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SESSION 1

AQUACULTURE IN PONDS AND TANKS

Seassion a : Fish and Shell-Fish Culture in Freshwater Ponds

Kuthelabhata—Fish seed Farm **—its construction, operation and economics**

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The most important aspect of fish culture is availability of fish seed. In India, the demand of fish seed is estimated at about 6,000 million fry as against the present production of 500 million. There is great dearth of nurseries and rearing facilities for raising fry and fingerlings as it involves lot of capital expenditure and many other problems. As a result of this, private and public enterprises are also afraid to take up fish seed production as an industry.

Madhya Pradesh is able to meet only 12% of its requirements of fry from its small and medium sized fish farms. In order to meet its present requirement of 400 million fry attempts have been made by the Fisheries Department to construct larger fish seed farms. One such fish seed farm was constructed at Kuthelabhata near Bhilai on a 20 ha land in 1975 at a cost of 1.67 million rupees. With an initial fish seed production of 0.6 million fry in 1975—76, it has increased its production to 7.7 million fry in 1977—78 and is now earning profit even after keeping the sale price of fry and fingerlings at par with that of Calcutta prices. As

soon as 12 million target of fry production is achieved and also sale of 8 to 10 tons of fish from the farm, it would be in a position to earn profit more than double the recurring expenditure and could even repay the capital cost within a period of 20 years.

Different aspects of construction, operation and economics of Kuthelabhata Fish Seed Farm are presented.

2 Observations on the culturable species of fresh water prawns of the genus *Macrobrachium* Bate occurring in Karnataka

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This paper presents a brief resume of the work carried out on fresh-water prawns of the genus *Macrobrachium* Bate. The present study is based on samples of *Macrobrachium* spp. collected from Nethravathy, Gurupur and Mulki rivers of Dakshina Kannada district. Out of the ten species studied, *M. naso* (Kemp), *M. novae hollandiae* (De Man) and *M. bairanense* (Parisi) are new records to Indian waters while *M. aemulum* (Nobili) is recorded for the first time from the west coast of India. A general account of the size range, feeding habits and fecundity of the above species is given. The percentage composition of freshwater prawns occurring in the area studied clearly indicates that *M. equidens* (Dana) dominates the catch. Biological aspects, such as growth, food and feeding habits, sex ratio, percentage berried females, egg size and their suitability for culture, have been described. The incidence and intensity of infection of bacterial and protozoan parasites affecting the population have been pointed out. Prospects of culture of the above species in water bodies of Dakshina Kannada are also discussed.

3 Spawning behaviour, post embryonic development and culture of *Anabas testudineus* (Bloch)

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Anabas testudineus (Bloch) is a commercially important species of North

Bihar. This fish is an inhabitant of derelict swamps, where there are such natural hazards as oxygen depletion and CO_2 accumulation which affects the survival of the spawn and fingerlings. With an idea to put swampy derelicted waters of the country to be productive enough the fishes were bred in the laboratory with proper hypophysation technique (dose—15—20 mg/100 g), the hatchlings were reared upto fingerling stage and then they were set free in their natural habitat for further growth.

During the present study some observations were made on the spawning behaviour of this species. Temperature is the vital point to be considered for proper spawning, $28.5 \pm 1^\circ\text{C}$ is the optimum temperature. Spawning took place after ten hours of courtship and continued for six hours. The fishes can breed even in day time if the temperature is controlled and the surroundings remain dark, calm and quiet.

The experiments were performed in natural as well as tap water. The fertilized eggs develop well in water with pH 7.2 to 8.2, bicarbonate alkalinity varying from 14.5 to 26 ppm, oxygen content 8.0 to 9.4 ppm, free CO_2 varying from 0.042 to 0.80 mg/l at water temperature $30 \pm 1^\circ\text{C}$ and no carbonate alkalinity. Though well water provides neutral pH yet being hypoxic, the hatchlings could not survive in it.

It has been observed that the hatchlings prefer to take Zooplankton, but at the same time *Cyclops* should be avoided, as they prey on the hatchlings.

4 Culture and body composition of the air-breathing fish *Heteropneustes fossilis*

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Under the All India co-ordinated research project (C.I.F.R.I.) considerable attempt has been made to culture the air-breathing fishes. However, very little attempt has been made to determine the dietary requirement of these fishes. Studies on body composition of air-breathing fishes in relation to different diets would provide an insight into the dietary requirement of these fishes. Hence, in the present work an attempt has been made to culture the air-breathing fish *Heteropneustes fossilis* on two natural foods and their

influence on the body composition of the fish. Juveniles of *H. fossilis* in the weight range of 1.110 to 1.230 g were grouped into three series and reared separately on an *ad libitum* diet of 1. *Tubifex tubifex*, 2. *Gambusia affinis* and 3. 50 % *T. tubifex* and 50 % *G. affinis*. The results indicate that 1 Kg of *H. fossilis* in the weight range of 1.110 ± 0.125 g requires 14.56 ± 2.478 Kg *Tubifex* worm in 50 days to produce 3.58 ± 0.755 Kg new flesh, while in the same duration 1 Kg of *H. fossilis* in the weight range of 1.14 ± 0.129 g requires 6.56 ± 0.491 Kg *G. affinis* to produce 1.69 ± 0.306 Kg new flesh. When worm and fish were offered in the ratio of 50 : 50, the flesh production in *H. fossilis* reduced to 1.47 ± 0.074 Kg. The influence of quality of food on body composition of *H. fossilis* has been discussed in the paper.

5 Culture of *Clarias batrachus* (Linn.) in small seasonal derelict pond

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It has been possible to develop a system to culture *Clarias batrachus* (magur) for commercial production from shallow, seasonal derelict water bodies in rural areas. Magur fingerlings of 10–15 g average weight stocked at the rate of 40,000 per hectare and moderately fed with a mixture of low grade dried marine trash fish and rice bran attained an average weight of 139 g in less than six months and indicated a total assessed gross production of 5.2 tons per hectare in less than six months. Similarly, stocking of magur fingerlings at the rate of 50,000 and 70,000 per hectare within small ponds yielded productions of 3.1 tons and 3.2 tons per hectare in 5–6 months. Details of inputs, growth rate and management practices are discussed.

Possibilities of utilising traditional carp nurseries and rearing ponds after seed harvesting by November-December for short term culture of

magur or magur with carps from January to June every year and harvesting the stock before monsoon to make the farm ponds available for usual carp seed production have been projected.

6 Studies on the success of the newly transplanted marine fish *Chrysophrys duratus* in Lake Qarun

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Lake Qarun which lies in the Western Desert is one of only two land locked lakes in Egypt. The water medium of the lake has undergone drastic chemical changes in the present time.

For the progressive increase of salinity, most of the fresh water fishes have disappeared.

To compensate the great loss in the annual fish production of the lake, fishes of marine origin as grey mullets (*Mugil cephalus*, *M. capito*, *M. chelo* and *M. saliens*); *Solea vulgaris*, *Atherina mochon* and *Anguilla vulgaris* have been introduced in the lake since 1928. In the year 1971, the Sea Bream *Chrysophrys auratus* fry had been introduced in the lake from the Mediterranean shore. The fish adapted to the new environment and attained good growth in length and weight but failed to spawn as was evident from the mature gonads and absence of new generations.

The present investigation reflects the rate of success of *Chrysophrys auratus* in Lake Qarun and gives advice for transplanting other marine species to increase the total fish production in Lake Qarun.

7 Culture of fish in ponds with fertilization.

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Experimental observations made in fish ponds at Killa Fish Farm, Cuttack

on composite culture of major Indian and exotic carp species with only fertilization (both by direct application and through grass carp faecal matter) indicated the possibilities of obtaining good fish crops.

While a production of 3341.34 kg/ha was obtained in a year in the first experiment, productions of 2437.55 kg/ha and 2539.94 kg/ha were obtained in two ponds in six months in the second experiment. Catla, rohu, mrigal, silver carp and common carp were the species cultured in both the experiments with grass carp, however, included only in the first. Stocking density resorted to was 6000 fingerlings/ha. The ponds were fertilized periodically with both organic manure (raw cowdung) and mineral fertilizers (Urea, triple super-phosphate and calcium ammonium nitrate). The average survival of all the species cultured was 67.3% in the first and 63.8%—64.2% in the second experiment; fishes attained sizes ranging from 507.8—1081.1 g in the former and 522.4—1680.1 g and 595.2—1918.2 g in the latter experiment, respectively.

The results of the above studies indicate the type of fish crop that may be produced with lesser inputs and this perhaps could be adopted in rural areas where pond owners may be able to go in for fish culture with limited inputs.

8. Use of 3-Nitro in nursery management of the Indian major carps *Labeo rohita*, *Catla catla* and the common carp *Cyprinus carpio*

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The use of the biological additive 3-Nitro-4-Oxyphenylarsonic acid (available as 3-Nitro 5% Premix) in spawn to fry rearing was found to improve survival rate and growth significantly in case of the Indian major carps *Labeo rohita*, *Catla catla* and the common carp *Cyprinus carpio*. 3-Nitro was mixed directly in the rearing medium at a dosage of 10 and 20 mg/l.

The results obtained in the laboratory experiments using small aquaria were translated into yard experiments using 300 to 400 litre capacity plastic pools with 3,000 to 5,000 spawn and as field scale in nursery ponds of

20 × 10 × 1 meter. Results have been encouraging and the technique can be applied profitably.

9 Observations on fish production through short-term rearing

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Observations were carried out in a pond (0.4 ha) of the harijan villagers in Pubasasan near Dhouli. The aquatic weeds were manually removed by the villagers. The pond was stocked with fingerlings of catla, rohu, mrigal, grass carp, silver carp and common carp @ 2500/ha in the ratio of 1.5:2.5:1.0:1.5:1.0:2.5 respectively. Management measures included liming and fertilizing the pond with the mixed fertilizer 'Gromor' and cow-dung and feeding the fish with groundnut oil cake and rice polish. Physico-chemical qualities of the soil and water were studied. The average weight attained by catla, rohu, mrigal, grass carp, silver carp and common carp in six months rearing was 1,520 g, 796 g, 444 g, 810 g, 1340 g and 1108 g respectively. A production to the tune of 2,000 kg/ha/6 months could be obtained from this pond, the cost of production being Rs. 2.72/kg of fish.

10 Freshwater alga *Spirogyra grosii* Schmidle as a nutritive source to *Cyprinus carpio* Linn

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Growth of the fry of *Cyprinus carpio*, fed on three diets comprising

alga powder (*Spirögyra grosii*), fish meal, and dried plankton mixed with potato starch, yeast powder, terramycin and salt in different ratios for 2 hr/day for 40 days, was studied with a view to asses the nutritive value of the filamentous alga, *S. grosii* as a source of protein. The experiment was conducted in plastic pools with proper arrangements of running water and aeration. The growth of fish achieved with the nutrients supplied by the feed prepared with alga powder was comparable to the growth of fish fed with dried plankton. This suggests the possibility of utilizing the thick infestations of this unwanted alga as a component in fish feed.

II Observations on the rearing of quality fish seed in the villages of Orissa

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The farmers of Ayatpur, Danduasipada Damodarpur villages of Cuttack district were trained in the scientific techniques of fish feed rearing in their small ponds, as a part of the Operational Research Project on fish culture in the rural area of Orissa. The induced bred spawn of catla, rohu and mrigal (3.05 lakhs) was stocked in five ponds (0.095 ha) and a total of 88,235 fry (catla-38,700; Rohu 38,395; Mrigal—11,140) were harvested and sold to the farmers from neighbouring villages, after meeting the demand of the farmers of these three villages. They could earn a net income ranging from Rs. 124.68 to Rs. 2,271.90 during the season from their small ponds (0.01 ha to 0.03 ha), with the survival of fry ranging from 8.97% to 47.20% (average survival—28.93%).

The studies have indicated the possibility of making the villages self-sufficient in quality seed of Indian major carps by supplying the spawn to the farmers and training them in the scientific method of fish seed rearing.

12 Observations on prolonged induced breeding of silver carp

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Hypophysation of silver carp, *Hypophthalmichthys molitrix* Val., was successful upto November, 1978 whereas, it was so only upto August previously. Proper brood fish care, delayed but regular monsoon (August-October) and accumulation of fresh rain water in the brood-fish ponds appear to have contributed towards prolongation of the breeding season. This could be considered an important step forward towards domestication of the species.

The receptivity period in mature females of silver carp has been observed to be much longer than in grass carp. In silver carp, the mature ova when not released, got resorbed and fresh batches of eggs continued to mature. Thus even when the bulging of the abdomen got reduced, viable eggs were obtained on hypophysation.

During 1978 breeding season, the number of eggs released/kg body weight and spawn obtained were maximum in September. Even in October, production of spawn was good which would have been far better in case sufficient number of mature males were available. However, milt could be preserved in advance to overcome this difficulty in future.

13 Oxygen packing of silver and grass carp fingerlings at different densities and Temperature ranges

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Transport of fingerlings of silver carp and grass carp are often necessitated almost throughout the year for purposes of composite fish culture, and that of grass carp for biological weed control. Hence, studies

on different rates of packing of fingerlings per tin under oxygen at three ranges of water temperature were made.

The silver carp fingerlings (104—149 mm), remained in good condition for 12 hours with 100% survival at stocking rates of 20 and 30/tin at a temperature range of 24—25°C and also at 20/tin at 26—30°C temperature range. However, the fish were in distress at 30/tin at 26—30°C and at 20 and 30/tin at 31—34°C temperature range.

The grass carp fingerlings (61—93 mm) remained in good condition for 24 hours with high percentage of survival (82—95%) at stocking rates of 100 & 125/tin at 25—25.8°C temperature range, also at 100/tin at 26—30°C temperature range. However, at 125/tin at 26—30°C and at 100 and 125/tin at 34—35°C temperature range the fish were in distress.

Changes in water quality (temperature, pH, D.O., total alkalinity, free CO₂ and free NH₃) were noted at regular intervals during the period of observation.

14 Observations on the use of various hormones and clomiphene citrate in hypophysation of Indian major carps

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Carp pituitary glands are extensively used in hypophysation of Indian major carps but the supply of required quantity of gland is not ensured. Studies were undertaken to find out suitable and cheaper substitute.

Pituitary glands of freshwater, brackishwater and marine fishes, salmon pituitary powder (Code-341), synthetic mammalian hormones and clomiphene citrate, a chemical, were tried on 115 sets in dosage ranging from 4—200 mg/kg body weight of the recipient female. The controls (57 sets) were injected with carp pituitary extract @ 4—18 mg/kg.

It was observed that while the pituitary glands of freshwater cat fishes (*Pangasius pangasius*, *Bagarius bagarius*, *Silondia silondia*, *Mystus seenghala*) and

Salmon pituitary powder (Code-341) precipitated successful spawning in the test fish, *Labeo rohita* (rohu), yielding one million of fish seed, negative results were obtained with the pituitary glands of brackishwater and marine fish, Antuitrin 'S', LHRH and with clomiphene citrate at various dose levels. However, the controls injected with carp pituitary extract spawned successfully producing over 7 millions of fish seed.

15 Observations on the hypophysation of albino *Catla catla*. Hamilton

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Albino catla obtained for the first time through hypophysation of normal catla, in 1960, at Cuttack, were found to be mature within two years like the normal catla. 8 sets of albino specimens ranging 1.6 kg to 7.6 kg in weight induced to spawn by pituitary injection so as to compare their response with that of normal catla, during 72—77. Both treated and controls were injected with same dose ranging 12 mg to 20 mg/kg body weight of the female recipients.

It was observed that the albino catla was equally responsive to pituitary treatment as the normal ones, yielding 88% success in spawning and producing 1.285 millions of fish seed. Further observations revealed that the progeny obtained through albino parents were all albino while all normal progeny was produced when one of the parents was a normal catla, indicating that the albino character is a recessive one.

16 Observations on the use of Human Chorionic Gonadotropin prepared in the laboratory, in inducing spawning in major carp—*Labeo rohita* Ham.

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Studies were undertaken aiming at finding out a suitable substitute

for fish-pituitary extract for induced fish breeding. The human chorionic gonadotropin prepared in the laboratory, was used in inducing spawning in rohu (*Labeo rohita*) keeping suitable controls injected with carp pituitary extract.

In all 34 female rohu were treated, of which 10 received HCG alone and the rest were treated with combined doses of HCG in carp pituitary. The dose ranged between 1 mg & 4 mg HCG and 1 mg HCG + 3 mg P.G. to 25 mg HCG + 6 P.G./mg/kg body weight of the recipients respectively. It was observed that the specimens that received HCG alone gave negative results whereas the combined dosages of HCG precipitated spawning in about 38% of the recipients. The results suggests that the use of HCG reduces the requirement of carp pituitary to a considerable extent.

17 Observations on artificial propagation of *Hilsa ilisha* (Hamilton) of river Narmada and its culture in confined water

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Results of experiments on artificial fecundation, effects of hydrological parameters like Fe^{++} , Ca^{++} , etc., on hatching of the resultant fertilised eggs, possibilities of hatching the eggs in modified indoor hatcheries and rearing of the hatchlings in freshwater ponds, in respect of *Hilsa ilisha* (Ham.) of river Narmada which spawn in estuarine areas have been presented.

Artificial fecundation was successfully achieved through "wet" method of stripping and percentage of fertilisation varied between 60 and 90. The fertilised eggs were hatched in markin and nylon cloth hapas fixed in ponds. In such ponds where the concentration of Fe^{++} varied between 100 and 186 ppm and antagonistic Ca^{++} ions from 20 to 40 ppm the percentage of hatching was low (10 to 30%) and all the hatchlings died within an hour of their birth. In situations where concentration of Fe^{++} and Ca^{++} varied between 0.16—0.18 and 30—40 ppm the percentage of hatching fluctuated between 70 and 80%, and only 10% of the hatchlings died during the next 24 hours of rearing in the hapas. In modified indoor hatcheries

wherein continuous water flow was maintained the hatching success varied between 90 and 95%. It was also observed that when incubator was made of 1/15" mesh monofilament nylon netting, 60—80% of the hatchlings could be segregated from dead eggs and egg shells.

In nursery pond (100x50 feet) 2.5 to 3.0 mm long, artificially produced, hatchlings had attained an average length of 75 mm in 50 days and are continuing to grow.

18 Studies on metabolism in pond reared fingerling of *Hilsa ilisha* (Hamilton)

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Results of experiments on routine and activity metabolism in pond reared fingerlings of *Hilsa ilisha* (Ham.) of river Narmada have been presented.

Routine and standard metabolism of *H. ilisha* (wt., 4.2 g, T.L., 7.2 cm) at ambient oxygen near air saturation at 27°C was determined.

Routine metabolism was calculated as 144 mg/kg/hr while the standard metabolic rate was 103 mg/kg/hour. The maximum and minimum activity recorded was 80 and 20 counts/hour respectively. The asphyxal oxygen level for the fish was observed at 1.20 mg/l ambient oxygen.

19 Monoculture of magur (*Clarias batrachus* Linn.) with and without water replenishment

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The potential of newly developed aquaculture systems adopting non-traditional species such as magur (*Clarias batrachus* Linn) for monoculture

in India is presented. This new system was given a field trial in farmers' ponds in two villages of West Bengal, viz. Sanko and Nabasthe, to demonstrate increased yields and high incomes from small village water as a means of boosting the rural economy. Monoculture of magur in small, shallow ponds at 50,000 fingerlings/ha gave, on an average, production of 3,687.7 kg/ha in 5½ months with 71.1% survival.

Very high productions are possible if the waters of magur ponds, laden with metabolites, are periodically changed. Magur, stocked at 2 lakhs/ha gave a production of 7.3 t/ha in 6½ months with a survival of 63.5% despite an extremely irregular schedule of watering the ponds. This system has a tremendous potential in areas having assured water supply such as from irrigation canals or tube-wells and holds a great promise in developing the economy in the rural sector.

20 High density rearing of rohu spawn in village ponds

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Improved nursery management techniques for high survival have made increased stocking densities of carp spawn possible. Further improvement in these techniques along with the use of protein-rich diet fortified with yeast resulted in much high rates of survival than hitherto obtained. Stocked at an average rate of 10.21 million/ha a survival of 80.73% was obtained with an average production cost of Rs. 3.79/1000 fry.

21 Some biological aspects of *Schizothorax esocinus*, Heckel, for its utility in culture

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The reported depletion of *Schizothorax esocinus* in Kashmir waters has given importance to the culture of this fish in the upland waters.

On the basis of food studies, *S. esocinus* has been classified as omnivore, with sizeable amount of decayed organic matter, both in juvenile and adult stages, apart from animal food (insect and fish) which is absent in juveniles.

Maturity study revealed that the fish has a prolonged spawning phase as the matured specimens were available almost throughout the year. The fish performs spawning migration in the only adjoining seasonal 'Arh' stream during May-June. The fecundity has been estimated to range from 4,573 to 19,976 eggs in fishes ranging from 194—485 mm and 100 to 1,000 g.

Most of the fish stock remain unspawned and large number of the newly hatched out fry and fingerlings perish, as from August the 'Arh' stream gets cut off from the Dal lake which hampers natural recruitment to a great extent. Other studies i.e. length-weight relationship, G.S.I. and relative condition factor etc. have also been discussed in the paper. The importance of these studies in the culture of this much prized indigenous fish has been stressed.

22 Constraints in rural aquaculture development by small farmers in some villages of Orissa

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The constraints and impediments encountered by the small and marginal farmers of some of the villages of Cuttack and Puri districts of Orissa in taking up fish culture have been identified during the course of the demonstration of the technique of raising quality fish seed and table-size fish in the ponds available in the rural area. The farmers' ignorance of the modern scientific method of composite fish culture, their lack of confidence in the profitability of aquaculture and the non-availability of adequate quantity of the seed of all the major carps are some of the principal constraints in rural aquaculture development. Other impediments include their financial limitations, social inhibition, fear of poaching and poisoning of their stock, lack of proper road communication to the remote villages, utility of the pond water for domestic purposes, non-availability of suitable piscicides, aquatic weed infestation, etc. The observations have indicated the existing gap between the research results and their field

application and that many of the impediments can be removed by supplying the seed to the farmers and training them in different aspects of scientific fish culture through demonstrations carried out in village ponds themselves. The farmers will adopt the technique of aquaculture, if they are provided with the spawn and technical assistance by trained personnel of the aquaculture development and extension agencies.

**23 Studies on the potentialities for pisciculture and its
 development in small ponds of coconut gardens at
 Krishnapuram, Kerala**

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The suitability of small homestead ponds of coconut garden for profitable fish production and scope for improvement was studied and the results are presented.

Pond area ranged from 1 to 6 cents (0.005 to 0.03 ha). water level fluctuation between seasons ranged between 2m and 3m. Most of the ponds were deep but long seasonal. *Salvinia* dominated other aquatic vegetations harboured by many ponds. Frogs, water snakes, and birds frequented ponds often. Murrel (*Channa* sp.) was the main local fish which was gaining easy entry from nearby paddy fields during heavy rains. Eighty three respondents showed interest in carps and 14 in murrel culture. Pearl spot (*Etroplus suratensis*) topped in taste-preference. Cast-netting and dew-atering were the chief methods of fish harvest. Majority had animal and plant wastes as fish culture inputs, in their own homesteads. With the introduction of fast growing carps in 1975, the average fish yield of ponds had increased 2.5 fold during 1977—78, with an individual maximum rate of 2,240 kg/ha/7 months. The results of the study indicate the suitability of these ponds for improved fish culture to meet the farmers' need.

24 Preliminary observations on species ratio manipulation to enhance growth rate of carps in ponds

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Experiments were carried out in two ponds of 0.25 ha each in Kausalyaganga fish farm with stocking density of 5,700/ha with six species composition of silver carp 3.75, catla 2.5, rohu 2.5, mrigal 2, common carp 2 and grass carp 1.5. Growth rate observed through monthly samplings showed unsatisfactory growth of catla and rohu during the initial months. Lowering the density of catla and rohu by 5% in one pond showed positive response in growth rate of rohu only in the fourth month. Further manipulation of stock was done and increase in relative growth of catla was recorded after reducing the density of silver carp population. The growth rate in the control pond was observed to be erratic in all the species throughout the one year rearing period.

Indications on growth behaviour of the six species of fishes in relation to their densities are discussed.

25 Studies on malathion toxicity in the catfish, *Clarias batrachus* (Linn)

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Air-Breathing Fish Culture
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In paddy fields and low-lying inundated areas where culture operations of air-breathing cat fishes *Clarias batrachus* and *Heteropneustes fossilis* are in vogue alongwith paddy cultivation, the use of the pesticide, malathion (0,0—dimethyl, dithiophosphate of diethyl mercaptosuccinate) is of concern. Extent of physiological damage and the effect on overall growth of the catfish, *Clarias batrachus* as affected by low level (0.5 ppm) exposure to malathion has been studied.

Multiple disturbances in the metabolism under malathion exposure of the fish have been elucidated and detailed mechanism of toxicity discussed.

The effect of malathion exposure (0.5 ppm) for 40 days on mitochondrial, lysosomal and microsomal enzyme activities from liver and gills of the catfish *C. batrachus*, esterase activities including brain acetylcholinesterase activity, changes in the electrophoretic pattern of serum proteins and the effect on immune response in the catfish towards pesticide exposure have been reported. The residual accumulation of malathion and its major metabolites in tissues have also been determined by gas liquid chromatography after exposing the fishes to malathion for forty days at a dose of 0.5 ppm.

Threshold indices of toxicity of malathion in *C. batrachus* have been discussed in the light of existing information. Possibilities of readapting paddy cum-fish culture, in the face of inevitable use of agricultural pesticide, have been projected.

26 Preliminary observations on the effect of tamarind seed husk on fish

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Powdered tamarind (*Tamarindus indica*, L.) seed husk added to water kept in glass jars, killed test fishes in laboratory experiments. Of the different dosages tried (5, 10, 15, 20, 25, 30, 40 & 50 mg/l), 5-10 mg/L concentrations proved effective in killing *Labeo rohita*, *Catla catla*, *Cirrhinus mrigala*, *Cyprinus carpio*, *Tilapia mossambica* and *Channa marulius* within 2 hours of its application in a temperature range of 28°—34°C. Fishes exhibited erratic movements at the water surface, lost their balance, subsequently died and settled down. Details are presented in this communication.

27 Rearing of major carp fry to fingerlings in freshwater ponds

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Rearing experiments of fifteen days old fry of Indian major carp, catla

(*Catla catla*), rohu (*Labeo rohita*) and mrigal (*Cirrhinus mrigala*), together with grass carp (*Ctenopharyngodon idella*) in two 0.8 ha rearing ponds were conducted for three months. The combined stocking density tried was 2.07 lakhs/ha used in the species ratio of 3.6 : 3.6 : 1.6 : 1.2 respectively. The fry were fed daily with a mixture of groundnut oil cake and rice polish in the ratio of 1 : 1. Organic and mineral fertilizers were also provided. The overall survival of fingerlings ranged between 75 and 89%. A production to the tune of 3000 kg/ha/3 months could be obtained.

The practicability of raising large crop of healthy carp fingerlings has been demonstrated by the experimental studies.

28

Effect of lime on fish pond soils

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The effects of Calcium oxide, Calcium hydroxide and Calcium carbonate at three rates (250, 500 and 1,000 kg/ha on equivalent CaO basis) on slightly acidic fish pond soil (pH 6.0) in enhancing soil pH, and mineralisation of nutrients were studied. The soil reaction, available nitrogen and available phosphorus increased with the three forms of lime according to the enhanced rate of application with corresponding decrease in organic carbon. Identical results were also obtained in the water quality with regards to pH, total alkalinity and dissolved inorganic phosphate. While the maximum increase was recorded with the highest rate of each form of calcium, the effect of calcium carbonate appeared superior as compared to the other two forms.

**29 Studies on composite fish culture in a running water pond
 at Bhavanisagar, Coimbatore District, Tamil Nadu**

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Experiments on composite fish culture in a running water pond, without fertilization but with artificial feeds yielded a gross and net production of 173.7 kg and 158.3 kg/0.03 ha in 12 months respectively which works out to 5.7 t and 5.2 t/ha/yr respectively. Mrigal, common carp and grass carp recorded better growth attaining an average weight of 604 g, 771 g and 600 g respectively. Catla and silver carp showed poor growth, in spite of their less numbers. The poor growth of these two is attributed to poor plankton in the running water pond without fertilization. The better performance of mrigal, common carp and grass carp is mainly due to their utilization of the artificial feeds.

**30 Observation on the large scale production of carp seed in
 open enclosures at Bhavanisagar, Tamil Nadu**

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Experiments on induced breeding of earps indicated that these could be made to breed successfully in open enclosures instead of putting them in closed enclosures like the traditional breeding hapas. The breeding work was undertaken in an open channel receiving seepage water from the dam above. The channel was partitioned into small compartments by putting stone and mud walls prevent the fishes from mixing between groups. The selected sets of brood fishes were released in each compartment where a mild flow

of water was maintained. The fishes started breeding 3—4 hours after the second injection with high percentage of fertilization and the eggs were collected at the inlets when they accumulated with the flowing water. The average water temperature was 29.5°C during the experiment. Water was very clear. There was practically no rainfall during this period. By this method, use of breeding hapas were completely eliminated and about 12.6 million hatchlings of Indian and exotic carps and hybrids were produced from April to September, 1978. This gives much scope for reducing the huge amount of money spent every year for breeding hapas in large scale breeding, especially in seed farms with flowing water facility.

31 Observations on the pond breeding of 'Magur'

Clarias batrachus (Linn)

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All India Coordinated Research Project

On Air-breathing Fish Culture

Central Inland Fisheries Research Institute

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While attempting to evolve a handy technique for raising seed of 'magur' for culture purposes, a trial on the pond breeding of the fish was made. The objective was also to study the aspects of survival and production of 'magur' fry and fingerlings in nature. Ten sets of spawners, each consisting of one male and one female, were injected with carp pituitary extract (10 mg/100 g body weight of the recipient) and released in a pond of 274 m² water area on 17.7.1978. After dewatering on 9.11.1978, 156 young ones (32 to 119 mm total length) of 'magur' could be collected from the pond giving a production of 0.57 young one/m². Analysis of the size frequency distribution of the retrieved young ones revealed two modal peaks around 50 and 90 mm lengths suggesting that there were two spurts of spawning in the pond. Contribution of the older group in lesser number in the total catch of the harvested young ones indicated that the survivability of 'magur' young ones in nature diminishes sharply with increase in their size. It was concluded that collection of the young ones of 'magur' from the breeding pond at their early stages of development and rearing

them separately with provisions for a suitable supplementary diet would bring forth sizable increase in their survival and production.

Analysis of the gut contents indicated that with increase in the size, predilection for insectivorous diet gets stronger in the fish. In the laboratory, the young ones showed definite preference to a diet of crushed *Anisops*.

32 Role fish food organisms in cold water fish culture

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Important cold water fishes, viz., *Schizothorax* spp., *Cyprinus carpio*, *Salmo trutta* are good zooplankton feeders. But under cold climatic conditions, the plankton population in natural waters is poor. This has a definite impact on the growth and development of these fishes in natural waters. Thus, for the successful nursery management of *Schizothorax* sp. under culture conditions, it becomes imperative to devise methods for the mass culture of certain accepted natural food organisms. In the present investigation, accepted food items of *Schizothorax* have been studied for their culture. The main organisms studied are *Daphnia pulex*, *Scapholebris kingi*, *Ceriodaphnia reticulata* and *Moina irrasa*. Successful methodology has been worked out after analysing various concentrations and dosages of different organic and inorganic nutrients to mass culture these micro-crustaceans under field and laboratory conditions. Detailed bio-ecological studies have also been carried out to help further improve the culture techniques. The peak population ranging between 4,000 and 9,000 organisms per litre from an initial inoculum of 30 to 50 organisms per litre have been obtained within 15 days under field conditions.

Ephippial eggs have been successfully germinated under laboratory conditions. Feeding experiments of *Schizothorax* with cultured organisms have been conducted. This is the first attempt to mass culture these fish food organisms under cold climatic conditions.

33

Angling—an effective method for harvesting mrigal

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Removal of column and bottom feeders such as rohu and mrigal from ponds with uneven bottoms, ghats, central pillars or temples and depths ranging from 3—6 m presents considerable difficulties. Fishermen in West Bengal and Orissa with dragnets without pockets are not generally able to harvest more than 50% rohu and 25% mrigal from such ponds. Experimental angling with 4 rods in 3 ponds (0.44—0.60 ha in area) indicated that both rohu and mrigal could be effectively harvested, the average catch/rod/day during the 5 day period being 16.66, 10.85 and 20.75 fish. Morning catches were better than those of afternoon. Mrigal fell an easy prey as compared to rohu.

Angling thus provides an easy means of harvest, especially in areas such as Jalpaiguri, where a fish-farmer has to hand over a minimum of 40% of the catch to the fishermen as labour charges. Besides being a sport, angling—if conducted properly could also be a means of self-employment to many.

34

Culture of murrels (*Ophicephalus* spp.) in a swamp

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To assess the possibilities of utilising derelict swampy waters, fingerlings of *Ophicephalus murillus* (Ham.), *O. punctatus* (Bloch), *O. orientalis* (Ham.) were stocked at the rate of 35,500 per hectare in a derelict pond of 0.1 ha at Lalbagh, Bangalore, Karnataka. The fingerlings were fed with low grade

dried marine trash fish and fresh silk worm pupae. Observations on the growth and survival of these fishes and environmental features of the water are discussed. Production at the rate of 4,041 kg/ha/yr of murels is a record, projecting for the first time the possibilities of culturing murels.

35 Primary productivity in a composite fish culture pond at Kulia fish farm, Kalyani, West Bengal

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Primary productivity in a composite fish culture pond at Kulia fish farm, Kalyani, Dist. Nadia, West Bengal was studied for a period of one year (March, 1974 to February, 1975). This was supplemented with the data on physico-chemical features and plankton of the pond for the same period. Gross production ranged from 1.143 to 8.625 GC/m³/day, while net production ranged from 0.662 to 6.575 GC/m³/day. The annual average values were 5.372 GC/m³/day and 3.816 GC/m³/day respectively for gross and net production. Respiration amounted to 28.97% of gross production. Net-gross ratio varied from 0.36 to 0.97. The rate of gross production was maximum in the surface water and minimum in the bottom, with an approximate production ratio of 9 : 2 : 1 respectively for surface, mid depths and bottom. Temperature showed a direct co-relation with productivity, whereas, no other factor studied showed any such relationship with productivity.

36 **Some economic aspects of composite fish culture in India**

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Composite fish culture has taken firm roots in India as a viable agricultural technology. Economic investigations of composite fish culture are therefore, necessary to provide a base for investment decisions. Economics of a model fish farm of composite fish culture alongwith averages of case studies in four zones of the country are presented. The key economic values such as security margin, degree of contribution and breakeven point are also estimated. Expenditure on feed constituted the dominant cost component in composite fish culture at 60 to 70% of total costs. It is critically examined as to what extent the expenditure on feed can be limited in different zones of the country, keeping in view the price levels of fish.

37 **Preliminary investigations on the mass culture of** *Macrobrachium lamarrei*

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Investigations on the culture of prawns and shrimps have created immense biological interest because of their high food value. The mass production of high quality prawns depends upon the supply of suitable food to the developing individuals. Supplementary food is known to give better growth rates in prawns. Although considerable success has been achieved in the culture of giant freshwater prawn *Macrobrachium rosenbergii*, no attempt has been made to culture the other species of *Macrobrachium*. In view of the high demand in the local market for these prawns, an attempt has been made to mass culture the freshwater prawn *M. lamarrei* on supplementary diet. Post-larvae of *M. lamarrei* weighing 172 mg were stocked at the rate of 4 g per sq.ft (or 14 larvae/sq.ft) in cement tanks (area : 27 sq.ft.). They were fed on rice bran and oilcake in the ratio of 1 : 1 for 30 days. The food intake, growth conversion efficiency and body composition of *M. lamarrei* have been determined and the results discussed.

38

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Experiments on mesh selectivity of gill nets for some freshwater carps in ponds were conducted using mesh sizes of 87, 100, 125 and 137 mm. Nets were woven by using nylon twine of code No. 210/2/3 with hanging coefficient 0.5 and depth 3 meters. Mesh selectivity curves were drawn for catla, rohu, mrigal, silver carp, grass carp and common carp where some curves extended with a fairly high value of efficiency. Curves were broader and skewed right which suggested the presence of tangling catch with large fish. Selectivity factor 'k' varied from slender to broad bodied fish. Gill net fisheries are highly selective of large, heavy and fast growing individuals and culling of fish around 1 kg size (marketable size) was found out to be about 120-135 mm mesh size.

The possible implications and importance of gill net operation in fishery management in cultivated water are discussed.

39

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Periodic sampling of fish in ponds guides proper fishery management. Weight loss in fish during the course of sampling, if fishes are handled too long, are likely to give erroneous estimates of production. Observations made on loss in weight at different intervals after harvest indicated a fall by 33.2, 26.9, 21.5 and 16.7% during the first four hours in freshwater carps. The average loss was observed to range between 1.86 to 2.38%, the highest being 3.43% for silver carp in Summer and the lowest was 0.97% for common

carp in Winter. Analysis of variance showed that specieswise hourly loss varied significantly. Coefficient of variation of loss in weight calculated for different seasons ranged from 16.0 to 51.6%. Information on likely loss in weight of different cultivable carps during different seasons is useful in marketing the fish.

40 Studies of composite fish culture at Ranchi, Bihar

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The results of experiments on Composite Fish Culture, conducted at Ranchi in Bihar, have indicated the possibilities of enhancing fish production on acidic and low productive soil. In the three sets of experiments completed so far, the fish production has gone upto 3,526.500/kg/ha/yr from that of 1,504.350/kg/ha/yr obtained in the first experiment. Inspite of the increasing cost of inputs, the cost of fish production has come down to Rs. 2.62 per kg of fish as against Rs. 5.79 per kg of fish in the first experiment.

The experiments conducted have indicated that by regulating liming and organic manuring alone and without increasing the artificial feed, high production of fish can profitably be obtained. Observations on hydrological aspects, plankton condition and different treatments with organic and inorganic fertilizers and combinations of fish species have been analysed and discussed.

41 Observations on the nutrient status of Ioni reservoir (M.P.)

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The paper attempts, on the basis of limnological investigations carried

out during the period 1958—70, to evaluate the nutrient characteristics of Loni reservoir in Madhya Pradesh giving due importance to relevant limno-chemical parameters of water edaphic features and primary production. The studies reveal that the soil of reservoir basin is characterised by moderate organic carbon (0.57—1.17%), moderate to rich available nitrogen (25.8—38.64 mg/100 g) and low in available phosphorus (0.8—1.8 mg/100 g). The pH of the soil was near-neutral (6.5—7.2). It is significant that the phosphate value of the water is of much higher order than what is reflected by the soil. This indicates the importance of geo-chemical features of drainage basin which appears to influence the basic productivity of the reservoir more than the chemical quality of reservoir basin soil. The reservoir also shows favourable concentration of available nitrogen in addition to favourable values of alkalinity and total hardness. These parameters point unmistakably that the reservoir is "above average" in productivity. This is further affirmed by the trends of primary productivity observed in the reservoir.

42 Production of major carp seed by partial hypophysation cum bundh breeding in Bilaspur area of Madhya Pradesh

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Bundh breeding of Indian carps is prevalent in West Bengal and Bihar in India and Chittagong in Bangladesh. More recently, large scale bundh breeding is being practiced in Madhya Pradesh. Partial hypophysation-cum-dry bundh breeding is the most modern technique adopted in the districts of Midnapore and Bankura of West Bengal where male and female brooders of major carps are injected with pituitary hormone extract before stocking in a dry bundh.

An attempt has been made to explore the possibility of mass breeding of carps by partial hypophysation in Dulhara dry bundh (area 0.106 ha) situated near Khutaghat fish farm, Bilaspur district of Madhya Pradesh. Only 36% of total brooders were injected with 4 mg/kg for males and 8 mg/kg for females. The brooders were catla and rohu with weights ranging from 4—5 kg and 2 kg respectively. The breeding was successful which opens a new method in the production of quality fish seed even without rain or regular flow of water which was hitherto practiced in West Bengal.

In the present case, the breeding took place only after pituitary hormone injections as the same brooders were not giving any response inspite of stocking them in the bundh for a period of more than 10 days probably due to non conducive climatic conditions such as high temperature and draught weather.

43 Hazards in fish farming in acid ponds of Jalpaiguri

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Ponds constructed on acid soils are known to be poorly productive the world over. The acid character of such ponds at Jalpaiguri was responsible for iron and manganese toxicity, low mineralisation rate, trace element deficiency, poor plankton production and consequently poor rate of fish growth, parasitic infections, high initial mortality and poor survival rates. Attempts to change the acid character and improve the mineralisation rate by liming often resulted in *Microcystis* blooms, oxygen-carbon-dioxide imbalances and fluctuations in pH hampering the supplementary feeding schedules. However, the acid character of Jalpaiguri ponds was completely changed by liming @ 2,000 kg/ha in divided doses at monthly intervals during the first six months followed by 1 000 kg/ha in divided doses at fortnightly intervals and the ponds made productive giving an average production of 3.2 t/ha/yr in the very first year of their utilisation for fish culture.

The change in water and soil conditions has been discussed.

44 Oxygen requirement of *Hilsa ilisha* (Ham) eggs and hatchlings

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Oxygen consumption of *Hilsa ilisha* (Ham) eggs and 1 to 4-day old

hatchlings have been determined by fixed bottle method and by modified method. In fixed bottle method, oxygen consumption of hilsa eggs and 1-day, 2-day, 3-day and 4-day hatchlings was estimated respectively as 0.25 mg, 0.94 mg and 1.56 mg, 2.0 mg, 2.0 mg, and 2.5 mg/1,000 hatchlings/hour. In modified method, the oxygen consumption values were slightly higher than the fixed bottle method.

45 **Preliminary observations on the effect of vitamin E and growth hormone on the gonadal maturity of carps**

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Effects of Vitamin E (Ephynal—Alpha Tocopheryl Acetate and growth hormone (Methandienone) as additives to conventional supplementary feed consisting of groundnut oilcake and rice bran (1 : 1 by weight) on the gonadal maturity of catla, *Catla catla*, rohu, *Labeo rohita* and common carp, *Cyprinus carpio* were studied.

It was observed that common carp when treated either with vitamin E or the growth hormone showed higher gonadosomatic index than the control fishes. Based on this, further experiments were carried out with catla and rohu, which were given vitamin E (@ 5 mg/kg body weight of the fish/day) along with the feed at 2—3% of the body weight. The treated carps showed higher gonadosomatic index, bigger ova; and on hypophysation yielded more number of eggs (Catla 0.171 million/kg body weight of the fish and rohu 0.177 million/kg body weight) than the control (Catla 0.124 million and rohu 0.130 million eggs/kg body weight). Further, complete spawning was obtained with treated fishes while it was only partial in the majority of untreated ones. These results indicate that vitamin E and growth hormone can be effectively used by the pisciculturist as additives along with the conventional supplementary feed to raise brood stock in proper condition and minimise the chances of failure in induced breeding of fishes.

Soil water interaction and nutrient turnover in a weed infested swamp

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The old derelict weed infested swampy water sheet at Kalyani (Dhakardha Beel), has been studied to assess its potential carrying capacity. Organic nutrients lying dormant in soil phase can be effectively brought to water phase for mineralization at faster rate by raking of the bottom soil. This increases ammoniacal nitrogen, nitrate nitrogen, phosphorus, alkalinity, organic carbon and specific conductivity, resulting in enhanced primary production and thereby bringing about a favourable balance of metabolic gases, such as dissolved oxygen and free carbon dioxide. The pH increases to near neutral or slightly alkaline from acidic range and thus the aquatic ecosystem turns highly productive for fish culture without additional inputs in terms of fertilizer or manuring.

Assuming the availability of solar energy and other essential elements constant over a small period, the primary production appears to be a single value function of the available phosphorus in solution. Again, the ammonia released during mineralization has been noted to be gradually converted into a more mobile nitrate form quantitatively.

47 Lay-out plan for semi-intensive and intensive culture of air-breathing catfishes

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The paper deals with general principles of fish pond construction for culture of air-breathing catfishes. A case study of Kalyani Bheel indicating alternate pond design has been given. Capital costs for different pond design and its usefulness in the long run have been discussed. Anticipated unit economics and other economic parameters are also presented.

48 Preliminary observations on the efficacy of grass carp in controlling submerged aquatic vegetation from large waters

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Grass carp, *Ctenopharyngodon idell* (Val) was introduced in two large water bodies of 10 hectare and 1.8 hectare effective water area, thickly infested with natural growth of *Hydrilla*, *Najas* and *Potamogeton* and scattered patches of *Trapa*. There was good stock of Indian major carps and common carp in both the water bodies. Grass carp could effectively control all these submerged aquatic weeds within a short period and the fish recorded very high growth rate.

The size and number of grass carp that are required to be stocked for early clearance of weeds from large waters have also been dealt with.

49 Toxicity of some herbicides to fishes

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The herbicides Simazine, Paraquat and 2,4—D sodium salt which show promise in the control of aquatic plants were tested for their toxicity to fishes by bioassay methods. The test fishes used were fingerlings of *Labeo rohita* (97—167 mm), *Cyprinus carpio* (43—116 mm) and *Tilapia mossambica* (54—107 mm).

In trials of 72 hour duration 2,4—D sodium salt at as high a dose as 400 ppm (a.i.) had no adverse effect on the fishes when water temperature varied from 22° to 28°C. In the case of Simazine, upto 20 ppm (a.i.) was observed to be safe concentration for *L. rohita* and *C. carpio* at temperature range of 20° to 30°C. In case of Paraquat the safe concentration was observed to be 3 ppm for *L. rohita*, 5 ppm for *C. carpio* and 7 ppm

for *T. mossambica*, when the temperature ranged from 28° to 31°C. The median tolerance limit for different fishes have been calculated.

50 Observations on the effect of some herbicides on plankton

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In adopting chemical method of weed control in fish culture ponds, it is feared that the natural growth of plankton may be adversely affected. Through a series of replicated treatments, it was observed that 2,4—D sodium salt when applied at 5 and 10 ppm concentrations (a.i.) had no bad effect on the growth of phytoplankton and zooplankton. Similar observations with Simazine indicated that at 0.2 and 0.5 ppm concentrations (a.i.) majority of phytoplankton disappeared after treatment, but gradually re-appeared.

In field trials also, there was no change in the plankton population with 2,4—D sodium salt at 5 ppm. However, with Simazine at 0.3 ppm (a.i.), all phytoplankton disappeared initially but re-appeared gradually in about four week's time.

51 Morpho-histology of the hypothalamo-hypophyseal neurosecretory system in *Cirrhinus mrigala* (Ham)

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The histological nature of the hypothalamic neurosecretory centres and neurohypophysis and the topographic arrangement of the neurosecretory pathway of *Cirrhinus mrigala* (Ham) have been investigated. The high secretory activity of the pars magnocellularis in the preoptic nuclei (NPO), transport of neurosecretory material (NSM), and their accumulation in the neurohypophysis have been discussed.

The topographic arrangement of the cells of the nuclei lateralis tuberis (NLT) is also described. The possible role of the hypothalamic neurosecretory material in motivating hypophyseal-gonadotropic mechanism is discussed in the paper.

52

**Observations on life history of grass carp,
Ctenopharyngodon idella (Valenciennes)**

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The life history stages of grass carp, *Ctenopharyngodon idella* (Valenciennes), introduced into India in 1959 have been described. Ovulated grass carp eggs were deep or golden brown in colour. Fertilized eggs got fully swollen in half an hour and measured about 4—4.5 mm in diameter. The first cleavage occurred in about 35 minutes after fertilization. The incubation period varied from 17.5 to 19.5 hours at water temperature ranging from 27—30°C. The hatchling measured 4.58 mm in total length and possessed 44—45 myotomes and was devoid of mouth, gills and body pigmentation. The yolk mass was conspicuous and club shaped and of pale brown colour.

The post-larva measured 7.34 mm in total length. The pelvic and anal fin buds appeared on the 7th day. By the 8th day all the 19 caudal rays were formed and by the 10th day the dorsal fin had 8 rays. Scales appeared by the 15th day when the fry measured 22 mm. Abdominal embryonic fin fold persisted upto the 20th day after hatching.

Some of larval and post-larval characters of grass carp have been compared with those in corresponding stages of major Indian carps and silver carp

**Observation on the life history of silver carp,
Hypophthalmichthys molitrix (Valenciennes)**

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Cuttack Orissa

Silver carp, *Hypophthalmichthys molitrix* (Valenciennes) introduced into the country in 1959 has been successfully induced bred and now forms an important component of the carp species being cultured in composite fish culture. The developmental stages of the eggs, larvae and post-larvae of the species are described.

The fully swollen fertilised eggs of this species measured 4 to 4.26 mm in diameter and was either pale blue or light pink in colour. The first cleavage was found to commence in about 40 minutes after fertilization. The incubation period varied from $17\frac{1}{2}$ to $19\frac{1}{2}$ hours at water temperature ranging from 27—30°C. The newly hatched larva, 4.52 mm long, was devoid of mouth, gills, body pigmentation and had about 38 myotomes. The yolk was club shaped and got fully absorbed within 96 hours after hatching. The post-larva measured 7.81 mm in total length. At this stage, embryonic fin folds showed black pigmentation. All the 19 branched caudal rays were formed by 10th day whereas the full compliment of 3+7 rays of the dorsal fin developed by 15th day. Scales appeared on the 25th day when the post-larva measured 31 mm. The distinguishing features of silver carp fry are also described.

**54 Investigations on composite fish culture with and without
supplementary feeding of fish and fertilization of pond**

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All India Coordinated Research Project

on Composite Fish Culture and Fish Seed

Production, Freshwater Aquaculture Research

and Training Centre

Bhubaneshwar Orissa.

Through composite fish culture a production of 7,371 kg/ha/year has

been achieved at Gujartal Farm, Jaunpur. The pond which has produced such high rate of production at Jaunpur had poor nutrient status of the soil and water in terms of fish production capacity. Though through regular fertilization, the soil and water nutrient status has improved considerably, it is difficult to account for the potential of the pond for such high production. Sinha (1973) indicated that besides species combination in proper ratio and density, supplementary feeding appears to be the main factor rather than fertilization of the ponds for achieving such high fish yields. Therefore, experiments were conducted at Jaunpur to assess the contribution of fertilization and supplementary feeding in achieving high production in composite fish culture.

Investigations were carried out in 1976-77 and 1977-78 in 7 ponds of 0.07-2.5 ha with similar stocking density and ratio of different carps. Supplementary feeds were supplied and also fertilizers were applied to two ponds, whereas other two ponds got only supplementary feed, another two ponds got only fertilizers and one pond had no treatment with fertilizer nor the supplementary feeds were supplied. Aquatic weed was supplied in equal quantity to feed the grass carp in all the seven ponds. The paper discusses the growth rate of different species and the magnitude of fish production in ponds with and without supplementary feed and fertilization, which clearly indicate the contribution of supplementary feed in achieving better growth rate of fishes and higher rate of fish production. Also an analysis of the production cost is made in those ponds with different treatments.

55 A study on the growth and fertility of intraspecific salmonid hybrids

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The better growth of the intraspecific F_1 hybrids produced by crossing the females of Rainbow trout with the males of Albino trout in II & III year has been observed. The fecundity of the hybrids was found to be more than that of either parent species. The size of the hybrid egg was noticed to be intermediate between the egg size of Rainbow trout and Albino

trout. The direct breeding of these hybrids and the backcrossing of these male hybrids with the eggs of both Rainbow trout and Albino Trout showed that they were fertile and the resultant progeny were surviving better upto the fry stage (the present stage).

**56 A case of phenomenal growth of *Catla catla* (Ham.)
 in a nursery pond near Allahabad**

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During the course of rearing carp spawn collected from river Yamuna in a hitherto unmanaged seasonal pond near Central Jail, Naini, Allahabad, a very remarkable growth of 382 mm of catla and 326 mm of rohu was observed in 110 days of rearing. A thick bloom of green algae *Volvox aureus* persisted in the pond for a considerable length of time and the gut analysis of the reared samples showed the presence of this food item, contributing 10 to 40 per cent to the total food ingested. The intensity of the bloom was such that it constituted 90.8% of the total planktonic biomass. Probable factors for the phenomenal growth, specially in case of catla, have been examined.

**57 Productive potentialities of some freshwater
 impoundments of Karnataka**

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The dissolved chemical constituents of two perennial tanks, Nagalcheruvu (4/ha × 6 m) and Doroji (800 ha × 4 m) in Bellary District and two seasonal tanks,

Hulikere (60 ha×6 m) and Ginigera (100 ha×4 m) in Raichur District were studied for one year. The annual average water temperature ranged between 23.5 and 35.0°C. In none of the tanks wide fluctuations in pH values and dissolved oxygen concentrations were noticed. The pH values were on average between 8.0 and 8.6 and DO ranged from 5.0 to 8.0 mg/l. During the year Nagalcheruvu and Hulikere tanks had EC values between 139.0 and 353.0 m mhos/cm and between 134.0 and 460.0 m mhos/cm respectively, as against 274.0—752.0 m mhos/cm and 328.0—1556.0 m mhos/cm in Doroji and Ginigera tanks respectively. The dissolved phosphate concentrations in all the tanks were very low while the estimated values of nitrate nitrogen were mostly high. The wide N/P ratio was proved to be undesirable in primary and secondary productivity. The euphotic zones of all the water bodies were greatly reduced by the persistent high turbidity due to colloidal suspensions. The other chemical responsive indices viz., alkalinity, hardness, chloride, silicate, iron were also taken into consideration.

58

Aquaculture in peninsular freshwater tanks

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The freshwater tanks of the Peninsular India are different from those of the plains in being both irrigational and storage impoundments in the form of long seasonal and perennial tanks of varying sizes. While many of these are available for fish culture, only some are amenable for intensive aquaculture involving high cost inputs to facilitate enhanced fish production. The others offer themselves for capture fishery operations as minimultipurpose reservoirs. Thus the tanks being midway between a pond and a reservoir, the differing ecosystems and other factors influencing fish production are discussed in the paper.

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The composite fish farming was experimented from 1974 to 1978 in Tarai ponds by culturing certain compatible fish species namely *Catla catla*, *Hypophthalmichthys molitrix*, *Labeo rohita*, *Cirrhinus mrigala*, *Cyprinus carpio* var. *specularis* and *Cyprinus carpio* var. *communis* and *Ctenopharyngodon idella* of different feeding habits to get high production per ha water area. Fingerlings of these species were reared at the rate of 5,000 per ha. The species ratio were fixed on the basis of their food and feeding habits and ecological niches of the ponds.

The ponds were fertilized with cow dung, ammoniumsulphate/urea+superphosphate at monthly intervals and fishes were fed daily with a mixture of mustard oil cake and rice polish. The grass carp *C. idella* were fed with burseem and para grass. The water sampling was regularly done to study the physico-chemical nature and plankton populations.

The relative growth of each species was studied by monthly sampling till the final harvesting at the completion of one year of rearing. The average 1,000 g weight was attained by the individual fish species with the average survival of 50% which resulted in a high rate of production ranging between 4,000 kg and 5,000 kg ha/year.

Biology and growth of common carps with their breeding behaviour

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Cyprinus carpio is an economically important fish due to its fast growth rate, high production efficiency, highly domesticated nature, good taste, easy digestibility and above all its breeding habit in confined waters. Studies on cycle of maturation and coefficient of maturity indicated the

presence of stray mature eggs throughout the year with the two main spawning periods, viz. July to September and February to March. Studies on gonadosomatic index of different sizes of mature females and males have been incorporated. Growth rates of fish under monoculture, four species culture and six species culture experiments have been studied and given.

61. Experiment on the mass culture of a cladoceran *Ceriodaphnia reticulata* Dana in glass Aquaria

A.C. Nandy, S.K. Majumder
and P.R. Das

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Effect of different items of feeds such as freshly cultured unicellular algae (*Chlorella, vulgaris*) ground-nut oilcake, dried brewer's yeast, a compounded diet and mustard oilcake and rice bran on the mass culture of a Cladoceran, *Ceriodaphnia reticulata* has been studied. Among the test diets, the propagation and growth of *Ceriodaphnia reticulata* was remarkably higher with *Chlorella vulgaris* than in the other feeds tried. The algae were given in suspension as food at the rate of 0.550 ml per individual per day. By stocking *Ceriodaphnia reticulata* at the rate of 10 units per litre a density of 13,620 units per litre was obtained in a period of 12 days. The test animals were fed with *Chlorella vulgaris* suspension on every alternate day. Rate of multiplication seems to be related to the protein content of the diet to some extent. The progenies obtained were genetically homogeneous and vigorous. A temperature range between 24°C and 32°C was found to be conducive for optimum growth.

62. Studies on the dixenic culture of a green alga, *scenedesmus obliquus* (Turpin) Kuetzing

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Barrackpore, West Bengal

Pure culture of a green algae, *Scenedesmus obliquus* (Turpin) Kuetzing

was obtained in the laboratory and yard experiments with different nutrient media such as modified Bristol solution, Chu no. 10, knop solution, Korshikov and Beijerinck solution. Of the media mentioned, modified Bristol solution has given promising results. The cell multiplication in respect of *Scenedesmus obliquus* was remarkably higher than in the other media tried. The exponential growth was observed from the 7th day after inoculation. The maximum cell density was attained 57×10^3 cells per ml from an initial inoculum of 260/ml in a period of 21 days.

63 **Effect of different auxins on the growth of *Chlorella vulgaris* Beijerinck in axenic culture**

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Experiments on the effect of various auxine such as alpha naphthalene acetic acid (NAA), Indole—3yl—acetic acid (IAA), Indole—3yl—butyric acid (IBA), Indole—3yl—propionic acid (IPA) and Gibberellic acid (GA) in promoting growth of *Chlorella vulgaris* Beijerinck are reported. Different concentrations of the plant hormones ranging from 0.1 to 2.0 mg per litre were incorporated separately into the nutritive medium, Modified Bristol solution indicated that the dose of 1.0 ppm Indole acetic acid resulted in a luxuriant growth of *Chlorella vulgaris* from an initial inoculum of 125 cells per ml to 4,60,320 cells per ml in five days. Almost all the auxins used were inhibitory to the growth at higher concentrations. The optimal dose for NAA, IPA, IBA and GA was 1.5 mg/litre and for IAA was 1.0 mg/litre. Out of all the auxins used, Indole-3yl-acetic acid (IAA) at a dose of 1.0 mg/litre yielded best results for increase in cell counts.

**64 Studies on the growth kinetics of *Nitzschia closterium*
(Ehrenberg) Wm. Smith in Axenic culture**

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Some phenomena related to the growth of *Nitzschia closterium* (Ehrenberg) Wm. Smith were observed with microscope by a method of semi-synchronous culture under constant conditions of light (2000 lux) and temperature ($20^{\circ}\text{C} \pm 2^{\circ}\text{C}$). The growth curves of individual cells were determined by measuring the variations of size distribution at twentyfour hour intervals for three weeks. Studies have yielded the nature of individual growth patterns in the life cycle of *Nitzschia closterium*. The growth was faster in the exponential phase and slower in the constant phase of population growth.

**65 On the mass culture of the diatom *Pinnularia*
gibba Ehrenberg in glass aquaria**

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Mass culture of the phytoplankter, *Pinnularia gibba* a freshwater diatom, has been successful in laboratory and yard trials. The technique employed included the use of urea, single superphosphate and sodium silicate (NPS_1) in the ratio of 100: 10: 5 as nutrients in the ambient medium at the rate of 385 ppm. Pure culture of *Pinnularia gibba* isolated on agar plates and slants in the laboratory was used to inoculate the nutrient medium at the rate of 485 cells which resulted in a cell multiplication of 1.3 million per ml within a period of 10 days. Cells obtained by this technique were genetically homogeneous.

**66 Magur (*Clarias batrachus* Linn.) culture in rural ponds
as a source of additional income**

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Demonstrations of scientific utilisation of small, shallow village water units initially as carp nursery and rearing ponds during the monsoon and post-monsoon months and later for magur culture have indicated that there is an immense scope for enhancing the income by their multiuse and multicropping than using them for production of table-size carps or carp fry/fingerlings alone. The paper presents case histories of five ponds ranging from 0.04 to 0.06 ha in area and 0.5 to 1.0 m in depth where rohu fry were first reared to fingerling size followed by magur culture. A projection is made for a possible high income per unit area and time.

67 Intensive monoculture of Singhi (*Heteropneustes fossilis* Bloch)

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Singhi constitutes a new species for culture in ponds and the technique being different, it involves a new system. A trial on its monoculture in a 0.04 ha village pond at a high stocking density of 2.5 lakhs/ha gave a production of 4,814.5 kg/ha in 6½ months, the rate of survival being 66.7%. While individual specimens ranged from 20 to 110 g, the average weight was 28.9 g. Management techniques for intensive monoculture of the species to obtain high rate of survival and faster growth are indicated.

**68 Physico-chemical and biological characterisation
of highly productive ponds under semi-intensive fish
culture in West Bengal**

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Based on a study conducted in 4 districts of West Bengal with seven ponds in 24 parganas, 12 ponds in Malda, 10 ponds in Burdwan and 12 ponds in Jalpaiguri under a semi-intensive fish culture programme, physico-chemical and biological characterisation of highly productive ponds (over 5,000 kg/ha/yr) was done. Physical parameters like water temperature (25—29°C), clear sky with long light hours (Jan.—June) and water depth (between 2—3 m) were found conducive for high plankton concentrations. Highly productive pond waters were characterised by pH, total alkalinity, phosphate, nitrate, ammonium nitrogen and specific conductivity ranging from 7.2—8.0 ppm, 50—210 ppm, 0.1—0.8 ppm, 0.05—0.1 ppm, 0.5—2.5 ppm and 200—800 micro mh/os/cm, respectively.

Soils of such ponds were in the neutral range (pH 6.8—7.2) while available phosphorus, organic carbon, total nitrogen and available nitrogen ranged from 6—18 mg/100 g of soil, 1.0—2.5%, 0.1—0.3% and 25—110 mg/100 g of soil respectively.

A plankton concentration of 1—6 mg/50 l of water per 100 g constituted mainly by zooplankton (80—95% of the total plankton volume) was an indicator of high pond productivity. Bottom fauna in productive ponds ranged from 2,000—3,000 units/sq m.

69 Phenomenal growth of *Catla catla* Ham.

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A case study of phenomenal growth of *Catla catla* in two ponds utilised for composite fish culture is presented. Stocked at 100 and 150

fingerlings/ha soon after the toxic effect of mahua oil cake was over, they grew to a maximum of 1,320 and 1,270 g with an average weight of 1,203 and 1,006 g respectively in 101 and 94 days. However, the growth increment in the two ponds was 11.56 and 11.25 g/day, respectively.

70 Preliminary observations on the digestive enzyme activity in grass carp *Ctenopharyngodon idella* Val

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Investigations on the distribution of digestive enzymes in the grass carp, *Ctenopharyngodon idella* Val., grown in ponds under semi-intensive fish culture showed the highest amylase and cellulase activity in the hepatopancreas. Contrary to the present belief, cellulase activity was also recorded in the gastro-intestinal tract. Protease activity was the highest in hepatopancreas and the lowest in oesophagus. Considerable lipase activity was noted in hepatopancreas, intestinal bulb and intestine. The reasons for the occurrence and variations in the enzymatic activities in various regions of the gastrointestinal tract and hepatopancreas are discussed.

71 Stocking fry in composite fish culture

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Against the usual practice of stocking fingerlings in the size range of

100–150 mm in composite fishculture, an experiment was conducted in Hadapsar fish farm, Pune, Maharashtra, under the All India Co-ordinated Research Project on Composite Fish Culture and Fish Seed Production where fry of the six species, catla, rohu, mrigal, common carp, silver carp and grass carp, in the mean size range of 34–52 mm were stocked, to test the feasibility of stocking fry directly in composite fish culture under circumstances where sufficient rearing facilities are not available. After rearing the fish for a full year a record net production of 10,183 kg/ha was obtained from this experiment. The overall survival rate of the fish was 98.8%. The experiment shows that under proper management composite fish culture can well be taken up with stocking of fry also.

72 Composite fish culture without grass carp

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Under the All India Co-ordinated Research Project on Composite Fish Culture and fish Seed Production an experiment was conducted in Hadapsar fish farm, Pune, Maharashtra where a pond was stocked with fry of the five species, catla, rohu, mrigal, common carp and silver carp, in the mean size range of 34–51 mm. The experiment was undertaken to explore the possibility of carrying out composite fish culture profitably in localities where providing weeds for grass carp is not practicable or possible. After rearing the fish for $12\frac{1}{2}$ months a record net production of 7,285 kg/ha was obtained. This evidently shows that even without grass carp composite fish culture can be undertaken with reasonable profit.

73 Scope of utilizing irrigation tanks and reservoirs of India as fish nursery and rearing ponds

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Natural fish seed collected from major rivers of India contributes to

about 90% of total carp seed resources, the rest being through induced and bundh breeding. To step up inland fish production through aquaculture, supply of fish seed is an important prerequisite. This can be achieved only by establishing more carp seed production centres. One of the major limitations in carp seed production of the country is the lack of adequate nursery and rearing space. The nursery and rearing area can be considerably increased with very little expenditure by utilizing a part of irrigation tanks and reservoirs for this purpose. This can be achieved by raising earthen bunds at suitable regions of these water bodies. Small bunds of 50 to 100 m in length, 2 m in height and 2 m width enclosing an area of about $\frac{1}{4}$ to $\frac{1}{2}$ ha in tanks and 1 to 2 ha in reservoirs, depending on their water spread area, with a sluice gate to release the fish fingerlings directly into the main water body can be constructed for this purpose. The expenditure involved in such constructions will be much less than the same for constructions of regular nursery and rearing ponds. The urgent need for developing this technique has been emphasised.

74 Limnology and productivity of Kulgarhi reservoir

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The paper describes the limnology of Kulgarhi reservoir (Madhya Pradesh) based on observations made on the physico-chemical factors and primary productivity during the period 1968 to 1972 and plankton from 1971 to 1973. Attempts have been made to correlate average fish production from 1967—68 to 1976—77 with primary production. The comparison of the fish harvest with the primary production has exhibited a very poor conversion ratio. The present observations show low production of biomass and fish even though soil and water quality indicate high productive potential. Probable causative factors for low fish production of the reservoir have been discussed.

75 Evaluation of chemical fertilizers in enhancing fish production in composite fish culture in tropical fresh water ponds

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An experiment was conducted in two freshwater ponds (0.25 ha each) at Cuttack for one year to evaluate the impact of chemical fertilizers on composite fish culture as well as on fertility of ponds. Pond—I was treated with chemical fertilizers at 1,020 kg/ha/yr (Urea, Superphosphate and potassium chlorid and Pond—II besides chemical fertilizers at 650 kg/ha/yr, was also treated with organic manure (cowdung) at 10,000 kg/ha/yr. Indian and exotic carps were stocked @ 7,500/ha in the two ponds.

The overall survival percentage (78.32) and gross/net fish production as 4,297/4,221 kg/ha/yr were of higher order in pond—I (chemical fertilizers) as compared to 60.32 and 3,352/3,276 kg/ha/yr respectively in pond—II (chemical fertilizers+organic manure). Silver carp showed excellent growth attaining an average weight of 1.00 kg in a year.

Fertilization improved the nutrient status and also the organic matter content of both the ponds.

76 The biological clock of oxygen consumption in *Heteropneustes fossilis* (Bloch) and its application in aquaculture

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Heteropneustes fossilis, a commercially important fish has a bimodal gas exchange mechanism. The seasonal variations in oxygen consumption under experimental conditions in which surfacing was either allowed or prevented were studied with a view to answer certain queries such as— (1) does this fish utilize its air breathing organs throughout the year? (2)

if not which are the months when this organ is properly utilized ? (3) does the utilization of accessory respiratory organ does any relationship with temperature, spring and autumn equinox, summersoltice and oxygen content of the water ? (4) does this organ assist in the supply of extra energy to the developing eggs and sperms ? and (5) is there any relationship between the cyclic changes in oxygen consumption and the gonadal activity of the fish ? A keen observation of the different dials of the clock shall certainly reply some of these queries. In the present paper the application of the biological clock of oxygen consumption in aquaculture has been discussed.

**77 Some aspects on the biology and control methods of *Argulus*
siamensis, a crustacean parasite of cultivable carps in
freshwater ponds**

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Several instances of fish mortality resulting in great economic loss due to *Argulus* infestation in the fish farm have been reported. The present contribution reports some aspects of biology and control of *Argulus siamensis* at vulnerable stages. The matured female parasites were collected and made to breed under suitable condition. The eggs were laid in batches of 269 to 447 per animal. Symmetrically arranged, white and sticky eggs took 11 to 27 days to hatch out. The range of temperature was recorded as 26.8°C to 35°C. It was observed that the parasite could breed throughout the year under suitable condition. The percentage of hatching was high and in the range of 90-95%. The newly born larvae look like adult except the suckers which develop within two days after hatching. By destroying the eggs of *Argulus* laid on the substrate the early stages of infestation in fish ponds could be controlled.

78 Toxicity of mohua oil cake under Laboratory and field conditions

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Toxicity of mohua oil cake, widely used as fish poison, was tested in the laboratory in 10-litre glass jars and also in the field ponds. Laboratory experiments indicated that mohua oil cake solution at 250 ppm takes 42 hours for detoxification. Dissolved oxygen value falls to a lethal limit (0.2-0.6 ppm) while free CO_2 increases highly (30-40 ppm) after application of mohua oil cake

Treatment of mohua oil cake solution with lime @ 200 ppm indicated no detoxification of the saponin except that the time taken for fish mortality was more than the control.

Similarly, treatment of mohua oil cake with KMnO_4 @ 2-4 ppm indicated no detoxification of the saponin but the time taken for fish mortality was more.

In the field conditions, time of detoxification varied greatly depending on the physico-chemical nature of the pond, temperature, amount of mohua used etc., but in general detoxification time is more than the laboratory. Raking, aeration and liming lowered the toxicity period.

The changes in physico-chemical parameters after mohua treatment in ponds are discussed.

79 The use of superphosphate to control aquatic weeds

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Laboratory and field experiments were conducted with superphosphate to control aquatic weeds. The plants present in the treated environment absorb the superphosphate from the aqueous medium and when it is in excess within the plant body the cells get disintegrated and the plants ultimately die.

Different doses of superphosphate were applied in jar under laboratory conditions and in pond water under field conditions. It is observed that if the superphosphate concentration in water can be increased between 23 and 25 ppm from traces and maintained for atleast 4 weeks by intermittent application of the chemical the control of the weeds can be achieved. The rooted plants absorb it from the soil but the floating plants absorb it from the water and when they are dead they settle on the bottom of the pond and decompose. with the decomposition of the plants *in situ*, there will be better growth of plankton, flora and fauna in the pond which in turn will help in fish production.

80 On the mortality of *Catla catla* (Hamilton) due to parasitic infection by *ligula*, a cestode parasite in kulgarhi reservoir of Madhya Pradesh

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Cases of mortality and emaciated growth of *Catla catla* (Hamilton), investigated by examination of 51 specimens (size range : 437-888 mm) have been reported from Kulgarhi reservoir (M. P.) Ligulosis, the disease caused by a cestode parasite, *Ligula intestinalis*, was found to play havoc with catla population, resulting in considerable loss to the culture fishery of the reservoir. The external symptoms of the disease were emaciation of body with enlarged abdomen and watery condition of muscle tissue.

In the life cycle of this parasite, the piscivorous birds are permanent hosts and *C. catla* serves as an intermediate host. The first larval stage of the parasite develops in the body of a copepod, which when eaten by *C. catla* metamorphoses to second larval stage in its body cavity. As *Ligula* larva has no suckers or hooks, it does not cause definite injury, but damages the functional capacity of organs by crowding in the body cavity of the fish.

The mortality of *C. catla*, infected with *Ligula* is also indirectly caused by the rupture of abdomen wall due to extreme pressure caused by the parasites inside the body cavity.

The biological control by breaking one of the chains in the life cycle of parasite, is the only feasible method against Ligulosis disease. Large scale shooting of host birds is likely to yield successful results towards the control/eradication of disease in Catla population of the reservoir.

81 Effect of cadmium chloride on the gonads of the fresh water fish *Labeo bata* (Ham.)

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Although cadmium salt (known to be industrial pollutant) is well known to harm the testis of mammals, very little is known about its effect on the gonads of fishes. Some specimens of *Labeo bata* were kept in 0.01% of the cadmium chloride solution before the onset of breeding season and were maintained in the same medium from March to June along with control comprising of same number of fishes maintained in tap water. Histological studies of the gonads revealed that the testis of the treated fish were on the verge of disruption and the germinal epithelium were mostly ruptured, whereas in the control there was full development of the testis and spermatogenesis was quite normal. In case of ovary of the treated fishes the follicular development was mostly arrested in oocyte-I and II stages, whereas in fishes kept as control oocyte III and IV stages were prominent. Higher concentration of cadmium salt (above 0.2%) when tried was fatal to the fish. This observation brings out the fact that cadmium as pollutant affects the reproductive system of the fishes.

82 A simple technique for mass breeding of murrels

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An attempt was made to simplify the technique to take up mass scale breeding of murrels in fields.

Three experiments of breeding of *Channa punctatus* (Bloch) and two of *Channa orientalis* (Hamilton) were conducted using ripe and healthy brooders collected from fish landing centres during May to June 1977. Out of 6 to 8 sets of brooders used for each experiment, 1 or 2 sets were marked and hypophysed with carp (*Labeo rohita*) pituitary extract at a dose of 20 mg/kg female and 5—10 mg/kg male and released into the cordoned off portion of a swampy pond. The percentage of successful spawning was 66.6 in *C. punctatus* and 58.3 in *C. orientalis*. The experiments yielded a total of 13,857 and 5,481 naturally reared young ones (4.5 to 12.3 mm in length) of *C. punctatus* and *C. orientalis* respectively. The technique not only proved to be convenient and less cumbersome for mass scale breeding of murels but also economical through minimised use of pituitary gland and labour on rearing the resultant spawn.

The physico-chemical conditions of the breeding environment and spawning behaviour of the fishes have been presented and discussed.

83 Some important field observations on successful breeding and hatching of silver carp

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Adverse weather conditions due to delayed or irregular monsoon seriously affects the induced breeding programme of silver carp, *Hypophthalmichthys molitrix* Val. in still water pond. Silver carp males release scanty milt even after thorough stripping and this necessitates large number of males for fertilisation of eggs liberated by a few females causing thereby depletion of the stock of male breeders and finally limit the production of seed. Some simple field modifications of the stripping technique of males have been observed to give more milt.

Early development of fertilised eggs is severely affected by unfavourable water temperature of stagnant water due to irregular monsoon. Shifting of fertilised eggs after water hardening from pond to the hapas fixed in flowing river has been observed to give very high hatching percentage. It has also

been observed that the use of inner hatching hapa may be dispensed with without affecting the production of hatchlings, when hatching is done in flowing water.

The paper records some practical suggestions to combat problems of breeding and hatching of silver carp, arising out of unfavourable weather conditions.

84 Hydrobiological investigations of the river Mundeswari with reference to the breeding of a gobioid fish

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Hydrobiological investigations have been made in a monsoon river, Mundeswari, at Khanakul, Hooghly district, West Bengal, from September 1976 to September 1977, in relation to the breeding of *Apoeryptes bato* (Hamilton).

Different physico-chemical factors of the breeding ground, cycles of maturation and depletion of gonad, breeding habit of the fish under discussion, were considered.

The surface water temperature showed two maxima and two minima. The atmospheric temperature also showed double oscillation. During the monsoon, the water temperature remained uniformly at the same optimum level with regular thermocline.

Heavy rainfall caused by south—west monsoon commenced in early June and during this period the amount of precipitation is about 95% of the total annual rainfall. The breeding season of *Apocryptes bato* coincides with this period. The average turbidity was 10.0 cm but during the dry months, nil. The range of salinity is narrowest during the dry months and widest during the monsoon. The pH value always remains towards alkalinity and during the breeding season of the fish, the value of dissolved oxygen is fluctuating.

Physical-chemical condition influencing spawning of this fish are decreased salinity and pH, increased turbidity and rainfall, optimum air and surface temperature fluctuating dissolved oxygen tension and abundance of plankton.

With the onset of breeding season gonadal enlargement takes place gradually to a functional state. Sexually mature specimens migrate from estuary to river. Most of the fishes return to the estuary when the breeding is over, but the leftovers burrow deep in the river bed. Nest building and parental care are found only in the males.

85 Preliminary experiments on the tagging of the giant

freshwater prawn, *Macrobrachium rosenbergii*

(De Mam) in pond culture

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The results of preliminary experiments undertaken on the culture of the giant freshwater prawn, *Macrobrachium rosenbergii* in freshwater ponds at Badampudi have been discussed. The prawns were released in ponds after tagging and their subsequent growth was recorded. In this experiments, the peterson disc tags were used. Synthetic monofilament has been utilised for attaching the discs. In one experiment, the prawns were observed retaining their tags for over 6 months with an average growth increment from 112.9 mm/12.6 g to 201.0 mm/82.4 g. The second experiment also gave encouraging results with a growth increment from 89.7 mm/6.5 g to 230.2 mm/150.6 g in 10 months. Tagging mortality and effect of tag on moulting of the prawn and other relevant aspects have also been discussed.

86 On the culture of Indian River prawn, *Macrobrachium malcolmsonii* (H. Milne Edwards) At Badampudi, Andhra Pradesh

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Four experiments have been conducted during 1974-'78 to evolve suitable culture technique for the Indian river prawn *Macrobrachium malcolmsonii* at Badampudi in West Godavari District of Andhra Pradesh. The seed was collected directly from river Godavari at Dowlaiswaram anicut and from the irrigation canals around Badampudi. Different stocking densities ranging from 30,000 to 1,00,000 per ha. were tried in different ponds. Monoculture and mixed culture with selected species of carps were attempted in these ponds. The duration of experiments ranged from 5½ to 10 months. Manuring and liming of ponds was done periodically. Supplemental feeds, viz., rice bran, groundnut oilcake and fish meal in 10:10:1 ratio and occasionally pieces of dried fish, sweet potato, etc., were given. A maximum production of 313.7 kg prawn/ha in monoculture and 327.1 kg prawn and 2084.3 kg fish/ha in mixed culture have so far been achieved. An average growth from the initial 22 mm/0.12 g to 112.2 mm/25.5 g was registered with a maximum of 200 mm/150 g and the highest survival of 63.8%.

87 Grass carp culture in upland waters of Tamilnadu

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The Biology of grass carp, *Ctenopharyngodon idella* is sufficiently known in India. But its growth and survival in cold waters in India is not documented. In order to test its utility in controlling aquatic weeds in upland lakes, they were introduced in Ooty-an altitude of 2500 m. A.S.L. In small cement nurseries it attained a growth of 2.3 kg (maximum) and

0.750 kg. (minimum) in 28 months. In Ooty lake, where they were introduced as fingerlings (4.0—6.0cm), the growth was as follows: 1.8 kg in 8½ months, 2.5 kg in 12 months, and 5.5 kg in 16½ months. This lake had a profused growth of submerged aquatic weeds like *Hydrilla*, *Potamogeton*, etc., which disappeared in two years. Differential growth of the same stock was noted.

Possibilities of culture of grass carp in lakes and its use to control submerged weeds are immense.

38 A comparative study on the availability of phosphorus from phosphatic fertilizers in relation to pond productivity

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Commercial fertilizers, single (16% P_2O_5) and triple superphosphates (40% P_2O_5) were tried in slightly acidic (pH 6.0) fresh water @ 25, 50 and 80 kg P_2O_5 /ha in the laboratory and @ 25 kg P_2O_5 /ha in the yard.

Triple superphosphate was found to be more efficient in maintaining higher level of soluble phosphorus in water phase while single superphosphate maintained higher level of available phosphorus in soil phase.

The results indicated that more of phosphorus from single superphosphate was fixed in soil as it was powdered form as compared to triple superphosphate which was in granular form.

Triple super phosphate @ 25 kg/ha gave best results in respect of survival and growth of rohu fry (65% ; 11.37 mm/13.95 mg) as compared to control (40% ; 10.45 mm/10.63 mg).

It appears that concentrated superphosphate (triple) together with concentrated nitrogenous fertilizer (urea) would form suitable combination of mixed fertilizers for fish ponds.

**89 *Kampa Goodu, a good source of prawns from Upputeru drain
of collair Lake as stocking material for culture purposes***

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The operational details of *Kampa goodu*, which is one of the major fishing methods in the *Upputeru* drain at the out let of **Collair** lake has been described. After selecting a suitable spot along the banks of the drain, cut branches, preferably of *Tumma* (*Acacia arabica*) tree are fixed over which some weeds like *Eichhornia* are placed and is left undisturbed for at least 15 days. The weeds placed over the spot initially and accumulated later due to entanglement result in the emergence of a peculiar smell due to soaking of the bark of the branches and decay of certain of its foliage along with some of the above weeds. It is believed that because of this, different species of fishes and prawns are attracted into the *goodu*, for shelter and feeding as well. For removing the catch, the area around the *Kampa goodu* is encircled with a net, the weeds and branches removed and the catch hauled up to the bank. Usually, 6 to 12 fishermen in one or two country boats are employed in this operation depending on the size of *goodu*. The seasons of operation, the catch composition and the effect of lunar phase on the catches have been discussed. The prawn species, the size range and the conditions in which they are captured along with their utility for further culture purposes have also been discussed.

**90 A case of phenomenal growth of *Catla catla* (Ham.) in a
nursery pond near Allahabad**

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During the course of rearing carp spawn collected from river Yamuna in a hitherto unmanaged seasonal pond near Central Jail, Naini, Allahabad, a very remarkable growth of 328 mm of catla and 326 mm of rohu was

observed in 110 days of rearing. A thick bloom of green algae *Volvox aureus* persisted in the pond for a considerable length of time and the gut analysis of the reared samples showed the presence of this food item, contributing 10 to 40 percent to the total food ingested. The intensity of the bloom was such that it constituted 90.8% of the total planktonic biomass. Probable factors for the phenomenal growth, specially in case of catla, have been examined.

91

Prospects of carp culture in lower sundarbans

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**Operational Research Project at Gosaba,
24-Parganas, West Bengal of the
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Mixed culture of Indian major carps was taken up in three farmers' ponds at Gosaba in Sundarbans, in West Bengal under the Operational Research Project of JARI. The chloride content of water varied from 36—62, 60—88.5 & 40—65 ppm in the three ponds respectively. Manuring schedules were phased according to the nutrient levels of the ponds. The stocking was done in July 1976 @ 7,500 fingerlings/ha in the ratio of catla 3.5 : rohu 3.5 : mrigal 3.0. The plankton content varied from 0.5—0.8 0.2—0.4, & 0.4—1.0 ml/45 of water in the 3 ponds respectively. Supplementary feeding was done @ 1—2% of body weight of standing crop with mustard oilcake and rice bran (1 : 1). The gross and net productions obtained were 5,225.29, and 5,144.76 kg/ha/13 months from pond no. 1, and 2,784.5 kg/ha/13 months from pond no. 2, 5,013.33 and 4,932.63 kg/ha/yr from pond number 3. The cost of production per kilogram of fish was Rs. 1.43; Rs. 2.43, and Rs. 1.92 from the 3 ponds respectively.

The demonstrations of high fish productions convinced fish farmers that scientific culture of the three autochthonous carps can be taken up in freshwaters of even the lower Sundarbans, contrary to the earlier belief, with a promise of very high economic return.

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A miniature hatchery complex for the Indian bullfrog and *Rana crassa* has been fabricated, installed and operated for commercial production of seeds for the first time. The production of seeds through hatchery has enormous advantage over the induced breeding technique and has a tremendous impact in meeting the country's demand for frog seeds. The process involves three steps, viz. hypophysation of frogs, removal of the highly sticky jelly coat on the surface of eggs; and incubation and hatching of eggs in hatchery jars under constant circulation of water. The Woynarovich method for common carp has been modified in the present experiments to remove the jelly coat of these amphibian eggs. Fertilised eggs were treated with sodium chloride (4g/l) and urea (3g/l) solutions in the proportion of 2:1 for $1\frac{1}{2}$ —2 hour, followed by further treatment with 500 ppm of pectinase solution for an hours. This resulted in the separation of egg mass. Even without the pectinase or tonic acid treatment, the eggs showed normal development and excellent hatching under proper circulation of good quality water.

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Grass carp, an important constituent of composite fish culture, contributes about 20% to the total production despite its low stocking density of 10% of the total stock. Stocking ponds with grass carp has an added advantage in that while it utilizes aquatic vegetation as its food, the undigested faecal matter forms the food of other bottom feeders such as

mrigal and common carp. However, where aquatic weeds are not available, it is a tendency amongst the farmers to exclude the species while stocking the ponds.

The present paper outlines the role of available terrestrial vegetation (*Musa* spp., *Amarantus* spp., *Spinacia oleracea*, *Lythrus* spp., *Morus indica*, *Pisum sativum*, *Raphanus sativum*, *Brassica* spp., *Bambosa* spp., *Oryza sativum*, *Laginia vulgaris*, *Cicer orientum* and some grasses) as feeds for grass carp. The fish recorded a remarkable growth in 60 days from 60 g to 615 g. It was also noted that grass carp has a preference for monocots over dicots. Since it feeds voraciously on *O. sativum* it cannot be utilised in paddy-cum-fish culture

94 **Observations on the freshwater prawn seed resources of the Godabari westend delta, Andhra Pradesh**

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Observations have been made during a survey at different locks and weirs along various irrigation canals in West Godavari District, leading from river Godavari, during January, 1978 to locate and study the potentiality of the prawn seed resources with a special reference to the seed of Indian river prawn *Macrobrachium malcolmsonii*. The bulk of the seed consists of *M. malcolmsonii*, *M. scabriculum* and *M. lamarrei*. The juveniles of these prawn species congregate from dusk onwards during nights near the locks and weirs along the canals flowing in this region and try to negotiate them. The relative abundance of different species and their size distribution at different collection centres along each canal system is given. It has been found that the Narsapur canal, Bank canal and Undi canal are more productive. The mode of collection and the method of transporting the seeds have been given. The importance of location of these collection centres for augmenting prawn production through culture practices in this region have been emphasised.

**95 Sympathetic breeding of Indian major carps through
hypophysation-cum-dry bundh breeding in West Bengal**

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Bundh breeding, an age old practice of spawning the fish has undergone considerable changes. Dry bundh breeding, because of its obvious advantages has gained popularity and almost replaced wet bundh breeding in the State of West Bengal.

During the last decade or so the practice of combining hypophysation with dry bundh breeding has changed the entire earlier concept of bundh breeding. Under the technique of hypophysation-cum-dry bundh breeding which is not very much dependent upon rainfall and other factors, 10 to 20 percent of the brooders were injected with single low dose of pituitary extract and released in the improvised dry bundh along with 80 percent un-injected brooders. The injected fishes started breeding, a few hours after the injection, and uninjected ones followed and the entire lot bred. The author during the course of bundh breeding of *Hypophthalmichthys molitrix* and *Ctenopharyngodon idella* in 1974 performed five such experiments on hypophysation-cum-dry bundh breeding of Indian major carps at Sirnolapal (Bankura), West Bengal, the results of which are embodied in this communication. A few recommendations on the improvement of the methodology have also been made.

**96 Loni reservoir : case study in promoting fisheries development
and management of small impoundments for aquaculture**

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Small impoundments, occupying an area of 2500,000 ha in the country, offer immense scope for augmenting inland fish production through extensive aquaculture technique. Studies conducted from 1967—1975 on Loni Reservoir,

a 200 ha irrigation reservoir, have amply demonstrated the fishery potential of such ecosystem. Detailed limnological studies were carried out to establish a base-line for formulation of development measures. There was medium to high concentration of basic nutrients (total alkalinity : 85—162 ppm, hardness : 27—101 ppm, Ca : 27—74 ppm) and no marked annual fluctuations in their levels were noticed. The fish food resources appeared to be adequate and well-distributed in all depths and zones. The loss of nutrients and plankton through withdrawal of water for irrigation was replenished by allochthonous enrichment. Through increasing temperature and decreasing water level, they got leached into the system by wind and wave action. Based on the basic productivity levels, the reservoir was designated as a moderately productive medium water reservoir.

Breeding of major carps was repeatedly observed to take place in areas engirding the spillway and, consequently, heavy escapement of brood took place resulting in inadequate natural recruitment. This posed a major trammel in development of the reservoir fishery. Through proper management techniques viz., stocking, increase in fishing effort and development of improved gear, the annual per hectare production estimated at 4—9 kg from 1967—70, could be enhanced to 54 kg in 1974.

It was observed that in such ecosystems with reduced summer level, the brood stock becomes so reduced in numbers that almost the entire catch from fishing depends on fish planted from outside thus establishing a good correlation between stocking ratios and catch per unit of effort.

Future opportunities are briefly discussed and an attempt is made to illustrate the problems, possible approach and opportunities for fisheries development in such ecosystems. They occupy a unique position in limnology analogous to field plots in agriculture science i.e., a means of assessing results on a reduced scale when compared to large multipurpose reservoirs.

97 **Experiments on pond culture of the freshwater prawn of
India, *Macrobrachium malcolmsonii* (H M Edw.)**

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During the year 1971—'75 the first attempt on culture of the freshwater prawn of India, *Macrobrachium malcolmsonii* was taken up in confined ponds in Andhra Pradesh, at Kateru and Kadium villages (East Godavari Dt.), Kovvali and Badampudi (West Godavari Dt). Vast natural seed resources are available along the anicuts across river Godavari. The performance of the ponds in regard to water characteristics are studied to determine optimal conditions.

Production in the four types of pond systems and two types of culture systems (Mono and mixed cultures) varied between 80 kg/ha/6 months to 400 kg/ha/8 months.

The paper examines all the considerations and conditions under which the freshwater prawn culture in India is carried out at present and could be conducted under a given set of conditions. An economic feasibility analysis is also presented. This culture is compared to the *M. rosenbergii* culture being conducted in countries such as Hawaii. The major points of similarity and differences, both in production as well as in the economic feasibility, are brought out.

98 **Preliminary observations on extension of fishculture in
certain villages in Puri district (Orissa)**

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Scientific fish culture programme was initiated in two villages, namely,

Gohala and Jagannathpur belonging to Pahala Panchayat in Puri district (Orissa) with the twin objective of showing the rural poor the scientific methods of fish culture in the available water area and to know their reactions in adopting such methods.

A proper survey was made of the ponds available in the villages and the constraints restricting the use of them for scientific fish culture. All the ponds surveyed in the villages were mostly used for bathing and washing. Considering the multipurpose use of the ponds, pond management for fish culture was shown in four small ponds (0.01—0.02 ha in area). The technique of rearing spawn to advanced fry stage was demonstrated, and after fry were harvested two of these ponds along with other eight (0.02—0.09 ha) were utilized for raising fry to table-size fish. The pond owners earned an income ranging from Rs 100—310 by selling fry from those 4 ponds and Rs. 227—1,340/—by selling the table-sized fish from 10 ponds. An analysis of the cost-benefit of such systems of culture is made in the paper and also the paper discusses remedy for certain constraints in undertaking scientific fish culture.

99 Design and construction of enclosures for rearing of froglets of *Rana hexadactyla* Lesson

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For rearing froglets of the aquatic green frog *Rana hexadactyla* Lesson, two 0.002 ha enclosures (nurseries) were designed and constructed. In each, amphibian environment providing land and water areas in equal proportions was created. A cement cistern having gradual slope and a maximum depth of 45 cm water area was constructed. *Lemna*, spread over the water surface, gave the appearance of natural aquatic environment. Grass and flowering plants were planted in the land area. Protection of the froglets from predation and escape was ensured by erecting 2.75 m high enclosures; brick walls upto a height of 0.75 m and wirenetting above. The roof covered with wirenet prevented entry of birds and other predatory animals. For attracting insects adequate lighting arrangements with florescent tubes were made in these enclosures. Water supply and drainage arrangements were also provided. Survival of froglets upto 96% was recorded in experimental studies.

Experiments on raising quality fish seed in floating nurseries and its role in aquaculture in India

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Among constraints that militate against fullscope development of aquaculture mention may be made of shortage of motivated farming cadre, gross shortfall in quality fish seed and acute inadequacy of ground nurseries. According to an estimate the available nursery space is about 4% of the total need of the country. The importance of floating nurseries under the circumstance for the full-scale development of aquaculture bears no further elaboration.

The paper describes floating nursery experiments, comprising a set of 4 floating cages each covering approximately an area of 3.5 sq.m. carried out in a tank having an area of 2.5 acres and depth 2.4—3 m Jari near Allahabad in the years 1976—78. The carp spawn reared in floating nurseries reached fry stage (46 mm) in 30 days and fingerling stage (122 mm) in 90 days at stocking rates 30,000/cage (i.e. 85,000,000/ha) for spawn to fry and 2500/cage (i.e. 7,000,000/ha) from fry to fingerling stages. Details of feed composition, feed ratio, feeding schedule, growth rate etc are given. Advantages of floating nurseries *vis a vis* ground nurseries and their role in India in jacking up inland fish production are highlighted.

101 Comparative response of certain fish species to D.D.T. : With special reference to brain enzyme sensitivity.

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The study deals with the effects of acute oral administration of D.D.T

in various dosages on the ATP ase, Pseudocholinesterase (ChE) & true Acetylcholinesterase (AChE) activities in the microsomal & synaptosomal fractions of brain tissues of rat, toad fish. Rat brain microsomal Mg^{+2} —ATP ase activity is inhibited by D.D.T, but in case of fish & toad the same enzyme activity in the same fraction is rather stimulated in a dose dependent manner & the stimulation is higher in fish than in toad. Rat brain synaptosomal Mg^{+2} —ATP ase activity is inhibited, but stimulated in fish and no change in toad is observed. In rat & fish both the synaptosomal & microsomal Na^{+} — K^{+} —ATP ase activities are stimulated whereas in toad the microsomal Na^{+} — K^{+} —ATP ase activity is perceptably inhibited at higher dose, but stimulation in synaptosomal Na^{+} — K^{+} —ATP ase is observed. True AChE activity is stimulated only in microsomal fraction of rat brain, but PseudoChE activity does not produce any change in either of microsomal & synaptosomal fractions. In fish, both PseudoChE & true AChE is inhibited in microsomal fraction, but stimulated in synaptosomal fraction. In toad, true AChE activity is stimulated in both microsomal & synaptosomal fractions, but PseudoChE Activity is inhibited in a dose related manner only in synaptosomal fraction. Results of these findings will be discussed in terms of the relative susceptibilities of different non-target organisms to chlorinated insecticides.

102 Result of rearing of eggs, alevins and fry of brown (*salmo trutta fario* Linnaeus) and rainbow (*salmo gairdneri richardson*) trouts in running water hatching boxes at Harwan and Laribal firms during 1968-71

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The communication highlights the results of incubating green eggs of brown and rainbow trouts upto swim-up fry stage. Segregation of spawnners sex-wise and feeding them on partially-boiled meat balls of schizothoracid fishes and common carp in ratio of 1 : 1 gave an increased yield of 14.5%

green eggs in brown trout against 12.0% in rainbow trout. Comparison of rearing of eyed- eggs and alevins in crowded and in thinly spread conditions in hatching trays is given. Technique of flushing hatching boxes with malachite green as a prophylactic against *Saprolegnia* infection is described. Manipulation of dissolved oxygen levels upto optimum condition in hatching boxes by additional supply of freshwater from the source increased the overall percentage of survival of eyed- eggs, alevins and fry. Application of the above stated precautionary measures resulted in cumulative percentag of survival of brown trout 69.7% at Harwan and 91.2% at Laribal against 23.2 and 57.8% in controls respectively. In rainbow, the cumulative rate of survival achieved was 73.8% in experimental and 19.8% in control. Factors responsible for lower rate of survival in Harwan farm are discussed. *Saprolegnia* infection, white spot, soft egg, octomitiasis, ichthyophthiriasis, lentosporidiosis and silt-laden water supply were the principal factors which caused mortality of eggs, alevins and fry in the two farms

103 Rearing of juveniles and raising of adults of *Rana hexadactyla*

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A rearing cum production experiment of fourteen months duration was conducted in a 0.018 ha enclosure where amphibian environment was created by providing land and water in the ratio of 3:1 respectively. Napier and other grasses and seasonal flowering plants were planted on land, while *Lemna polyrhiza* was provided as cover on the water surface to simulate natural aquatic environment. Juveniles of *Rana hexadactyla* of 64.5 mm/40 g average size were stocked at a density of 6,000/ha which attained marketable size (86.5mm/96g) and the production was 370 kg/ha. During the experimental period, feeding was done at regular intervals of 3 days mainly with aquatic insects viz. *Notonectid* sp., *Belostoma* sp., *Ranatra* sp. & earthworm, etc., as well as insects attracted by the flowering plants and lights fixed in the enclosure.

**104 Control of cannibalism amongst *Rana tigrina* and *R. crassa*
tadpoles with use of silkworm pupae as feed**

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Rana tigrina (the Indian bullfrog) and *R. crassa* (the Jerdon's frog) contribute substantially to Indian frogleg export business. Tadpoles of these two species are highly carnivorous and have tremendous rate of cannibalism, the latter being the major factor of their mortality in culture operations, sometimes extending to over 90 percent. Earlier observations have revealed that cannibalism could be markedly checked either through inter-specific hybridization between these two species, or through provision of frog meat, shark meat and tubificid worms as feed. The present paper deals with the experiments carried out with silkworm pupae as feed, the results of which showed that survival of tadpoles could be raised to over 80 percent through almost complete check of cannibalism. Moreover, silkworm pupae induced excellent growth amongst tadpoles of these two species. Based on the high protein content of characteristic nature in silkworm pupae, it can be concluded that cannibalism amongst the tadpoles of *R. tigrina* and *R. crassa* is due to their severe hunger for high quality animal proteins and non-availability or low availability of this in their diet during this stage of development.

**105 Production cum demonstration of composite fish culture
in West Bengal**

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Barrackpore, West Bengal

As an effective means of extension the demonstrations of Composite Fish Culture with six, three and four species combinations were taken up at Mirhati, Nilganj and Khardah Centres. Step by step 41 demonstrations of Composite Fish Culture technique were held which were attended by

3191 fish farmers/interested persons. Productions demonstrated in farmers' ponds with different species combinations ranged from 3829-5253 kg/ha/yr. Also identified various field constraints and limiting factors mainly based on the demonstrations of the technology of Composite Fish Culture and its highly lucrative yield convinced the fish farmers about the feasibility of obtaining 6 to 8½ times higher production than the average production in the country. It is heartening to note that progressive fish farmers became so interested that even few have already initiated scientific fish culture in their ponds.

106 Observations on metamorphosis of tadpoles of *Rana hexadactyla*

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Early and late monsoon and spring offsprings of the aquatic green frog *Rana hexadactyla* Lesson have been studied with regard to the duration of larval period and growth. Variations in metamorphosis percentage observed are reported.

The offsprings of early monsoon and late spring required 50-72 days to metamorphose into early frogs; while late monsoon offsprings took 90-196 days. Percentage of metamorphosed early frogs ranged from 72-82 days in early monsoon, 60-70 in spring and below 45 in case of late monsoon offsprings.

107 Effect of physico-chemical methods in controlling seepage in fish ponds

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Control of seepage in fish pond soils has been investigated both in

the laboratory and under semifield conditions. Various physico-chemical applications have been made on soils from two different states (i) from Barrackpore, West Bengal and (ii) from Lingipore, Orissa. Dilute solutions of sodium chloride mixed with dilute caustic soda solution reduced the seepage rate to the extent of 95%, caustic soda solution also helped in the dispersion of the soil complex. Application of Bentonite, a kind of montomorillonite clay of 2 : 1 expansion, @ 0.1% reduced the seepage rate further (0.03 Cm/hr). Bentonite has been found quite satisfactory for controlling seepage in both kinds of soils.

Section 1—B Fish and shell-fish culture in brackishwater ponds

108 Effect of organic manuring on the availability of phosphorus in brackishwater fish pond soil under different levels of water salinity.

L.N. Mandal

Bidhan Chandra Krishi Vishwa Vidyalyaya, Kalyani.

G.N. Chattopadhyay

Central Inland Fisheries Research Institute, Barrackpore.

Effect of combination of organic manuring and phosphate fertilization on the availability of phosphorus was studied in laboratory using poultry manure and cowdung under different water salinity levels normally occurring in brackishwater ponds. Application of phosphorus in combination with organic manures, on an average, maintained higher levels of water soluble phosphorus over that in the series with added phosphorus only. Phosphorus when applied along with poultry manure, in general, maintained higher amount of phosphorus in available form in the soil than the corresponding calculated cumulative values of separate applications of the manure and phosphorus. In case of cowdung, such beneficial effects could be observed only during the later period of investigation.

The results suggested that application of organic manures in brackishwater ponds prior to application of phosphorus would be helpful in maintaining higher amount of phosphorus in easily available form.

109 Aid to field identification of the seed of important brackishwater fishes of the Hooghly-Matlah estuary

K. K. Bhanot

Central Inland Fisheries Research Institute

Barrackpore, West Bengal

Identification characteristics of the juvenile stages of selected mullets, thread fins, perches, clupeids, sciaenids, etc. in the size group of 4.3 to 12.00 mm have been described along with diagrams. Breeding seasons and peak periods of larval occurrence have been pointed out as an aid to identification. A key of the relevant meristic counts and pertinent identifying structures has also been provided.

II0 A note on the palaemonid prawns of Pulicat lake and their utility for aquaculture

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Central Inland Fisheries Research Institute, Madras

Four species of palaemonid prawns, viz., *Macrobrachium rude*, *M. malcolmsonii*, *M. scabriculum* and *Palaemon sommelenki* occur in the Pulicat lake especially during and after the monsoon season. Of these, the first and the last species occur in good numbers and the other two scantily. The seasonal abundance, size range and sex ratio of these species are presented.

The abundance of their young ones during post monsoon, wide salinity tolerance and the ease with which some of them breed under captivity make them suitable for small scale aquaculture. Their utility for satisfying the local demands is stressed in view of soaring prices of the larger palaemonid prawns rated as foreign exchange earners.

III Preliminary studies on culture of the portunid crabs *Scylla serrata* and *Portunus pelagicus*

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Central-Inland Fisheries Research Institute, Madras

Laboratory experiments were conducted in glass jars and earthenware tubs. to study the effect of two stocking rates on the portunid crab *Scylla serrata* and *Portunus pelagicus*. As expected the higher stocking rate (3/tub) showed lesser growth rate than the other (2/tub) *S. serrata* recorded an average monthly growth of 8.75 mm/10.1 g in the 1/tub experiment as against 6.67 mm/4.3 g in the 3/tub experiment. The corresponding figures for *P. pelagicus* were 11.83 mm/3.77 g and 9.8 mm/4.0 g respectively. The effect of 3 feeds viz. (i) animal matter, (ii) animal matter + vegetable matter and (iii) vegetable matter on *S. serrata* was studied by laboratory experiments with 5—6 replicates. Animal matter gave better rate of growth than the other two.

**112 use of analysis of variance to determine the period of
 abundance of prawn seed in Muriganga estuary**

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and P.K. Ghosh

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An attempt was made to identify the peak abundance period of *Penaeus monodon* (Fabricius) and *Penaeus indicus* (H.M. Edwards) in Muriganga estuary using statistical model. Critical analysis of a factorial experiment shows that April, May, June and July is the desired period of *Penaeus monodon*, whereas peak abundance period of *Penaeus indicus* was observed in February, March and July and significantly different than other months ($p < .01$). The investigation confirms the observations of earlier workers with high degree of confidence.

**113 Preliminary observations on the effect of supplementary
 feed on growth, survival and production of a grey
 mullet, *Liza tade* Forskal**

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& N.M. Chakraborty

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Central Inland Fisheries Research Institute,
Kakdwip, West Bengal

Rearing experiments were carried out in 0.02 ha brackishwater ponds at an uniform stocking density of 8.750 nos./ha for 210 days, to study the effect of three locally available and cheap supplementary feeds on the growth, survival and production of *Liza tade* Forskal.

Growth and production in all treated ponds were significantly higher than those in control pond. Best growth increment of 111.5 gm was obtained with fish meal and rice bran (1 : 3) containing 17.38% protein. A maximum survival of 97.71% and a net production of 837.90 kg/ha/210 days were achieved by application of rice bran and wheat flour (1 : 1) containing 12.95% protein, which is quite a satisfactory feed for raising the production of *L. tade*. Patterns of growth under different treatments were studied and discussed.

114 Experimental studies on the effect of aeration and rearing density on growth and survival of a grey mullet, *Liza tade* Forskal

D.D. Halder and A.K. Roy
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Central Inland Fisheries Research Institute,
Kakdwip, West Bengal

A 3² factorial experiment on the principle of randomised complete block design was conducted in the laboratory for 21 days with three levels of aeration (0, 4, and 8 hours/day) and three levels of rearing density (1, 2, and 3 nos./l), with three replicates for each treatment combination, to study the effect of aeration and rearing density on growth and survival of *Liza tade* Forskal (18—22 mm).

Statistical analysis of the results indicated that effects of both the factors, i.e., aeration and rearing density, on weight increment are significant ($P < .01$), but interaction effect of factors on weight increment is nonsignificant. Effects of the two main factors as well as interaction are found nonsignificant on survival. Within the levels of each factor under study, maximum weight increment of 151.66 mg was achieved with aeration for 8 hours/day and maximum weight increment of 199.43 mg was achieved with rearing density of 1 no./l.

The fitted linear relationship between weight increment and aeration is $W = 130.36 + 4.85 A$ and that between weight increment and rearing density is $W = 130.36 - 67.49 D$ where W is an estimated weight increment in mg, A is the aeration (hours/day) and D is the rearing density (No./l).

115 Notes on benthic macrofauna in brackishwater ponds

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Seasonal abundance and fluctuations of macrobenthic fauna of brackishwater farm were studied for two years in order to assess the production of natural food organisms for prawn culture. Polychaete worms and two groups of small crustaceans, namely amphipods and tanaids, formed the main components of the macrofauna. The occurrence and abundance of different groups were correlated with ambient salinity and temperature of pond water. Maximum concentration of all the groups was recorded during the pre-monsoon months of March—April when their total biomass ranged from 20 to 50 g/m². A marked decrease in their abundance was noticed during monsoon season subsequent to an abrupt drop in the salinity.

116 Observations on moulting and growth in a penaeid prawn, *Penaeus monodon* Fabricius

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Postlarvae and juveniles of the prawn, *Penaeus monodon* Fabricius, collected from natural sources were reared under different laboratory condi-

tions to study the moulting frequency and rate of growth. The intermoult period was found to increase gradually from 2 days in the case of late postlarvae to 12 days in juveniles of 80 to 100 mm. The growth per moult varied from 2 mm to 8 mm and the average growth rate in different size groups ranged from 20 mm to 25 mm per month. In 50—100 mm juveniles, the range of increase in weight per moult observed was 136 to 557 mg with monthly growth ranging from 0.18 to 1.83 g.

The moulting frequency and growth in relation to physico-chemical factors, like temperature and salinity, have been discussed.

**117 On designing and constructing brackishwater fish farm
 in the sand-filled coastal areas with particular
 reference to the Kakinada Bay**

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Often it is found that the shallow backwaters formed adjacent to the bays are filled up with coarse and fine sand in course of time due to various geographical and geological causes and it lies unutilised and fallow. Attempts may be made to develop those areas, which is otherwise unsuitable for any cultivation, as brackishwater farms. There are some typical problems regarding water management, retaining water in the farm and constructing dykes in those areas alongwith some advantages side by side. In the present article, the favourable and unfavourable points are discussed in detail on the basis of the observations made by the author during the survey of a fallow sandy land in the close vicinity of the Kakinada Bay in Andhra Pradesh.

**Experimental studies on the growth of *Liza parsia*
(Hamilton) fry**

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Central Inland Fisheries Research Institute,
Madras

The grey mullet, *Liza parsia* can be cultured both in brackish and freshwaters. While some information is available on the growth of the species in natural brackishwater systems of India, its growth in confined waters is not well known. The selection of suitable species for aquaculture depends largely on growth. With a view to understanding the growth of the species, rearing experiments were conducted in plastic pools, enclosures and pond. The specific growth rate, relative growth rate and growth parameters are presented which would help in developing suitable culture techniques for the species.

**119 Organic productivity and its bearing on brackishwater
fish culture in Ennore and Adyar estuaries**

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Central Inland Fisheries Research Institute,
Madras

Primary productivity estimations were made in Ennore and Adyar estuaries for a period of one year from April '74 to March '75 with a view to finding their biological productive potential. The studies revealed that both the environments are highly productive and can be utilized for fish culture of plankton feeders in pens and cages.

120 Effect of salinity on the laboratory culture of a brackishwater diatom, *Navicula lanceolata* (Kutzing) cleve

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Observations on the effect of salinity on laboratory culture of *Navicula lanceolata* (Kutzing) cleve, a pennate diatom is reported. *N. lanceolata* obtained from cultures of silt algae collected from an intertidal region of the lower Sunderbans was cultured in nine grades of salinities ranging from 5—45 ppt. Results showed that the rate of cell multiplication is maximum at a salinity around 30 ppt. In a nutrient rich sterile culture medium of this salinity, 1,08,800 cells/ml was obtained in 8 days from an initial inoculum of 65 cells/ml.

121 Observations on the gonadal maturation of a penaeid prawn, *Metapenaeus brevicornis* H. M. Edwards from brackishwater ponds

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Metapenaeus brevicornis with maturing ovaries, at different stages of development, were collected from a brackishwater pond. The yellowish green ovaries were visible through the exoskeleton, throughout the length of the body, in specimens measuring 100 to 120 mm in total length. The gonadosomatic indices of the prawns ranged from 3.0985 to 16.2921. Ova diameter measurements from different regions of the ovary indicated that the maturation takes place simultaneously throughout the length of the ovary. In a mature ovary at development stage IV with GSI 16.2921, the ova diameter ranged between 0.20 mm and 0.40 mm with maximum frequency at 0.29 to 0.30 mm. The significance of naturally maturing prawns in brackishwater ponds is discussed.

122 Biological control of *Oryzias melastigma* (McClelland) in less saline ponds of Bakkhali by *Megalops cyprinoides* (Broussonet)

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Rain-fed ponds of Bakkhali with less saline water had large populations of *Oryzias melastigma* which could be effectively checked with the introducing of a few *Megalops cyprinoides*. The feeding intensity of the predators at different sizes and the growth obtained thereof are discussed together with a description of the habitat.

123 Observation on the growth of *Penaeus monodon* (Fabricius) in the low saline ponds of Sunderbans with notes on acclimatisation and transport of their fry

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Acclimatisation process of juveniles of *Penaeus monodon* in the length range of 18-26 mm without mortality to waters of very low salinity, (1.5 ppt) through different stages has been described. Growth trend of the prawn in nursery as well as stocking ponds having low saline water was very encouraging. The observed growth rates in such environment have been discussed and compared with reported data from elsewhere. Methods of rearing of postlarvae to juveniles in controlled conditions have been presented.

No mortality was observed when juveniles in open containers were transported over a duration of three hours without anaesthesia.

**124 Studies on the induced maturation of *Penaeus monodon* Fabricius
in brackishwater ponds under control conditions**

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Experiments conducted on the induced maturation of *Penaeus monodon* Fabricius, under captivity in brackishwater conditions, by eye-stalk ablation at Leganes, Ilo-ilo city, Philippines, are reported. The author succeeded in maturing this species in the brackishwater pond conditions by eye-stalk ablation technique. The methodology developed has been discussed in this communication with relation to various physico-chemical parameters observed.

**125 Observations on the benthic ecology and hydrobiology of
some brackishwater ponds in Madras with a note on
their suitability for fish culture**

M. Kaliyamurthy, S. Radhakrishna
and K. Raman
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Institute, Madras

Detailed studies were made on the hydrography, plankton, benthic

flora and fauna in four brackishwater fish ponds of varying sizes (0.11 to 3.2 ha) at Adyar, Madras, for a period of two years from Sept. 71 through Aug. 73.

All the ponds were found to be highly productive in terms of both plankton and benthic communities. Hydrographic features such as salinity, water temperature, oxity and pH were in the optimum levels. The present study indicates that these ponds are highly suitable for farming prawns, mullets, *Chanos* and other brckishwater benthophagous fishes that can better utilise the abundantly available macrophytes and benthic animals.

126 Studies on the culture of percoid fishes in brackishwater environments

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Results of the experiments conducted on the growth of some commercially important percoid fishes of the Pulicat lake, viz *Sillago sihama*, *Gerres* spp, *Siganus canaliculatus* and *Etroplus suratensis* are presented- The fry and fingerlings of the above species were reared in plastic pools, earthen vats, and velon cages with natural and artificial feeds. Except *S. canaliculatus* all the other species were acclimated to freshwater and reared to varying periods from 1 to 3 months.

Fry of *S. sihama*, *Gerres oyena* and *G. filamentosus* were cultured in a brackishwater pond along with mullet fry indicating their siutability in brackishwater poly culture.

127 Management of commercial brackishwater aquafarm

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Seven steps of management as recommended for freshwater fish

farms are not fully applicable under brackishwater conditions. In context to the commercial farms at Alampore, Frasergung & Digha, the present paper deals with the location of the farm in relation to the water supply resource, size of the farm ponds, management practices involved and per unit production obtained highlighting the fact that the same management practice does not yield similar results. The possible causes for such variations have been discussed and steps of management to be followed under a given set of conditions have been brought out.

128 Observations on the mass culture of a brackishwater diatom,
Navicula lanceolata (Kuetzing) cleve

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Sustained culture of the diatom, *Navicula lanceolata* (Kuetzing) cleve has been successfully achieved in the laboratory and field experiments by using urea-single superphosphate-muriate of potash and sodium silicate in the ratio of 18 : 8 : 4 : 10 in 20‰ salinity. Maximum cell density was observed from the 5th day after inoculation. The alga was isolated from a fish pond located at brackishwater fish farm, Kakdwip, West Bengal. The cell density yielded 4.5 million cells per ml in a period of ten days from an initial inoculum of 2462 per ml. Observations on mass culture in six different salinities ranging from 5 ‰ to 30‰ showed that the rate of cell multiplication was highest in 20‰ and that the species could be maintained for longer periods in this medium.

129 Technique to obtain sustained culture of a brackishwater diatom,
Skeletonema costatum (Geville) cleve

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Barrackpore West Bengal

Large scale culture of a brackishwater diatom, *Skeletonema costatum*

(Greville) Cleve was obtained in plastic pools of 250 litre capacities by utilising NPKS₁ fertilisers in the ratio 100 : 10 : 5 : 10 at 385 ppm. Urea-single superphosphate-potassium nitrate and sodium silicate were used as N-P-K-S₁ sources. The maintenance of the culture was seen to be higher at 19.5 ppt salinity. The culture containers were inoculated with pure strain of *Skeletonema costatum* previously cultured in the laboratory. The exponential growth phase was observed from the 5th day after-inoculation. Maximum cell density of 2.5 million cells per ml was obtained in a period of ten days from an initial inoculum of 1150/ml. Media treated with inorganic nitrogen at a higher level was found to be responsible for enhanced production of *Skeletonema costatum*.

130 **Studies on the effect of thyroxine on growth and moulting in *Penaeus monodon* Fabricius**

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The effect of thyroxine on growth and moulting in postlarvae (12—13 mm) and early juveniles (21—22 mm) of *Penaeus monodon* based on a randomised complete block desing experiment with three concentrations of thyroxine, viz. 1.0 micro g/l, 3.0 micro g/l and 5.0 micro g/l, has been reported. In 14 days the postlarvae registered a maximum growth increment of 7.5 mm in length and 29.25 mg in weight at 3.0 micro g/l of thyroxine which is significantly different at 1 per cent level, while the early juveniles recorded a maximum growth of 11.2 mm and 89.00 mg at 5.0 micro g/l of thyroxine which is significantly different at 5 per cent level, compared to the other treatments. At 3.0 micro g/l concentration of thyroxine the postlarvae moulted at an average interval of 2.055 days, and 4.50 moults were observed in 14 days of experiment. For the same duration, the intermoult period of the early juveniles was 3.364 days with an average number of 2.75 moults.

The results are interpreted to show that thyroxine in microquantities accelerates growth and ecdysis in *P. monodon*.

131

**Observations on the culture of *Crassostrea*
madrasensis Preston in the Pulicat lake**

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Experiments were conducted for a period of 19 months at three places in the lake Pulicat using different cultch materials hung onto the rafts with a view to finding out the suitable locality and cultch material for culturing oysters. Of the three localities around Pulicat village viz. Alithurai, Light house and Ice plant, the last one was found suitable where the hydrological conditions were congenial for culturing the oyster *Crassostrea madrasensis*.

Four types of cultch materials viz. dead oyster shells, tiles coated with cement and lime and asbestos sheets were used for selecting the most suitable one. Taking the density of attachment as an index it was observed that asbestos sheets were the best cultch material.

**132 Water and soil characteristics of two brackishwater ecosystems
in the Madras region with a note on their
utilisation for aquaculture**

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Central Inland Fisheries Research
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The Pulicat lake and the Adyar estuary are two brackishwater ecosystems differing slightly in their physiognomy in the neighbourhood of Madras city. Both serve as nursery grounds for a number of commercially important prawns and fishes.

The seasonal changes in some of the physico-chemical features of water and soil of the two brackishwater ecosystems during the period November 1977 to October 1978 are discussed.

Both the ecosystems are found suitable for aquaculture operations especially pen-culture and cage-culture minimising the limiting effects of pollutants which are present to some extent at Adyar estuary. This would also suit the low tidal amplitude of the area.

133 Short-term culture of prawns in brackishwater ponds at Kakdwip

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Experiments on mixed culture of post-larvae and fry of *Penaeus indicus*, *Penaeus monodon*, *Palaemon styliferus*, *Metapenaeus monoceros* and *Metapenaeus brevicornis* upto marketable size were conducted in two ponds of 0.02 ha. Three short-term crops, first two of 75 days each without and the third of 120 days with supplementary feeding (Protein—10.2%, were harvested from each pond. Stocking was done at 2 lakh/ha with varying species ratio and the ponds were treated with organic and inorganic fertilizers.

Best survival of *P. indicus* was observed in April—June (75 days) and that for *P. styliferus*, *M. monoceros* and *M. brevicornis* in January-March (75 days) coinciding with high salinity & temperature and medium salinity & temperature regimes respectively. Poor survival for *P. monodon* was noticed in both the ponds.

No significantly better growth, even with supplementary feeding and enhanced rearing period of 20 days, was observed in prawns which attained marketable size in 75 days itself. Best growth period for prawns was found to be April—June cultuer period

Production of 666.0 to 850.5 kg/ha/9 months from mixed prawn farming is considered encouraging and highest so far reported from deltaic West Bengal.

Observations on silt load distribution in relation to tidal amplitude and lunar periodicity and its control in brackishwater fish farming

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The regular exchange of tidal water in brackishwater farm results in heavy silt deposition in pond bed which incurs heavy expenditure for desiltation. An experiment was conducted in Brackishwater Experimental Fish Farm, Kakdwip for quantitative estimation of silt load with inflow of tidal water through sluice gates operated at different levels and its distribution in relation to tidal amplitude and lunar periodicity, using a statistical model.

Multifactor analysis of variance demonstrated significant interaction effect of lunar periodicity, tidal amplitude and wooden shutter type sluice. For adequate inflow of water with minimum silt load, operation of wooden shutter sluice at a height of 122 cm from base during the tidal amplitude range of 4.01—4.35 m of full moon period is recommended.

Artificial propagation of Indian major carps in low saline ponds

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Artificial propagation of Indian major carps through homoplastic or heteroplastic hypophysation has been a well established fact in freshwater fish culture operations. Earlier works indicate that carps can be cultured profitably in low saline ponds also. In order to make the economics cheaper, attempts were made to mature & breed Indian major carps in low saline ponds. The present paper embodies the result of experiments carried out in these directions and points out the possibilities of carp culture, gonadal development, maturation and artificial propagation of carps under captivity in low saline ponds.

**Preliminary observations on rearing of milkfish *Chanos chanos*
(Forsk.) fingerlings in brackishwater ponds at
Kakdwip, West Bengal**

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Rearing experiments on milkfish, *Chanos chanos* (Forsk.) fingerlings were conducted for a period of 90 days in two brackishwater ponds of 0.02 ha area each, fertilized with poultry manure @ 2,000 kg/ha/yr, urea and superphosphate @ 240 kg/ha/yr each and uniform stocking density of 12,000 nos/ha.

An average weight increment of 13.44 g, maximum survival of 74.01% and a net production of 119.16 kg/ha/90 days were obtained from the control pond. On the contrary, an average weight increment of 32.54 g with a survival rate of 42.22% and net production of 154.32 kg/ha/90 days, could be achieved from the pond where supplementary feed viz. rice bran and maize powder (1:1) was provided.

The effect of supplementary feed and natural food, in comparison to natural food alone, on survival, growth and production of milkfish fingerlings is discussed.

Experiments with artificial feeds on *Liza parsia* (Hamilton) fry

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The results of experiments conducted on *L. parsia* fry to find out the

suitability of some commonly available items as feeds are presented. Six pelleted feeds were prepared from individual items, namely, ground nut oil cake, mustard oil cake, prawn head, wheat bran, algae, weeds, ragi, pea and Bengal gram. A mixture of ground nut oil cake, prawn head and sago in the ratio of 2:2:1 gave the best growth followed by Bengal gram + prawn head + algae (2:1:1) and pea + Bengal gram + ragi (1:1:1). Confirmatory experiments were conducted with the same feeds on the growth and survival of the species which corroborated the above observations.

138 Role of estuarine silt on the environmental and nutrient balance of brackishwater impoundments

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The nutrient status of silt has been studied for a period of two years at Barrackpore and Kakdwip. The silt load in spring tide-water rises to 1.86—1.90 g/l in monsoon. There is seasonal variation of the nutrient levels in the silt. During monsoon, the available nitrogen in the silt, when settled, is maximum i.e. 19.6 mg/100 g. Phosphate is also high, 13.5 mg/100 g and the pH varies from 7.2—7.4.

Continuous flushing due to heavy rains or the discharge from Farakka barrage has shifted the salinity gradient towards the sea mouth and the soluble phosphate of silt under these environments helps in improving the productivity in brackishwater impoundments replenished by tide-water. It also adsorbs the toxicants that may come along with the tide water.

SESSION 2

OTHER SYSTEMS OF AQUACULTURE

Section A : Aquaculture in raceways, cages, fish pens and net enclosures

**139 Assessment of seed resources and observation on culture of
Mystus seenghala (Sykes) in cages in river Ganga**

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To explore the possibilities and to evolve scientific technology for the culture of catfishes, investigations were initiated at the Riverine and Lacustrine Division of the Institute at Allahabad in the year 1974. The investigations included the assesment of catfish seed in time and space, the rearing of hatchlings to fingerlings, determination of artificial feed acceptable to the fish at various sizes and other related studies necessary for the culture of *Mystus seenghala* (Sykes) a commercially important food fish of wide distribution. The fish attains a large size.

The breeding pits locally known as *Thala* are generally found in shallow regions of the river at a depth of about 1.0 to 1.5 m and at a distance of about 5 m and above from the water edge. In such shallow regions of the river having breeding pits the current is feeble and aquatic weeds, mainly *Hydrilla*, *Ceratophyllum*, etc., are abundantly present.

The breeding takes place in the pits and the resultant hatchlings continue to live there till they are about 60 mm in total length. The male parent mostly remains inside the pit to guard the offspring and Saigal and also to nurse them. According to Raj (1940 and 1962) and Motwani (1961), the hatchlings feed on scum 'the white secretion exuding from the inflamed ventral surface of the parent', which appears to be main feed of the hatchlings in the pit. The chironomid egg mass as initial feed followed by semi-boiled trash fish was used as a successful supplementary feed in rearing hatchlings/early fry of an average 28 mm to 200 mm size during 233 days in floating nylon cages, in one of the experiments. The success achieved for the first time paves way for culture of the fish on large scale by forming a second line of production in terms of protein, thus adding to the inland aquaculture.

140 Fish pen operation in freshwater reservoir of West Bengal

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Experimental pen culture operation was carried out in an unproductive reservoir, Kangsabati-Kumari in the districts of Bankura-Purulia of West Bengal. The pen was constructed along the periphery of the reservoir in the area away from the main water course. This culture operation has been found to be an effective commercial system for development of reservoir fisheries.

This operation indicated that the rate of growth in the pen when fed with supplementary feed with agricultural bye-product is markedly different and higher than those directly stocked. The survival percentage of the pen cultured fish in subsequent fishery of the reservoir was also found to be higher. The present paper deals with pen construction, care of the pen and steps to be taken for successful culture of younger ones for reservoir stocking.

Section B : Integration of aquaculture with agriculture and/or livestock

141 Observations on paddy-cum-fish culture

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&

P.K. Pati, R.K. Nigam and R.P. Singh
Central Rice Research Institute, Cuttack

Results of rearing carp fingerlings along with mahsuri, variety of paddy, in a 0.16 ha plot at the Central Rice Research Institute, Cuttack, have been reported. In 2-months the fish, stocked at a combined density of 6,000/ha in the species ratio of *Cyprinus carpio* 5 : *Cirrhinus mrigala* 3 : *Labeo rohita* 2, recorded an overall recovery of 34%, the percentage survival being 45, 32 and 7 respectively with respective average length/weight increments of 30 mm/18.5 g, 23 mm/3.6 g and 23 mm/3.5 g.

In a subsequent experiment in two adjoining plots, the net productions obtained on stocking *C. carpio* fry @ 7,250/ha were estimated to be 82.5 kg/ha and 72.0 kg/ha/119 days. 'CR 1014' variety of paddy, cultivated in the above two plots, yielded crops @ 2,800 kg/ha and 2,638 kg/ha respectively.

142 Renovation methods of paddy field for integrating fish culture

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In most of the far eastern countries, integration of fish in paddy fields for culture has been practised for long. In India, about 39.0 million hectares of land is presently under paddy cultivation——the highest in the world. In recent years, use of pesticides, has greatly hampered and curtailed the

possibility of fish culture in paddy fields. Notwithstanding the constraints of rearing fish in ordinary paddy fields, some renovation of paddy fields are considered essential primarily (i) to control the inflow of pesticide washings and prevent escapement of fish stocked, (ii) to extend the yearling period of the fish, and (iii) to hold rain water in the system for raising a second crop of paddy during 'Rabi' season. The planning, design of layout and other construction details of paddy field renovations including cost to undertake such culture operations have been presented.

143 A critical analysis of fish culture in paddy fields

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Mention is made, how, with the culture of prawns and brackishwater fishes in low lying coastal paddy fields of West Bengal and Kerala, paddy-cum-fish culture has become a mainstay of farmers in these regions. However, the extension of paddy-cum-fish culture to the freshwater inland areas of the country is beset with a number of problems.

Emphasis is placed on the adverse effect of advanced agrarian practices on fish culture, like spraying of pesticides, weedicides and fungicides with the advent of high yielding varieties of paddy. The recent concept of multiple cropping in agriculture leaves little scope for pisciculture by not providing long or short spells of wet fallow periods. The pros and cons of other prevailing conditions like shallowness leading to high temperature in paddy fields, poor plankton production, the erratic monsoons, the presence of fish enemies like frogs and water snakes and the generally weak dykes vulnerable to burrowing by predators like rats and crabs are highlighted. The practical difficulties of large-scale adoption of paddy-cum-fish culture on the basis of research results obtained mostly from small experimental plots, have been discussed.

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The fertilizing effect of the bird droppings enhances biological productivity which in turn is reported to increase duck production by 10%. Approximately 500 birds can be raised in one hectare of pond surface and they are estimated to yield about 3 tons duck manure per year and cause 8,000 to 9,000 kg/ha annual production of fish without adding any other fertilizer and at no extra cost. If the egg class ducks such as Runner and Khak Cambell are raised, they would produce 50,000 eggs annually and would fetch an additional income of about Rs. 16,000/per annum to the farmer. However it is necessary to integrate fish and duck husbandry in a balancing way, otherwise, over concentration of one may work to the detriment of the other. The need for basic information on physiological and chemical reasons for the growth of the species under investigation as well as on obtaining better understanding of reproductive physiology, the nature of genes etc., is needed before releasing package programmes to entrepreneurs.

145 Hydrobiological investigations of a jute-retting pond and prospects of fish culture in such waters

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Fish mortality commonly reported from jute-retting ponds has led to the the belief that such waters are not suitable for fish culture. Adverse effects of physico-chemical conditions of jute-retting pond waters have been reported in the past even on air-breathing fishes. Observations on the soil,

water and plankton bio-mass of a jute-retting pond at JARI Nilgunj have suggested good manurial value of such waters. Prospects of culture of *Tilapia mossambica*, *H. fossilis*, *C. batrachus* and other fishes during post and pre-retting period in jute-retting ponds are discussed.

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Observations on fish-cum-duck rearing

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Results of the preliminary studies made to integrate fish culture with duck rearing and to assess the effectiveness of duck droppings as manure, in composite fish culture, are presented in this communication. The ducks moved freely over the pond during the day time and for night shelter, they were housed in improvised floating duck houses. The excrements of the ducks served as manure for the pond. No supplementary feed or fertilizer was given.

A total fish yield of 6397 kg, corresponding to a production rate of 4323 kg/ha/yr was attained from a pond of 1.48 ha. Rs. 1.38 worked out to be the average cost of production of one kg. of fish. 1835 eggs laid by the ducks fetched Rs. 734.00. An over all profit of Rs. 27,095.00 was made through fish-cum-duck rearing.

It is estimated that 100—150 ducks are required for manuring of a pond of 1 ha water spread area.

Fish yield and economics of fish-cum-duck rearing have been compared with the productions and economics attained through composite fish culture involving feeding and fertilization of ponds.

**147 Rural development through integration of aquaculture
 with agriculture**

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Integration of aquaculture with agriculture could play considerable role in boosting the rural economy. 'Haveli' system of wheat cultivation around Jabalpur in Madhya Pradesh is undertaken in fields where rainwater is held for a period of four months during monsoons. 'Haveli' wheat fields, which remain fallow during the monsoon and get choked with weeds hampering wheat cultivation, were utilised for a short-term fish culture and stocked with common carp and grass carp. A production of 750—1000 kg/ha/4 months of common carp was obtained without fertilization and supplementary feeding. Grass carp effectively controlled the weeds. While a great scope for augmenting the per hectare production exists, utilization of this hitherto unused resource would greatly increase fish production. Use of seasonal nurseries for growing wheat and summer 'moong'—the latter well-known as a nitrogen-fixing crop—was also made.

**148 Comparative studies on the role of thiamine and inositol alone
 and/or in combination with folacin and cyanocobalamin on the
 survival and growth of *Cirrhina mrigala* during the first year
 of its life**

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Using complete synthetic diet (CSD) as control and three diets deficient either in all the four vitamins or in different combinations, a

series of experiments extending over a year were designed to study the role and inter-relationship of these important water-soluble vitamins on the survival and growth of the hatchlings of *Cirrhina mrigala*.

Observation on the behavioural and morphological variations of the deficient groups of fishes are recorded in addition to the statistical analyses of cumulative mortality and survival and supplemented with haematological studies at later stages of development.

Maximum retardation was observed in the group which was deficient in all the four vitamins eventually leading to mass mortality. Recovery diet after four weeks on deficient diet resulted in 100% survival accompanied by a statistically significant (92%) improvement in food conversion ratio ($P < 0.01$). Mortality and food conversion percent in the other two deficient groups were far less than those of the control group but it has been shown that these changes were more pronounced in the group deficient in vitamin B12 and folic acid than thiamine and inositol deficient group.

Haematological studies revealed that the changes in erythrocyte number and related values were particularly significant in the folic acid and vitamin B12 deficient groups. On recovery diet all these deficiency symptoms disappeared within a period of 30 days.

The relevance of these findings to aquacultural practices is discussed.

149 **Stocking density and its influence on production** **in *Heteropneustes fossilis***

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Effect of stocking density on food utilisation, surfacing and swimming activities in *Heteropneustes fossilis* was studied five groups, viz, 1 g/4 l, (1 individual), 2 g/4l (2 individuals), 4g/ 4l (4 individuals), 8 g/4l (individuals

and 16 g/4l (16 individuals) were studied. Feeding rate decreased from 229 g cal/g/day in controls of 1 g/4l biomass to 107 g cal/g/day in the maximum stocking biomass of 16 g/4l. Conversion rate and efficiency also showed similar decreasing trends from 43 g cal/g/day and 19% respectively in control series to 15 g cal/g/day and 14% at maximum density. The surfacing and swimming activities respectively increased as density was raised. Under high stocking density fish ate less and also converted less efficiently. The probable causes for this and its relevance to aquaculture have been briefly discussed.

SESSION II

OTHER SYSTEMS OF AQUACULTURE

Section c : Aquaculture in recirculating water and with recycling of water

148 Observations on the recycling of swine dung in composite fish culture

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This is perhaps the first attempt in India to integrate fish culture with pig rearing. The paper embodies the results obtained through recycling pig dung in suitable daily doses, for composite fish culture. No other fertilizer or supplementary feed was used.

All the species stocked, except common carp, recorded remarkable growth rates. Silver carp, grass carp, catla, rohu and mrigal attained weights of 2.1, 1.3, 1.1, 1.0 and 0.8 Kg. respectively in 12 months rearing. A fish yield of 7300 Kg/ha/yr could be achieved in this experiment. The average cost of production of fish worked out to Rs. 0.93 Kg. Profit of Rs. 4,881.93 was made through fish culture from the 0.1 ha pond. An additional profit of Rs. 1,578.85 was made through pig rearing. Thus an over all profit of Rs. 6,460.00 was made through fish culture and pig rearing from a small pond.

Observations on the growth and survival of grass carp fed purely on chopped green cattle fodders grown on the terraced embankments of the pond were made and compared with the growth obtained by grass carp fed on aquatic vegetation.

Fish yield and economics of fish-cum-pig rearing have been compared with the productions and economics of composite fish culture, involving feeding and fertilization of ponds.

149 Recycling sewage for fish culture

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Recycling sewage for fish culture has the advantage of growing fish

at a very low cost and also of maintaining a cleaner environment. A small experimental complex for fish culture utilizing sewage and sullage from the residential quarters and hostels of the Tamil Nadu Agricultural University Campus was set up. The sewage was pumped to an oxidation pond and the effluents from the oxidation pond were led to fish ponds and compatible species of fishes i. e. those now used in composite fish culture, namely the Indian major carps, catla, rahu and mrigal, the fringe-lipped carp, the common carp and two Chinese carps (silver and grass carps), were stocked at densities of 9600-13, 460/ha. No feeding and fertilization other than sewage addition was adopted. A maximum production of 8442/kg/ha/year was achieved in a pond directly connected to the oxidation pond. Production in three other ponds were 4287, 3520, and 3342 kg/ha/year. Silver carp and catla showed maximum growth, followed by mrigal and common carp. The production economics worked out very favourably. In specimens cooked under Indian condition (curried or fried) or by steaming none of the enterobacteriaceae tested survived.

150 Fertility and productivity status of a sewage enriched tank compared to a general tank in Karnataka State

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The biotic and abiotic conditions of two tanks—one defunct secondary sewage sedimentation tank of 332 ha and the other, a general tank of 510 ha, were studied for one year. It was observed that the accumulated organic matter possessed a considerable residual impact on the overall productivity of the water area. The aquatic fertility as well as productivity of the general tank were found to be comparatively low. The sedimentation tank experienced a very wide fluctuation of diurnal dissolved oxygen values (from 8.4 to 25.4 mg/l) and so also the pH (9.3—9.6) whereas the general tank had minimum fluctuation (D. O. 5.5 to 6.2 mg/l ; pH 8.0—8.3). The sewage fed tank maintained sustained higher values of dissolved major nutrients viz., phosphorus and nitrogen. The high fertility status of the organic rich tank duly responded to the plankton biomass and fish production. Limnological conditions of the two tanks have been discussed in the paper.

151 Effect of digested sewage sludge cake on plankton and fish production

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Experiments were conducted to evaluate the effect of digested sewage sludge cake on plankton and fish production. A study of the chemical composition of this manure has revealed that the nitrogen content was quite high while the phosphorus content varied from 1.5 to 2.0%. On fertilisation of cisterns, the plankton production was found to occur very rapidly, reaching a peak by the 14th day after application. However, the plankton production was short-lived. The growth of catla and common carp in the cisterns treated with sewage sludge cake was significantly faster than that in the control. The overall average growth of catla and common carp was 1.12 g/day and 0.77 g/day respectively in the treated cisterns whereas in the control cistern the corresponding growth was only 0.03 g/day and 0.18 g/day. A total fish production of over 2,000 Kg/ha/year was recorded in the cisterns fertilised with sludge cake.

152 The primary production of the Hooghly estuary with reference to disposal of sulphite pulp and paper mill effluent

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Effect of pollution on the primary productivity of the Hooghly estuary around a sulphite pulp and paper mill outfall, investigated in 1974 during low tide condition under neap tidal phase of different seasons, are discussed. Pollutants containing highly oxidisable organics and inorganics are reflected in the reduction of phytoplankton and gross primary productivity to the extent of 61% and 77% respectively. The overall adverse effect on water quality and plankton was more pronounced at the marginal stretch below the outfall, whereas effect on primary productivity was up to a lateral stretch of 100 m. Lowering of DO and pH values and increase in the levels of free carbon dioxide, alkalinity, chloride and turbidity were the main factors affecting the biological equilibrium. Summer condition intensified the nature and degree of pollution. The primary productivity and plankton remained affected beyond 1.2 km below the outfall although the environmental conditions recovered with that stretch. Remedial measures to prevent the effect of pollution caused by sulphite pulp and paper mill waste are suggested.

**153 Observations on the productivity of carps in a culture system
fertilised with domestic sewage effluents**

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Utilization of domestic sewage in aquaculture practices has gained much importance in recent years not only from the point of view of its productive potential but also as a method to dispose community wastes without bringing any ecological disorder in nature. While designing fish culture using domestic sewage, it is considered that short herbivorous food chain, where domestic sewage will be converted into micro-algae and finally into fish flesh, will be more convenient for operation in the ecosystem to attain high production of fish. With this in view, three mixed culture experiments using fry of Indian major carps, Chinese carp and common carp with three stocking densities and ratios were undertaken during the period 1975-77 in Titagarh Municipal fish pond at Rahara, West Bengal. The productivity of fish pond in relation to inflow of sewage effluents and its physico-chemical conditions during the culture period have been discussed.

**154 Biochemical and pathobiological studies on the catfish, *clarias batrachus*
during pesticide stress conditions**

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Air-breathing catfish, *Clarias batrachus* were exposed to malathion (500 ug/litre in ambient water) for forty days. The effect of this pesticide on liver and gill alkaline phosphatase activity was studied. Marked increase in the enzyme activity could be noted in malathion exposed fishes. Investigations on the level of some biochemical constituents in liver and serum were also carried out. Liver phospholipid, sialic acid, ascorbic acid and glycogen level and lipid profile in blood of malathion treated fishes were observed. Changes in the absolute amounts of total phospholipids, phosphatidyl choline, phosphatidyl ethanolamine owing to malathion exposure have been reported. Histological studies of liver, gill, kidney, intestine and testes have also been carried out to correlate the observed biochemical changes. The physiological and biochemical significance of these findings are presented and discussed.

155 Aquatic weed utilisation for rural development

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Aquatic vegetation in the rural area offer challenging possibilities of their utilisation in the various rural agro-industries for productive part-time or full-time employment of unskilled and semi-skilled labour. The domestic wastes and sewage could be safely utilized to fertilize and sustain cultivation of usable aquatic vegetation in waste-water lagoons, pools and ditches, where cultivation of fishes is not at all possible or severely limited. Co-cultivation of fish and surface vegetation is possible in large fertile water areas. Cultivation of aquatic vegetation could also form part of a tight integrated farming complex with dairy, poultry, piggery fishery and horticulture as the other components so as to ensure a leak-proof productive cycle.

The most economical utilisation of water hyacinth is to use it *in situ* to fertilise the fishery. In an integrated farming system, the cultivation and the uses of the weeds could be diversified for fuller utilisation. Duck-weeds could be processed into feeds. Aquatic grasses and submerged weeds could be cultivated to feed grass carp. *Ipomea carnea* could be used as domestic fuel. Water hyacinth could also be used as a cheaper part-substitute for the conventional feed-stock, cow-dung, in rural biogas plants. Most of the aquatic weeds are easily composted into rich fertilizer. The shoots, rhizomes, fruits of some aquatic vegetation are delicious vegetables.

Cultivation, harvesting and processing aquatic vegetation offer tremendous scope for rural employment.

156 Adverse effect of common insecticides to aquaculture

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Insecticides, now in common use in agriculture, comes under three broad groups, namely, chlorinated hydrocarbon, organophosphorus and carbamate groups.

Use of insecticides under chlorinated hydrocarbon group has become rather limited for pest control purpose because of their various adverse effects. They are being gradually replaced either by the other two. Adverse effects of the insecticides under these groups have been evaluated by determining their LC values in respect of two bound water species of fish.

Tests carried out in glass aquaria with few insecticides under these different groups in the laboratory, either in presence or absence of soil layer at the bottom of test aquaria, indicated that tolerance of aquatic fauna like fishes increase in presence of soil layer at the bottom.

L C₅₀ value of carbaryl and other organophosphorus compounds along with their fiducial limits have been determined for different exposure periods when *C. carpio* and *T. mossambica* were exposed to water polluted by insecticides mentioned above. Results indicated that culture of *T. mossambica* should get priority over *C. carpio* where possibility of insecticidal pollution of water exists:

157 Effect of mercury poisoning on growth, mortality and glycogen reserve in liver and muscle of freshwater fish, *Channa Punctatus* (Bloch)

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The paper reports the effect of graded sublethal doses of mercuric chloride in food, viz., 0.01, 0.1, 0.5 and 1.0 per cent. A parallel control was maintained.

Mercury poisoning resulted in significant decrease ($P < 0.001$) in growth at 0.5 and 1.0% level accompanied by mortality, while there was no mortality at 0.01% level of pollution. At 0.1% level mercury poisoning upto 45 days resulted in 2% mortality.

Biochemical studies revealed a significant decrease in glycogen content of liver and muscle.

The significance of these studies in aquaculture is discussed.

158 Aquatic pollution and the use of haematopoietic studies in fish

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The use of fish as an indicator of water pollution is an established practice all over the world but this is generally done by measuring mortality rates. Death being an end point in a series of adverse changes is therefore a poor indicator if we aim at nipping the evil of aquatic pollution at a stage where permanent and longer damage to affected aquatic ecosystem is to be avoided.

The results of a series of investigations over the years aimed at finding more sensitive, reliable and conveniently possible methods of monitoring water quality using fish blood and haematopoietic organs as indicator tissues are presented. The findings have demonstrated that if certain base line information on a normal healthy endemic fish species is available, it is possible to measure the extent of pollutional stress even at sublethal levels by just drawing a few drops of blood and/or making imprints of haematopoietic tissues from the fish body.

Thus, in our extensive and intensive studies on *Channa punctatus* using Alkyl Aryl Sulphonate (AAS) as pollutant at various sublethal levels we have been able to establish that a highly significant increase in both large and small lymphoid haemoblasts and a corresponding decrease in metamyelocytes are the most sensitive indices of pollutional stress and that this can be further related to the concentration of pollutants and the time of exposure as well as to cell populations in peripheral blood.

The relevance of these studies in growing fish in aquacultural system is discussed.

159 Studies on the effect of pesticide and heavy metal pollution on the general biology of *Channa Punctatus* (Bloch) and its relevance in aquaculture

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The paper reports the results of a series of experiments designed on an air-breathing fish *Channa punctatus* at various low sub-lethal levels of aldrin

and mercuric chloride when dissolved in water and/or mixed with food. Changes in general and feeding behaviour, growth, respiratory movement and mortality are reported in detail.

Both short and long term experiments showed that aldrin is more toxic at the same level of pollution as compared to mercuric chloride whether in food or dissolved in water. In both pollutants, the effect of pollution was least obvious when the pollutant was a part of the food as compared to when the same level was dissolved in water. The response is however synergistic when any of these pollutants administered both in water and food.

Relevance of these studies in practical aquaculture is elaborated and discussed.

160 Use of mohua oil cake and cotton seed waste in fish farming

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The toxicity as well as manurial potentiality of mohua oil cake and cotton seed waste applied with and without combination, in fresh and brackish-water fish ponds, have been studied. The 4-hr LC_{50} values for mohua oil cake were 74 mg/1 and 80 mg/1 respectively in fresh and brackishwater. For cotton seed waste, these concentrations were 104 mg/1 in fresh water and 113 mg/1 in brackishwater. In all the cases *T. mosambica* was the test animal. Mohua oil cake was found to be more toxic but less degradable, compared to cotton seed waste. Either of the toxicants when charged 200 mg/1 could exert 5 day BOD load between 34 and 120 mg/1 during the initial 10 days. The N/P ratio of the cotton seed waste being narrower compared to mohua oil cake, a better availability of nitrate nitrogen to the water phase was observed with the former. Both the manures were found to be potential plankton producers especially suitable as food for spawn. A combination of the two manures was found to be equally effective at a lower cost.

**161 Limnology of lower lake, Bhopal with special reference to
sewage pollution and fish culture**

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Limnological studies were carried out on sewage polluted Lower Lake, situated amidst the densely populated area of Bhopal City. The lake is very turbid with permanent algal blooms which curtail light and limit euphotic zone only upto a depth of 1-2 metres. Thermal stratification in summer and higher decomposition of organic matter lead to depletion of oxygen in hypolimnion and make water uncomfortable for normal fish life. Surface oxygen saturation becomes as high as 200 per cent. As compared to phytoplankton production, zooplankton and fish production was very low. The present investigation reveals that the lake is badly polluted by the continuous inflow of sewage from the surrounding areas. In such nearly anaerobic conditions even at the depth below 3 meters, the lake is unsuitable for any fish culture. It is, therefore, recommended not to use such lakes for fish seed stocking till they are recovered from severe state of pollution.

162 Economic utilisation of municipal wastes for increased fish production

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The physico-chemical character of the wastes under seasonal influence has been studied to ascertain their responsive indices under different seasons. A positive correlation of the available nutrients with temperature is noticed. Mineralisation rate percent of the waste ensures the impact on the saline aquatic ecology when the waste is charged there also, and it is best favoured with soluble phosphate in the system, at near neutral conditions. The waste can be best utilised to mitigate the harmful effect of salinity.

**163 Studies on the relative efficiency of organic manures and inorganic fertilizer
in plankton production and its relation with the water quality**

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Seven organic wastes of animal and plant origin namely duck and

poultry droppings, goat, cow and horse dung and oil cakes of mohua and ground nut were tested for their relative efficiency in producing plankton and their efficacy compared with inorganic fertilizer.

Plankton production with ground nut oil cake, horse dung and poultry droppings were significantly better than inorganic fertilizer. Though the plankton productions in duck droppings, goat and cow-dung treatments were better than the control, it was less than that of the inorganic fertilizer.

The results of plankton and water quality were tested statistically for possible correlations. Significant positive correlation was observed between the plankton production and dissolved phosphorus. Besides the concentration of dissolved inorganic nitrogen and phosphorus, the ratio N/P appeared also to influence the plankton production : 1.4 : 1 to 1.5 : 1 is considered the optimal ratio.

164 Algal culture and aquaculture in Shahpur waste-stabilization ponds at Bhopal

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The paper presents preliminary results on algal culture and aquaculture, the two components of a project entitled "Multipurpose Sewage Treatment at Bhopal". The mineralised N and P salts of sewage constitute a real danger for eutrophication should the effluents from the secondary treatment be discharged directly into receiving waters. A tertiary treatment of the effluents is therefore absolutely necessary.

The idea of purifying waste waters especially domestic wastes by means of large scale production of algae is getting into use more and more on account of the high cost of chemical tertiary treatment in western countries. The mass culturing of algae as a method of purification can also, by harvesting and processing of the algal biomass, lead to an interesting cheap protein source which can be introduced into the food chain of fish and as organic N biofertilizer in agriculture replacing a part of the costly inorganic N fertilizer. How these two objectives have been achieved is explained in the case of the Shahpur Sewage Treatment Plant at Bhopal.

SESSION III

NUTRITIONAL REQUIREMENTS OF CULTIVATED FISH AND SHELL-FISH AND FEED TECHNOLOGY

- 165 Studies on the growth rates of catla, rohu and common carp
fed on different formulated feeds**

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Development of a cheap nutritionally rich supplementary feed is the key for success in intensive carp culture. In an attempt in this direction, the effect of three different supplementary feeds was tested on catla, rohu and common carp over a period of 98 days. The feeds used were the conventional feed (a mixture of rice bran and oil cake at 1 : 1 ratio), a pelleted feed containing dried silkworm pupae as the principal source of protein (pellet 'S') and another pelleted feed containing fish meal as the principal protein source (pellet 'F'). The growth rate was the maximum in catla, being 2.05 g/day when fed with the silkworm pupae pellet followed by that fed with fish meal pellet, conventional feed and in control in that order. The pattern of growth rate in common carp when fed with the different feeds was similar to that observed in catla. However, in rohu, the growth rate was maximum when fed with pellet 'F' followed by conventional feed, pellet 'S' and in control cisterns. The possible reasons for such differential growth rates in catla, rohu and common carp when fed with different feeds are discussed.

- 166 Preliminary observations on the life history and culture of *Ceriodaphnia cornuta* Sars (Cladocera : Dcaphnidae)**

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Observations on life history and culture of *Ceriodaphnia cornuta*, an

important fish food organism, under laboratory conditions indicated the species to have 2 pre-adult and 25 adult instars in a life span of 31 days. The adult produces 150.95 eggs in average within this period. The number of eggs produced and the duration of embryonic development was observed to be influenced by the culture media. The species could be cultured successfully in 10 l jars in raw cowdung and triple superphosphate media at concentrations of 200+100 mg/l and 400+200 mg/l. The species continued to multiply for over two months with the weekly addition of tap water and measured quantities of the above concentrates. The observations made herein have been compared with those of earlier workers and additional information highlighted.

167 Use of a new artificial feed in carp seed raising

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Although a number of artificial fish feeds are in use in fish farming, there is still the scope and necessity too for finding out a comparatively cheap as well as effective feed to substitute the rather costly ones hitherto used. With this in view efficacy of a newly available feed—'EPIC' fish feed, a product of the West Bengal Poultry and Dairy Development Corporation, was studied and compared with that of some other commonly used feeds in respect to survival and growth of spawn, fry and fingerlings of Indian and exotic carps. Experiments, conducted both at yard and field, have indicated high survival and growth with 'EPIC' fish feed, Chemical composition of EPIC fish feed was also analysed.

168 Investigations on the culture of the cyprinid fish *Puntius Dorsalis* on natural and supplementary diets

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Studies on the nutritional requirement of fish has gained considerable impetus because of their food value. Although considerable success has been obtained in the culture of major carps due to the development of supplementary diets, very little information is available on the culture and nutritional require-

ments of cyprinid forage fishes, which form the secondary but staple food of local people. Hence, an attempt has been made to culture the cyprinid fish *Puntius dorsalis* on the oligochaete worm *Tubifex tubifex*; and supplementary diet viz., oilcake and ricebran. Fish in the weight range of 238 to 610 mg were grouped and reared in aquaria for 30 days on the two types of diets. Flesh production appears to be more in individuals reared on the supplementary diet as compared to fish reared on the oligochaete worm. An attempt has been made to analyse the biochemical components such as fat, ash, protein etc., and the results are discussed in the light of dietary requirement and culture of *P. dorsalis*.

169 Experiments on feeds and nutrition of *Penaeus monodon*

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Results of experiments conducted on feeds and nutrition of prawn *Penaeus monodon* at the Kakdwip Research Centre of the Central Inland Fisheries Research Institute during 1977-'78 are presented.

The relationship of stocking density to survival under aeration was established and was followed by tests of 5 diet formulations against growth (weight) increment at given intervals of time. Acceptance and rejection of feed was noted. Statistical significance of values of growth with each diet tried was tested.

The five test diets consisted of different combinations of soyabean meal, squid meal, trash fish meal, crustacean meal (small shrimp and mysids), brewer's yeast etc. to improve the protein composition. In the tested feeds the percentage of protein varied between 20 to 36. Best performance by way of growth increment was given by feeds with soyabean meal and squid meal. The conversion ratios ranged from 2.4 to 6.6 and cost varied between Rs. 2 to 9.

Nutrition of penaeid prawns in general and *P. monodon* in particular is discussed.

170 Experimental studies on the scope for enhancing productivity of air-breathing fishes

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In tropical countries like India, where availability of freshwater is limited, air-breathing fishes may be chosen for aquaculture, as they thrive in shallow waters deficient in oxygen. However, the advantageous air-breathing habit of these fishes and the consequent need to surface more or less at regular intervals impose considerable drain of energy, which otherwise, could have been channelled into fish production. Aspects of optimising energy drain due to surfacing activity have been intensively studied in *Channa striatus*, *Anabas*, *scandens* and *Macropodus Cupanus*. In shallow aquarium the fishes surfaced less frequently, consumed less, but converted food more efficiently. Aeration of the aquarium elevated surfacing and swimming activities but failed to significantly alter the pattern of food utilisation. Rate and efficiency of food utilisation were maximum at 32°C. A proportion of 2 : 1 animal and algal food proved to be the most economic combination in *A. scandens*. Smaller individuals are recommended to be fed more frequently than the larger ones. A ration of about 66% of the maximum food intake proved to be the most economical.

171 Experiments on the utilization of brackishwater macrophytes as supplemental diet for fish

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Results of yard experiments conducted to find out the utility of some easily available brackishwater macrophytes as fish feed are presented. The feed items tested were dry and powdered *Hypnea*, *Polysiphonia*, *Halophila*, *Cymodocea*, *Enteromorpha* and *Chaetomorpha* and a pelleted feed mixture comprising brackishwater plants, filamentous algae, slaughter house waste and ground nut oil cake in the ratio 2 : 2 : 1 : 1. Of these, the first three feed items and the pelleted feed gave encouraging growth in mullet fry.

172 Possibility on the utilization of dry poultry droppings in the formulation of pelleted feed for common carp

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Experiments to find out the acceptance and the growth of fingerlings of common carp, *Cyprinus carpio* fed on three types of supplemental feeds were conducted. The feeds formulated with a mixture of fish meal, ricebran, oil cake, poultry droppings, mineral salts and vitamins in different combinations were tried. The diet comprising dried poultry droppings as one of the main ingredients was found to be the cheapest of the three feeds. The increment in weight of fishes fed with this feed alone was quite encouraging. The nutritive values of each feed in relation to the growth of the fish have been discussed. The differences within the treatment and between the treatments have been statistically analysed and reported.

173 Utilisation of slaughter-house offal in compounding prawn feed

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Waste products like slaughter-house offal, prawn-head meal and brackishwater algae for preparing compounded feed for prawn farming were studied. The raw materials, offal meal, prawn meal and algal powder were found to contain 69.1, 57.1 and 9.1 percent protein respectively. Feed mixtures of ingredients at different proportions were made into dry pellets using wheat flour as binding agent. A series of rearing experiments were conducted to test the acceptance, growth and conversion efficiency in the prawn *Penaeus monodon* Fabricius. The artificial pelleted diet based on offal-meal, having 45.2 per cent protein, gave a conversion ratio of 2.4 and was found quite adequate for raising prawns in the laboratory as well as in the production ponds.

174 Studies on the growth of chanos fingerlings with and without artificial feeding

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Four artificial feed mixtures viz., prawn head powder+lab, lab

Commercial feed+lab lab, wheat bran+lab lab and rice bran+ground nut oil cake were tried to assess their efficacy as feed for chanos fingerlings in the yard. Of these the commercial feed and a mixture of rice bran and ground nut oil cake gave better results. Experiments were conducted in a 0.01 ha brackishwater nursery pond at Adyar with and without artificial feeds. Of the two feed combinations tried, viz., rice bran+ground nut oil cake and rice bran+ground nut oil cake+prawn head powder, the latter gave better results.

A short term experiment was conducted in a fresh water pond also, but the growth was comparatively poor.

Without artificial feed, the fingerlings showed appreciable growth in the young stages. After attaining a size of above 100 mm, the growth was hampered in the small pond even when supplementary feed was given. However, the fish recorded further growth when transferred to a larger pond.

175 The role of Iron in the early growth of fingerlings of *Labio Rohita*

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Results of experiments to determine optimum nutritional requirement of iron in the diet of the fingerlings of *Labeo rohita* are reported. Survival rate, growth and food conversion efficiency of different groups fed synthetic diet containing graded levels of dietary iron for 180 days were recorded periodically.

At 14.5 mg iron/100 g of diet food conversion efficiency, growth and survival were optimal. Supply of iron in diet below or above this level affected these parameters adversely. Mortality increased 100% when the iron supply in the diet was either reduced to 50% or increased by 100% from the optimal level. Complete absence of iron in diet proved to be lethal resulting in more than 67% mortality.

Practical application and significance of these findings from the aquacultural point of view particularly in the early growth stages of carps are discussed.

176 Preliminary trials with a pelleted feed on the growth and survival of tadpoles of *Rana Tigrina* (Daud)

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Two different kinds of supplementary feeds were tried to enhance the growth rate and survival of the tadpoles of *Rana tigrina* (Daud). Pelleted feed prepared by the author comprising of wheatflour, boiled and dehydrated liver and fishmeal in equal ratios, gave encouraging growth of tadpoles with an average weight of 1.5g in 29 days from an initial average weight of 0.017g. The tadpoles metamorphosed within 21-41 days, the survival being 60.5%.

Tadpoles supplied with fishmeal on the second day of hatching and minced goat meat during the remaining period gave an average weight of 1.16g within 29 days from the same initial average weight. Metamorphosis took place within 25-59 days, the survival being 56%.

In the control the tadpoles exhibited acute cannibalism resulting in 16% survival and metamorphosis took place within 22-29 days.

**177 Influence of anabolic steroid hormones on air-breathing
fish *Channa Striatus***

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The air-breathing fish *Channa striatus*, were treated with different doses of anabolic steroid hormones viz, 1 Diethylstilbesterol and 2 Testosterone dipropionate. Rate of food uptake, efficiency of the feed utilization and surfacing activity were measured. Individuals were treated with different doses of diethylstilbesterol (0.00 ; 0.01, 0.02, 0.04 ml/fish). Feeding rate was increased (14.2-23.34 mg/g/day) in a dose dependent way ; whereas with higher dose of diethylstilbesterol (0.04 ml/fish) the extent of increase was less, i.e. 14.06 mg/g/day against 23.3 mg/g/day of 0.02 ml/fish treated group. In regard to the surfacing activity, decreasing trend (996-873 time/day) with increasing dosage of diethylstilbesterol was observed. Similar trend was observed with testosterone dipropionate injected individuals. Hence it is desirable giving injection of low doses (0.02 ml/fish of hormones rather than higher doses in order to obtain maximum food utilization efficiency.

**178 Formulation of dry pelletized feeds of brown (*Salmo Trutta Fario* Linnæus)
and rainbow (*Salmo Gairdneri* Richardson) trouts and their trials in
Kashmir farms during 1974-77**

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Formulation of four dietary mixtures containing crude protein levels from 28-39% are described. Mash and pellets ranging 0.25-5.0 mm in size were tried over brown and rainbow trouts ranging from fry to two-year old fish. The rate of feeding was adjusted according to the size of test fish and water temperature. The feeding trials lasted from 40 to 180 days. In brown trout, conversion rates obtained were 2.0, 1.9, 1.9 & 1.4 at 28.0, 35.0, 37.6 and 39.1% crude protein levels respectively. In rainbow trout, feeds having crude protein levels

of 28.0, 35.0, 37.6 and 39.1% gave conversion ratios of 1.8, 1.5, 2.1 and 1.7 respectively. Conversion ratio and feed efficiency of pellets containing different crude protein levels, when test fish of different size groups are fed, have been calculated. Economics of feeding with dry and conventional feeds are discussed.

179 Utilization of some aquatic weeds as feed for rearing carp spawn and fry

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The common weeds *Nymphoides cristatum* and *Spirodela polyrhiza* were dried, powdered and fed to spawn and fry of major carps alone and in combination with rice bran. The survival and rate of growth was compared with that of conventional feed viz., mixture of rice bran and groundnut oil cake and zooplankton. The survival rates were high, being 60-75 percent for spawn and 90-100 percent for fry with all the feeds given.

The growth of spawn of *Labeo rohita*, *Cirrhinus mrigala* and *Catla catla* fed with groundnut oil cake+rice bran was quite comparable to that of weed powder+rice bran mixture. In case of fry rearing the same trend was observed except with *C. catla* where both the feeds did not appear to be well accepted.

180 Nutritional Requirement of Vitamin C in *Cirrhina Mrigala* during early growth

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Using complete synthetic diet, hatchlings of *Cirrhina mrigala* obtained through induced breeding were fed graded levels of ascorbic acid viz. 0, 6, 30, 60, 90 and 120 mg/100 g diet upto 240 days. Studies on survival, growth and morphological changes of these fishes are reported.

Statistical analysis of growth and survival rates suggested an optimum requirement of 65-75 mg ascorbic acid per 100 g diet in the early part of the life of the fish.

Avitaminosis resulted in poor growth, high mortality rate (upto 42%) and severe haemorrhages, fin necrosis, increased pigmentation and spinal flexures. 6 mg and 30 mg ascorbic acid/100 g dietary levels too resulted in poor survival and growth rate. Skeletal deformities and muscular dystrophy were also recorded in some of these fishes.

Significance of these studies in practical aquaculture is discussed.

SESSION 4

Present status & strategy for development of aquaculture as an industry including legal, social & economic aspects

183 Some scope for development of aquaculture from subsistence level to modernization as an industry

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Aquaculture is the culture and husbandry of aquatic organisms. It involves the management of aquatic plants and animals reared in large number in controlled or selected environment for economic and social benefit. However, this management of aquaculture yet cannot take the full advantage of material and energy flow through the ecosystems that are the basis of capture fisheries. The direction of control takes to speed up turnover by adding nutrients and energy to the culture system in such a manner that one obtains the the most output for the least additional input of such items as material and labour for pond, enclosure constructions, fertilizer, feed and fuel

Aquatic protein resources and methods for their cultivation, and harvesting have realistic potential for expanding development, production and utilization. Both capture as well as culture will play an important role in Asia during the rest of this century and for the future. Polyculture may add atleast 1 million ton or more per year towards production. These aspects are being discussed in this paper and their development policies and programmes. There are many biological, technological legal and other obstacles which must be overcome to achieve a break-through in continuous enhanced production.

Research in reproduction processes promises to contribute significantly to integrated-aquaculture production in the long run and researches are also needed on fishbiology, nutritional aspects, waste utilization and disposal and basic policies in aquacultural development in Asia. Fishes have proved to be excellent assay animals for pollutants, toxins, hormones, vitamins, anti-metabolites and antibiotics. The management is needed for territorial

and aquatic environment in order to enhance the production of organic substances for use as human food, fibres pharmaceutical and chemical raw materials.

The high productive technology for ecosystem management will increase the carrying capacity in certain selected, well endowed, intensively managed areas. This has inturn enabled with little human efforts to produce vastly increased productivity or yield of intensively managed aquaculture, the commitment of resources for that should be done on planned way. These aspects are discussed in this paper.

Review of development of fresh water carp culture in Orissa and suggested startegy for commercialisation

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Three decades of planned development of fresh water fish culture by the State and Central fisheries organisations have raised the level of technology to ensure a fair return on investments in this industry. There are, however, some constraints to be removed before the various activities, till now mainly departmental, are commercialised.

The paper reviews the shortcomings and outlines a strategy to accelerate the process of industrialisation of fish seed and fish production in the state. It has been recommended that the Government should clearly delineate fishery waters of different types, create new fish farms out of derelict areas and settle fishery rights on a sufficiently long term basis so as to enable banks to issue capital. Simple mechanised equipment should be evolved for desilting of tanks. Commercial fishery service centres should be established to meet all the technical and material needs of the fish farmer under one roof. Functions of such a centre have been outlined.

**185 The role of *Macrobrachium* species in the freshwater
aquaculture systems**

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In aquaculture systems *Macrobrachium* species of prawns have more important role in upland and inland areas as opposed to the coastal aquaculture for Penaeids. There are at present some 10—15 species of *Macrobrachium* in the world that could be brought to use in aquaculture practices. The more important of these are : *M. cryphiops* (Ceylon), *M. carcinus*, *M. ohione*, *M. acanthurus*, *M. olfersii*, *M. faustinum* and *M. heterochirus* (North America); *M. rosenbergii* (Asia, Malaysia, India), *M. malcolmsonii* (India, Bangladesh, Pakistan) and *M. birmanicum choprai* (India). Life cycles of most of these species are worked out and techniques of development are known. It is known that all these species pass through a saline-water phase in early life cycle but advanced stages behave differently-requiring environments ranging from semi-estuarine conditions to pure freshwaters. This freshwater and estuarine phase persists in adult status in growth and breeding phases respectively. Therefore, when we use these species for culture in freshwater systems, success or failure in survival is based usually on this factor plus the need for flow-water systems. In India all our aquaculture practices at present are in standing waters without inflows and outflows.

A critical study of the aquaculture system suitable for *Macrobrachium* species based on their ecology, is made in this paper.

**186 Need & techniques for improving data-base of Indian
inland fisheries**

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The paper discusses the existing base of Indian inland fisheries statistics, their frequency and methods of collection and classification. The inherent contradictions in available statistics on inland fisheries released by

various agencies, the irregular frequency of collection, lack of a coordinating agency for planning, compiling and analysing and the general insufficiency of data for planning and evaluation purposes are presented.

The need for identifying the items on which data are necessary to meet the requirement of the changing scene of Indian inland fisheries, especially with the development of different culture systems, are presented. Effort has been made to define the basic minimum of data requirement and provide unequivocal definitions of terms.

The role that the available machinery for data collection in the country, such as the NSSO, Directorate of Marketing & Statistics, State Government agencies and other national institutions, can play in providing required data on a continued or ad-hoc basis is discussed.

The experience of application of sampling techniques for estimation of some aspects of inland fisheries statistics, especially on catch, disposal and resource data are also reviewed and techniques holding promise are briefly delineated.

187 Importance of aquaculture education through Universities for rural development

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About 80% of India's population lives in rural areas and majority of that consists of tribals and persons below poverty line. The rural population is mainly dependent on agriculture but majority of them depend on dry cultivation which is not profitable to the farmers and in spite of the financial assistance provided by the Government, the conditions of the farmers particularly of tribals have deteriorated. Aquaculture has occupied significant position in the rural development. Experiments conducted by CIFRI throughout the country have shown that as much as 9 tonst of fish per hectare can be produced from small water bodies thereby earning huge profits. Besides this, great emphasis is laid on integrated approach of land and water development instead of producing rice alone. The state of Madhya Pradesh is engaged in aquaculture in about 20 000 tanks and recently experiments

188 **An appraisal of the strategy for the development of aquaculture
in India**

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The objective of the present paper would, therefore, be to make a needful enquiry into the state of affairs in aquaculture development and practice in the realm of integrated rural developmet. An attempt has also been made to suggest effective measures towards the solution of this problem.

189. Planning for aquaculture as an industry

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The major aspects of aquaculture planning have been described and the basic data required thereof have been enumerated. The need for deciding on production objectives, such as type and level of culture, extensive or intensive culture, small scale rural or large scale industrial aquaculture and nature of end products, in relation to national objectives and economic realities has been pointed out. Procedures for the planning of small scale rural aquaculture and large scale industrial aquaculture have been elucidated. The necessity for and methods of assessment of manpower requirements, training of personnel, research support, extension service and economic appraisal have been pointed out.

190 Economic potentials of *Clarias batrachus* (Linn.) and its seed trade in West Bengal

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West Bengal is bestowed by nature an estimated 0.2 million acres of derelict and unexploited water areas, which can be readily and successfully brought under air-breathing fish culture. The opportunity cost of these water bodies is presently negligible. To develop these natural resources on intensive or semi-intensive basis, information for feed trade and unit economics are essential. With this objective, a survey of the marketing of air-breathing fishes was carried out at Canning in West Bengal during August 1976 to July 1978. The seasonal variations in landings and prices of fingerlings and food fish of *Clarias batrachus* have been presented. The cost benefit analysis of *Clarias* culture project in these water bodies for intensive and semi-intensive systems has also been presented.

**191 Brackishwater aquafarming in large bodies of water,
transfer of technology**

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Impounding of brackishwater fin fish and shell fish in tidal mud flats and paddy fields in West Bengal and Kerala is an age old practice. Brackishwater aquafarming in large bodies of water on scientific principle is of recent origin. Perhaps West Bengal leads India in this respect. The technology developed at the Brackishwater Fish Farm of CIFRI, Kakdwip during the year 1968—76 mainly based on work done in small compartments, when applied to large bodies of water in three commercial fish farms of State Fisheries Development Corpn, West Bengal resulted in various degrees of success. The present paper deals with the methodology involved, the success achieved, as also identifies various constraints, limiting factors and areas of conflicts to pin-point probable solutions to overcome these problems so that commercial culture on scientific principles can develop as an industry.

**192 Fishery resources of West Bengal with special reference
to coastal aquaculture**

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Fishery resources of the State of West Bengal are immense. The inland resources of the State comprising Hill Streams, rivers, canals, beels & baors, tanks and ponds, bhasa-bada and sewage-fed fisheries, estuaries and tidal creeks, mud flats and swamps have been estimated to be 32.4 lakh acres. The marine resources including coastal, off-shore and mid water

amount to 6,600 sq. miles. The total annual productions from all these sources have been estimated as 2,55,000 t of which 23,000 to 33,000 are contributed by the marine and coastal water and the rest from the fresh water resources.

The present status of fisheries and the major constraints have been discussed. The available potential and possibilities of utilising the resource for further development of fisheries in the State particularly in the field of fresh water culture fishery and utilisation of nature's gift of Sunderban for coastal farming of shell—fish and fin—fish have been highlighted in the context of development of fisheries in India as a whole.

193 Aquaculture — constraints and opportunity

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Britannia Sea foods

Bombay

In the field of aquaculture, emphasis is placed on the production of fish, shrimps, molluscs, seaweeds and other aquatic organisms. There are opportunities to engage in practical research, to develop an industry, as a source of food. Most important, we must delineate a national policy for fish culture. This paper reviews the areas of production systems, Science and technology, economics and business, and law and administration focused on for policy makers to draw up well-defined fisheries development policies.

194 Prospects and problems of rural aquaculture

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Though knowledge in aquaculture science has vastly increased, the problem still remains as to how to bring the knowledge to the farmers' fields. The latest attempt in this direction is the establishment of the innovative Institute of Krishi Vigyan Kendra (KVK). The only KVK in West Bengal is situated in the heart of rural life at Kapgari (Midnapore district).

A preliminary survey, conducted in the area, revealed that though there is immense potentiality in the area, the water areas are either lying fallow or are very much under-utilized. The production from the cultural water areas is estimated to be as low as 83.5 kg/ha/yr. The constraints in developing pisciculture in this area and possible solutions are discussed in this area and possible solutions are discussed in the paper. The role of Krishi Vigyan Kendra for effective transfer of technology, increased production of fish, utilization of resources and thereby improving the socio-economic condition of the rural mass is also discussed.

195 Potentials of single set of rohu brooders in supporting fish culture operations in small village ponds and their impact on rural economy a case study

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During demonstrations on breeding and rearing techniques under the Rural Aquaculture Project, the spawn produced (2.2 lakhs) from a single set of rohu (2.25 kg female) was reared at 5 million/ha in a 0.045 ha nursery producing 1,70,940 fry (survival 77.7%) in 15 days. 1,20,800 fry from this stock, when reared in 16 ponds, located in 6 villages within a radius of 5 km, at 1 to 4.2 lakh fry/ha resulted in the production of 71,200 fingerlings (60.2—155.6 mm/1.8—35.6 g) with an average survival of 59%. The economics of various operations is presented.

The fingerlings thus produced brought 14 ha of water area under fish culture. The impact of these operations on rural economy is discussed.