecosystem. Improved management plans are advocated for the project area.

42. Bailey, W.M. and Rahman, S. 1979.

An evaluation of fishery development needs in irrigation and flood control projects in Bangladesh. *In* Fishery Development in Irrigation and Flood Control Systems. Final Report: 9-5.

Of the 150 development projects to control flooding and provide water for irrigation or drainage, 84 have been completed and 66 are ongoing. The rich freshwater fishery is dependent upon the flooding. An investigation (IDA 605, fisheries sub-project) showed that the natural fishery declined sharply inside the poldered area. In the Chandpur Irrigation Project a decline of over 35% was noted following closure of the project. Identification of potential fishery development works is done in the light of the demands by the human population for flood control as well as for fish for consumption. The description, data sources, fishery impact and the potential for the above listed projects are outlined very briefly.

43. Banu, N., Ali, S. and Vakta, N.C. 1983.

The fecundity of *Colisa fasciata* (Bloch & Schneider) of Dharmicpara, Dhaka district (Perciformes : Anabantidae).
4th Nat. Zool. Conf. Sec.IV. Abstr.# 56.

Colisa fasciata was found to spawn in March and April. The fecundity of 21 females showed that the number of eggs varied from 5,123 to 13,450.

44. Banu, N. and Joarder, S. 1982.

Fecundity of *Channa punctatus* (Bloch & Schneider).
Dhaka Univ. Stud.B. 30(2): 139-143.

The fecundity of *Channa punctatus* ranged from 6,000 to 19,000 in females, ranging in length from 11.5 to 19.0 cm. The number of eggs was highly correlated with the size of the female fish.

45. Bari, G.A. and Nazneen, S. 1984.
Biological studies on the alimentary canal structures of some fishes of Haleji lake (Pakistan) with their herbivorous nature of feeding.
Pak. J. Sci. Ind. Res. **27(1)**: 28-32.

Haleji lake is 55 miles from Karachi and rich in plant material. Nine herbivorous species belonging to three genera, *Labeo, Puntius* and *Sarotherodon* (*tilapia*) were found to inhabited the lake. Alimentary canal structures of these species were studied and it was found that these species were stomachless and contained an enlarged forgut or intestinal bulb instead of a true stomach. The structure of the alimentary canals of these fishes supported by predominantly plant material in rear guts, confirmed their herbivorous nature.

46. Barua, G., Islam, M.A. and Mollah, M.F.A. 1986.
Some aspects of reproductive biology of *Clarias batrachus* (L.) with notes on some climatological parameters.
Bangladesh J. Fish. **9(1-2)**: 23-31.

Studies on the breeding biology of the *Clarias batrachus* in Mymensingh district during 1984-85 shows that there was a single spawning season that lasted from May to July. The smallest ripe male measured 18.1 cm in length and 51.2 g in weight and the smallest ripe female was 17.2 cm in length and 52.3 g in weight. June was the peak of the spawning season. Both male and female laid down substantial fat reserves prior to spawning.

47. Barua, G and Mollah, M.F.A. 1987.
Observations on the spawning behaviour of *Mystus tengara* (Ham.).
Bangladesh J. Fish. **10(2)**: 43-46.

Mystus tengara (Ham.) were brought to breeding condition by frog pituitary injections. Spawning activity started 4 hours after injection of extracts of two pituitary glands and the spawning was complete in 6 to 7 hours after injection. Behavioural components listed are nudging, circling, pressing and spawning.

26

48. Bhuiyan, A.S. and Rahman, K. 1983.
On the fecundity of snakehead fish, *Channa gachua* (Ham.).
Bangladesh j. zool. **10(2)**: 101-110.

Thirty female fish were collected from Woohata *beel* near Rajshahi during 1981-82. The fecundity varied from 487 to 4,482 eggs (mean length of fish, 19.2 cm, mean weight, 28.5g).

49. Bhuiyan, A.S. and Haque, M.S. 1985.
Observation on the food of the fry of *Glossogobius giuris* from the River Padma.
Bangladesh J. Aquac. **6-7(1)**: 31-34.

The gut contents of one hundred fry of *G. giuris* (lengths, 1.0-2.0 cm) were examined. The fry were omnivorous and fed on diatoms (31%), green algae (20.9%), protozoans (17.6%) and microcrustaceans (30.4%). The plant and animal food occurred in the ratio 52 : 48. *Navicula* among diatoms and *Cyclops* among crustaceans were the most preferred food of the fry.

50. Bhuiyan, A.S. and Hossain, A. 1988.
Percentage composition of the food items of *Gudusia chapra* (Ham.).
13th Ann. Sci. Conf. BAAS. Bangladesh. Sec.II. Abst. No.122.

The stomach contents of 231 specimens of *G. chapra* (Ham.) revealed that the microcrustaceans comprised the highest percentage (35.27%) of food, followed by mud and sand (21.02%), algae (18.96%), debris and detritus (17.37%), protozoans (3.05%), rotifers (92.92%) and insects (1.4%). The crustaceans were present throughout the year.

51. Bhuiyan, A.S. and Sultana, N. 1992.
Seasonal variation in the percentage composition of the food of *Aspidoparia morar.*
17th Ann. Sc. Conf. BAAS. Gazipur. abst. # 68.

A total of 617 specimens of *A. morar* was studied during 1990-91. According to the fullness of stomachs, the active period of feeding was from April to August with a peak in May.

Stomachs were full of crustaceans, aquatic insects, sand and mud. The fish was a bottom feeder.

52. Bisht, R.S. and Das, S.M. 1981.

Observations on aquatic insects as food of fishes and the predatory action of some aquatic insects on fish and fish food.

J. Inland Fish. Soc. India. **13(2)**: 80-86.

The results of investigations on the qualitative and quantitative estimation of food of some omnivorous (*Puntius ticto, Cyprinus carpio, Tor tor*) and some carnivorous (*Nemacheilus rupicola, Channa gachua*) fishes of the Kumaon lakes are given. It was observed that the gut contents of these fishes contain a variety of aquatic insects which constitute an important food item for them. Laboratory experiments have shown that some aquatic insects, such as, *Lactrephes* and *Ranatra* (Nepidae : Hemiptera) and *Hyphoporous, Rhantus, Aqobus, Hydaticus* and *Cybister* prey on a variety of organisms including insects which are the natural food of fishes. The predatory aquatic insects also kill fish fry and fingerlings. *Cybister*, in particular, was the most destructive predator of juvenile fish.

53. Biswas, A.K. 1990.

Some aspects of biology of silver carp, *Hypophthalmichthys molitrix* (Val.) from the Baluhor Baor, Jhenidah.

M. Sc. Thesis. Dept. of Zool. Univ. of Dhaka: 128 pp.

Two hundred and seven specimens of silver carp were studied. The length-weight relationship was expressed by log W = -2.27650 + 3.34231 log L. Scales were used to determine age and growth rate. The body length - scale radius relationship was linear. True rings are formed during spawning season. The percentage of annual growth increment varied from 52.13% during first year to 4.74% in fifth year of life. Growth in weight increased from the second year of life reaching 5.2 kg in the fifth year. The fish fed more on phytoplankton than zooplankton.

54. Butt, J.A. and Khan, K. 1988.
Food of freshwater fishes of North West Frontier province, Pakistan.
Proc. 7th Pakistan Congress of Zoology: 217-233.

The natural food of some freshwater fishes from the NW Frontier province in Pakistan was studied. *Barilius bandelisis, Tor putitora, Mystus bleekeri, Gagata cenia, Glyptothorax naziri, Heteropneustes fossilis*, and *Eutropiichthys vacha* were found to be predominantly carnivorous, while *Wallago attu* was found to be completely carnivorous. *Barilius modestus, Danio devario, Schizothorax punjabensis* were found to utilize a mixed plant and animal diet. *Chela cachius, Cyprinion watsoni, Labeo dero, Crossocheilus latius, Garra gotyla*, and *Puntius ticto* were found to be mainly herbivorous.

55. Chacko, P.I., Zobairi, A.R.K. and Krishanamurthi, B. 1948.
The radii of scales of *Hilsa ilisha* (Ham.) as an index of growth and age.
Current Science. **17(5)**: 158 -159.

A review of past investigations to develop a relationship between scale characteristics and age is presented. They propose a direct correlation between the number of scale radii and fish length in inches.

56. Chacko, P.I. and Dixithulu, D.V.H. 1951.
Further observation on the radii of scales of *Hilsa ilisha* (Ham.).
Proc. 38th Indian Sc. Congr. Calcutta. **3(7)**: 227 (Abst.).

Scales of hilsa were used to investigate the age and growth of small fish. Each complete and incomplete radii was considered to represent one inch of growth in length.

57. Chacko, P.I. and Dixithulu, D.V.H. 1951.
An unusual occurrence of a fishery of *Hilsa ilisha* (Ham.) in Godavari coast.
Proc. 38th Indian Sc. Congr. Calcutta. **3(7)**: 228 (Abstr.).

The abstract provides an explanation for the large shoals of hilsa observed along the Godavari coast in 1949. Low water levels and siltation are believed to have kept the fish out of the river thereby forcing them to move along the coast.

58. Chandra, R., Desai, V.R. and Das, S.K. 1984.
Observations on the bathymetric distribution of Hilsa larvae in middle stretch of River Ganga near Allahabad.
J. Bombay Nat. Hist. Soc. **80(2)**: 427-429.

Observations on the spawning of *Hilsa ilisha* (Hamilton) made by earlier workers in different rivers more or less explain the availability of eggs and larvae in surface and sub-surface layers of water. Eggs and larvae of hilsa were collected from the Narmada river using a spawn collection net. A surface tow net was used for collecting hilsa larvae from the Hooghly estuary. The occurrence of hilsa eggs in the sub-surface zones, juveniles in the surface waters and later stages in deeper zones were reported. The distribution of hilsa larvae with regard to different depths was studied by operating a special net made of mosquito netting (1.6 mm), comprising three portions: upper; middle and lower. The larvae were more commonly encountered in the collections of upper and middle buckets i.e. surface and sub-surface depth ranging from 10 to 50 cm, whereas the number of larvae was insignificant in lower bucket i.e. in the sub-surface depth exceeding 50 cm approximately.

59. Chatterji, A. 1985.
A study on the morphometric characters of *Labeo gonius* (Ham.) from two different freshwater environments.
Bangladesh j. zool. **13(2)**: 73-76.

The study describes relationships between various body measurements and the total length of fish, collected from two different environments. A total of 640 specimens of *L. gonius* was collected from the Kali River and a pond at Chautal. The regression lines of different body measurements on total length were found to be linear and showed isometric growth of the fish. Significant differences in some morphometric characters between riverine and pond fishes strongly suggests that the fishes belong to two different independent stocks. The differences are due to the ecological condition of the environment or due to a genetic effect.

60. Chatterji, A. and Siddiqui, A.Q. 1979.
Feeding habits of *Labeo bata* (Ham.) (Cyprinidae, Teleostei) in the River Kali.
J. Asiatic Soc. Bangladesh (Sc.). **5(2)**: 33-40.

Labeo bata is a bottom feeder, algae and detritus being the most important food items throughout the year. The fingerlings (30-70 mm total length) showed a strong positive selection for zooplankton, while the adults (101-450 mm total length) preferred phytoplankton. The adults did not show any preference for any particular alga. The feeding intensity was affected by the maturation of the gonads, as low feeding was recorded in May-July, the period of spawning.

61. Cross, D.1992.
Synchronocity, energetics and the stability of the floodplain fisheries.
Proc. 8th Nat. Zool. Conf., Bangladesh. Rajshahi: 1-6.

In the Jamuna River complex of Bangladesh year-class 0+ fish play an important role in the transfer of chemical energy contained in organic residues on the floodplain at the end of one dry season to the aquatic environments at the start of the next. The anomalously high fish species diversity is a result of niche specialisation for exploiting terrestrial energy sources, rather than very small niche hyper volumes in the dry-season river ecosystem. Modelling of the predicted impacts of flood control interventions using the Mike 11 General Model indicates that synchronocity between overbank flooding and the peak of fish fry recruitment potential is an essential relationship in maintaining the integrity of the energetics of the floodplain ecosystem. The relevance of hydraulic modelling to the assessment of the impacts of flood control is discussed.

62. Das, N.N., Nishida, T., Azad, S.A., Islam, M.S., Hossain, M.M. and Huq, Q.M. 1987.
Analysis of some morphometric and meristic characters of *Hilsa ilisha* of Bangladesh waters.
*BOBP. Colombo. BOBP/REP/***36**: 96-109.

There were no significant differences in the mean values of six morphometric and two meristic characters between sampling stations. The period of storage under frozen conditions affected some morphometric data which were rejected.

63. Day, F. 1873.
Report on the freshwater fish and fisheries of India and Burma.
Calcutta. **22**: 35-36.

Details are presented on the spawning movement of hilsa into the rivers which flow into the Bay of Bengal. Variation in the timing of the spawning migration between rivers is also discussed.

64. De, D.K. 1980.
Maturity, fecundity and spawning of post-monsoon run of Hilsa, *Hilsa ilisha* (Hamilton) in the upper stretches of the Hooghly estuarine system.
J. Inland. Fish. Soc. India. **12(1)**: 54-63.

Gonadal maturity, fecundity and spawning behaviour of hilsa, *Hilsa ilisha* were studied, based on samples collected from the upper stretches of the Hooghly estuarine system during the post-monsoon period of 1977. Various stages in the development of the ovary are described. The estimated fecundity of the fish varied between 373,120 and 1,323,500. Mature ovarian eggs measured 0.76-0.87 mm in diameter. The relationships between fecundity and length, body weight, ovary weight and egg size were determined and it is interpreted that the breeding of this species is seasonal.

65. Deb, A.K. and Haque, M.N. 1970.
Study on nutritional aspects of some cheap variety of freshwater fishes of East Pakistan.
21st-22nd Pakistan Sci. Conf. Sec.II. Abst. B-35.

Thirteen species of small freshwater fishes, two species of larger fishes and one variety of prawn were studied. These fishes were found to be a good source of protein and minerals. Percentage of fish flesh free from bones and scales varies widely from 46.5% for *koi* (*Anabas testudineus*) to 74.5% for *shingi* (*Heteropneutes fossilis*); water from 75.12% for *katari* (*Chela bacaila*) to 80.85% for *bailla* (*Glossogobius guiris*); protein from 14.37% for *kechki* (*Mugil cascasia*) to 20.25% for *foli* (*Notopterus notopterus*) and fat from 0.4 % for *aor* (*Mystus aor*) to 6.2% for *koi*.

66. De Silva, S.S. 1988.

Reservoirs of Sri Lanka and their fisheries.

FAO Fish. Tech. Pap. **298**. 128 pp.

The inland fisheries of Sri Lanka are confined to man-made lakes and are dependent on a single exotic introduced species, *Oreochromis mossambicus*. In Sri Lanka, there are no commercial riverine fisheries. The inland fishery accounts for 20 % of total fish production. Of the twelve freshwater food fishes, only *Labeo dussumieri* and *Barbus sarana* are of commercial importance.

67. Department of Fisheries.

Fish catch statistics of Bangladesh 1983-84. 26 pp.

The first publication of fisheries statistics from the Fisheries Resource Survey System (FRSS) Project. The booklet details the total fish catch by district, water body and major fishes from inland and marine fisheries. River systems are divided into principal, major and minor rivers and separated from other water bodies: floodlands; *beels*; *baors*; Kaptai Lake; shrimp farms; ponds and the marine fisheries of the Bay of Bengal. The total production for the period September 1983 to August 1984 was 753,502 t, made up of 588,620 t (78.1%) from inland fisheries and 164,882 t (21.9%) from marine fisheries. The procedures for the collection of the data and the extrapolation are outlined.

68. Department of Fisheries.

Fish catch statistics of Bangladesh 1984-85. 15 pp.

The format of this document is exactly the same as the previous publication. The total fish catch for this reporting period (July 1984 to June 1985) was 773,979 t, composed of 462,605 t (59.8%) from the inland capture fisheries, 123,811 t (16.0%) from culture fisheries and 187,563 t (24.2%) from marine fisheries.

69. Department of Fisheries.

Fish catch statistics of Bangladesh 1985-86. 43 pp.

In addition to the information provided in the previous booklet, statistics on the species composition of catches of different water bodies and carp spawn/hatchling (fry) production from natural and artificial sources are also given. There was a slight increase in the total production from the previous year: during the reporting period, July 1985 to June 1986, the catch was 793,923 t. Inland fisheries constituted 73.9% (586,522 t) and marine fisheries 26.2% (207,401 t) of the total catch.

70. Department of Fisheries.

Fish catch statistics of Bangladesh 1986-87. 39 pp.

The fourth publication of fish catch statistics of Bangladesh, presenting the same detailed information as the previous years. Total fish catch for the country rose to 814,685 t during the period July 1986 to June 1987, with the relevant fisheries components of 431,006 t (52.9%), 166,100 t (20.4%) and 217,579 t (26.7%) for inland capture, inland culture and marine fisheries, respectively.

71. Department of Fisheries.

Fish catch statistics of Bangladesh 1987-88. 36 pp.

The FRSS publication for July 1987 to June 1988 gives the total fish catch by district, water body and major fishes species or groups of species from inland and marine fisheries. Total production is reported to be 827,105 t, 423,593 t of which is from inland capture fisheries, 175,925 t from inland culture fisheries and 227,582 t from marine fisheries.

72. Department of Fisheries.

Fish catch statistics of Bangladesh 1988-89. 33 pp.

The latest publication from the FRSS detailing catch statistics for the old districts. Proposals to update the frame survey done in 1981 to 1983 for the 64 new districts are planned. Catch figures for the July 1988 to June 1988 period are given as 424,140 t for inland capture

fisheries, 183,505 t for culture fisheries and 233,281 t for the marine fisheries, making a total production for the year of 840,926 t.

73. Dewan, S., Miah, M.J.U. and Uddin, M.N. 1983.
Studies on the food and feeding habits of *Cyprinus carpio* (L.) .1. Types and amount of food taken by the fish and its size and pattern of feeding.
4th Nat. Zool. Conf., Sec.IV. Abst. No. 53.

The feeding habits of fry and fingerlings of *C. carpio* (L.) were studied. They were found to be omnivorous with higher feeding preference for debris. The preferred food items were Cyanophyceae, Chlorophyceae and Bacillariophyceae among the plant food and Rotifera , Copepoda and Cladocera among the animal food. The small size group showed surface feeding tendencies but bottom feeding tendencies increased with the increase in size.

74. Dewan, S., Miah, M.J.U. and Mazumder, K. 1985.
Types and amount of food taken by *Cirrhina reba* (Ham.) and its diel pattern of feeding.
Bangladesh J. Aquac. **6-7(1)**: 39-44.

The fish was found to be an omnivore with higher feeding preference for plant material, which were Cyanophyceae, Chlorophyceae, Bacillariophyceae and higher aquatic plants. It was also found to be a bottom feeder, continuously feeding but with two peaks in activity at dusk and noon.

75. Dewan, S., Miah, M.J.U. and Islam,. M.S. 1987.
A study on food and feeding habits of *Glossogobius giuris* (Ham.) in a fish pond of Mymensingh, Bangladesh.
J. Aquaculture. **9(1)**: 1-9.

Glossagobius giuris fish showed some cannibalism. Fish, insects, organic debris and prawns were preferred food, but food preferences changed with season. The fish fed continuously day and night with two feeding peaks, one at noon and another at late night. Comparatively higher feeding activity was observed during summer months.

76. Doha, S. 1970.

Carapace length-weight relationships and condition factors for the male and female freshwater shrimp, *Palaemon birmanicus* (Schenke).

21st-22nd Pakistan Sci. Conf. Abst.II (Fisheries). B-35.

P. birmanicus is available in commercial catches throughout most of the year in the rivers of E. Pakistan. A total of 98 male and 103 female prawns were studied from the Brahmaputra River. The carapace length - weight relationships (CL-W) of male and female prawns were estimated as log W = - 4.1139 + 3.1205 log CL and log W = - 2.9202 + 2.3866 log CL, respectively. The relative condition factors (K_n) in male and female specimens were found to be 1.02 and 0.99 respectively.

77. Doha, S. 1974.

Investigation into the biology of the gobi, *Glossogobius giuris* (Ham.) (Perciformes:Gobiidae).

Bangladesh j. zool. **2(2)**: 95-106.

The food and feeding habits, length-weight relationship, condition, and the breeding habits of the freshwater gobi, *Glossogobius giuris*, were studied. The juveniles were carnivorous and insectivorous, while the adults were piscivorous and mollusc eaters. Cannibalism was common in both juveniles and adults. The length-weight relationship and condition factors were estimated. Sexual dimorphism was observed, the males having straight, thin and pointed genital papillae, and the females having short, fleshy and circular genital papillae. The male to female ratio was 1:1.4. The maximum fecundity was recorded as 29,580 eggs. The fish had a prolonged spawning season, Young fish was the adult females containing mature eggs in their ovaries from March to November caught through out the year.

78. Fallon, L. and Potkin, A. 1989.

Aquatic resources and fisheries in Bangladesh. Revised draft. World Resources Inst. Centre for International Development and Environment. Washington. 16 pp.

This paper is an annex of the Bangladesh environment and natural resource assessment. There is tremendous genetic diversity embodying over 500 aquatic species known to inhabit Bangladesh's waters. Little substantive data on the ecology of these species are available. As

much as 70% of the rural population is engaged in seasonal part-time fishing. In 1987 the floodplains along with the rivers, *beels*, *haors* etc. were the source of 62 % of total fisheries production. Fishing pressure is extremely heavy in late March, when the broodstocks of fishes take shelter in perennial water bodies, such as, rivers, *beels* and *haors*. The floodplains are inundated in June, when the flooding triggers the broodstocks to reproduce. Fish fry grow rapidly in the open space of the floodplain where natural food is abundant. The juvenile fishes attain marketable size in 4-6 months. Some *beels* and *haors* produce upto 5,000/ha/year. The food web is subsidized with the annual deliveries of nutrient-laden silts. The carp fisheries are partly capture and partly culture. Stocking of culture fishery is done with both hatchery raised and wild-caught fry, the latter source being vulnerable to ecological disruption. Farmers harvest fish for 5/6 months throughout the three million ha of floodplain. The full-time fishermen start fishing in *beels*, *haors* and rivers from November.
Culture-based enhancement of the gradually declining floodplain fishery is considered essential.

The riverine fishery is also very important. Hilsa represents over 40 % of the inland capture production. Little is known about the specific salinity requirements for spawning adults of hilsa or hatching fry; requisite substrate conditions (if any) to induce spawning; or the role of water temperature, turbidity and velocity in spawning. Any of these factors might be altered by flood control, drainage, and irrigation projects. In the past, the majority of hilsa fishing was done in the rivers, during inward migration, spawning and outward migration. In recent years the stocks of hilsa in the rivers have been on the decline and the main locations of hilsa fishery have shifted to lower reaches of the major rivers and to estuarine waters. The changes have been attributed to sediment blocking and overfishing and premature capture of juvenile fish is also cited as a contributing factor. Bangladesh is the world's leading producer of freshwater shrimp. Out of a total of 73,000 tonnes of shrimp caught in 1986-87, 43,000 tonnes came from inland waters. Shrimp landings may also be declining.

79. Ghosh, A.N., Bhattacharya, R.K. and Rao, K.V. 1968.
On the identification of the sub-population of *Hilsa ilisha* (Ham.) in the Gangetic system with a note on their distribution.
Proc. Nat. Acad. Sci. India. Sec. B., **34(1)**: 44-57.

Using analysis of co-variance, three sub-populations of hilsa : broad, broader, and slender, were identified. Discriminant scores were developed with two variables, total length and

Ca3

body height. The equations were then applied to samples from different areas of the Ganges River and the results indicated a wide distribution of the three forms of hilsa.

80. Ghosh, T.K. and Krishnamurthi, K.P. 1986.
Effects of sewage on gonad development and fat accumulation in fishes. *Environment and Ecology*. **4(2)**: 191-196.

Major carps (*L. rohita* and *C. mrigala*) and air breathers (*Clarias batrachus* and *Heteropneustes fossilis*) were reared separately in diluted settled sewage/stabilization pond effluent and clear water fertilized with commercial manures. Studies on fecundity and maturity index of mature fishes did not indicate any detrimental effects of waste water; rather production of eggs was enhanced in *C. batrachus*. For artificial breeding, air breathers responded well to pituitary extract, human chorionic gonadotrophin (HCG) and leutonizing hormone (LH) producing eggs and subsequently hatchlings. The accumulation of 3.91, 0.29, 1.86 and 1.06 % fat in liver, muscles, testes and ovaries of brood of *C. mrigala* was comparable to the control.

81. Gupta, R.A., Mandal, S.K. and Paul, S. 1991.
Methodology for collection and estimation of inland fisheries statistics in India. *Bull. No. 58 (revised). CICFRI. Barrackpore. India*: 64 pp.

The book includes chapters on the conceptual framework of the database (sampling concepts, collection of catch and fishing effort details, population and choice of sampling unit, collection of catch data) and the estimation of fish catch from rivers and streams.

82. Hafizuddin, A.K.M. 1985.
Freshwater fishes of Chittagong and Chittagong Hill Tracts.
Chittagong Univer. Stud. E. **9(2)**: 65-70.

A check-list of 76 species of freshwater fishes including five exotic species belonging to 27 families and 51 genera, collected from the two districts, is presented.

83. Halder, D.D. 1968.
Observations on the food of young *Hilsa ilisha* (Ham.) around Nabadwip in the Hooghly estuary.
J. Nat. Hist. Soc. Bombay. **65(3)**: 796-798.

The feeding intensity of young hilsa from March to June is described. Results indicate the stomach fullness to be much higher in March/April than in May/June. Speculations are made concerning the influence of river flow and plankton production during the study period.

84. Halder, G.C., Haroon, A.K.Y., Khan, M.A.A. and Tsai, C. 1991.
Fish nursery ground investigation of the Feni River estuary (Bangladesh) with reference to impacts of the irrigation flood control project.
Bangladesh j. zool. **19(1)**: 85-94.

The Feni River estuary (1978-79) was used for various purposes by 34 species of upstream freshwater fishes, 11 species of estuarine-dependent freshwater fishes and nine species of marine fishes at different stages of their lives. Cross-dams and regulators constructed in the lower reaches of the estuary would inevitably change the present brackishwater estuary into a freshwater lake during the dry season, which would destroy the nursery grounds of fish and prawn juveniles. It is recommended that fish passage structures be built into the already installed cross-dam/regulator of the Feni river.

85. Hannan, M.A., Alam, A.K.M.N., Mazid, M.A. and Humayun, N.B. 1988.
Preliminary study on the culture of *Pangasius pangasius* (Ham.).
Bangladesh J. Fish. **11(1)**: 19-22.

The culture of *P. pangasius* was practiced for 7 months in a 1970 m^2 pond at the Riverine Station of the Fisheries Research Institute at Chandpur in 1986. The stocking rate was 8,700 fry/ha. The fishes were fed on a mixed supplementary diet of rice-bran, wheat-bran, fish-meal, mustard oil-cake, blood and slaughter house wastes. The growth of *P. pangasius* was poor, attaining an average length of only 167 mm and weight of 196.5 g in seven months.

86. Haque, A.K.M.A. 1989.

Environment, conservation and management of fishery resources in Bangladesh: *In* Aguero, M., Huq, S., Rahman, A.K.A. and Ahmed, M.(eds.). Inland fisheries management in Bangladesh. DOF and BCAS, Dhaka. ICLARM, Philippines: 24-35.

Management of the environment contributes to the sustainability of fish populations. The problems of major pollutants in the water and their chain of actions are discussed. An effective mechanism to enforce legislation, instead of mere enactment, is stressed. The use of satellite imagery to help in tackling many management problems is suggested. The increase in fish production through conservation of the stocks, artificial breeding and the reduction in mortality is suggested.

87. Haque, M.S., Hossain, M.A. and Kasem, M.A. 1983.

A checklist of the piscivorous vertebrates of the River Padma of Rajshai district. *Raj. Fish. Bull.* **1(2)**: 44-50.

Piscivorous vertebrates of the River Padma of Rajshahi district, other than fishes were sampled. The list includes two species of Amphibia (*Rana tigrina* and *R. hexadactyla*), three species of Reptilia (tortoise, *Tryonix gangeticus*; crocodile, *Gavialis gangeticus* and water snake, *Natrix piscator*), forty species of Aves (king-fisher, kite, tern, stork, goose etc.) and two species of Mammalia (otter, *L. lutra*; dolphin, *Platanista gangetica*).

88. Hoque, B. and Islam, M.A. 1990.

Statistical relationships between body measurements of the climbing perch, *Anabas testudineus* (Bloch).

J. Asiat. Soc., Bangladesh., (Sci.). **16(2)**: 113-117.

The results showed that the pectoral fin length, pelvic fin length, head length, snout length, and sub-orbital depth (dependent variables) in 184 specimens of *A. testudineus* from Chittagong ponds were highly correlated with the total length (independent variable). The eye diameter and postorbital head length were correlated with head length.

89. Haroon, A.K.Y., Tsai, C., and Hill, M.T. 1978.
Impacts of the South Dakatia River regulator and pumping station on natural recruitment of carp and prawn fry and juveniles both inside and outside the Chandpur Irrigation Project.
FDP. DOF. Working Document. **23.** 63 pp.

Interruption of the natural flow and change in water levels by the water control structures created a stagnant but stable freshwater environment inside the Chandpur Irrigation Project area. Such a regulated water body produced a beneficial effect on two species of resident freshwater prawns (*M. lamarrei* and *Cardina* sp.), but caused different biological effects on three species of commercially important tidal/estuarine prawns (*M. rosenbergii, M. malcolmsonii* and *M. villosimanus*). The water control structures apparently became a migratory obstacle for *M. villosimanus* and *M. mirabilis* which were immigrants from the Meghna River. Juveniles of *M. rosenbergii*, feed in the rich inundated paddy fields during the monsoon seasons and these inundated paddy fields were no longer available inside the project area.

The juveniles lost rich feeding grounds inside the project area and now feed in river canals, causing a decrease in growth rate. In contrast, *M. malcolmsonii* and *M. villosimanus* grew faster attaining larger size in the stagnant water inside the project area, but their berried females became extremely rare. The stagnant water seemed to become an environmental inhibitor preventing maturation of these two species. There were 18 species of tidal/estuarine fishes that were most adversely affected by the water control structures, which blocked their migration. It is suggested that collection of detailed information on the life history of prawns and fishes, with respect to growth rate, longevity, fecundity, reproduction, feeding habits, migratory route and habitat requirement is necessary. Such biological information will be useful for a better assessment of effects on aquatic resources by environmental modification caused by irrigation and flood control projects, besides being essential for developing future fishery management policy.

90. Hora, S.L. and Nair, K.K. 1940.
The jatka fish of Eastern Bengal and its significance in the fishery of the so-called Indian shad, *Hilsa ilisha* (Ham.)
Records of Indian Museum. **42(4)**: 553-565.

This report discusses the historical information on *jatka* and confirms that the fish so-called is the young of *Hilsa ilisha*. Some information on the seasonality of jatka is also presented.

91. Hora, S.L. 1942.
The effects of dams on the migration of hilsa fish in Indian waters.
Current Science. **11(2)**: 470-471.

This note discusses the effects of dams, anicuts and other obstructions on the biology of migratory fishes. It emphasises that before planning and construction of dams and barrages, fishery experts should be consulted and carry out a thorough survey in order to safeguard against deleterious effects on fish.

92. Hora, S.L. 1942.
Interim recommendations for the protection of immature hilsa and carp fisheries of Bengal. Bengal Govt. Press. Calcutta. India.

This report expresses concern over the harvesting of large quantities of young hilsa and carps and makes recommendation for their protection.

93. Hossain, M.A. 1988.
Prawn fisheries of Bangladesh.
13th Bangladesh Sc. Conf., Mymensingh. Sec.II. 18 pp.

The freshwater palaemonids are abundant in all rivers, canals, *beels*, *haors* and *baors* throughout the year. Most of these freshwater prawns breed in the rivers or confined waters. Some riverine species (*M. rosenbergii*) come to lower estuarine areas in April and May, and after hatching, larvae start migrating the upper reaches of the rivers. The peak breeding period of *M. lamarrei* in September. In *M. dayanus* peak breeding is January and July to August. In *M. malcolmsonii* and *M. rosenbergii* reproductive activities continue from February to October. Prawn fishing gears in Bangladesh include ten nets and eight traps.

94. Hossain, M.A. and Afroze, S. 1991.

Small fishes as a resource in rural Bangladesh. *Fishbyte*, December: 16-18.

The role of small fishes in the diet of the rural poor in Bangladesh is described. Maximum sizes of the fishes, length-weight relationships and prices of 42 species, belonging to 10 families are presented. Sizes ranged from 2 cm, *Danio rerio* (Cyprinidae) to 16 cm maximum length of *Gudusia chapra* (Clupeidae). The floodplains produced 84 kg/ha/year during 1970-80 and 65 kg/ha/year during 1986-87. The causes for decline are mentioned; pollution (e.g. through pesticides), periodic outbreak of diseases and the destruction of spawning and nursery grounds through irrigation, drainage and other flood control measures.

95. Hossain, M.A. and Parween, S. 1982.

Sexual periodicity in freshwater prawn, *Macrobrachium dayanum* (Henderson). *Bangladesh J. Sci. & Ind. Res.* **17(3&4)**: 236-245.

A total of 489 female specimens were collected from Nachatta *beel* area of Rajshahi district from July 1977 to July 1978. The sexual periodicity in females was determined with the help of percentage of berried females in the catch against time, gonado-somatic index, gonadal-length index, ovary stages and colour of gonads relative condition factor. It was found that the species is more or less a continuous breeder with two peaks during January to March and July to August.

96. Hossain, M.A. and Rafiq, M.A. 1981.

Female reproductive system and reproductive periodicity of freshwater prawn, *Macrobrachium rosenbergii* (H.Milne-Edward).
Proc. 3rd Nat. Zool. Conf. Bangladesh (Dhaka): 178-190.

The females attained sexual maturity at a length of 56 mm. The developmental stages of the oocyte are as follows: immature, early developing; maturing and ripe. Spawning occurs for seven months from April to October, with two peaks in April and in June. The species spawns more than once during its intensive breeding period.

97. Hossain, M.A., Rahman, M.H. and Parveen, S. 1991.
Notes on the length-weight relationship of *Lepidocephalus guntea* (Ham.).
Bangladesh j. zool. **19(1)**: 145-146.

Six hundred specimens of *L. guntea* were collected from fish landing centres of Rajshahi during 1988-89 for the study. The total lengths of 276 male specimens ranged from 52 to 92 mm where weight varied from 0.8 to 6.4 g. For the 324 female specimens total lengths ranged from 52 to 96 mm and weights from 1.0 to 8.0 g. The length-weight relationships for male and female were expressed by :

Male, $\log W = -5.671 + 3.3166 \log l$, $r = 0.98$;
Female, $\log W = -5.494 + 3.1422 \log l$, $r = 0.97$.

98. Hossain, M.A., Taleb, A. and Rahman M. H. 1991.
Food and feeding habitats of *Ompok pabda* (Ham.) (Siluridae: Cypriniformes).
J. asiat. Soc. Bangladesh, Sci, **17(1)**: 49-52.

A total 267 specimens of *O. pabda*, ranging from 68 to 167 mm in total length were collected from the Baranari River near Noahala for food and feeding studies. The maximum stomach fullness was observed during May, while the maximum stomach emptiness was recorded in August. Fishes (42.96%) and crustaceans (49.44%) were the most prevalent food items, and algae (0.45%), insects (0.73%) and parts of higher plants (2.84%) and debris (3.05%) were also common. During the breeding season feeding activity declined, but increased towards the end of the breeding season in females.

99. Hossain, M.M. 1975.
Studies on some aspects of biology of *Hilsa ilisha* (*Hamilton Buchanan*) of the River Padma.
M.Sc. Thesis. Dept. of Zool., Dhaka Univ.: 141 pp.

The length-weight relationship and condition factors were studied. Age determination was attempted by four methods. It was found that scales could not be used for age and growth determination. Five year classes were determined by modal lengths through the application of length frequency methods and found similar to those obtained using the otolith method.

82

Age determination was also possible by using opercular bones. Growth was related to feeding intensity. There was no significant difference from the expected 1:1 sex-ratio. Size composition of male and female showed sexual dimorphism.

100. Hossain, M.M. 1985.

Spawning time and early life-history of *Hilsa ilisha* in Bangladesh.
M.Sc. Thesis. Univ. British Columbia, Vancouver, B.C. Canada. 90 pp.

Methods of ageing hilsa and the identification of spawning periods have been studied. Daily growth from otoliths of juvenile hilsa, length frequency analysis, and gonado-somatic index were used to identify peak spawning periods. The seasonal distribution of young hilsa is also discussed.

101. Huda, K.M.N. and Rahman, M. 1983.

Mosquito control potential of some indigenous fishes in Bangladesh.
Bangladesh j. zool. **10(2)**: 145-147.

The fishes studied were *Amblypharyngodon mola, Anabas testudineus, Aplocheilus panchax, Clarias batrachus, Colisa fasciata, Channa* spp., *Puntius ticto* and *Rasbora daniconius*. It was evident that *A. panchax* consumed 100 % larvae in the first 30 minutes, while *R. daniconius* and *C. fasciata* fed on 87.5 % and 62.5 % respectively. Some indigenous fishes may be profitably used in mosquito control in Bangladesh.

102. Islam, A.K.M.N. 1974.

Preliminary studies on the food of some fish.
The Dhaka Univ. Stud. Pt. B. **XXII(1)**: 47-51.

Sexually mature hilsa feeds during its spawning migration. The stomachs of *Mystus aor* contained Spirogyra filaments.

103. Islam, M.S. and Hossain, M.A. 1983.

An account of the fishes of the Padma River near Rajshahi.

Raj. Fish. Bull. **1(2)**: 1-31.

A collection of one hundred and ten species of fish of the River Padma near Rajshahi representing fifty-nine genera, twenty-eight families, twelve orders and two classes are studied and listed. A brief note on the systematic account, local name, seasonal availability, breeding season, and relative economic importance of each species are also provided. A single species, *Trygon* represents the class Chondrichthyes. The breeding months of most of the fishes listed varied from April to August. The abundance of fishes is decreasing due to the continuous siltation of the river. The normal flow of water has been obstructed by the Farakka Dam and most of the areas became dry during winter and summer time.

104. Islam, M.S. and Hossain, M.A. 1984.

On the fecundity of Chela, *Oxygaster bacaila* (Ham.) (Cypriniforms : Cyprinidae) from the River Padma.

Univ. j. zool. R. U. **3**. 48 pp.

Seventy ripe females of *O. bacaila* were collected from the Padma River near Rajshahi during the months from June to August, 1981. The fecundity ranged from 7,146 eggs (fish length 8.5 cm and weight 3.7 gm) to 33,997 eggs (fish length 15.2 cm and weight 23.0 gm). 1,404 eggs were produced per gm body weight. The relationships between fecundity and length and weight were calculated.

105. Islam, M.S. and Hossain, M.A. 1986.

Fecundity of small catfish, *Clupisoma atherinoides* (Bloch) (Schilbeidae: Cypriniformes) from the River Padma.

Bangladesh J. Aquaculture. **8(1)**: 53-55.

Fecundity of 121 ripe females of *C. atherinoides* from the Padma River was estimated by gravimetric method. The fecundity ranged from 2,424 eggs (for a fish measuring 6.7 cm in length and 2.1 gm in weight) to 12,261 eggs (length of 8.3 cm and weight of 5.1 gm). The relationships between fecundity and length, weight and gonad weight were estimated, these relationships were linear.

106. Islam, M.A., Choudhury, M.H., Rahman, M.M. 1984.
Some morphological characteristics of maturing and non-maturing *Labeo rohita* of a lentic and lotic environment.
Bangladesh J. Fish. **6(1-2)**: 69-78.

A total of 9 morphometric and 8 meristic characters of 44 maturing and 72 non-maturing *L. rohita,* representing both lentic and lotic populations were studied. Body depth, pre-dorsal, pre-pectoral, pre-anal and head lengths showed linear relationships with total length, whereas eye diameter and mouth length showed linear relationship with head length. A significant intra-habitat variation was found in all the morphometric features. Adjusted means and 95% confidence limits of all the meristic characters were calculated for easy differentiation. Only a minor variation was observed in meristic characters.

107. Islam, M.S., Huq, Q.M., Hossain, M., Azad, S.A. and Das, N.N. 1987.
Maturity and spawning of hilsa shad, *Hilsa ilisha* of Bangladesh.
*BOBP Programme. Colombo. BOBP/REP/***36**: 82-95.

The males of *Hilsa ilisha* were generally more numerous up to a length of 35cm. The females showed faster growth. The males attained first maturity at sizes 26-29 cm compared to 31-33 cm in the case of females. The presence of *jatka* (young hilsa) indicated spawning in October, November and January in the Sandwip estuarine area/riverine area around Chandpur and Khepupara. The juveniles were available from December to August at Chandpur, probably indicating the occurrence of intermittent spawning throughout the year.

108. Islam, M.N. and Bhuiyan, A.S. 1990.
Fecundity of *Xenentodon cancila* (Ham.) (Belonidae : Beloniformes).
15th Bangladesh Conf. BAAS. Dhaka (Savar). Extended Synopsis No.4.

The fecundity of 99 mature females of *X. cancila*, collected from Rajshahi and Pabna during 1987-88, were studied. The fish were caught from May to September, mostly in August. The fecundity varied from 1,100 eggs (for a fish 19.3 cm in length, 15.0 gm in weight) to 2,852 eggs (for a fish 22.2 cm in length and 33.5 gm in weight). *X. cancila* was found to be a moderately fecund fish which breeds once a year.

109. Islam, M.S., Rahman. M.J., Moula, G. and Mazid, M.A. 1990.
Hilsa (*Tenualosa ilisha*) fishery in the Bay of Bengal with some biological aspects. *7th Nat. Conf. Zool. Soc. Bangladesh, Dhaka.* Abst. No.52.

The annual production, catch rates, gears and crafts, length-frequency, sex-ratio, (gonado-somatic index (GSI) and fecundity of *T. ilisha* were studied. The annual production was 152,220 t from November 1986 to October 1987. Drifting gill nets and mechanised boats were employed to catch hilsa. The length frequency ranged from 26.0 to 53.0 cm with modal lengths from 37.0-43.0 cm. The male to female ratio was 1:1.07. GSI values showed peak spawning in January, September and October in males, and September and October in females. Fecundity ranged from 3,750,000 eggs (for a fish 32.5 cm in length and 425 g in weight) to 14,230,000 eggs (for a fish 49.2 cm in length and 1,600 g in weight). The fecundity per gram body weight was 877 eggs.

110. Islam, M.A., Azadi, M.A. and Parveen, N. 1990.
Length-weight relationship relative condition and reproductive strategy of *Mystus cavasius* (Ham.) in lake Kaptai, Bangladesh.
7th Nat. Zool. Conf. Abst. No. 61.

The results showed that *Mystus cavasius* breeds once a year between April and August. There are four maturation stages for females. The fecundity varied from 15,555 eggs (for a fish 17.5 cm in length and 37.0 g in weight) to 58,321 eggs (for a fish 22.3 cm in length and 100 g in weight). The length-weight regression coefficients were 2.833 and 2.604 for males and females, respectively. The sex-ratio of male and female was 1.00 : 1.68.

111. Jafri, S. and Melvin, G. D. 1988.
An annotated bibliography (1803-1987) of Indian Shad, *Tenualosa ilisha* (Ham.) (Clupeidae: Teleostei). International Development Research Centre. Manuscript Report **178e**. 84 pp.

This annotated bibliography is a precis of 368 papers concerning all aspects of the biology of *Tenualosa ilisha* (Ham.) and its fisheries. It is indexed by subject, country and water body.

112. Jain, A.K., Singh, R., Alkesh, D. and Mitra, S.D. 1985.
Role of rainfall in the breeding of *Labeo rohita* (Ham.), *Cirrhinus mrigala* (Ham.), *Catla catla* (Ham.) at Damdama (Haryana), a semi-arid zone.
J. Indian Fish. Assoc. **14&15**: 67-73.

The role of several environmental factors on the breeding and hatching of fish has been worked out by many earlier investigators. Perfection in hypophysation techniques helped to some extent in by-passing the environmental variables, such as, temperature, light and rain. With the use of modern fish hatcheries, it is possible to attain maximum success in breeding and hatching, even without rain.

113. Jhingran, A.G. 1986.
Fish passes. *In*: Reservoir Fisheries Management in India. Bull. No. **45**. CIFRI. India. 39 pp.

Provision of fish passes in the dams is less recognised in the tropical countries and many fish ways built in the dams have failed to be effective. The fisheries of *Hilsa ilisha*, an anadromous fish of high economic value, has been adversely affected in many rivers because of the construction of dams, weirs and barrages. In the Godavari River, hilsa could ascend up to 280 km, but after the construction of Dhaleswarian anicut it is confined to the lower reaches of the river. In the Krishna and Cauvery rivers, hilsa could ascend up to 175 km and 160 km respectively prior to construction of the anicuts at Bezwada and lower Anicut. Hilsa known to migrate up river in the Ganga to a distance of about 1,300 - 1,600 km from the sea and contribute about 300 t (30-60% of the total catch) annually at Allahabad has almost completely disappeared from the river above Farakka barrage in the lower Ganga. Since fish passages are expensive to build and operate, it requires close coordination between engineers, fishery biologists and environmental scientists to design and construct effective pathways.

114. Jhingran, V.G. 1957.
Age determination of the Indian major carp, *Cirrhinus mrigala* (Ham.) by means of scales. *Nature*. **179**: 468-469.

Four hundred scales, from 807 specimens of the size range 103.0-1010.0 mm in total length, collected from the River Ganga at Buxur during 1952-55 were studied. The scales were taken

from the area directly below the dorsal fin and above lateral line of the fishes. The annuli are laid down in spring or summer months, when the intensity of feeding is very low, probably suggesting starvation as the cause of annulus formation. Whether starvation is due to want of food supply in the environment or some other cause is not known. The gonads of two-year old and older fish rapidly mature during spring and summer months, and the fish then breeds as soon as the monsoon rains break in late June or early July.

115. Jhingran, V.G. 1959.

Studies on the age and growth of *Cirrhina mrigala* (Ham.) from the River Ganga. *Proc. Nat. Sci., India.* **25, B, (3)**: 107-137.

The observations of progressively larger numbers of annuli on scales of *Cirrhina mrigala* of increasing length and lessening distance between successive annuli with age, have furnished preliminary evidence suggesting the application of the scale method for age and growth studies of *mrigel*. A close correspondence in early growth between scale and length-frequency distribution methods has supported this recommendation. Starvation is suggested as a probable cause of annulus formation. Detailed growth for the first three years, absolute growth in length for twelve years and relative growth for seven years of the life of *mrigel* were estimated. Weight frequency distributions were also studied. *Mrigel* is known to breed in North India during the monsoon months (June - August) and "the fish of the year" enter the commercial fishery as fingerlings in September. The ultimate length of *mrigel* was estimated as 1,039mm. The length of the largest fish encountered was 1,016 mm. The value of the regression coefficient in the length-weight (L-W) relationship has been estimated to be 3.221.

116. Jhingran, V.G. 1985.

Fish and Fisheries of India. Hindustan Publisher. Co. New Delhi. India. 666 pp.

The textbook provides an excellent review of both marine and freshwater fishes and fisheries, including major carps, hilsa and prawns of India. Details are presented on most aspects of the life cycles and changes in the fisheries with time. Additional information is reported on the effects of dams, physico-chemical characteristics of major Indian rivers and on fishermen and types of gear used throughout the country.

117. Jones, S. 1957.

On the late winter and early spring migration of the Indian shad, *Hilsa ilisha* (Ham.) in the Gangetic delta.

Indian J. Fish. **4(2)**: 304-314.

Movement of hilsa into the rivers of the Gangetic delta is discussed in relation to landings at Goalundo and Lalgola ghat. Increasing water temperature was considered the controlling factor that stimulates late winter and early spring migrations of hilsa into rivers.

118. Joshi, S.N. 1987.

Annual ovarian cycle in the fish *Labeo gonius* in relation to the changes in some external factors of the environment.

Environment and Ecology. **5(1)**. ISSN 0970-0420: 41-45.

Ovarian cycle in the fish, *Labeo gonius* was closely related to the changes in the environment. The ovary of the fish passed through resting, reviving, early maturing, advanced maturing, mature, spawning and spent phases within one year. The oogenetic activities started in November and continued until July, when the ovary was full of eggs. The ova were discharged and atretic eggs and discharged follicles were seen in August. The majority of ripe oocytes occurred during June and July when day length and water surface temperature were maximum. Changes in the volume of ovaries and gonado-somatic index were related to water surface temperature. Volume of ovaries and GSI increased approximately 91 and 60 times respectively during the spawning period. The onset of the monsoon rains seemed to stimulate initiation of peak breeding activity. The pH 7.5 - 7.6 was favourable for spawning in July.

119. Karamchandani, S.J. 1961.

On the location of spawning grounds of Indian shad, *Hilsa ilisha* (Ham.), in freshwater regions of the Narbada river.

Current Science. **30(10)**: 373-375.

Freshwater spawning grounds are located in the river. The importance of season and river flows are discussed. Length frequency and sex-ratios are presented. The occurrence of differential spawning behaviour of large vs small mature hilsa is also discussed.

120. Karim, M.A. and Hossain, A. 1972.

Studies on the biology of *Mastacembelus pancalus* (spiny eel, Hamilton) in artificial ponds. Part I. Natural habitat, distribution, food and feeding habits and economic importance. Part II. Sexual maturity and fecundity.
Bangladesh J. Biol. Agr. Sci. **1(2)**: 10-18.

The stomach contents of 98 specimens of *Mastacembellus pancalus* contained larvae of Lepidoptera, Diptera and Hemiptera. The sexes were equally distributed. The spawning period extended from May to November with the peak in May to July. The fecundity was found to vary from 1,296 to 3,296 eggs. The males showed three stages of maturity (immature, mature and spent). Macro and microgonadal characters of females showed seven stages of maturity.

121. Karim, M. 1980.

A look into Bangladesh fisheries with suggestion for inland fisheries development.
Farm Economy. Bangladesh (1979). **1(1)**: 323-333.

Fish production reportedly declined from the 1962 level of 677,000 tonnes to 640,000 tonnes in 1975. This has resulted in a reduced consumption of fish and animal protein. The nations' minimum nutritional requirement alone stood at about 2.7 million tonnes in 1985, so the present production is around 0.64 million tonne is inadequate. The open water fisheries are constantly being reduced and qualitatively degraded both through natural phenomenon and man-made changes. Culture fisheries, although it has great potential, is still in its infancy in Bangladesh. Thus effective policy measures are necessary to protect and sustain our open water fisheries.

122. Khaled, M.S. 1985.

Production technology of the riverine fisheries in Bangladesh. *In*. D. Banayoton (Ed.). Small-scale fisheries in Asia, socio-economic analysis and policy. IDRC. Canada: 113-120.

Chandpur on the Meghna River and Goalunda on the Pabna River, have been selected for estimation of their fish production technologies, i.e. to analyse the productivities of various inputs, evaluate the efficiency of resource allocation and examine the profitability of

investment in fishing. The results for Chandpur during the rainy season are presented. No significant difference was found between catches by the two types of nets, drift and seine nets. Use of less expensive drift nets has been advocated. The returns to effort are found to be diminishing and a doubling of effort would lead to only an 89 % rise in catch of fish because the stock of fish is fixed. An implication of the result is that the rental for fish stock would be equal to 11 % of the gross revenues from fishing. At present, the majority of this amount is received by the owner of the fishing assets and the share of the rental accruing to the Government through the auction of fisheries is very low. There is considerable scope for raising the rental for the fish resources. The fishing inputs are misallocated. To achieve optional resource allocation at the current prices, the inputs of labour and nets should be reduced and that of boats raised. The marginal productivity of nets is indeed negative at its present level of use. Fishing appears to be a profitable business to invest in when its return is composed of the institutional rate (6 %). The accidental loss of nets is a rather disturbing phenomenon to the fishermen. The introduction of an insurance scheme for nets is likely to augment the catch of fish by encouraging quick repair or replacement of nets.

123. Khaleque, M.A. and Islam, M.R. 1985.

The relative use and efficiency common commercial and subsistence fishing gears in Bangladesh.

Bangladesh J. Aquaculture. **6-7**(1): 35-38.

A study of relative use and efficiency of fishing gears was made in the Chandpur Irrigation Project area during the period from 1977 to 1979. The use of gill nets and cast nets remained relatively constant through out the entire period of study. The relative efficiency of the different gears for catching fish showed marked differences. With construction of the artificial barriers, like water regulators, pumping station and embankment, the recruitment and replenishment of fish within the project area drastically reduced.

124. Khambi, R.V. 1986.

Age, growth and reproductive strategy of the snakehead, Ophicephalus striatus Bloch, from Sri Lanka.

J. Fish. Biol. **29**: 13-22.

A total of 281 specimens of snakeheads, *O. striatus,* collected from inundated rice fields and

swamps in SW Sri Lanka during 1982-1983, was analyzed. Age determination by length frequencies and scale annuli revealed six age groups. An asymptotic length of 520 mm was estimated using the von Bertalanffy growth model. The ova were assigned to four developmental stages and a maturity scale was developed for the females. Fast growing 2 year old fish attained sexual maturity in that year. The ovum size frequencies and occurrence of mature and spent fish indicate that the fish spawns during the south-west monsoon season. Fecundity estimates ranged from 1,688 to 7,146 ova. Total length and weight are equally useful for predicting fecundity.

125. Khan, S. and Hossain, S.M.D. 1984.
The size-frequency distribution of the freshwater prawn, *Macrobrachium dolichodactylus* Hilgendorf.
Bangladesh j. zool. **12(1)**: 11-20.

The size frequency distribution of *M. dolichodactylus* was based on 1,173 specimens caught from the River Meghna near Daudkandi in 1979. The minimum size of carapace length for both sexes was 7 mm in May and the maximum size was 27 and 20 mm during September and October for males and females respectively. At a carapace length of 12 mm the females predominated over the males, while at a length of 18 mm carapace length, males dominated over females. The maximum length of male was greater than that of female.

126. Khandker, N.A. and Huq, A. 1970.
Length-weight relationship of *Labeo rohita* (Ham.)
21st-22nd Pak. Sci. Conf. Abst. II. Fish.: B-36.

The length-weight relationship of *L. rohita* was calculated from observations on 355 fish, collected from Daudkandi, Comilla (East Pakistan). The largest specimen observed had a total length of 945 mm and weight 16,750 g; the smallest was 150 mm in length and 30 gm in weight. The value of the regression coefficient in the length-weight relationship was 3.16612.

127. Khumar, F. and Siddiqui, M.S. 1990.
The growth and fishery of the carp, *Puntius sarana* (Ham.) (Pisces-Cyprinidae).
J. Freshwat. Biol. **2**(1): 51-56.

Back-calculated annual growth of the fish revealed that the males attained an average length of 120 mm, 185 mm, 240 mm, 285 mm, 320 mm, 340 mm at the end of the first, second, third, forth, fifth and sixth year of life respectively. The females were found to attain the length of 112 mm, 172 mm, 250 mm, 292 mm, 330 mm and 344 mm for the first, second, third, forth, fifth and sixth years respectively. The specific growth rate decreased with increasing age and size of the fish.

128. Khumar, F. and Siddiqui, M.S. 1991.
Length-weight relationship of the carp, *Puntius sarana* (Ham.) of a reservoir and three riverine ecosystems in north India.
J. Freshwater. Biol. **3**(1): 81-88.

The length-weight relationship of *Puntius sarana* did not strictly follow the cube law. The riverine fish grew better than the reservoir fish. The males were heavier than the females of the same size before the fish attained maturity. After attaining maturity the males were lighter than the females of the same size. The size of the fish at first maturity was found to be between 200 mm and 220 mm in length.

129. Kibria, G., Khaleque, M.A. and Rainboth ,W.J. 1979.
Abundance and distribution of the finfish and prawn at five trawling stations of the Meghna River Bangladesh.
Bangladesh j. zool. **7**(2): 87-94.

Collections were made in 1977 in about 92 miles of the Meghna River from about 20 miles upstream from Chandpur town down to the river mouth. Species composition, relative abundance and distribution of fishes and prawns at five trawling stations (Meghna River between Satnal and Gazaria, upstream from Chandpur, opposite Hajimara regulator, Kaliganj-Gazipur char and Shabazpur River north of Hatia island) of the Meghna River and estuarine zone of the upper Bay of Bengal were studied. A total of 50 species of fish and 7 species of prawns were recorded. *Pangasius pangasius*, *Clupisoma garua*, *Nangra nangra*,

Pama pama, *Apocryptes bato*, *Ailia coila*, *Silonia silondia* and *Odontamblyopus rubicundus* were the eight most abundant fish species by number. *Macrobrachium mirabilis* and *M. malcolmsonii* were the most common prawns. The most important fish species by weight were *Rita rita*, *P. pangasius*, *M.aor*, *P.pama* and *C.garua*.

130. Kibria, G., Choudhury, A.Q. and Bailey, W.M. 1980.

A qualitative and quantitative study of the fishes and prawns of the Chandpur Irrigation and Flood Control Project. IFDC. DOF. Working Doc. No. **24**: 52 pp.

During the dry season of 1978-79, 157,095 specimens of fish and prawns were taken from four habitats in and adjacent to Chandpur Irrigation Project area. Seventy-three species of fish and five species of prawns were identified. Comparative studies were made with the catch composition of different gear types in the different habitats both outside and inside the project area. Relative abundance and total weight of each species was recorded. Standing crops of different habitats were estimated by dewatering, jag netting (brush shelter) and rotenone application. The average standing crops of the project ponds, *khals*, borrow pits and river was estimated to be 503.37 kg/ha, 193.93 kg/ha, 306.77 kg/ha and 370.90 kg/ha respectively. The most conservative total estimate of standing crop in the Chandpur project was 2,445.70 metric tonnes for all aquatic habitats. This total was made up of 593.80 t in the river and major *khals*, 527.10 t in newly excavated *khals*, 115.80 t in the borrowpits and 1,209.00 t in ponds.

131. Kibria, G. 1983.

The catch composition of jag fishery (brush shelter) of the Dakatia River, Bangladesh.

Bangladesh j. zool. **11(2)**: 127-132.

A jag or man made fish shelter is a pile of branches of trees, which are placed in the river and covered with water hyacinth. The fishes and prawns are allowed to concentrate for a couple of months before it is surrounded by seine net and harvested. Jay fishing occurs particularly during winter months. Fish and prawn specimens were collected from 24 jags in the Dakatia River. A total of 34 species of fish and seven species of prawn were recorded. *Chanda ranga*, *Puntius sophore* and *Rohtee cotio* were the most abundant fish species by number *Wallagonia attu, Notopterus chitala*, *Puntius sophore* and *Channa striata* were the

most inpormat species by weight. The standing crop determined ranged from 83.02 kg/ha to 1,608.07 kg/ha.

132. Kuaian, G.K. 1973.

Fishing gear in freshwater reservoirs of India. *Fish. Tech.* **10(1)**: 1-5.

Selection of an appropriate mesh size is dependent upon the predominant size group of commercially dominant species of fish in the reservoir. Comparative studies with three types of nets, namely, simple gill net, vertical line net and framed net have shown the apparent superiority of framed nets. The increase in catch recorded was 1.4 to 4.76 times. The framed net with a 1.75 m frame was found to be superior to others. In Govindasagar reservoir monofilament gill nets were found to be better than the nets made with twines of multifilament yarn.

133. Maheswari, U.K., Somalingham, J. and Langer, R.K. 1990.

Growth of intergeneric hybrid *Catla catla* (Ham.) male x *Labeo rohita* (Ham.) female in Tawa reservoir Madhyapradesh. National workshop on reservoir fisheries. Asian Fisheries Soc. Indian branch. CICFRI, Barrackpore, India.

The *Catla catla* male x *Labeo rohita* female hybrid is known to grow better than true bred *L. rohita* (rohu) and is suitable for stocking in the reservoirs. During 1983-87, 262,000 hybrid fingerlings (measuring 60-80 mm in length) were stocked in Tawa reservoir. In Chota 164,000 hybrid fingerlings were released and in some ponds in Bhopal a total of 235,000 were stocked. In three years, the hybrids attained an average weight of 1.2-1.3 kg yr^{-1} in Chota and the ponds, and 1.5-1.6 kg yr^{-1} in Tawa reservoir. The growth (in weight) was 30-38% more that of rohu. The paper describes the suitability of the hybrids for stocking and enhancing fish production in reservoirs.

134. Malhotra, Y.R. and Gupta, A. 1990.

Seasonal fluctuations in food and feeding of *Puntius conchonius* inhabiting lake, Mansur, Jammu.

J. Freshwat. Biol. **2(2)**: 147-151.

This present paper deals with seasonal fluctuations in food and feeding, food composition and food intake of *Puntius conchonius* inhabitating the freshwater lake Mansur at Jammu. *P.conchonius*, an omnivorous fish, feeds generally on plankton (both zooplankton and phytoplankton) and algal material.

135. Mandal, T.K. and Pal, J. 1988.

Ethology of the giant gourami, *Colisa fasciata*.
Nat. Symp. Uni. of Kalyani, W. B., India. Abst. No. C77.

The paper presents with the general behaviour, aggressive behaviour, dominance hierarchy pattern and reproductive behaviour of the giant gourami, *C. fasciata*. The general behaviour of the fish consisted of various motor patterns, e.g., swimming, hovering, fin-flickering, flexing, floating, chaffing, snapping of mouth, air gulping and bubble blowing. The fish fed on the bottom at an angle of 45° to 90°. Reproductive motor patterns and embryonic development of fish were also investigated.

136. Master Plan Organisation. 1985.

Open water capture fishery resources. Ministry of Irrigation, Water Development and Flood Control. Tech. Rep. No. **16**. 34 pp.

The report deals with resource characteristics and present trends and potential of open water fisheries. Three catchments are identified : North East catchment with high *beel* density and deep flooding during monsoon, North West with high *beel* density as well as ponds, and South West with oxbow lakes. According to the FRSS (1983-84), 8,804,000 rural households practiced subsistence fishing and harvested 200,615 t of fish. An area of 1,031,563 ha of river water (including estuaries) yielded 207,776 t of fish in 1983-84. The sustenance of openwater fisheries depends on reproduction, migration, feeding and growth of fishes. In the past, openwater habitats have been the key to production and have formed the bulk of the harvest. Floodplains have provided a wide range of suitable habitats for fish reproduction, early development, growth and production. Any reduction in the linkages between the rivers and the floodplains will adversely affect future openwater fish production.

137. Master Plan Organization. 1987.
Fisheries and flood control, drainage and irrigation development.
Master Plan Organization. Ministry of Irrigation, Water Development and Flood Control. GoB. Technical Document No. **17**. 54 pp.

The report details the known effects of flood control, drainage and irrigation projects on fisheries. It presents information from the studies of Chandpur Irrigation Project (CIP) on the detrimental effects on the commercial prawn fisheries, the decline in the carp fisheries and the decrease in the standing crops in all major habitats. Changes in the fisheries caused by the Muhuri Irrigation Project (MIP) are also given, particularly the destruction of the hilsa fishery on the Feni River. Mitigation measures are proposed for both projects, including the development of extensive aquaculture with the opening of the hatchery at Raipur in the case of the CIP and artificial stocking of the reservoir created by impounding the Feni River. Fisheries data were from IFDC Annual Reports. The report goes on the discuss the impacts of FCD and FCDI's in different regions in Bangladesh and in different habitats. It proposes fisheries investigations into: the standing "crop" of fish and prawn in different depths of water by month in all regions of the country; the species that require floodland for breeding and depth requirements for breeding; species that breed in rivers and the timing of spawning migrations; effects of submersible embankments on migrations of brood stocks (particularly in Sylhet and Mymensingh) and the timing of fry movements from rivers to floodplains; patterns of migrations (particularly in the *haor* areas); the influence of hydrological parameters on the spawning and feeding of fish and prawns; effects of specific FCD/I's; topography, depth contour and the surface area of water remaining in *beels* in the dry season and the standing "crop" in the *beels* at different water depths by species, age, size and year class.

138. Master Plan Organisation. 1985.
Economic analysis of fisheries modes of development. Ministry of Irrigation, Water Development and Flood Control Technical Report No. **28**.

Three major fish production systems (openwater capture, closed water, and marine) are documented (a fisheries development mode prescribes the ways and means of boosting fish production and/or preserving fish stocks. There have been 18 modes of fisheries development identified, having relevance in the context of fisheries production systems in Bangladesh. Of these, 16 modes belong to closed water fisheries production systems which have been

analyzed and evaluated in detail. Two modes of development for open water capture fisheries are identified, but could not be analyzed owing to inadequate data on costs and benefits. Open water capture is closely tied to the pattern and depth of flooding during the monsoon season. Any interference with the floodplain affects fish stocks and yields. Removal of floodplain will result in the loss of recruitment and a decline in the perennial fisheries. Two modes of open water capture fisheries deal with (a) stocking of selected *beels* in openwater areas of the North-West region for augmenting fish stock and (b) construction of protective embankments around the existing recorded *beels* to preserve them as reservoirs of fish stock and natural production units.

139. Mathai, T.J., Abraham, R., Sulochanan, P and Sadanandan, K.A. 1971.
Preliminary observations on the lunar and tidal influence on the catches of seer by gill nets. *Fish. Technol.* **8(1)**: 65-68.

The authors studied the lunar and tidal influences on the catch of seer and certain preliminary observations are presented. There is a significant relationship between the catch of seer and the lunar phase and the tidal rhythm, however, the moon was not the only factor which affected the seer landings. The best period for the efficient exploitation of seer is darker nights with low tide.

140. Mitra, P.N. and De, D.K. 1981.
A regression model for estimating fecundity of *Hilsa ilisha* (Ham.) of the Hooghly estuary.
J. Inland Fish. Soc., India. **13(2)**: 1-5.

Multiple regression analysis was used to determine the best estimators of fecundity in hilsa from the River Hooghly. Fecundity was estimated by:-

$$X1 = -713.89 + 39.23\ X2 + 26.23\ X3,$$

where, X1 = fecundity in hundreds, X2 = gonad weight (g) and X3 = total length (mm).

141. Miyamoto, H. 1959.

Suggestions for preservation of fishing nets.

Indian Fish. Bull. **6(3)**: 44-46.

A method of preserving fish net twines by applying a mixture of coal tar and kerosene subsequent to tanning treatment is described. The method is suitable for trawl nets, stake nets and other types of gear which are immersed in water for longer periods. As the weight of the net increases with this treatment, it is not recommended for gill nets and the like.

142. Mohsin, M.A., Sabur, A. and Rahmatullah, S.M. 1983.

A study on the food and feeding habits of *Rohtee cotio* (Ham.) in a Bangladesh pond.

4th Nat. Zool. Conf. Sec. IV. Abst. No. 50.

The stomach contents of 79 specimens of *R. cotio* were examined. The food categories were Cyanophyceae, Chlorophyceae, Bacillariophyceae, higher plant, debris, rotifera, copepods, cladocerans, insects, sand and mud. The most important food item was debris. The fish showed greater feeding intensity after sunset.

143. Mohsin, M.A., Dey, P.C. and Hanif, M.A. 1983.

Studies on food and feeding habits of *Pangasius pangasius* of the River Bishkhali, Patuakhali.

4th Nat. Zool. Conf., Sec.IV. Abst. No. 48.

The flood and feeding habits of one hundred specimens of *P.pangasius*, with length range varying from 110 mm to 250 mm, were studied. The food items found in the stomachs were *Macrobrachium* spp. (crustaceans), poafish, scales of bony fish, ants, trichoptera, snails, banana seeds, fruits, rice husks and plant roots. The fish was found to be omnivoreous.

144. Mohsin, MD., Ahmed, A.T.A., Muslemuddin, M. and Begum, A. 1990.

Effect of habitat and use of water-weed on the rate of spoilage in Mrigal fish, *Cirrhina mrigala*.

Proc. 7th Nat. Zool. Conf. Bangladesh: 23-29.

The effect of habitat (wild and culture) and the use of water-weed (*Hygroriza aristata*) on the rate of spoilage in *mrigel* fish during short term storage at ambient temperatures have been studied using different organoleptic (body surface, eye, gill, texture, odour and overall acceptability score) and chemical variables. The spoilage rate was higher in wild fish than in cultured fish, kept under the same conditions. While the wild fish became unacceptable after 15.00 hours at ambient temperature (29-31° C.), the cultured ones remained in acceptable condition upto 19.00 hours. The spoilage rate was reduced when the fish were kept covered with *H.aristata* (Doldola). The shelf life was extended to 18.25 and 21.30 hours for wide and cultured fish respectively when kept covered with doldola.

145. Mollalv, M.F.A. 1986.

Cyclic changes in the ovary of freshwater catfish, *Clarias macrocephalus* (Gunther).

Indian J. Fish. **33(1)**: 54-55.

The paper describes histologically 7 stages of oocyte maturation in *C. macrocephalus*. These stages are related to 6 morphological stages. Cyclic changes involving oogonial multiplication, and vitellogenesis in different months were also reported.

146. Moni, M.N.I. 1979.

Studies on the age and growth, length-weight relationship and relative condition of *Labeo rohita* (Hamilton).

M.Sc. Thesis. Dept of zoology, Dhaka Univ. 130 pp.

Labeo rohita from the Sitalakhya River and Karnaphuli Reservoir were studied. The scale method was used to determine the age and rate of growth. The scale radius and fish length showed a linear relationship. The annulus was formed on the scales of the fish during spawning from May to July in Karnaphuli reservoir and from March to May in the Sitalakhya River. Highest growth was obtained during the first and second years of life for fish in both waters. The growth of *Labeo rohita* followed von Bertalanffy's growth formula.

147. Morris, E.L. 1977.

Results of the economic and catch assessment programme in the Chandpur Muhuri, Halda and Ichamati project areas. Irrigation Fishery Development Project. Working Doc. No.**4**. 59 pp.

The results are divided into the four irrigation projects. In the Chandpur Project area there were 1,285 commercial fishing units and 2,067 artisanal fishing units operating during the high water period in July and August. The average daily catch of the commercial fishing units was 6.3 kg and for artisanal units 2.6 kg. (Artisanal fishermen = fishing must be primary activity during July/August and not less than 25% of total income must come from the fishing activity.). Total daily catch was 8,095.5 kg and 5,374.2 kg respectively. Total fish consumption by the people within the project area was about 18,746 kg daily. The commercial catch amounted to 43.2% of total consumption and the artisanal catch 28.7%. Subsistence fishing accounted for 5.5% of consumption (1,033 kg). The remaining 4,243 kg of fish consumed (22.6%) was from subsistence catch, which was marketed by the fishermen, and imports of fish into the project area. The commercial and artisanal catch were almost entirely from the riverine habitat. There were no harvesting of ponds during high water season.

There were only 92 commercial fishing units that operated in the Muhuri Project area during July/August. All of these units were involved in riverine fishing. There were no artisanal fishermen encountered during the survey. The average daily catch for the commercial fishing units was 9.79 kg. Total daily catch of the commercial fishery was estimated at 900.7 kg. Total consumption of fish in the Muhuri project area was estimated to be 21,180 kg daily. Of the total consumption, the commercial catch amounted to only 4.3%. Subsistence fishing accounted for 9,837.7 kg of the daily consumption, 46.4%. The remaining 10,441.6 kg consumed was from subsistence fishermen, who sell their excess catch, and from imports into the project area. There was no harvesting of ponds during high water season.

On the Halda River, during July/August, there were 917 commercial fishing units. Average daily catch of the commercial fishing units was 4.2 kg. and the total daily commercial catch was estimated to be 3,851.4 kg. The total daily consumption in the Halda River area was estimated to be 6,440 kg. of fish, of which the commercial catch accounted for 59.8% and the subsistence (and self-consumed) catch was approximately 11.8%. Ponds were not harvested during July/August.

The Ichamati Project area is bounded by the Ichamati River. The project area itself has 358 commercial fishing units, the majority of which also fished outside the project area in the Ichamati and Karnaphuli Rivers. The average daily catch of the commercial fishing unit was 1.25 kg. and the total daily catch amounted to 447.5 kg. Total consumption of fish by the population of the project area was estimated to be 2,235 kg per day, of which 20% was from commercial catches and 7.2% from subsistence catches. The remaining 1,626.8 kg of daily consumption came from subsistence catch, which was sold by the fishermen, and from imports into the area.

148. Mortuza, M.G., Parveen, S. and Hossain, M.A. 1992.
Impact of flood control and drainage (FCD) project of the River Barnai on fishes. *17th Ann. Sci. Conf.* BASS. Salna Bangladesh. Abst. No. 28.

A study of the floodplain fisheries of the Barnai River and effect of FCD project was made from June, 1990 to May, 1991. The total catch of fishes decreased to 67 %. The average size of carps decreased to 6 fishes/kg and that of *Wallagonia attu* to 1 or less fish/kg. The same fate was found in other available fishes. At present the fish of less than 1 year are caught in every part of the river. Due to the restriction of free movement important fish species such as, *Hilsa ilisha*, *Pangasius pangasius*, *Nandus nandus*, *Setipinna phasa*, *Labeo nandina*, *Channa* spp. and *Silonia silondia* were once abundant and have now reached the critical levels. A suggestion is made for sustainable development of the project area through integrated farming giving priority to aquaculture and multipurpose use of water.

149. Mukhopadhyay, S.K. and Sarangi, N. 1985.
Survival, growth and production of freshwater prawn, *Macrobrachium malcolmsonii*. *Environment and Ecology*. **3(2)**: 198-201.

The distribution of the river prawn, *M.malcolmsonii* is restricted. It is only available in the rivers draining into the Bay of Bengal. In a field experiment during 1970-71, fingerlings of *M. malcolmsonii* were reared at 25,000/ha along with *catla* and *silver carp* together at 2,000/ha in three small nursery ponds. Survival and production of artificially fed prawns averaged about 29% and 147 kg/ha. Manuring of two ponds with cow dung, leading to an algal bloom might have resulted in the low survival rate. It was suggested that higher production in the third pond was because of the predominance of males which had better

y2

growth rates than females. For this reason the adoption of monoculture of male *M. malcolmsonii* is proposed.

150. Mustafa, G.and Ahmed, A.T.A. 1979.
Food of *Notopterus notopterus* (Pallas) (Notopteridae : Clupeiformes).
Bangladesh j. zool. **7(1)**: 7-14.

The food of *N. notopterus* was studied from a pond and a *jheel* (lake). The fish is predominantly carnivorous and feeds throughout the water column. Protozoans, crustaceans, algae and insects were consumed in both the waters. Consumption of plants was greater in the pond than in the *jheel*.

151. Mustafa, G., Islam, K.R. and Ali, S. 1981.
Seasonal patterns of feeding of the freshwater fish, *Colisa fasciata* (Bloch).
Bangladesh j. zool. **9(1)**: 49-50.

Seasonal patterns of feeding of *C. fasciata* were studied. Among the major food items, the fish was found to prefer algae in winter, insect larvae in summer, diatoms and protozoans in autumn.

152. Mustafa, G., Ahmed, A.T.A. and Islam, K.R. 1980.
Food, feeding habits and fecundity of a freshwater perch, menifish.
J. Agri. Bangladesh. **5(4)**: 205-210.

The fish, *Nandus nandus*, was predominantly carnivorous. It fed both on the bottom and throughout the water column. Its food consisted mainly of prawns, small fish, fish fry, chironomids and insect larvae. The fecundity ranged from 7,381 eggs (fish length 9.7 cm) to 46,222 eggs (fish length 13.5 cm). The fish was highly fecund for its size. Breeding months were June and July.

153. Mustafa, G., Islam, K.R., Ali, S. and Alam, A.K.M.A. 1980.
Some aspects of the biology of *Puntius sarana* (Ham.)
Bangladesh j. zool. **10(2)**: 92-100.

Large *P.sarana* showed a remarkable preference for higher aquatic plants. Fecundity varied from 13,925 to 78,929 eggs for fish of lengths ranging from 15.5 cm to 25.0 cm.

154. Nabi, M.R. and Hossain, M.A. 1983.
Carps seed of the River Padma.
Raj. Fish. Bull. **1(2)**: 38-43.

All over the Padma River 14 centres yielding carp seed, composed of *rohu*, 20-30%, *catla*, 50-65% and *mrigel*, 10-15% during the chintz period, and during the galon period the percentage of minor carps spawn, i.e., *Labeo bata* and *Cirrhinus reba* exceed the spawn of individual major carp species (*rohu*, 40%, *catla*, 10-15%, *mrigel*, 15-20% and minor carps, 40-45%). It has been estimated that they altogether contributed about 70-75% of the total seed production of Rajshahi during 1980-82.

155. Nabi, M.R. and Hossain, M.A. 1983.
Methods of collection of spawn, fry and fingerlings of major carps from the Padma and Jamuna Rivers.
Raj. Fish. Bull. **1(2)**: 51-60.

On the Padma and Jamuna rivers, two types of nets are mainly used for the collection of spawn, fry and fingerlings of major carps. Rajshahi type nets i.e. those of 2 mm mesh, tapering from 1.73 m wide at the mouth to 20 cm at the cod end, kept open by a ring of split bamboo cane comprised 80% of the nets employed. Midnapore type nets i.e. those of having 2.5 mm mesh, tapering from 5.0 m wide at the mouth to 20 cm at the cod end, kept open by an extra stick, called *matcha* comprised the remaining 20%.

156. Nair, K.K. 1954.
Dams and Hilsa fisheries.
J. Asiatic. Soc. Science. **20(1)**: 77-79.

This article provides a general review of the problems associated with dams and hilsa, the inefficiency of fishways and the lack of basic knowledge of hilsa biology. Recommendations for the protection of hilsa include closed seasons in areas where hilsa congregate.

157. Nargis, A., Hossain, M.A. and Kasem, M.A. 1983.
On the food, feeding, fecundity and sex-ratio of *Anabas testudineus*.
4th Nat. Zool. Conf. Sec. IV. Abst. No.46.

Two hundred and nine specimens of *A. testudineus* were collected by cast nets and gill nets in Rajshahi during 1980-81. The principal food items were insects, molluscs, fish remains and plant matter. The fish is an omnivore preferring debris and plant food. Feeding activity was poor from April to July. Peak feeding period was from August to December. The fecundity varied from 3,789 to 72,562 eggs.

158. Nargis, A. and Hossain, M.A. 1987.
Food and feeding habit of koi fish (*Anabas testudineus* Bloch) Bangladesh.
J. Agri. **12(2)**: 121-127.

Food items in the stomach contents of 204 samples of *A. testudineus* consisted of crustacea (18.5%), insects (3.5%), molluscs (6.1%), fishes(9.5%), plant debris (46.9%) and semi digested matter (15.7%). The mature fish fed less actively in May which was the spawning period. The fish is an omnivore.

159. Naser, M. N., Shafi M., Shah, M. S. and Barua, G-1990.
Some aspects of rearing of catfish fry *Clarias batrachus* (L).
Proc. Seventh Nat. Zool. Carf. Bangladesh: 51-59.

Some information on the feeding of fry of *Clarias batrachus* is presented. Food items during the 7 and 9 week rearing periods included crustaceans, algae, insect nymphs and larvae, diatoms, rotifers and annelids.

160. Natarajan. A.V. 1989.

Environmental impact of Ganga Basin development on gene-pool and fisheries of the Ganga River system. p. 545-560. *In* D.P. Dodge (ed) Proceedings of the International Large River Symposium. Can. Publ. Fish. Aquat. Sci. 106 pp.

Much of the ecological malady that afflicts the Ganga River system and the recent decline in its fisheries are traceable to the impacts of cultural development associated with population growth in the Ganga Basin. Among these, irrigation projects and flood control measures have nearly destroyed floodplains and oxbow lakes which are breeding habitats of major carps. The impairment of recruitment in these fish has set into motion changes and readjustments of fish populations at the second and third trophic levels. The major carp populations, *Labeo rohita* (Ham.), *Cirrhina mrigala* (Ham.), and *Catla catla* (Ham.) are now declining, while minor carps and other less economic species are increasing in relative abundance. The impact of irrigation projects on fisheries is compounded by land use practices, pollution, exploitation, and fishing. Hydraulic structures have all but eliminated the fishery for anadromous *Hilsa ilisha* (Ham.) in riverine stretches of the Ganga River. The present paper emphasizes rehabilitation and management techniques to protect the diminishing gene-stocks and to augment fisheries of the Ganga River system. Such management conforms to a holistic approach which places fisheries in the perspective of the total environment.

161. Nuruzzaman A. K.M. 1989.

Survey and data collection in rural fishing communities for fisheries resources management. *In* Aguero, M. Huq, S., Rahman, A.K.A. and Ahmed, M. (eds) 1989. Inland Fisheries Management in Bangladesh. DOF and BCAS, Dhaka: ICLARM Philippines: 35-60.

This paper deals with problems in data collection in rural fishing communities. Present irregularities, inconsistency and lack of representativeness in the data should be removed through provision of trained personnel, coordination with other departments/agencies and the use of improved statistical appraisal.

162. Nuruzzaman, A.K.M. 1991.

Effects of environmental modifications on riverine fisheries in Bangladesh. Paper at the WFC, Athens. 27 pp.

The paper describes the impact of human activities, environment and sedimentation on riverine fisheries. The environmental impacts include irrigation and power projects, flood control projects and water abstraction. Topographical changes, sediment load and turbidity, industrialization and urbanization, dam construction, barrages obstructing hilsa migration, industrial pollution, pesticides and fertilizers and their effects on fisheries production are briefly discussed.

163. Pandey, A., Kunwar, G.K. and Munshi, J.S.D. 1987.

Comparative study of the gill surface area of *Hilsa ilisha* (Ham.) and a major carp *Labeo rohita* (Ham.)

Proc. Indian Natu. Sci. Acad. **53(3)**: 205-214.

The paper deals with comparative anatomy of gills in *H. ilisha* and *L. rohita* from the River Ganga. Hilsa has less of the shorter filaments, but greater gill area than those of *rohu* of the same body weight.

164. Parveen, S., Begum, N., Rahman, M.H. and Hossain, M.A. 1992.

On the breeding periodicity in *Esomus danricus* (Ham.).

17th Ann. Sci. Conf. BAAS. Salna. Abst. No. 29.

Four hundred and seventy three males and seven hundred and twenty seven females of *E.danricus* were collected from different fish landing centres in Rajshahi during 1990-91. The fishes were caught using hand nets with mosquito curtains, cast nets and seine nets (*ber jal*). The gonado-somatic index (GSI), number of ripe females and diameter of ova showed that the fish bred from March to September with a peak from April to July.

165. Patra, R.W.R. 1976.

The fecundity of *Macrobrachium rosenbergii* De Man.

Bangladesh j. zool. **4(2)**: 1-9.

M. rosenbergii were collected during 1970-71 from the Meghna River near Daudkandi and Bhairab and from the Doratana River near Bagerhat. The mean fecundity of 20 specimens was estimated as about 130,000 eggs, but the number of eggs produced by single female ranged from 54,000 to 276,000 depending on size and condition of the individual. The data were analysed to show relationships of fecundity with the total-length, carapace-length and weight of the specimen. The relationships between fecundity and all other factors were linear.

166. Patra, R.W.R. 1977.

Seasonal abundance and the sex-ratio of the natural population of *Macrobrachium rosenbergii* De Man.

Bangladesh j. zool. **5(2)** :101-106.

Prawns were sampled at two stations, Daudkandi (Comilla) and Bagerhat (Khulna) during 1970-71. At Daudkandi the samples were collected from the Gumti, Kathalia and Meghna rivers and their branches. At Bagerhat, the collections were made mainly from the Pasur, Bhairab, Doratana, Balweshar and Rayenda rivers. In March, April and May, the numbers of prawns were insignificant at Daudkandi, whereas during the same period at the estuarine station at Bagerhat they were relatively abundant, probably indicating spawning of this species in estuarine areas. In June and July the prawns were entirely absent in freshwater areas and very few at estuarine areas, suggesting movement of the prawns towards freshwater areas. The sex-ratio of the male and female populations showed fluctuations in certain months, although the average ratio for the year was 1 : 1. The males always attained a larger size.

167. Perschbacher, P.W., Saha, S.B. and Deppert, D.L. 1989.

Description of the feminised male form of *Macrobrachium malcolmsonii* from prawn catches in Bangladesh.

Asian Fish. Sc.: 149-151.

Male *M. malcolmsonii* in drag net catches from the Old Brahmanputra River at Mymensingh, were 87% of the normal form and 13% of the feminised form. The latter male form was distinguished from typical males by lighter coloration, smaller carapace, second cheliped spination and significantly ($P < 0.01$) smaller second chelipeds. The second cheliped/body length ratio averaged 1.9 in normal males and 0.97 in feminised form. As the tail yield

increased from 36.4 to 51.4 and territorial area was reduced in this form compared to the normal males, further studies in terms of aquaculture potential appear warranted.

168. Pisolkar, M.D. and Karamchandani, S.J. 1981.
Fishery and biology of *Tor tor* (Hamilton) from Govindgarh lake (Madhya Pradesh).
J. Inland Fish. Soc., India. **13(1)**: 15-24.

The food and feeding habits of *Tor tor* which formed the main fishery in Govindgarh lake were studied. The species was found to be herbivorous, feeding mainly on higher aquatic plants. The diet of fish greater than 200 mm in length, consisted of insects, molluscs and fish. The feeding intensity was poor during the breeding season.

169. Prakash, S. and Gupta, R.A. 1986.
Studies on the comparative growth rates of three major carps of the Govindgarh lake.
Indian J. Fish. **33(1)**: 45-53.

Comparative growth rates of *catla*, *rohu* and *mrigel* are reported from the Govindgarh lake by means of scale studies. The relationship of fish-length and scale-length and time of annuli formation were estimated. Age wise instantaneous and absolute growth rates are calculated. Months of peak and lean growth were recorded. The growth curves are affected during the first year because of the intensity of feeding and during adulthood by feeding and maturation.

170. Quddus, M. M. A., Makoto, S. and Yukio, N. 1984.
Comparison of age and growth of two types of *Hilsa ilisha* in Bangladesh waters.
Japanese Soc. Sc. & Fish. **50(1)**: 51-57.

Age and growth of two types of hilsa from the Padma and Meghna rivers using otolith readings are discussed. Significant differences in the body length/ otolith size relationship are noted between the types. In the case of type A hyaline zones (the annual marks on the otoliths) appeared during June and July while in type B it was in January and February, i.e., during their respective spawning seasons. Back-calculated mean lengths ranged from 158.8

to 417.5 mm and 142.8 to 398.3 mm at the age of 1 to 5 years of types A and B, respectively. A marked difference in the growth by weight was also observed in the two types. Bertalanffy's growth equation for length fitted well. They are given as follows:

$L_t = 642\ (1-e^{-0.1907(t+0.4929)})$ for type A and
$L_t = 680\ (1-e^{-0.1608(t+0.4689)})$ for type B.

171. Quddus, M. M. A., Makoto, S, and Yukio, N. 1984.
Spawning and fecundity of two types of *Hilsa ilisha* in Bangladesh waters. *Bull. Japanese Soc. Sci. & Fish.* **50(2)**: 177-181.

The paper describes the difference between spawning season, fecundity and sex-ratio of the two types (A and B) of hilsa. The breeding season in type A is from July to October and from January to March in type B. Peak spawning occurred in September for A and February for B type. Fecundity was also different in the two types.

172. Qureshi, M. R. 1968.
Problems concerning fishery of hilsa *Hilsa ilisha* (Ham.) in the River Indus. *Pakistan. J. Sci. & Indus. Res.*: 85-94.

Various aspects of the River Indus hilsa fishery are discussed in this report. Specific attention is given to fecundity, maturation, spawning, sex-ratio, age and growth, effects of barrages, gear and crafts, and the conservation of hilsa.

173. Rahman, A. K. A. 1989.
The new management policy of open water fisheries in Bangladesh under experimental monitoring and evaluation: 14-23. *In* Aguero, M., Huq, S., Rahman, A.K.A. and Ahmed, M. (eds.) Inland Fisheries management in Bangladesh. DOF and BCAS. Dhaka. ICLARM. Philippines. 149 pp.

The paper describes the present revenue-oriented management system of the government - owned fisheries as conducted by the Ministry of Lands. The problems and drawbacks of the present revenue management system are highlighted. A brief history of the introduction of

the New Fisheries Management Policy (NFMP) in selected water bodies is provided. The main features of the NFMP are discussed, which include (a) gradual replacement of the present practice of leasing of water bodies to intermediaries, (b) introduction of a system of granting fishing rights to genuine fishermen and (c) conservation of fisheries resources. The experimental design to find a suitable system of management through alternative approaches, now being monitored and evaluated in twelve selected water bodies under the new management system, is explained and discussed.

174. Rahman, A. K. A. 1989.
Freshwater fishes of Bangladesh. Radiant, Dhaka, Bangladesh.

This book provides descriptions of 260 species of freshwater fish collected from all over Bangladesh. As well as taxonomic descriptions of each species, habitat preferences and information on the size ranges are given. The book is prefaced by a comprehensive description of the fish habitats of Bangladesh. Illustrations include morphological and anatomical features used in classifying fish.

175. Rahman, M.M., Choudhury, A.Q. and Bailey, W.M. 1980.
Report on the hilsa fishing of the Feni River. IFDP. DOF. Working Doc. No. 39. 8 pp.

Hilsa fishing usually started in the Feni River from June and continued till October. Hilsa being a migratory fish needs both marine and freshwater habitats to complete its life cycle. The construction of the cross-dam on the Feni River will restrict migration resulting in the elimination of this fishery unless regulator operation allows migration. During June to October the average monthly catch of hilsa in the Feni River is 126 metric tonnes and the total disruption on the supply of this fish will certainly affect the fish markets.

176. Rahman, Y., Afroze, S. and Hossain, M.A. 1983.
Baits and bait-fishing of the River Padma.
Raj. Fish. Bull. **1(2)**: 38-43.

Different types of mixed baits (such as worms) and ground baits (finely ground and fried oil

cake powder, mixed with sweetmeat syrup or wine, rice grain and rotten meat) are used by the anglers for catching different species of fish in the Padma River. Major carps are usually caught by mixed baits. Predatory fishes, such as *boal*, *chital* and *foli* prefer live bait (small shrimps, cockroaches, fishes like *bailla*, rats and frogs).

177. Rainboth, W. J. and Kibria, G. 1978.

Results of the October 1977, cruise of the R. V. Machhranga. Irrigation Fishery Development Project Working Document No. **9**. 23 pp.

This is one of a series of papers detailing the development of fisheries in the Chandpur, Muhuri and Karnafuli (Halda and Ichamati) irrigation and flood control projects. In this survey, five trawls of the Meghna River and estuary were made, to assess the relative abundance, standing crop, species composition and general distribution of species stocks. A species list, detailing 50 species of fin fish and 7 species of prawn is provided. Estimates of the standing crop at each station are given (means at each station ranged from 0.073 kg/ha to 3.02 kg/ha). The low levels are suggested because of the selectivity of the trawls. Further studies are planned.

178. Raja, B.T.A. 1985.

A review of the biology and fisheries of *Hilsa ilisha* in the upper Bay of Bengal. *BOBP. Colombo. BOBP/WP/***37**. 66 pp.

The paper describes the hilsa fishery of the upper Bay of Bengal which includes Orissa, West Bengal, Bangladesh and Burma. It reviews current knowledge on the biology and fisheries of *Hilsa ilisha*, sets out the findings of field observations in these areas and makes recommendations on future work needed to better understand the nature of stocks exploited in India and Bangladesh.

179. Ramkrishnia, M. 1986.

Studies on the fishery and biology of *Pangasius pangasius* (Ham.) of the Nagar Junasagar reservoir in Andhra Pradesh.

Indian J. Fish. **33(3)**: 320-335.

P. pangasius landings at Nagar Junasagar were 51.7 t/year during 1976-80. The average length was much below the length at maturity (above 630 mm). The main age groups were III, IV and V year classes, and in the VI year class the number of females was greater. The growth rates between the sexes were not significantly different but the length-weight relationship differed. A single mode of mature eggs was found in mature ovaries. This omnivorous fish showed a preference for molluscs, but consumed other items if necessary.

180. Ramkrishnia, M. 1988.

Age, growth and fishery of *Mystus aor* (Hamilton) from Nagar Junasagar reservoir. *In* Joseph, M.M. (ed.). The First Indian Fisheries Forum, Proc. Asian Fish Soc.Indian Br. Mangalor: 185-189.

The age of *M. aor* has been estimated using rings on pectoral spines as well as by length frequency distributions. The estimated lengths during 1 to 7 years were 257 mm, 382 mm, 480 mm, 558 mm, 620 mm, 669 mm and 709 mm respectively. The von Bertalanffy growth equation for *M. aor* was $L_t = 860 [1 - e^{-0.23 (t + 0.552)}]$. Fishery contained largely 3, 4 and 5 year old fish, which together accounted for over 85% of the catch. The average length in the catch ranged between 482 mm and 544 mm and was similar to the length at first maturity indicating a high rate of exploitation. The length-weight relationship of *M.aor* was log W = -5.3416 + 3.0055 log L. The mortality rates were 0.667, 0.703, 0.748 and 0.680 for the four years respectively (1976-80). Total mortality ranged from 67 and 75%. However, it was suggested that the present rate of exploitation did not adversely affect the stock density.

181. Rana, K.S., Singh, S. and Bhati, D.P.S. 1982.

Studies on the food and feeding habits of some selected fishes in relation to their environment.

Indian J. Zootomy. **23(3)**: 179-182.

The gut contents of fry and fingerlings of five species of fishes (*Labeo gonius*, *Cirrhinus*

mrigala, *Notopterus chitala*, *Wallago attu* and *Puntius ticto*) collected from the Keetham lake, Agra, were carefully examined. It was found that the food, in addition to the phytoplankton, consisted of algae, rotifers, crustaceans, insect larvae and adult insects. The adults were found to be omnivorous plankton feeders. Fry and fingerlings were exclusively plankton feeders. There was a positive correlation between the available food material (plankton) and the food taken.

182. Ranade, S.S. and Kewalramani. H.G. (Date not available).
Studies on the rate of food passage in the intestine of *Labeo rohita (Ham.), Cirrhina mrigala (Ham.)* and *Catla catla (Ham.)*: 349-358.

The different studies show that major carps are capable of ingesting a wide range of food material. To what extent these are utilized is, however, not known. The present data show that in individuals of nearly the same size of the same species, the rate of passage of different types of food varies considerably. The algae, *Microcystis, Anabaena, Scendesmus* and *Chlorella* for example, were retained in the intestine longer than the filamentous algae, *Spirogyra* and *Ulothrix*. *Daphnia, Cyclops, Diatomus* and *Cypris* were digested rapidly except for the thin chitinous shell. Chopped prawn and mosquito larvae with a more thickly chitinized exoskeleton were retained for a longer time in the intestine. The passage of partially digestible plant matter was fastest in *C. mrigala*, slower in *L. rohita* and slowest in *C. catla*. Conversely, the rate of passage of several animal food was found to be fastest in *C. catla,* slower in *C. mrigala* and slowest in *L. rohita*.

The rate of food passage is related to the efficiency of digestion. Food items more biochemically amenable to the digestive enzymes of a particular species, passed through the gut faster than others. It is suggested that food items, which pass through rapidly, are more efficiently used since rapid food passage is associated with high digestibility as a consequence of high concentration of requisite enzymes.

183. Report of the 2nd working group meeting of hilsa investigations in Bangladesh during 1985-86 under the UNDP/FAO Project, at Dhaka, 1986. BOBP reports.

It is recommended that nighttime landings at Chandpur during the monsoon period are sampled. Many of the 3,000 licensed gill net fishermen in motorised boats were not fishing.

The highest estimate of boats landing at Chittagong and Cox's Bazar together did not exceed 1,700. Although the UNDP/FAO Fisheries resources survey system project has plans for developing a sampling scheme for a catch survey of marine districts, it was considered that sampling by FRI could be a complementary effort. For stock assessment purposes an index of variation in the status of the fisheries and resources may be obtained by monitoring through experimental fishing. Difficulties of obtaining information from fishermen and permission to take length measurements affected the sampling for catch and effort and length frequencies on the basis of mesh sizes used. The experimental fishing results were poor and future experimental fishing may consider using separate sets of nets of each mesh size for better catches. In view of the high degree of entangling and wide range of fish size caught by each mesh size the gill net was considered efficient for experimental fishing. Sampling of commercial catches should also be carried out, for length frequency and identification of components of population exploited by commercial fishery. The confusion in the identification of *jatka* from other similar species is highlighted. The collection of spent recovering specimens around Sandwip area in October indicated evidence of a spawning ground.

184. Roberts, R.J., Wooten, R., MacRae, I., Millar, S. and Struthers, W. 1989. Ulcerative disease survey, Bangladesh. Final Report. Inst.of Aquacalture, Univ. of Stirling, Scotland. 105 pp.

A team of specialists visited Bangladesh from 27 October-18 November, 1988 and 20-27 January, 1989, in order to survey the area for ulcerative disease in fish. Wild and pond fish samples were collected from 35 sites in 16 districts, for histopathological and virological analysis. Water quality variables were measured at selected sites and fish were sampled for heavy metals and pesticide residues. The survey confirmed that ulcerative disease was epizootic throughout Bangladesh. The clinical signs and histopathology of the disease were similar to those in other countries. In particular snakeheads and *Puntius spp.* were severely affected. Indian major carps were as affected by the disease as had been observed in pond-reared snakeheads in Thailand in 1981-83. Ulcerative disease caused major mortalities of juvenile major carp in hatcheries. Chinese and European carps are refractory to the disease. The virus, found in affected fish elsewhere, was not isolated in Bangladesh. Histopathological studies showed the presence of Oomcete fungus which could be the primary or secondary pathogen. Isolates of *Aeromonas sobria* and *A. hydrophila* were obtained from diseased carp, but the significance of these is uncertain. No significant water pollutants,

heavy metals or pesticide residues were detected. No environmental variable was identified as contributing to the spread of the ulcerative disease. Lime or potassium permanganate had been used in affected ponds but their efficiency was uncertain. Antifungal agents, such as, malachite green, may be effective.

185. Saha, M.S. and Haque, A.K.M.A. 1980.
Qualitative and quantitative study of samples of fry and fingerlings of major carps from Old Brahmanputra River at Mymensingh.
J. Agr. Sc. Bangladesh. **7(2)**: 169-174.

Fry and fingerlings of 25 species of fishes including three species of major carps and two species of medium carps (*L. calbasu* and *C.reba*), have been obtained in the samples. The three major carps together constituted 37.7%, the two medium carps, 4.5% and the remaining 20 species of fishes constituted 48.5% of the total catch.

186. Saha, S.B., Perschbacher, P.W., Deppert, D. and Shah, M.S. 1988.
Prawns of the Old Brahmanputra River, Mymensingh.
Bangladesh J. Fish. **11(2)**: 35-40.

The species composition, abundance of prawns and sex ratio of *Macrobrachium malcolmsonii* of the Old Brahmaputra River at Mymensingh during May to October, 1987 are reported. Six species of prawns, *M. malcolmsonii, M. rosenbergii, M lammariei, M. dayanus* and *M. dolichodactylus* were identified. *M. malcolmsonii* was the most abundant. The percentage of female *M. malcolmsonii* was higher than males in all samples. In addition, 13 % of the males were the "feminized" form.

187. Shafi, M. 1987.
Marine fisheries sector, present status and future prospects.
The Journal of NOAMI. **4(2)**: 15-17.

Until the commissioning of Farakka Barrage in 1974 in West Bengal (India), hilsa fishing in Bangladesh was restricted to the upper reaches of the main rivers. Presently, hilsa is primarily caught in estuarine and coastal marine water. The production of hilsa above the

Farakka Barrage on the Ganges River has decreased from about 400 t to nil. In Bangladesh there has been a steady decline of the hilsa catch from the rivers and their tributaries. The Farakka Barrage has destroyed the habitats of hilsa and major carps in the River Padma. Indiscriminate fishing for *jatka*, the juveniles of hilsa, as well as ripe hilsa during breeding period, are extremely detrimental to resident or migratory hilsa. Further research into production, biology, race, migration and breeding requirements of hilsa are advocated. Effective fish passes should be provided so that the adult fish can reach spawning grounds in rivers or tributaries, and juveniles can more downstream to mature.

188. Shafi, M., Haque, B. and Islam, N. 1985.

Studies on the age and growth of Ruifish, *Labeo rohita* (Ham.) from the Karnaphuli Reservoir.

J. Asiatic Soc. of Bangladesh. **XI(1)**: 11-21.

Age and back-calculated growth were determined from annual rings on the scales, of 354 Riu fish during the 12 months study. Annuli appeared as a light band formed by a space between two circulii. The annulus was formed during monsoon between April and July, most being formed in June and July. A linear relationship was found between body length and scale length. The maximum growth was observed during the first two years of life. The percentages of annual growth increments varied from 30.6 in the first year to 2.01 in the 11th year of life. The calculated asymptotic length (L_{max} = 97.00 cm) was close to the observed value (94.50 cm). The von Bertalanffy growth equation was $l_t = 97(1 - e^{-0.282\ (t-0.250)})$.

189. Shafi, M. and Mustafa, G. 1976.

Observations on some aspects of the biology of the climbing perch, *Anabas testudineus* (Bloch) (Anabantidae: Perciformes).

Bangladesh j. zool. **4(1)**: 21-28.

Some aspects of the biology of *Anabas testudineus* from two ponds in Dhaka city were studied. The males and females showed an annual growth rate of 10.0 and 13.3 mm, respectively. The weight-length relationship in males and females showed that the fish followed the cube law. The highest value for relative condition was obtained for the 70 mm length group in both sexes. *Daphnia, Cyclops* and *Cypris* were the principal food items of

the fish. Protozoa, Rotifera, Crustacea, insects, fish remains and plant matter were also observed in the stomachs. The sex-ratio was apparently 1:1. The fecundity varied from 6,478 eggs (for a female 94 mm in length and 38 g in weight) to 44,395 eggs (for a female 179 mm in length and 144 g in weight).

190. Shafi, M., Naser, M.N. and Rahman, A.K.M.S. 1992.
Some biological aspects of the grass carp, *Ctenopharyngodon idella* (Val.) from fish farm pond.
17th Ann. Sc. Conf. BAAS. Gazipur. Abst. No.63.

The length-weight relationship of *C. idella* was expressed by:-

$$\log W = 1.8490 + 3.0106 \log l - r = 0.99.$$

The fecundity of grass carp varied from 209,700 to 293,832 eggs. The relationships between fecundity and length, weight and gonadal weight are given.

191. Shafi, M. and Quddus, M. M.A. 1973.
Age, growth and food of the giant prawn *Macrobrachium rosenbergii* (De Man. 1879) of Bangladesh.
Bangladesh J. Biol. and Agri, Sci. **2(2)**: 3-6.

A total of 1,320 prawns were studied from the Daudkandi fish landing centre in Comilla. Polygon method was used to study age and growth. From the size frequency study six age groups were observed in males and three in females. Growth was faster in males. The size sampled varied from 21 mm carapace length (103 mm total length) to 102 mm carapace length (340 mm total length). Females were predominant in the population (66%). Gut contents revealed an omnivorous and bottom feeding habit. Diatoms and copepods were the major food of young prawns. Crustaceans were the principal food of adults.

192. Shafi, M. and Quddus, M.M.A. 1974.

Bionomics of the common puti, *Puntius stigma* (Cuv.& Val.) of Bangladesh. *Bangladesh j. zool.* **2**(1): 77-82.

A population of *P. stigma* from Dhaka water was studied in terms of growth, food and feeding habits, length-weight relationship, relative condition factor, age, sexual maturity and sex-ratio. The stomachs of all fish caught from September to November were empty. *Cyclops*, *Daphnia*, Crustacea larvae and plant debris were the main food during June to August. No annulus was found in any of the scales or opercular bones and the fish were assumed to be 0+ year group (less than one year old). In the samples 69% of the fish were males.

193. Shafi, M. and Quddus, M.M.A. 1974.

The fecundity of the common punti, *Puntius stigma* (Cuv. & Val.) (Cyprinidae : Cypriniformes).

Bangladesh j. zool. **2**(2): 133-145.

Fecundity of the common punti, *Puntius stigma*, from a tributary of the Buriganga River, was estimated by the gravimetric method. Fecundity varied from 1,242 ova (length of fish 8.6 cm and weight 9.0 g) to 6,831 ova (length 9.7 cm and weight 15.2 g), with a mean number of 3,192 ova for a fish 9.5 cm in total length and 13.3 g in weight. Mathematical relationships of fecundity with length, weight and gonad weight were estimated.

194. Shafi, M. and Quddus, M.M.A. 1974.

The length-weight and length-girth relationships and condition in *Hilsa ilisha* Hamilton -Buchanan (Clupeidae).

Bangladesh j. zool. **2**(2): 179-185.

The results of an analysis on the total length-weight, total length-girth and relative condition in 362 specimens of *Hilsa ilisha* from the Padma and Meghna rivers are presented. The length-weight relationship of hilsa is expressed by the equation log W = -1.61822 + 2.76829 log TL. The relationship between length and girth is described by the formula, log girth = 0.068753 + 0.84263 log TL. The first peak in the relative condition factor is possibly attributable to the recovery in freshwater after migration from saltwater. The only

trough and second peak are probably due to spawning and recovery after spawning respectively.

195. Shafi, M. and Quddus, M.M.A. 1974.

The length-weight relationship and condition in the giant prawn *Macrobrachium rosenbergii* (De Man, 1879) of Bangladesh.

J. Asiatic Soc., Bangladesh. **X,IX(1)**: 1-10.

A total of 1,320 specimens were studied from Daudkandi fish landing centre during 1969 - 1973, of which 839 were females and 481 males. 1,300 specimens (male and female combined) were divided into 102 millimetre length groups for the study of the total length-carapace length relationship. Groupings were also done for the determinations of the total length-total weight relationship and the carapace length-total weight relationship. Isometric growth was observed between carapace length and total length. The study of the relationship between total length and total weight shows that the prawn did not follow the cube law. The relationship between carapace length and total length followed the cube law in male only. The weight of the female fish is affected by the spawning condition and this might be the reason for deviation in females from the cube law. The smallest prawns showed the lowest relative condition values. Thereafter, fluctuations in condition values were cyclical showing peaks followed by troughs.

The first condition trough at 110-120 mm total lengths was probably be attributable to the migration of young from their hatching ground in the estuaries to freshwater zones. Recovery in freshwater might be responsible for subsequent increase in condition values at 120-180 mm in males and 120-165 mm in females. The low condition values in the second trough region at 185 mm in both sexes may be attributable to the attainment of maturity.

196. Shafi, M. and Quddus, M.M.A. 1975.

Observations on some aspects of the biology of the freshwater prawn, *Macrobrachium malcolmsonii* H. Milne Edwards (Decapoda, Palaemonidae) of Bangladesh.

J. Asiatic Soc. Bangladesh (Sc.). **1(1)**: 1-9.

A total of 1,372 specimens, with a range from 52-160 mm in total length and 1.2-65.0 g in

weight, was studied from the Meghna and Sitalakhya rivers during 1972-74. The relationship between carapace length and total length was estimated separately for male and female. Similar growth rates were found among the first year groups, but thereafter the males grew faster than females. The adults were bottom feeders and omnivorous. Their principal food items were chironomid larvae and crustaceans. Juveniles mostly fed on diatoms, Spirogyra, copepods and crustaceans. Berried females were caught from May to October. Fecundity varied from 2,253 eggs (for females measuring 93 mm in total length and 7.0 g in weight) to 7, 356 eggs (for a female measuring 123 mm in total length and 23 g in weight).

197. Shafi, M. and Quddus, M.M.A. 1975.

Studies on reproduction juveniles of the giant prawn, *Macrobrachium rosenbergii* (De Man) of Bangladesh.

Bangladesh J.Sci. & Indus. Res. **X(3&4)**: 251-258.

As many as 1,320 specimens of *Macrobrachium rosenbergii* from Daudkandi fish landing centre were studied from 1969 to 1973, of which, 839 were females and 481 males. Females were always more abundant than the males. The breeding period was confined to seven months from January to July. Non-availability of juveniles in the Meghna, Gumti and Kathalia rivers at Daudkandi and their presence in the River Doratana at Bagerhat indicate that the species spawns in brackishwater in the lower estuarine zones of Sundarban area. Early development of its eggs and hatchlings seem to occur in brackishwater further down the River Doratana. The average number of eggs was 94,917 for a prawn with a total length of 173 mm and a weight of 58.6g. Three to seven horizontal lines on the carapace are characteristics of the juveniles.

198. Shafi, M. and Quddus, M.M.A. 1976.

Observations on some aspects of biology of *Macrobrachium rudis* (Heller 1862) from the Sundarbans estuaries. D.U. Stud. B, **XXIV(2)**: 97-104.

For these studies, 804 specimens of *Macrobrachium rudis* (Heller) were collected from Bagerhat area in 1974. The relationship between carapace and total length was estimated. The growth rate ranged from 10.0 - 17.5 mm and 10.0 - 25.0 mm per month in males and females respectively. The relationships between total length, weight and condition factor (K_n) for different length groups were determined. Crustaceans, copepods, polychaetes and

molluscs shells were the preferred food items. Significant discrepancy ($P < 0.05$) in the monthly sex-ratio (males 53.3 %, females 46.6 %) was observed. Fecundity ranged from 6,250 ova to 12,009 ova. The species was abundant during winter months.

199. Shafi., M. and Quddus, M.M.A. 1982.
Bangladesher Mathsya Shampad (Fisheries of Bangladesh). (in Bengali). Bangla Academy, Dhaka. 444 pp.

This book contains descriptions of 148 species of freshwater fishes and 10 species of freshwater prawns of Bangladesh. Besides, brief taxonomic descriptions of each species, the habitat, food and feeding behaviour and breeding have been discussed. The names of gears used to catch each fish species are given. The life histories of some commercially important fishes are also given.

200. Shafi, M., Quddus, M.M.A. and Haque, B. 1977.
Studies on the age and growth of *Catla catla* (Hamitton - Buchanan, 1822) from the Karnaphuli Reservoir and Dacca University pond.
J. Asiatic Soc. Bangladesh (Sc.), **3(1)**: 47-68.

Age and growth were studied from scales which reportedly had a linear relationship with body length. In fish from Karnaphuli Reservoir, annual rings appeared in May - July due to spawning stress. The rings appeared earlier (March and April) in the fish from the pond, probably resulting from starvation, because insufficient food was available. Growth was fast during the first two years in both waters, but decreased gradually thereafter. Marked differences in growth in weight of fish between the two waters were observed. The Von-Bertalanffy growth expressions were:-

$L_t = 97 (1 - e^{-0.246(t-0.044)})$ for fish from the reservoir
and $L_t = 92 (1 - e^{-0.173(t-0.058)})$ for fish from the pond.

201. Shafi, M., Quddus, M.M.A. and Hossain, M. 1976.
Problems concerning the determination of age and growth of *Hilsa ilisha*.
1st Bangladesh Sc. Conf. BAAS. Abst. No. 102. Dhaka.

A total of 511 specimens of *H. ilisha*, caught from the Padma River, was studied. None of the scales of the fishes showed any annuli. Isometric growth was observed between the fish and their scales. Radii varied in number on the different scales of the same fish. Growth rates obtained from the study of radii of scales did not agree with values obtained from the study of the length frequency distributions. Opercular bones showed faint transparent and opaque zones of growth, but the zones of all the fishes were not readable. Sagittal otoliths showed comparatively clear zones of growth. All fish below 11.0 cm in length showed one zone of growth. Fishes above 11.5 cm in length showed two or more alternating zones of growth. Analysis of homologous groups in the length frequency distributions closely agreed with the groups obtained from otoliths. Relationships of fish length with the length and width of the otoliths were isometric. The study concluded that the determination of age and growth of *H. ilisha* with the help of otoliths is preferable to scale reading.

202. Shafi, M., Quddus, M.M.A. and Hossain, M. 1978.
Studies on length-girth relationship, sex-ratio, size composition, gears and abundance of *Hilsa ilisha* (Hamilton Buchanan) in the River Padma.
Dhaka Univ. B. **XXVI(1)**: 123-127.

The length-girth relationship of *Hilsa ilisha* from the River Padma was estimated. Sex-ratio was not significantly different from 1:1. The size compositions of males and females were different, the females being larger than the males. Six different types of nets were used to catch hilsa. The fishermens' choice of nets for operating in different areas and different seasons was dependent on the current speed of the river, the nature of catch and to a large extent on their financial situation. October was the month of highest yields (i.e. towards the end of monsoon season). The total landing at Goalando declined from 12,414 t in 1960 to 2,231 t in 1975.

203. Shafi, M., Quddus, M.M.A. and Islam, M.N. 1977.
Studies of gonad weight, sex-ratio and fecundity of *Hilsa ilisha* (Hamilton-Buchanan) from the River Meghna.
J. Asiatic Soc. Bangladesh (Sc.). **11(2)**: 51-58.

Among the regressions of gonad weight on length, weight and ova-diameter, that of gonad weight on length showed greater than the cube relationship, while weight and ova-diameter showed less than the linear relationship. Sex-ratio was not significantly different from the expected 1:1 ratio. In the highly fecund hilsa, ova production varied from 382,702 to 1,821,490 for fishes of length ranging from 38.0 to 52.0 cm. The average number of ova per kilogram of body weight was 848,459. The regressions of fecundity on total length showed greater than the cube relationship, while those of weight and gonad weight showed a linear relationship.

204. Shafi, M., Quddus, M.M.A. and Islam, N. 1978.
Maturation and spawning of *Hilsa ilisha* (Hamilton-Buchanan) of the River Meghna.
D.U. Stud. B. **XXVI(2)**: 63-71.

Based on physical features and histological structures of gonad and ova diameter frequency, eight stages of maturity were described in male and female hilsa. Hilsa showed two breeding seasons, one from January to March and the other from July to October. The smallest mature male hilsa was 27.0 cm in length and 200 g in weight, and the smallest mature female was 32.0 cm in length and 400 g in weight. The characteristics of fishes at every stage of maturity in both sexes are given. Fluctuations in the modes in gonado-somatic index values showed that both the sexes matured simultaneously and spawned in the same season. The early maturing, advanced maturing and partly spent ovaries contained two groups of ova, one smaller size group of upto 300 microns and other larger group of upto 887 microns. Advanced maturing or partly spent ova were present throughout the peak of spawning seasons, but completely spent hilsa were found at the end of spawning seasons, i.e., in April, October and November. Hence, the secondary group of maturing ova also attained maturity and were shed in the same spawning season.

205. Shafi, M., Quddus, M.M.A. and Nahar, S. 1977.

Observations on the biology of the prawns, *Macrobrachium lammariei* Edwards and *Macrobrachium mirabilis* Kemp.

J. Sci. & Indust. Res., Bangladesh. **XII(3&4)**: 137-142.

Different aspects of the biology of *Macrobrachium lamarrei* and *M. mirabilis* have been studied. The specimens were collected monthly from the Buriganga (Dhaka) and Kadalia (Comilla) rivers in 1974. The specimens were divided into fourteen, 2mm length groups for *M. lammariei* and fifteen 2mm length groups for *M. mirabilis* for the studies. The specimens were sexed with the help of appendix masculina of male. Ova were measured with an ocular micrometer. Relationships between carapace and total length, and weight and total length were estimated for each species. Values of the relative condition factors for different length groups were calculated. Crustaceans constituted the major part of the stomach contents in both the species. They were omnivorous, feeding off the substratum. Berried females of *M. lammariei* were mostly caught during the rainy season. *M. mirabilis* was a perennial breeder. In *M. lammariei,* the fecundity varied from 124 eggs (for a prawn 50 mm in total length and 0.7 g in weight) to 394 eggs (for a prawn 63 mm in total length and 2.5 g in weight). In *M. mirabilis*, fecundity varied from 611 eggs (for a prawn 50 mm in total length and 1.5 g in weight) to 2,413 eggs (for a prawn 64 mm in total length and 3.0 g in weight).

206. Silva, Eil and Davies, R.W. 1987.

Aspects of the biology of *Ompok bimaculatus* (Bloch) (Fam.Siluridae), in lake Parakrama Samudra (Sri Lanka).

Rop. Ecol. **28(1)**: 126-132.

O. bimaculatus, an indigenous riverine fish, was studied in Parakrama Samudra, a dry zone man-made lake in Sri Lanka. This species showed strong diurnal piscivorous feeding behaviour, with a diet consisting largely of the small cyprinid, *Puntius chola.* In Parakrama Samudra the population size structure of *O. bimaculatus* primarily consisted of the larger size classes, as spawning does not occur within the lake. The condition factor and fecundity of the species are similar to those recorded for lotic populations. Biomass production was low probably because recruitment of post-spawners and fingerlings is uncertain.

207. Shah, M.S. and Haque, A.K.M.A. 1980.

Qualitative and quantitative study of samples of fry and fingerlings of major carps from the River Old Brahmaputra at Mymensingh.

Bangladesh J. Agril. Sci. **7(2)**: 169-174.

A qualitative and quantitative study of samples of fry and fingerlings of major carps collected from Old Brahmaputra River at Mymensingh was made. Fry and fingerlings of 25 species of fishes including three species of major carps and two species of medium carps (*Labeo calbasu* and *Cirrhinus reba*) were identified. The three major carps together constituted 37.73%, the medium carps, 4.5% and out of the remaining 20 species of fishes, an unidentified species of the genus *Puntius* alone constituted 48.54% of the total catch. The number of species found in the catch and the abundance of each species were related to the occurrence of monsoon floods, both being greater in samples immediately following flood.

208. Shah, S.B., Shah, M.S.and Modak, P.C. 1988.

Fecundity of *Macrobrachium malcolmsonii* (H.M.Edwards) of the Old Brahmanputra River.

Bangladesh j. zool. **3**: 29-33.

Average fecundity of 50 specimens of *M. malcolmsonii* from the Old Brahmaputra River was estimated at about 33,420 eggs, ranging from 14,306 to 54,730 for a length range of 9.0 to 14.0 cm. Ovary weight was found to be the best estimator of fecundity.

209. Singh, S.B., Dey, R.K., Reddy, P.V.G.K. and Mishra, B.K. 1980.

Some observations on breeding, growth and fecundity of *Notopterus chitala*.

J. Inland Fish. Soc. India. **12(2)**: 13-17.

Natural spawning of *N. chitala* was observed in ponds during July, 1977. Fecundity of the fish was estimated to be around 4,000 eggs/kg body weight. The ovarian eggs were of varying sizes, nearly 66% measured between 0.5-1.9 mm (the immature eggs) ; 7% between 2.0-2.7 mm (the maturing ones) and 27% between 2.8-4.8 mm (the mature and nearly mature ones). The eggs are adhesive and deposited profusely on the hard surfaces of stone blocks kept inside a tin carrier and also on its walls. Parental care and incubation are mentioned. The chital fry (2.5 cm in size) feed on zooplankton and fry (5.0 cm in size) on mosquito

larvae and common carp eggs. The fishes grew to 36 cm/320 g in eight months. Fish of 30 cm size in 60-70 days was reported in other waters.

210. Smith, M.A.K. 1991.

Models of seasonal growth of the equatorial carp *Labeo dussumieri* in response to the river flood cycle.

Environmental Biology of Fishes (Netherlands). **31**: 157-170.

The phenology of *Labeo dussumieri*, an omnivorous carp common to South Asia, was investigated in a population inhabiting a floodplain anabranch of the Mahaweli Ganga which exhibited the bimodal discharge pattern typical of many equatorial rivers, with a minor peak during the S.W. monsoon and a major peak during the N.E. monsoon. Seasonal changes in several lotic variables were measured in an attempt to correlate changes in environmental conditions to reproduction and growth in *L. dussumieri*. The onset of gonad recrudescence and spawning were synchronized with the increased river discharge during the S.W. and N.E. monsoons ; gonad development followed one monsoonal discharge peak and spawning took place at the beginning of the other.

Most fish spawned at the beginning of the major discharge peak in October and November following the September dry season. Increased discharge was concomitant with a fall in temperature, light intensity, pH and conductivity. Growth was shown to be seasonal, exhibiting an annual bimodal pattern with peaks coincident with S.W. and N.E. monsoonal rains. Seasonal changes in growth were expressed by two models in terms of : (a) change of somatic weight or fork length with time, (b) change of specific growth rate in response to river discharge, modified by somatic weight. Gonad recrudescence and spawning stress did not appear to influence growth rate.

211. Srinath, M. 1986.

A simple method of estimation of mortality.

Indian J. Fish. **33(2)**: 235-237.

A simple method of estimation of mortality from length-frequency data has been proposed. The approach also facilitates simultaneous estimation of standard error of the estimate.

212. Sujansinghani, K.H. 1957.

Growth of the Indian shad, *Hilsa ilisha* (Ham.) in the tidal stretches of the Hooghly.

Indian J. Fish. **4(2)**: 315-335.

Growth increments of hilsa in the Hooghly estuary were estimated to be 15-20 mm/month in the first 2-3 months after hatching, thereafter decreasing to about 10 mm/month. Yearly differences in mean length and length-weight relationships of annual samples are also discussed.

213. Symposium on the impact of current land use pattern and water resources development on riverine fisheries. 1987. Proceedings highlights and recommendations. CICFRI,. Barrackpore. India. 40 pp.

A fish pass on the Farakka barrage of the River Ganges acts as a trap rather than a pass. The water fall is only about 2 metres and suitability of fish locks and lifts should be examined. The endemic strain of hilsa is breeding upstream in rivers blocked by dams. Farakka barrage affects the migration of hilsa. Hilsa breeding experiments were conducted downstream of Farakka barrage. The breeding was done by stripping and later fertilized eggs were hatched at the field site. The hatchling transportation experiments conducted in open containers without oxygen recorded better survival in comparison to closed containers having oxygen packing. Hatchlings could not be reared for a longer period and the culture aspects of this work were not a success. There has been no study on the food of hilsa larvae. Stomach content analysis revealed that copepods and rotifers were the most important food items. Cladocerans were the next most important group.

214. Talwar, P.K. and Jhingran, A.G. 1991.

Inland fishes. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, India.

This two volume compendium is a comprehensive treatise of freshwater and estuarine fishes of the South Asian subcontinent: India; Pakistan; Nepal; Sri Lanka; Bangladesh and Burma. The total of 930 fish species are systematically described in terms of their diagnostic features, colour, sizes, geographic distribution, biology and abundance.

215. Thakur, N.K. and Das, P. 1985.

Synopsis on biological data on magur, *Clarias batrachus* (Linnaeus) 1758. CIFRI. Barrackpore (India). Bull. No.**41**. 82 pp.

C. batrachus attains maturity at the end of first year of life. It is monogamous i.e. a female courts with only one male. A female of 31.5 cm in total length and 251.6 g in weight produces 11,612 eggs. Spawning coincided with the south-west monsoon in N-E India. It breeds in confined waters. For the induction of spawning, the pituitary glands of major carps (dosages of 5-20 mg/100 g body weight) were effectively used. Gut content analysis of juveniles showed that copepods, cladocerans, ostracods, oligochaetes, dipteran larvae, filamentous algae and parts of aquatic plants were the main food items. Adults were predominantly insectivorous.

Different species of *Channa* are the main predators of young *magur*. Age and growth was studied on the basis of growth rings in transverse sections of pectoral spines. The rings were formed in July-August due to the cumulative effect of the stress caused by maturation and reduction in feeding intensity during these months. The exponential value of 3.1195 in length-weight (L-W) relationship does not differ significantly from 3.0 at the 5% significance level, showing isometric growth. *Claris batrachus* is generally caught by hand, cage traps, cast nets, drag nets, gill nets, tobacco poisoning, hooks and long lines.

216. Thakur, N.K. and Das, P. 1986.

Synopsis of biological data on koi, *Anabas testudineus* (Bloch, 1792). CIFRI, Barrackpore (India). Bull. No. **40**. 47 pp.

It was observed that during the breeding season (March-April) the female's body changes to a light brown colour and pelvic fins turn deep brown. The species attains sexual maturity in the first year of life (males at 8.0 cm and 11.3 g and females at 8.2 cm and 12.2 g). It is monogamous. Spawning takes place during rainy season (monsoon). *Koi* are well known for migrating into and breeding in prepared carp nurseries. Fry (3-15 mm) feed on ciliates, flagellates, small crustaceans, unicellular algae, mosquito larvae and worms. Adults feed on damsel and dragon fly larvae, crustaceans, rotifers, protozoans, fish, fish eggs and unicellular algae. The fish is generally caught by hand, cast nets, drag nets, hooks and lines.

217. Tripathi, Y.R. 1954.

Some observations on parasites of hilsa.

J. Asiatic Soc., Science. **20(1)**. 75.

The report illustrates the differences in parasitic fauna of hilsa from the Ganges and Chilka lake, and suggests their use for investigation of stock or racial differences.

218. Tsai, C., Khan, M.A.A. and Halder, G.C. 1978.

Prawn nursery ground investigation of the Feni river estuary (Bangladesh) with reference to impacts of the irrigation flood control project.

J. mar. biol. Assoc. India. **20(1&2)**: 1-9.

Prawn sampling was conducted monthly from February, 1978 to January, 1979 in the Feni River estuary located at the tip of the Bay of Bengal. The estuary was found to be utilized as nursery grounds by three species of marine prawns, *Parapenaeopsis sculptilis*, *Metapenaeus monoceros* and *M. brevicornis*, a species of estuarine prawn *Palaemon styliferus* and three species of freshwater prawns, *Macrobrachium mirabilis*, *M. malcolmsonii* and *M. dayanus*. Construction of a proposed cross dam and regulator in the lower reaches of the estuary will change the present brackishwater estuary into a freshwater lake during the dry season. The proposed dam will change the estuary into a stable freshwater reservoir above the dam and a tidal seawater area below the dam. This means during the post-construction period the brackishwater estuary will not exist in dry season. During monsoon season, the estuary will remain freshwater both above and below the dam. This change will destroy the nursery grounds of *P. sculptilis* and *P. styliferus* whose juveniles require brackishwater for nursing during the dry season, but not the other two species of marine prawns *M. monoceros* and *M. brevicornis* which require waters of very low salinity for nursing their juveniles during the monsoon season. Due to the instability of the estuary, sessile flora and fauna were virtually absent. The benthic invertebrate community is also extremely poor. There are no mussels, clams and oysters, which normally indicate a rich estuary.

219. Tsai, C., Islam, M.N., Karim, M.R. and Rahman, K.U.M.S. 1981.
Spawning of major carps in the lower Halda River, Bangladesh.
Estuaries. **4(2)**: 127-138.

Spawning biology and spawn fishery of three valuable species of Indian major carps, *Catla catla, Labeo rohita* and *Cirrhinus mrigala*, in the lower Halda River, Bangladesh, were studied in 1978. The major carps spawned only in the Sonairchar oxbow-bend from April to June on or near the dates of the full moon and the new moon. The tide was then at its highest level, and there was heavy flood water run off from the hill region with sharp increases in water level, turbidity and current velocity, as well as decreases in water temperature, dissolved oxygen, and hydrogen ion concentration. These three heterogeneric species, as a result of parallelism or convergence in evolution, overlap in their environmental requirements for spawning. The nursery grounds of the major carp fry spawned in the Halda River was found to be in the coastal water in the Bay of Bengal (low salinity during rainy season). The brood stock was suspected to originate in the Shanka River, 40 miles south of the Karnafuli River. The spawn fishery in the Halda River is intensive but inefficient. Engineering works and water management schemes are threatening the spawning grounds.

220. Tsai, C., and Ali, Md. L. 1985.
Open water fisheries (carp) management programme in Bangladesh.
Bgd. Fish. Inf. Bull. **2(4)**. 51 pp.

Three stocks of major carps have been identified, the Brahmaputra stock, Padma stock and Upper Meghna stock. The spawning migration of Brahmaputra stock occurs from late February to late April and spawning takes place in Assam and Letha range of the river. The spawning migration of the Padma stock starts in April and May and spawning takes place in June and July in a section of the Padma River not far from Farakka Barrage. The Meghna stock is associated with the Sylhet-Mymensingh basin (inundated 4-6 months during monsoon). These fish spawn in the Letha range in India. Major carps do not spawn in the Padma-Brahmaputra river system within Bangladesh. The three stocks have apparently declined. Farakka dam, embankments and sedimentation are the three major factors causing the decrease in the habitats available for major carps. Overfishing is the most important factor linked to the decline of major carps in the inland open waters of the river systems. Mortality due to overfishing of young fish leads to poor yields and low profits. Reduction of fishing mortality by decreasing fishing intensity and increase in size of fish at entry to the

exploited phase have been suggested as management strategies for the open water inland carp fishery. Several regulations for management are suggested. Length frequency data, catch data and fishing effort data acquisition programmes are recommended to develop and enhance the study of population dynamics.

221. Tsai, C., and Ali, Md. L. 1986.

Carp spawn fishery in the Padma (Ganges) - Brahmanputra river system, Bangladesh.

Indian J. Fish. **33(4)**: 386-401.

An investigation of the carp-spawn fishery in the Padma-Brahmaputra river system in Bangladesh, in 1984 and 1985, showed that in 1984 there were 1,212 savar (savar = local name for a group of spawn collection nets operating as a unit). There were 24,053 spawn collection nets operating at 161 spawn collection centres. Total spawn production from the river system was 23,657 kg, contributing 93.86% of the total spawn in Bangladesh. The total production of spawn in monetary terms was estimated to be Tk. 47.93 million (US $ 1.76 million). In the river system, the instantaneous rate of natural reduction of spawn caused by natural mortality, emigration, retention and other natural causes was calculated to be 0.0049 (a reduction rate of 0.49% per km). In the Jamuna - Brahmaputra River and its tributaries, the fishing intensity ranged between 20.72 nets/km and 51.45 nets/km. The instantaneous rate of fishing reduction of spawn (reduction of spawn abundance in the river due to fishing activity) ranged between 0.0066 and 0.0139, contributing 60.16% and 73.94% of the rate of total reduction. On the other hand, in the Padma River and its tributaries the fishing intensity was low, ranging between 5.86 nets/km and 7.22 nets/km. The rate of fishing reduction was 0.0001, which was only 2 % of the rate of total reduction of spawn in the river. The effects of the carp spawn fishery on major carp stocks and on pond culture in Bangladesh are discussed.

222. Tsai, C., and Ali, Md. L. 1987.

The changes in fish community and major carp population in *beels* in the Sylhet - Mymensingh basin, Bangladesh.

Indian J. Fish. **34(1)**: 78-88.

The fish community in *beels* in the Sylhet-Mymensingh basin in Bangladesh changed

22

dramatically from 1967-1973 to 1984. The dominant species of carp in the community shifted from large *Labeo rohita, Catla catla, Cirrhinus mrigala* and *L. nandina* to small *L. calbasu, L. gonius* and miscellaneous fishes. Major carp populations which were composed of large 1-2 years old (I^+) and 2-3 years old (II^+) in 1967-73 changed to populations which primarily consisted of small fish less than one year old (0^+) in 1985. The above changes in the major carp population structure suggest that overfishing is a major cause for the scarcity of large fish and decline in major carp stocks in *beels* in Sylhet/ Mymensingh basin. For 1967-73 data from Gacherdahor *beel* and an anonymous *beel* were used, in 1984 data from Bhogly, Suchar Chandia and Karcher *beels* were used and for 1985, data from Kuri, Karcher and Chakia *beels* were used.

223. Varghese, T.J. 1973.

The fecundity of the Rohu, *Labeo rohu* (Hamilton).

Proc. Indian Aca. Sci. **LXXVII, B(5)**: 214-223.

Fecundity estimations were made from 65 specimens of *L. rohita* from a Bombay lake. The relationships between fecundity and length, weight and ovary weight have been calculated. Fecundity varied from 59,650 to 1,227,500 eggs in fishes ranging in length from 26 cm to 53 cm and in weight from 150 g to 5,000 g. The number of eggs produced per gram of body weight varied from 239 to 307 (average 256) in different length groups. The fecundity was not influenced by the size of the fish. As much as 32% of the eggs were retained in the ovary during spawning.

224. Wishard, S.K., Singh, B. and Mehrotra, S.N. 1988.

Effect of certain selective environmental factors on the natural spawning of Indian major carps.

Nat. Symp. Kalyani Univ., West Bengal, India. Abst.No. C37.

Environmental conditions influencing the natural spawning of Indian major carps, *L.rohita*, *C.catla* and *C.mrigala* have been a debatable issue. Extensive studies revealed that the cumulative effect of certain selective variables are responsible for the natural spawning of major carps. A temperature shift from a higher to lower (optimum 27 +. 1^0 c), a near neutral pH (7.2-7.6), higher turbidity (200-400 ppm) and dissolved oxygen (4.0-6.8 mg l^{-1}), instantaneous dilution of electrolyte concentration (150-50 /m mhos or 400-250 /m mhos) and

electrostatic influence on the ambient waters, as evidenced by the electrophoretic mobilities of the colloidal particles (Zeta potentials) from 41.0 to 61.0 mv form a characteristic environment conducive for the natural spawning of major carps.

Moderate rains, on a cloudy day are sufficient to induce such an environment in a small dry bundh, but heavy rains for a longer duration are necessary to bring about the same in the rivers, wet bundhs and reservoirs. Increased rheotaxis is the primary response in sexually mature spawners in a fluviatile environment.

225. World Bank. 1991.
Bangladesh Fisheries Sector Review.
Document of the World Bank. Report No. **8830-BD**. 194 pp.

This report examines the present status of the fisheries of Bangladesh, in terms of the resources and the financial performance of institutions involved in fisheries. The prospects of future supplies and demand, exports and the comparative advantages of different fisheries sectors are explored. Strategies for fisheries development are proposed, including: development, promotion and conservation programmes for carp species, hilsa, and other promising new aquaculture technologies; public sector participation; increasing accountability of fisheries institutions; the public sector provision of infrastructure facilities to boost private sector investment; NGO's support by providing support and training; improving coordination between bankers and fishermen to ease credit access; promotion of aquaculture technology transfers from research bodies to villages; public sector stocking of open water; provision of infrastructure to encourage development and forcefully implementing conservation measures, like protection, rehabilitation and management of existing natural fish stocks in open waters.

3 INDEXES

SUBJECT INDEX

SUBJECT INDEX (Cont'd)

FISH SPECIES INDEX

Scientific names	Local names	Reference number
Johnius coitor	: *Koitor*	: 16
Labeo bata	: *Bata*	: 60,154
Labeo calbasu	: *Kalbaus*	: 207
Labeo dero	: *Kursha*	: 54
Labeo dussumieri		: 66,210
Labeo gonius	: *Goni*	: 59,118,181
Labeo nandina	: *Nandina*	: 145
Labeo rohita	: *Rohu, rui*	:23,24,106,112,126,133,143,160,163,182,188
Lepidocephalus guntea	: *Gutum*	: 97
Macrobrachium brevicornis		: 218
Macrobrachium dayanum		: 95
Macrobrachium dolichodactylus		: 125
Macrobrachium lammariei	: *Kunchu icha*	: 205
Macrobrachium malcolmsonii	: *Chingri chotka*	: 12,149,167,186,196,208
Macrobrachium mirabilis	: *Lotia icha*	: 129,205
Macrobrachium rosenbergii	: *Golda*	: 16,96,165,166,191,195,197
Macrobrachium rudis	: *Shola icha*	: 198
Macrobrachium spp	: *Chingri*	:12,16,31,41,95,96,125,129,143,149,165,166, 167,186,191,195,196,197,198,205,208,218.
Macrobrachium villosimanus	: *Chingri dimua*	: 41
Mastacembelus armatus	: *Baral baim*	: 23
Mastacembelus pancalus	: *Guci, pankal*	: 120
Metapenäeus monoceros		: 218
Mugil cascasia	: *Halla*	: 65
Mystus aor	: *Ayre*	: 180
Mystus bleekeri	: *Golsha tengra*	: 54
Mystus cavasius	: *Kabashi*	: 110
Mystus tengara	: *Bajari*	: 15,47
Mystus vittatus	: *Tengra*	: 34
Nandus nandus	: *Bheda*	: 23,148,152
Nangra nangra		: 129
Nemacheilus rupicola		: 52
Notopterus chitala	: *Chital*	: 131,181,209
Notopterus notopterus	: *Foli*	: 30,65,150
Odontamblyopus rubicundus	: *Lal chewa*	: 129
Ompok bimaculatus	: *Kani pabda*	: 205
Ompok pabda	: *Madhu pabda*	: 98
Oreochromis (Oreochromis) mossambicus	: *Tilapia*	: 66
Oreochromis (Oreochromis) nilotica	: *Nilotica*	: 66
Oxygaster bacaila-See Salmostoma bacaila	: *Katari*	: 104
Peneaus indicus		: 31
Peneaus monoceros		: 31

FISH SPECIES INDEX (Cont'd)