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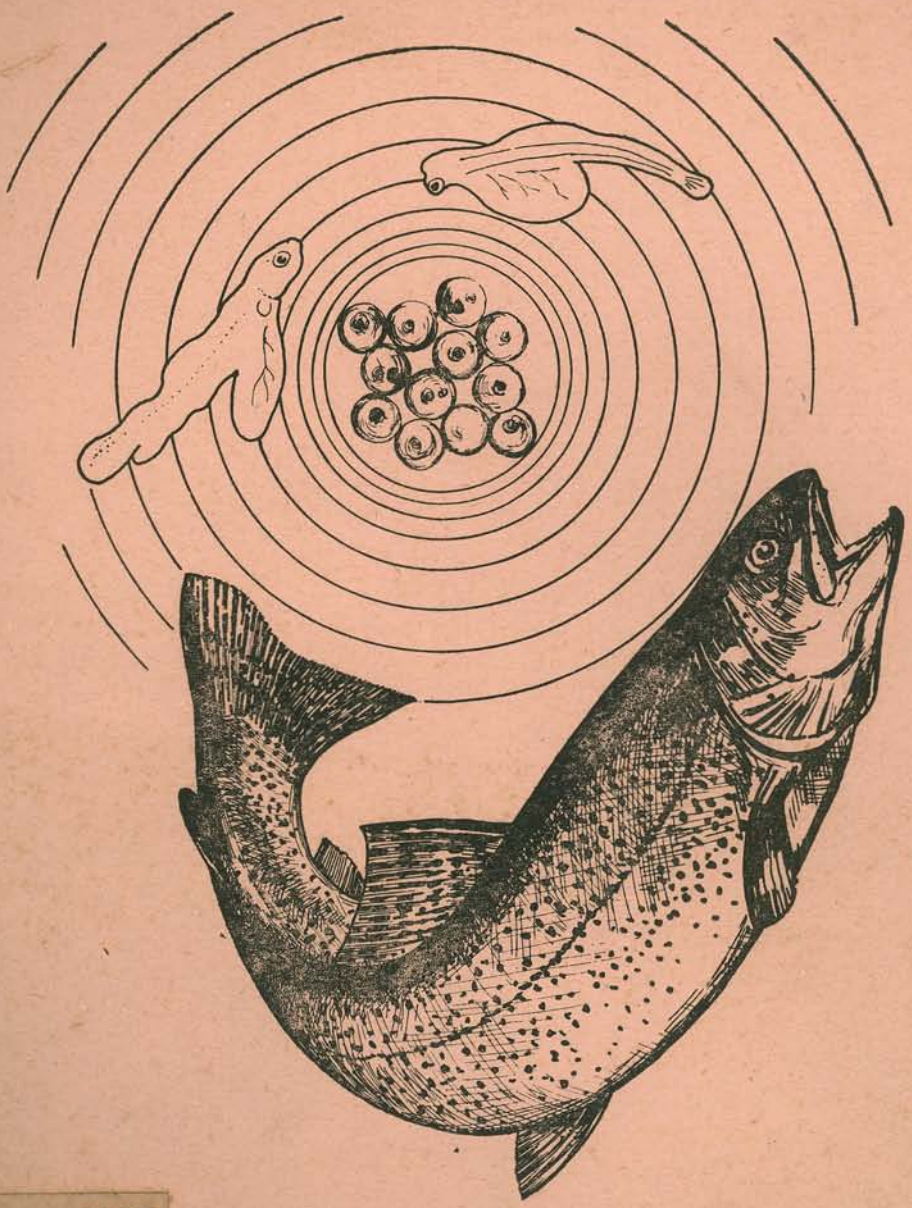

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GOVERNMENT OF INDIA

CENTRAL INLAND FISHERIES RESEARCH INSTITUTE

BARRACKPORE, WEST BENGAL

INDIA

Annual Report 1966-67

Government of India
Central Inland Fisheries Research Institute,
Barrackpore, West Bengal,
India

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I. GENERAL

Steady progress was maintained during the year in all the research projects undertaken both at the headquarters and at the various sub-stations, units and research centres of the Institute located in different parts of the country. The Pond Culture Unit of the Institute at Joysagar, Assam, was closed down and re-established at Panna (Madhya Pradesh), where the site has been selected for the construction of an Experimental Fish Farm.

The following appointments were made during the year.

1) Dr. V.G. Jhingran	-	Director
2) Shri V.D. Singh	-	Fisheries Training Superintendent
3) Shri A.C. De	-	Administrative Officer
4) Shri H.N. Banerjee	-	Accounts Officer

Dr. B.S. Bhimachar, Director of the Institute retired from service on 6th July 1966 (AN). Shri A. Sengupta was relieved of his duties as Research Officer (Junior Scale) to enable him to take up the appointment as Deputy Director of Fisheries under the Government of West Bengal. Shri B.B. Pakrasi, Chief Training Superintendent, changed over to the post of Research Officer (Junior Scale). Dr. A.K. Mondal, Frog Research & Development Officer, on his being transferred together with his post from the Central Marine Fisheries Research Institute, Mandapam Camp, South India, reported for duty at the Central Inland Fisheries Research Institute at Barrackpore on 29th August 1966. Shri I.N. Chahande, Administrative Officer was relieved of his duties at this Institute so as to enable him to revert to his parent department.

TRAINING

The 19th session of the Inland Fisheries Training Course commenced on the 1st of June, 1966. A total of 43 candidates consisting of 31 deputees from various Indian States -

1 each from West Bengal, Mysore, Haryana, N.E.F.A and Gujarat; 2 each from Himachal Pradesh and Madhya Pradesh; 3 each from Orissa and Nagaland; 4 each from Bihar and Uttar Pradesh and 8 from Punjab; 8 Stipendiaries - 3 from Assam and 5 from Tripura; 1 Colombo Plan Scholar from Malaysia; and 3 Special Commonwealth African Assistance Plan candidates from Nigeria are undergoing training at this Institute. 25 trainees from the Central Institute of Fisheries Education, Bombay, a batch of trainees from the Inland Fisheries Training Centre, Lucknow and Shri Z.A. Adesanya of Nigeria were imparted training on various aspects of fisheries. Shri M. Govardhan, Assistant Director of Fisheries, Andhra State was given training in fish tagging methods. Special training was given to 3 Nigerian Officers for six weeks and to one officer each from Nepal and from the Department of Fisheries, Uttar Pradesh, for 2 weeks.

VISITORS

Shri Hari Har Patel, Hon'ble Minister for Industries & Fisheries, Shri Murari Prasad Misra, Deputy Minister for Fisheries, and the Members of the Estimates Committee, Government of Orissa; Dr. J. Hamre, FAO Expert, and Shri K.H. Alikunhi, Director, Central Institute of Fisheries Education, Bombay; Dr. G.P. Dubey, Director of Fisheries, Madhya Pradesh; Dr. E.A. Surber, FAO Water Pollution Expert; Dr. G.P. Sharma, Dr. G.L. Arora and Dr. H.C. Vashist, Department of Zoology, University of Punjab; Miss Mary Samuel, Assistant Fisheries Development Adviser and Shri Joginder Singh, Under Secretary, Ministry of Food and Agriculture, Government of India, New Delhi; Dr.(Miss) Hamilton of United Kingdom; Dr. M.D.L. Srivastava, Dr. D.N. Verma, Dr. A.N. Chattoraj, Department of Zoology, University of Allahabad; Shri N.C. Koli, Managing Director, Maharashtra Rajya Machhimar Sahakari Sangh, Bombay; Dr. S.W. Ling, FAO Regional Office, Bangkok; Shri K.H. Bain, FAO Sub-Regional Office, New Delhi; Dr. P.K. Bhattacharyya, National Chemical Laboratory, Poona; Shri G.S. Banerjee, I.A.S., Director of Fisheries and Shri S.N. Ghosh, Deputy Director of Fisheries, Government of West Bengal; Shri S.C. Guha with 21 students and 3 lecturers of Serampore College, Serampore; Shri Chin Phui Kong, Fisheries Branch, Department of Agriculture, Sabah, Malaysia; Shri Jinda Thiemmedh, College of Fisheries, Bangkok; Shri K.S. Dargan, Head of Agronomy and Plant Physiology and Shri S.M. Pandey, Assistant Agronomist of Jute Research Institute, Barrackpore; Shri S.C. Dey, Gauhati University, Assam;

Dr. S.B. Setna, New India Fisheries, Bombay; Shri P.R. Bakhshi, Trade Commissioner, Government of Bhutan, Calcutta; Lt. Commander B.N. Srinivasan, Indian Navy, Bombay; Shri I.A. Ronguillo, Philippine Fisheries Commissioner, Manila; Dr. M. Banhawy, Ain Shams University, Cairo, UAR; Dr. A.C. Mazumdar and Shri I.N. Sengupta of the Indian Institute of Experimental Medicine, Calcutta, visited this Institute.

II. INVESTIGATIONS ON CULTURE FISHERIES

1. Pond culture techniques

In order to confirm the results of the previous year's preliminary observations on the survival and growth of fry of catla, rohu, mrigal and common carp (Cyprinus) during a three month rearing period, the experiment was repeated during 1966. After 15 days' rearing in nursery ponds (0.08 ha), the fry were stocked in rearing ponds in the ratio of 3:4:1:2 and at stocking densities of 62500, 93750 and 125,000 per hectare with one replication for each density. Apart from manuring the ponds with organic and inorganic fertilisers, the fry were fed with a mixture of mustard oil cake and rice bran. The results are summarised in Table I.

Table 1.

Stocking density/ ha	No. stocked in each pond	Initial length (mm)	Initial total wt. (kg)	Final av. length (mm)	Av. wt. (final) (gm)	Survival %	Gross prod. kg/ 3mths	Gross prod. kg/ha/ 3mths
62,500	5,000	19-36	1.12	163.22	57.44	66.11	161.07	2002.28
93,750	7,500	"	1.68	143.47	37.93	66.14	168.48	2106.31
125,000	10,000	"	2.24	129.91	33.04	73.77	211.13	2469.54

As seen from the table, though the survival and production were maximum at the highest stocking density, there was progressive decrease in length and weight as the stocking rate increased. This was particularly true of catla. The respective averages for length, weight and percentage of survival in the various species at various stocking densities were 133.31, 37.45 and 66.06 for catla; 137.21, 32.09 and 76.52 for rohu; 193.99, 75.00 and 70.10 for mrigal; and 117.61, 26.66 and 62.02 for common carp.

Experimental observations on the optimum per hectare production of Indian major carps under different stocking densities and in the ratio of 3(catla): 4(rohu): 3(mrigal) were continued in some private ponds and a few ponds at Killa. In an experiment in a 0.12 ha private pond stocked at 3750/ha, the survival and net increase in weight in one year were 96.3% and 816 gm for catla; 35.8% and 771.6 gm for rohu; and 31.1% and 653.5 gm for mrigal with a net production of 1444.60 kg/ha in one year which was 535.0 kg short of estimated net production on the assumption of 75% survival. Against this fairly good production in spite of a low survival rate of rohu and mrigal, a duplicate 0.24 ha private pond gave only an estimated (the pond being not completely netted out) net production of 389.29 kg/ha/annum with the final average weights of the fishes ranging from 149-315 gm. This was due to improper management by the pond owner concerned. In a second experiment in progress in two ponds at the stocking rate of 5000/ha, the estimated net productions in two months have been 79 and 211 kg/ha respectively. However, the estimated net productions in six months in two ponds stocked at 7500/ha were 940.33 and 998.33 kg/ha respectively which could be considered quite satisfactory.

In a fourth experiment with a high stocking rate of 15,000/ha and with the species ratio slightly modified i.e. 1:1:1 the results were satisfactory in terms of the survival (80-89%) and production (2968 kg/ha/annum) but the average weights of 171-240 gm attained by individual species in one year were far from satisfactory. The pond was, however, treated with cow dung at 10,000 kg/ha and inorganic manures at 3,000 kg/ha in the course of one year. A total of 2650 kg/ha feed was also used.

A few experiments were also carried out to determine the optimum per hectare production of Indian major carps with species ratios other than the one (3:4:3) referred to above but

at the same density (3750/ha) of stocking. In an experiment, undertaken in two ponds, the stocking ratio of 4(catla): 3(rohu): 3(mrigal) gave a net production of 2343.9 and 1225 kg/ha/annum, low production in the latter case being due to insufficient manuring and non-clearance of weeds in time. The net production from the three ponds employing a ratio of 3(catla): 5(rohu): 2(mrigal) was 378 kg/ha in four months and 316 and 425 kg/ha in five months.

Studies on the optimum/ha production of fish by composite farming of compatible and economic varieties of Indian and exotic species with a view to fully exploiting the fish food resources of a pond were continued. In an experiment conducted in two ponds (0.4 and 0.133 ha each) and stocked with seven species viz. catla, rohu, mrigal, silver carp, grass carp, common carp and gourami in the ratio of 1.5:5:1 :4:3:3:0.3 at 4500 fingerlings/ha, the larger pond gave a net production of 2478 kg/ha/annum with a survival of 69.5% and an average final weight of 574.8 gm/individual as compared to 2024 kg/ha/annum with survival and average weight of individuals being 76.3% and 657.2 gm respectively from the smaller pond. These ponds were manured with cowdung and N-P-K at 25,000 and 110 kg/ha respectively, but there was no feeding. Another experiment in two 0.133 ha ponds, manured with cowdung and inorganic fertilizers at 25,000 and 1700 kg/ha respectively and employing a stocking density of 5000 fingerlings/ha but the same species ratio, gave a net production of 3494 and 3969.5 kg/ha/annum with an average survival of 73.2 and 75.7% respectively from the two ponds. In this experiment, artificial feed of mustard-oil cake and rice bran at 2400 kg/ha was also used. It is clear from these experiments that fairly good production could be obtained from well-managed ponds by composite farming. Further experiments with replications, different stocking rates and species ratios are in progress.

Studies on the seasonal succession and vertical distribution of periphyton organisms commenced in January 1965 were completed in December, 1966, the general trends in 1966 being more or less the same as in 1965 with the development of minimum the algae and maximum of fauna during July-September and with greater algal abundance at the surface than at the bottom. However, Characium, which developed abundantly during October-December in 1965 predominated during the first two quarters of 1966 besides the last quarter and the animal organisms were usually more abundant in the middle layer than at the bottom.

Pituitary extract prepared in glycerine in 1965 and kept under refrigeration when injected on 21 sets of rohu, after a period of 9-12 months, induced spawning in 77.7% cases. Catla-rohu-mrigal mixed gland extract in glycerine, kept in ampoules and preserved for 12 months under refrigeration, induced spawning in one of the 10 sets of rohu. No success was obtained with glycerine extracts kept at room temperature when injected on 11 sets of rohu. Since suspended tissue particles are not completely removed from the pituitary extract by ordinary centrifugation, the same could be removed completely by filtering the extract with ordinary filter paper. The clear filtrate on injection gave positive results thereby indicating that the potency is not lost by filtration.

Fish pituitary extract, freshly prepared in propylene glycol, when injected on 26 sets of rohu induced spawning in 85% of the sets. 10 days' old refrigerated propylene glycol extract induced spawning in 60% of the sets when injected on 10 sets of rohu whereas extract preserved for 30 days induced spawning in 10% of the sets when 10 sets of fishes were treated with normal doses. Thus it showed that propylene glycol may be used as a preservative for fish pituitary extract for long term duration as the potency of the extract is also not adversely affected.

All these experiments showed that the pituitary extract could be preserved well in advance of the breeding season as a step towards commercial production.

Studies on the effect of gonadotrophin extracted by trichloroacetic acid were continued for further improvement and confirmation of the previous years' findings. In an experiment 7 sets of rohu were treated with gonadotrophin extracted in 1.5% TCA by 6 hours, immersion of the gland and 43% positive results were obtained confirming last years' findings. With a view to determining whether any potent gonadotrophin was left behind in the gland after immersion, distilled water extract prepared from such glands was injected in another 7 sets of test fishes at 30 to 40 mg/kg. Negative results were obtained in 6 sets. The negative result thus confirmed that no potent gonadotrophin was probably left behind in the gland proper after immersion. However, in one instance where successful spawning occurred extraction of gonadotrophin was probably not complete. TCA extracted gonadotrophin kept in ampoules for an year at room temperature and under refrigeration did not appear to retain its potency as indicated by negative response when injected in test fishes.

As a substitute to fish pituitary glands human chorionic gonadotrophin collected from pregnancy urine by alcohol precipitation method was injected in 15 sets of Cyprinus carpio with varying doses, keeping suitable control. As all the treated as well as the control sets spawned, no conclusions could be drawn from these experiments. However, experiments are being continued to determine the effectiveness of HCG on inducing spawning of carps. Incidental to the above experiments, 3.60 lakhs of spawn was produced.

Since it is known that oxytocin induces spawning reflex in fish, experiments were carried out to determine the effect of commercial oxytocin on spawning. A preparatory dose of 2 mg/kg of pituitary extract and a final dose of 10 - 13 I.U. of oxytocin (extract of posterior lobe of bovine pituitary gland) did not cause any ovulation in 8 sets of breeders whereas oxytocin used in combination with pituitary extract (4 - 6 mg of fish pituitary and 5 I.U. of oxytocin) gave positive results.

With a view to find out whether any sex specificity exists in carp pituitary glands in inducing spawning, 54 sets of rohu were treated; 27 sets with extract from female glands and 27 sets with extract from male glands with identical dosages in similar conditions. While recipients treated with female gland extract induced spawning in 77.7% of the sets, male gland gave positive results in 66.6% of the sets. No final conclusions are drawn yet.

Studies on the fat content of the flesh of rohu during various stages of maturity were continued. Analysis of 104 samples of fish flesh revealed that the fat content was higher in males in all the stages/maturity (I, II, IV, V, VI /of & VII) than in females. Iodine value was more in ripe females but less in spent and resorbed ones.

Studies on the histology and histochemical changes of the hypophysis of rohu during different stages of maturity indicated that : (1) the granular thyrotroph cells dominated during the 1st to 4th stages, attaining maximum size during the 3rd stage thereby indicating maximum activity of TSH. In the 5th stage they were degranulated. (2) The nongranular gonadotroph cells were few in the 1st to 3rd stages, but gradually increased in the meso-adenohypophysis during the 4th and 5th stages becoming abundant in all regions of the adenohypophysis

during the spent condition. With increased activity of TSH in the 7th stage they decreased in number, (3) Granular and dumbel-shaped acidophil cells occurred in the perivascular spaces of adenohypophysis during the 1st to 3rd stages; these were absent in the 4th and 5th stages but reappeared in spent condition and (4) the reserve chromophobe cells present in all stages of maturity probably gave rise to thyrotroph, gonadotroph and acidophil cells.

A large number of Amblyparyngodon mola from different ponds in Killa were examined in connection with the study of maturity of weed fishes under different ecological conditions. It was found that attainment of maturity was not simultaneous in all the ponds and probably varied according to the ecological conditions and availability of food.

To avoid undesirable effects of continuous inbreeding, attempts were made to rejuvenate the Killa fish stock by crossing breeders of riverine origin with the Killa stock and crossing outside males and females. The spawn obtained are being reared in separate nurseries for further study.

F_1 hybrids of mrigal-calbasu and rohu-calbasu were successfully induced to spawn and backcrossed with parent species and with catla male. The fully swollen eggs varied from 3.460-5.716 mm in diameter. Altogether 147,300 spawn were obtained in these experiments. Observations on the growth of spawn stocked in different nurseries are in progress.

Studies on spermicides for controlling breeding in Tilapia have been initiated with various chemicals.

Incidental to various experiments a total of 43.32 lakhs of spawn comprising catla (15.73 lakhs), coloured catla (1.40 lakhs), rohu (22.06 lakhs), mrigal (0.98 lakhs) and calbasu (0.65 lakhs) were produced.

3. Exotic fish culture

A series of experiments to induce spawning in Chinese carps were conducted with a view to standardise the technique. The main object was to achieve complete natural spawning in injected grass and silver carps on a large scale as already

attained in the case of Indian major carps. Altogether 35 sets of grass carp and 39 sets of silver carp were injected with fish pituitary extract. Out of these, in 25 sets of grass carp and 22 sets of silver carp the females released eggs naturally and / or on stripping. Healthy fry were obtained from 19 sets of grass carp and 6 sets of silver carp. The total yield of fry was 1.64 lakhs of grass carp and 1.14 lakhs of silver carp.

The results achieved in the case of grass carp were very encouraging. Out of 19 sets that yielded healthy fry, 12 sets spawned naturally of which in 11 sets the spawning was complete. The yield of fry was comparatively low on account of considerable mortality of developing eggs (a phenomenon reported earlier also). The dose of pituitary extract administered usually varied from 9 to 12 mg/kg body weight of recipient females. However, in two cases 14 mg/kg and in one case 15 mg/kg were also administered but without successful results. Though the total dose of the extract to the females was usually administered in the course of 2 and 3 injections, 4 injections were also tried. It was observed that 2 and 3 injections gave good results, and the females receiving 3 injections were mostly ready for stripping or spawned a little earlier than those receiving 2 injections. The males were given a single dose of 2 to 4 mg/kg body weight, usually at the time of the final injection to the females.

Partial natural spawning in the case of silver carp was achieved in one set only. The dose of the extract varied from 9-17 mg/kg body weight of recipient females, but mostly doses varying from 9-12 mg/kg were tried. In general, 2 and 3 injections were tried but in a few cases 4 injections were also given and successful results obtained. However, 2 and 3 injections appeared quite adequate. The males were administered a dose of 2 to 6 mg/kg in one injection.

The experiments with silver carp were greatly restricted for want of sufficient number of good female breeders because of heavy mortality of silver carps during May, 1966 due to prolonged drought resulting in adverse water conditions.

Observations on per hectare production of fry of Chinese carps were made in nursery ponds (0.04 ha). The spawn of grass carp was stocked at the rate of 12.5 lakhs, 11.25 lakhs and 7.5 lakhs/ha approximately and of silver carp at the rate of 10 lakhs and 7.5/lakhs ha. The survival and growth of fry in general were good, average survival being 50-55%. However, frequent netting of the nurseries for the supply of seed to various parties resulted in some mortality of fry.

A field experiment on per hectare production of fingerlings was conducted in four 0.08 ha rearing ponds. Fry of silver carp, grass carp and common carp were stocked (in duplicate sets) at 90,000 and 60,000/ha in the ratio of 4:3:3. The observations were continued for 3 months and the details are given in Table 2.

Table 2.

Pond No.	Species and No. stocked/pond	Av. wt. (gm) Initial	Av. wt. (gm) Final	No. fingerlings recovered	% Survival	Production per pond (kg)
RP_3	Silver carp 3000	0.50	27.0	2986	99.5	80.7
	Grass carp 2250	0.29	17.6	1622	72.1	28.5
	Cyprinus 2250	0.43	27.5	2112	93.8	58.1
RP_6	Silver carp 3000	0.50	77.3	1640	54.6	126.8
	Grass carp 2250	0.29	17.6	1773	78.8	31.2
	Cyprinus 2250	0.43	19.4	1280	56.9	24.8
RP_4	Silver carp 2000	0.50	52.1	1953	97.6	101.7
	Grass carp 1500	0.29	17.7	1453	96.8	25.7
	Cyprinus 1500	0.43	34.6	1446	96.4	50.0
RP_{10}	Silver carp 2000	0.50	67.3	1373	68.7	92.4
	Grass carp 1500	0.29	32.6	844	56.3	27.5
	Cyprinus 1500	0.43	8.8	957	63.8	8.4

The replicate of each rate of stocking gave poor survival owing to the possible presence of predators. However, the survival in the other two sets was very satisfactory. The overall survival of the three species worked out to 89.6% and 62.6% (6720 and 4693 in number) at the higher rate of stocking and 97.4% and 63.5% (4852 and 3174 in number) at the lower rate of stocking, the per hactare production for 3 months being 2091 and 2285 kg at the higher rate of stocking and 2218 and 1604 kg at the lower rate. Mustard oil cake and rice bran (1:1) were given daily /aftificial food while only occasionally grass carp were /as fed on duckweeds.

The observations on per hectare production of yearlings in two 0.12 ha ponds were concluded after one year. The ponds were stocked at the rate of 3700/ha with silver carp, grass carp and common carp in the ratio 4:2:3. The details are given in Table 3.

Table 3.

Pond No. & area	Species	No. stocked	Initial av.length and wt.	No. recovered	Final av.length and wt.	% survival	Production/ pond annum. (kg)
	Silver carp	200	190 mm (69 gm)	196	456 mm (1170 gm)	98	229.52
RP_{15} (0.12 ha)	Grass carp	100	159 mm (49 gm)	76	408 mm (680 gm)	76	52.13
	Common carp	150	116 mm (24 gm)	133	299 mm (420 gm)	88.7	55.80
	Silver carp	200	190 mm (69 gm)	199	478 mm (1200 gm)	99.5	238.80
RP_{16} (0.12 ha)	Grass carp	100	159 mm (49 gm)	77	399 mm (640 gm)	77	49.25
	Common carp	150	116 mm (24 gm)	136	298 mm (450 gm)	90.7	62.30

In addition to the above production, natural breeding of common carp was also recorded in the ponds, and production per hectare therefrom came to about 85 kg and 4 kg in RP 15 and RP 16 respectively. The total production/ha/annum worked out to 2896 and 2922 kg in the two ponds respectively. The ponds were fertilized with ammonium sulphate, super phosphate and calcium ammonium nitrate at 900 kg, 400 kg and 41 kg/ha approx. which were applied in four instalments. The grass carps could only be occasionally fed with weeds.

A number of field experiments were conducted to study the efficacy of grass carp in controlling various aquatic weeds which are described below :

i) Hydrilla

In one 0.08 ha pond, 450 kg of Hydrilla and 97 grass carps (av. wt. 955 gm) were introduced. The fish consumed the weed within a week. Later, 425 kg of the weed was introduced which was cleared within 4 days. Feeding was continued with another 375 kg of Hydrilla which the fish consumed within 3 days.

One 0.1 ha pond, covered one fourth by thick growth of Hydrilla (2076 kg) mixed with Najas (888 kg), was stocked with 520 grass carps (av. wt. 62 gm). Within 18 days the weeds were cleared and on sampling only 450 fish were recovered weighing on an average 113 gm. Presence of the predator Wallago attu (3-4 kg size) was noticed, which could account for the loss of grass carps.

In a bigger pond (0.65 ha) choked with Hydrilla (25 tonnes) and Najas (19 tonnes), 425 grass carps (av. wt. 113 gm) were stocked. The fish cleared the submerged weeds within 6 weeks, and on sampling the fish weighed 322 gm on an average.

In another pond (0.08 ha) infested with Hydrilla along with Najas, Nechamandra, Vallisneria and Marsilea, 30 starving grass carps were introduced (av. wt. 1.7 kg) and control for the weed was maintained. It was observed that Hydrilla was cleared first and Najas next. Within two months almost all the weeds were cleared up except some cut-up portions of Nechamandra. At the end all the fish were recovered in excellent condition weighing on an average 3.1 kg.

ii) Ceratophyllum

In one 0.28 ha pond infested with the weed (estimated quantity 13.5 tonnes), 70 grass carps (av. wt. 974 gm) were introduced. Within 39 days most of the weed was cleared except what remained towards the shallow margins where the fish could not reach easily for feeding. As poaching activity was reported,

the observations were concluded and 55 fish with an average weight of 1250 gm recovered. The remaining weed, estimated to be about 2 tonnes, was manually removed. The weeds inside the control remained healthy throughout.

iii) Utricularia

One 0.04 ha pond was stocked with 29 grass carps (about 1 kg in av. wt.) and fed with 45 kg of the weed which was consumed within one week. Later, 125 kg of Utricularia mixed with Myriophyllum was again introduced in the pond which was consumed within 9 days and the fish were recovered in good condition.

iv) Nechamandra

Fresh growth of Nechamandra was noticed in one 0.04 ha pond, where 19 grass carps (av. wt. 1 kg) were introduced initially, but as the weed continued spreading further, 10 more grass carps (av. wt. 525 gm) were stocked after one week. The fish cleared the pond within 33 days and were recovered in good condition.

v) Salvinia

250 kg of the weed was introduced in one 0.08 ha pond and 95 grass carps (av. wt. 950 gm) were stocked therein. Control for the weed was maintained. Within 17 days all the weed was cleared, and the fish were recovered in good condition (av. wt. 1 kg), control remaining healthy.

vi) Nitella

Thick natural growth of Nitella was noticed in a 0.08 ha pond. To curb its growth, 27 grass carps (av. wt. 1.2 kg) were introduced after sampling the weed density and marking out the control. Within 17 days all the weed was cleared, the fish at the end weighing 1.6 kg on an average.

In yard experiments (conducted in a plastic pool), juveniles of grass carp were observed to consume Potamogeton pectinatus, Halophila ovata, Myriophyllum and also cut bits of Eichhornia. However, tender shoots of Jussiaea were not taken by the fish. Though the juveniles consumed bits of Eichhornia leaf, their condition after one month's feeding was found to be not satisfactory.

Breeding of scale carp was taken up on a limited scale and 8.25 lakhs of spawn were produced; in addition 3.6 lakhs of spawn were produced by the Fish Breeding Unit.

The experiment on intensive cultivation of Tilapia was continued during the year and 1078 kg of tilapia and 230 kg of other fishes were harvested. No feeding and manuring were done this year. The total production during the 33 month period came to 3093 kg of tilapia and 461 kg of other fishes. Considerable thinning of tilapia and destruction of its young ones were done to improve the size of the fish.

4. Brackishwater fish farming

Studies on the relationship between the productivity of brackishwater ponds (bheris) and the prevalent hydrobiological conditions were continued. Observations in six bheris showed that the highest abundance of algae occurred during May-August with a peak in July, being 267.5 cc/sq m in the Bager bheri. The abundance of different genera was found to be correlated with prevalent salinities, Oscillatoria spp being the dominant algae during the summer months (April-June) when the salinity values were the maximum followed by Lyngbya, Cladophora and Mougeotia spp during the rainy season. Ruppia occurred in almost all the bheris, its highest abundance being from September to November. Observations on plankton contents showed their maximum abundance to be during October-November in almost all the bheris. However, the Taldi bheri which recorded the greatest abundance of plankton during August (0.27 cc/l or 363 units/l) was the most productive of all bheries from the point of view of plankton production. Zooplankton, represented mainly by nauplii, Cyclops and Diaptomus, dominated the plankton contents. Phytoplankton was represented by Oscillatoria spp and diatoms, Gyrosigma being the most dominant amongst them throughout the year.

Analyses of the physico-chemical conditions of the water showed the temperature, turbidity, salinity, pH, D.O. carbonate, bicarbonates, calcium, magnesium, nitrogen, phosphate and potassium to range from 17.5-35°.0 C, transparent to 5.5 cm, 11.5-39.0‰, 7.4-8.2, 4.8-12.4 ppm, nil to 51 ppm, 46-148 ppm, 270-804 ppm, 1329-3044 ppm, 0.1-1.75 ppm, traces to 0.11 ppm and 67-200 ppm respectively.

Analyses of the chemical conditions of the soil phase indicated the pH, nitrogen, phosphorus, potassium, calcium and magnesium to range from 7.6-8.0, 2.2-8.3 mg/100 gm, 2.1-6.9 mg/100 gm, 41-113 mg/100 gm, 97-210 mg/100 gm and 60-168 mg/100 gm respectively. The nutrient status of the bheries indicated that Bager was the most fertile of all bheris, followed by Taldi. It was further observed that during April-June when the nutrient status of the bheri waters was at its highest, algal production was also high attaining its peak in July.

A series/experiments were conducted to determine the /of effective methods of transportation of the fry of brackishwater species. The fry of M. parsia (18-30 mm) were kept in ordinary estuarine water without conditioning and after conditioning, and also after conditioning in estuarine water treated with chloral hydrate and with oxygen under pressure. However, the maximum number 1300 fry that could be kept for 24 hours without mortality was in case of fry kept in plastic bag with oxygen.

Studies on the food of M. parsia fry (16-42 mm) collected from bheris indicated organic matter (56%) to be the most important food item, followed by diatoms (11.5%). Other minor food items occasionally encountered in the gut contents were vegetable matter, unidentified eggs, nematode worms, polychaete setae etc. Sand and silt formed 32.4% of the gut contents. The feeding intensity of the fry during December, January, February and March was rather low with only 1.2% of the guts being full; and while 27.5% of the guts were empty, 26.8% had only traces of food items. Not even a single gut was found in the 'gorged' condition.

5. Weed control

In connection with studies on the control of water hyacinth using "Taficide - 80" (80% sodium salt of 2,4-D), a 1.9 m deep, medium-sized pond (area 3312 sq m) in Stewart School compound, Cuttack, fully and thickly covered by the weed (21 kg/ 33 plants/sq m) and open to reinfestation from a marshy, low-lying area on the inlet side and from a water hyacinth choked area on the out-let side, was taken up for detailed studies on its control, follow-up maintenance of the pond and its economics.

The total quantity of weed in the pond was estimated to be 69 tonnes. Spraying was done with a pedal pump sprayer with a 40 m long, polythene delivery tube fitted with a single cone-jet spray nozzle, the pump being worked by a man on the pond shore while the spray gun and tube carried by a second man walking on stout bamboo poles laid on the infestation (as done in previous experiments) for spraying the areas away from shore.

Amount of Taficide-80 used for spraying	2080 gm
Per cent weedicide concentration in the aqueous spray soln.	1.6 gm
Additives used & their concentn.	- detergent 'Surf' - 0.1% + Kerosene 1 ml/1.
Area covered by 10 litres of spray soln.	- 250 sq m (approx.)

Av. dose of weedicide per plant - $\frac{2080 \text{ gm}}{109296 \text{ plants}}$ = 1.9 mg/plant

About 2.080 kg of Taficide-80 was made into an aqueous solution having a concentration of 1.6% and to which were added the detergent 'Surf' (0.1%) and kerosene 1ml/1. 250 sq m were covered by 10 litres of the solution and the average dose of the weedicide received by each plant was 1.9 mg. Total spraying effort covered 39 man hours.

Except for a few clumps of weeds, which obviously did not receive sufficient dose of the spray, the bulk of the infestation died and dried at the end of about four weeks and floated on the water surface as a thin cover. In another four weeks the killed weeds had become sufficiently soft for a boat to be paddled about, but the partially affected clumps started regenerating by this time. 334 kg of these were removed by employing two men from a boat for 14 man hours. The dead mass of weeds of approximately 4000 kg (or four times the live clumps) with a density of 11 kg/sq m was then pushed to a third of the area originally occupied (packing density 32 kg/sq m) and the pond could be drag-netted easily for collecting the existing fish. The estimated percentage reduction of infestation at this stage was 94.3%.

With the gradual shrinking and sinking of the dead mass, Spirodela appeared in the pond and by the end of eleven weeks after treatment when the weed mass had shrunk to 1/4 of the pond area, Spirodela covered the rest of the area. Small Pistia plants also appeared sporadically. These scattered plants were pushed to one corner and sprayed with Taficide-80 plus Surf. To control Spirodela, 450 grass carp fingerlings (8-10 cm) were also released in the pond. However, since Spirodela spread rapidly covering the entire pond within a month of its initial appearance, the entire mass of about 4000 kg was netted out for feeding grass carp stocked elsewhere. A month later both Spirodela and Pistia, with the later more dominant, spread over the pond, the total estimated weed mass being 2562 kg. This was again removed by skimming with bamboo poles and heaping over the embankment (average height 0.63 m) employing six man hours of labour at a cost of Rs.3/-, the 6 hr effort being 2562 x 0.63 or 1614.06 kg manual work of lifting.

Before treatment of the infestation the pond water had low (0.9 ppm) oxygen which was reduced to nil during weed disintegration. With the subsequent exposure of water surface the oxygen level increased. No fish was killed during the entire observational period. There was 300% increase in organic carbon after the sinking of the weed mass. Plankton density which was low when the water surface was covered by live or dead weeds increased remarkably after weed clearance reaching a maximum in February, with zooplankters constituting 56% of the total.

The estimated economics of the entire operation was as follows :

A. For water hyacinth only (during the first 3 months)

(a) Cost of 2, 4-D spray and follow-up operations :

Cost of 2 kg of weedicide at Rs.8/- kg	=	Rs 16.00
Labour cost for spraying (39 man hrs. at Rs.3/- per 6 man hrs.)	=	Rs 19.50
Cost of detergent	=	Rs 2.00
Cost of Kerosene	=	Rs 1.00
Labour cost for 60 man hrs of follow-up operations (drag-netting, etc.)	=	Rs 30.00
Total:		Rs 68.50 or Rs 69/- approx.

Cost per hectare = $\frac{69}{0.33}$ = Rs. 209/-

(b) Cost estimate for clearance solely by manual labour :

Manual labour employed to lift 2562 kg over 0.33 m embankment	= 2562 x 0.63 = 1614 kg in 6 man hrs at Rs.3/-
Cost of lifting 69,000 kg of original infestation over av. height of 1 m from the 0.33 ha pond.	$\frac{69,000 \times 3}{1614}$ = Rs. 128.25
Cost per hectare	$\frac{128.25}{0.33}$ = Rs.387/-

B. For Spirodela and Pistia (during the second 3-month period)

Cost of 100 man hrs of labour for 0.33 ha water area	Rs.50/- (approx.)
Cost of labour/ha	Rs. 152/-

Thus, the actual clearance of water hyacinth by 2, 4-D and the follow-up operations including the clearance of Spirodela and Pistia within a six-month period cost Rs.361/- per ha against an estimated cost of Rs.539/- if done by manual labour alone.

Studies on the use of 'Paraquat' ('Grammoxone' of I.C.I.) for controlling water hyacinth were continued. A small shallow pond of 500 sq m covered with small-sized water hyacinth plants (20 plants/sq m and 5 kg/sq m) was treated with the weedicide in two instalments totalling 4 kg/ha. The first spraying killed approximately 65% of the plants and the next most of the rest. Still some fresh plants were found along the margin and had to be removed manually. The total cost of clearance worked out to Rs.280/- per ha, Rs.160/- being for the weedicide and the rest for manual labour. Further studies could not be carried out since the weedicide was in short supply.

Application of copper sulphate in mud pellets on the bottom soil at 20 kg/ha after manual clearance of water hyacinth from a moat section at Killa was helpful in minimising regrowth of the weed. New plants which appeared sporadically could be controlled by manual labour.

In yard experiments Lemna and Azolla were totally killed by 'Grammoxone' spray at 3 kg/ha. It was also observed that Pistia is more responsive to Taficide-80 plus detergent spray during the warmer months than during winter months.

By treating a Hydrilla infested pond for three years in succession with ammonia it has been possible to achieve almost complete clearance of the weed. With the third treatment during the current year, 96.5 percent reduction has been obtained, the left over debris being removed manually. It is proposed to check any further regeneration by ground application of suitable weedicides other than ammonia since the latter is more suitable and economic for clearing the original thick infestation than the thin growth appearing subsequently. Detailed data on the observations are given in Table 4.

Table 4.

Year	Density of infestation				Density of reinfestation (kg/ha) after 1 yr.
	Initial		Residual (after ammonia appln)		
	Kg/sq m	% of original (1964-65)	Kg/sq m	% of density before treatment	
1964-65	29.40	100.0	1.944	6.6	4.24
1965-66	4.24	14.5	1.896	44.7	3.40
1966-67	3.40	11.6	0.578	17.0	under observation

Experiments were conducted to prepare an easy granular formulation of 'Taficide-80' for application in the bottom soil against young, submerged plants. 22 kg of granules prepared by mixing only 200 gm of the weedicide with sand and binding material (starch) were applied uniformly in two 180 sq m plots of a pond infested with young Hydrilla, the rest of the pond serving as control. Initial observations indicate that the growing shoot tips are adversely affected.. This is in partial confirmation of results obtained in the yard where the growth of roots and shoots were temporarily arrested.

'Tacicide-80' at 15 kg/ha sprayed as a 1.5% aqueous solution with 0.25% detergent effectively uprooted the bulk of an infestation (2.9 kg/sq m) of Nymphoides indicum in a small scale field trial. However, runners developed from the axils of affected leaves within four weeks after spraying.

Kurasol - G (20% 2- 2,4,5 - trichlorophenoxy-propionic acid, granular formulation) at 45 kg/ha gave only partial control of the weed.

There has been practically no regrowth in the field plots of Cyperus treated and killed during the previous year with 'Taficide-80' at 28 kg/ha along with 0.25% detergent. A lower rate of 15 kg/ha with 0.25% detergent tried this year also proved effective. Regeneration was observed from the rhizomes of mature plants two months after treatment.

Two small scale field trials indicated the possibility of controlling effectively even mature stands of Cyperus when mud-pelleted 'Tafacide-80' @ 200 kg/ha is applied on the ground. Panicum also appears to be susceptible to ground treatment at this rate. Trials are to be continued with lower rates to make it more economical.

6. Soil chemistry and fish production

To study the relative efficiency of different nitrogenous fertilisers for increased production of fish food organisms, a yard experiment of three months' duration was carried out in ten cement cisterns using an acidic soil (pH-5.8) from Lingipur fish farm and the fertilisers sodium nitrate, urea, ammonium sulphate and calcium ammonium nitrate. After an application of a basal dose of P_2O_5 at 40 kg/ha, the fertilisers were applied on an equivalent nitrogen basis of 80 kg N/ha, there being one replication for each treatment and control. Average values of most of the water qualities for the 3-month period did not show any significant difference in the treated and untreated cisterns. However, available nitrogen was much higher in the treated cisterns (0.29 - 0.45 ppm) than in the control (0.04 ppm), the highest value being with sodium nitrate. Plankton density was also the highest (68,750 /l) in the pond treated with sodium nitrate and least in the control (19,930/l), with urea, ammonium sulphate and calcium ammonium nitrate giving figures of 43889, 36683 and 22311/l respectively. Phytoplankton constituted 96.7% of the plankton with Eudorina, Botryococcus, Micrasterias, Trachelomonas and Anabaena dominating. Among zooplankters, Difflugia, rotifers, Cyclops and nauplii dominated.

Repetition of the experiment in 12 ponds at Lingipur Farm using only urea, ammonium sulphate and calcium ammonium nitrate at the same rates and with initial application of phosphates but with two replications for each treatment and control gave more or less comparable results with more of available nitrogen in treated ponds than in control and with maximum density of plankton (1818/l) in the pond receiving urea treatment and minimum (1184/l) in the control. However, calcium ammonium nitrate gave a higher plankton density (1517/l) than ammonium sulphate (1244/l). Also, zooplankters constituted 54.6-68.9% of the plankton. The results of both yard and field experiments thus indicate that nitrogenous fertilisers influence the production of plankton significantly.

To study the response of a low nutrient, acidic soil of sandy texture to different combinations of the inorganic fertiliser N-P, a field experiment was initiated at Lingipur Farm during the second quarter of the year under report and concluded during the last quarter. The combinations used were NoPo, N80 Po, NoP40 and N80 P40, each treatment and control having two replications. All the ponds were stocked with catla, rohu and mrigal at a uniform rate. The chemical quality of water, including the nutrients, nitrogen and phosphorus, did not show any marked difference in the treated and untreated ponds during the study whereas the average plankton volume was always higher in the treated ones than in control. In all the ponds there was a general increase in the volume of plankton from October to December. The fishes were netted out during the second week of February. The production of fish in the different ponds is being assessed.

To gain knowledge on the response of different types of soils to frequent and regular intensive fertilisation with single phosphate fertiliser, an experiment was initiated in two farms, one at Kausalya Ganga having near neutral soil and the other at Humari with slightly alkaline soil. However, detailed study could be undertaken only at Kausalya Ganga. The Kausalya Ganga ponds with near neutral soil having low available nitrogen and phosphorus and slightly alkaline water with medium total alkalinity, low phosphate and fair concentration of dissolved nitrogen was stocked with fingerlings of catla, rohu and mrigal at 3000/ha and in the ratio 1:1:1. Manuring was done every month with single phosphate (16% P_2O_5) at 50 kg/ha. Though no significant difference in water qualities and plankton could be seen between the treated and untreated ponds, a sample netting after a rearing period of six months indicated marked difference in the growth rates of the three species.

With a view to understand the chemistry of phosphorus in different soil types ranging from highly acidic to highly alkaline, pond soils collected from different soil zones of India were grouped into six types on the basis of their pH, viz., (1) highly acidic (pH 4.5), (2) moderately acidic (pH 4.5 - 5.5), (3) slightly acidic (pH 5.5 - 6.5), (4) nearly neutral (pH 6.5-7.5), (5) moderately alkaline (pH 7.5 - 8.5) and (6) highly alkaline (pH 8.5). Complete analysis of several samples were carried out to estimate different forms of total and exchangeable nutrients and the different forms of bound phosphorus. It was found that the percentage of calcium-bound phosphorus and

iron-bound phosphorus are markedly influenced by soil pH, the former increasing with increase of pH and the latter decreasing with increasing pH. While saloid-bound phosphorus represented only a minor fraction, aluminium-bound phosphorus did not show any clear relationship.

In connection with studies on the correlation between calcium-bound phosphorus and free calcium carbonate in soil under water-logged condition, soil samples with varying percentages of calcium, viz., 0.5 - 2.75, 3.0-3.65, 5.82-7.65, 9.1 - 10.8 and 12.3 - 14.05 were selected and kept water-logged for about a month and the calcium-bound phosphorus determined. The average Ca-bound phosphorus expressed as percentage of total inorganically bound phosphate for the respective soil samples were 17.2, 22.19, 36.44, 67.92 and 74.99 thereby showing that Ca-bound phosphorus bears a direct correlation with the concentration of free calcium carbonate in the soil.

Studies on the mineralisation of organic nitrogen in pond soil by superphosphate, lime and manganous sulphate were carried out in the laboratory using soils from ponds in and around Cuttack. Two rates, one low and the other high, of each mineral were tried with one replication for each treatment. Samples were analysed for mineralised nitrogen in the frist and second weeks after treatment and subsequently every fortnight up to 60 days. It appeared from these studies that the maximum yield of mineralised nitrogen (223 mg/100 gm) was in the high rate lime treatment after 15 days. Considerably high values of nitrogen were found in all the treatments for a period of 30 days after treatment but thereafter there was a decline or the difference from control was negligible.

The field experiment started in the long pond at the Killa Farm during the previous year in connection with a study of the ecology of fish ponds with special reference to their bottom fauna was concluded during August in the current year. The production of fish in the stocked half of the 0.03 hectare pond was 42.6 kg for a total rearing period of 244 days, which works out to 2125.9 kg/ha/annum. The production has been much better than in similar experiments of previous years. Percentage of recovery was the highest in common carp and mrigal, while the highest increase in weight was in catla and the lowest in common carp. In almost all the samples the unstocked half of the pond showed a higher density of bottom fauna. Unlike in previous years the experiment was continued through the

monsoon months of June and July. From May onwards there was a steady fall in the bottom fauna till it reached the lowest level in July, the unstocked half showing only 41 organisms/sq m and the stocked half 4/sq m. The pond which was kept under observation even after the harvesting of fish in early August showed a steady increase in the fauna from August onwards with a peak in September and another in December, the former due to an abundance of chironomid larvae and the latter due to oligochaet worms, especially the bracheate forms. There was no appreciable variation in plankton density between the stocked and unstocked portions of the pond. Gut content analysis of fishes in the stocked half revealed that common carp and mrigal utilised the bottom fauna. In the guts of the former chironomid larvae, bits of oligochaet worms and plenty of chitinous setae were encountered whereas in mrigal bits of worms and insect appendages and plenty of mud and sand particles and organic debris were found.

7. Fish production and supply of fish seed

Incidental to experimental fish culture at Killa Fish Farm, 5058.68 kg of fish (3874.83 kg of carps and 1183.85 kg of tilapia and miscellaneous fishes) and 34,450 fingerlings were harvested and sold for Rs.13,414.61 and the amount deposited with the Orissa Fisheries Department. In addition, the department was supplied with 42.97 lakhs of spawn, 21,827 fry and fingerlings and 29.75 kg of fish of an estimated value of Rs.5,481.05.

Details of the supply of the seed of grass and silver carps, which have been in great demand, are as follows (Table 5).

Table 5.

Name of State/ Country	Grass carp			Silver carp		Remarks
	Spawn	Fry	Finger-lings	Fry	Finger-lings	
Assam	-	1000	-	-	-	Free
Gujarat	-	200	-	-	-	"
Madhya Pradesh	-	1500	-	-	-	"
Madras	-	500	-	500	-	"
Maharashtra	-	200	-	200	-	"
Mysore(T.B. Dam)	-	200	-	300	-	"
Orissa	40,000	-	12,843	-	8984	"
Punjab	-	300	-	200	-	"
Tripura	-	200	-	200	-	"
Uttar Pradesh	-	500	-	-	-	"
West Bengal	-	2250	-	250	-	"
Orissa Fisheries Dev. Corpn.	-	-	925	-	1175	On payment
Other parties	-	-	100	-	6625	On payment
Nepal	-	200	-	200	-	Gift
Total :	40,000	7050	13,868	1850	16,784	

In connection with the scheme of providing the technical know-how to local private fish farmers who were willing to co-operate with the substation, 7850 fingerlings of Indian major carps were supplied to them free of cost for experimental culture.

8. Frog farming

With the transfer of the post of the Frog Research and Development Officer from the Central Marine Fisheries Research Institute, Mandapam Camp, to this Institute, further work on frog farming was carried out at Barrackpore from August 29, 1966. Attempts were made to induce the two commercially important species of Indian frogs, Rana tigrina and R. hexadactyla, to ovulate under laboratory conditions by administration of pituitary extract. Extract of seven homoplastic pituitary glands, in five doses, injected to each of the ten specimens of R. tigrina (107-115 mm in size and 193-210 gm in weight) during the second half of December did not induce them to ovulate. Morphological and histological examination of the gonads indicated their complete regression during the period, though in a few cases oogenesis had proceeded up to the primary oocyte stage. However, three of the twelve specimens of R. hexadactyla (115-120 mm/150-168 gm) ovulated during January-February, 1967 when injected with a total dose of seven pituitary glands each though only a few eggs were released. Another experiment conducted with freshly collected, larger individuals of R. hexadactyla (118-121 mm/193-270 gm) during February, 1967 resulted in the ovulation of all the three specimens on the third day when injected with the extract of a total of five pituitary glands each, one gland on the first day and four in equal doses at six-hourly intervals on the second day. The specimens serving as control showed no reproductive activity. It needs to be noted that a peak breeding phase exists during this period.

A study of the annual sexual cycle of R. hexadactyla initiated during February, 1965 and completed in January, 1967 has revealed (i) that spermatogenesis proceeds throughout the year with several peaks, (ii) that oogenesis proceeds in a different manner in different age- and size groups, (iii) that the species is a potential perennial breeder with peak breeding during February/March and July/August.

Studies on the life history of R. hexadactyla have revealed that complete metamorphosis in the laboratory as well as field conditions takes 5-6 weeks. Preliminary studies on the food of R. hexadactyla in West Bengal have shown that the early

tadpoles feed on Spirogyra sp. ; advanced tadpoles on Hydrilla sp.; small frogs on ants or other small insects, and, juveniles and adults on Vallisneria and Hydrilla sp. Vegetable matter comprised 70-90% by volume of the gut contents, small gastropods and aquatic insects (usually bugs) contributing to the rest. In controlled experiments, it was also observed to feed on another aquatic weed, Potamogeton crispus, common in ponds and tanks. In the laboratory, the species can even be fed on cockroaches.

Preliminary survey of available frog resources with special reference to commercial species was conducted in the following districts of Madras, Kerala, Orissa and West Bengal with a view to developing commercial frog- and frog-cum-fish-farming (Table 6).

Table 6

State	District	Commercial frog species	Abundance	Remarks
Madras	1. Ramnad	Mainly R. crassa, also R. tigrina & R. hexadactyla.	Fairly good quantity	Mostly R.crassa in East Ramnad & R.crassa and R.tigrina in West Ramnad.
	2. Madurai	Mainly R.crassa & R.hexadactyla, also R. tigrina.	Fairly good quantity	R.crassa very common in marshy areas, wayside ditches and borrow pits, while R. hexadactyla in ponds and creeks in the plains.
	3. Kanya Kumari	R.tigrina, R. hexadactyla & R. crassa	Good quantity	Big-sized R. crassa available but with black pigmentation on leg joints. Plains and forests are rich in the above species.

contd.....

contd.....

State	District	Commercial frog species	Abundance	Remarks
Kerala	1. Trivandrum	R.tigrina, R. hexadactyla & R.crassa.	Fairly good quantity	R.tigrina & R.crassa in forest plains while all the 3 sp. between Quilon and Trivandrum districts.
	2. Kottayam	R.tigrina, R.crassa & R.hexadactyla.	Huge quantity	-
Orissa	1. Cuttack	R.tigrina only	Fairly good quantity	Frog catching season may be from May through September.
	2. Bhubaneswar	R.tigrina only	Not much	-do-
	3. Puri	R.tigrina only	Fairly good quantity	-do-
West Bengal	1. Birbhum	R.tigrina mainly, R. hexadactyla also.	-do-	Catching season may be May through September.
	2. Nadia	R.tigrina mainly R. hexadactyla also	Good quantity	-do-

A monograph on "South Indian Salientia" is under preparation.

III. INVESTIGATION ON CAPTURE FISHERIES

1. Spawn prospecting investigations

With a view to locating new centres for commercial exploitation of carp seed, eight riverine stretch were selected after a thorough pre-monsoon survey for conducting spawn prospecting investigations. Detailed investigations were undertaken

at Loduwal on the Sutlej and Wazir Bhullar on the Beas and Majhawali on the Yamuna in Punjab. Mant on the Yamuna and Ghagra ghat on the Ghagra in Uttar Pradesh and Khagaria on the Burhi Gandak, Babuaghat on the Kosi Khanua Dhar and Mehdi Jhajha on the Badua in Bihar.

The salient features of the observations made at various centres are given below :

(A) Punjab

(i) River Sutlej

Loduwal

A 144 km stretch of river Sutlej, extending from Gidderpindi in the west to Rupar in the east, was taken up for spawn prospecting during the period 1.7.66 to 7.9.66. One site at Gidderpindi to the west of Loduwal and two sites at Mattewara and Rupar to the east of Loduwal were selected for trial net operation. During investigations, only the receding phase of the floods yielded 26,742 ml of desirable spawn out of a total yield of 28,344 ml in three spurts at Loduwal. These three spurts, ranging in duration from 10-42 hours, covered a total period of 74 hours but desirable spawn was available for 64 hours only.

While analyses of spawn samples revealed the percentage of major carp content in spurts 1, 2 and 3 to range from 4-12, 12-84 and 24-58 respectively, the results of rearing experiments showed that major carp were totally absent in spurts 1 and 3 and were represented to the extent of only 2.6% in spurt 2, probably due to differential mortality of major carp spawn in the nursery. The major carp species represented in the samples were L. rohita, C. mrigala and C. catla. The indices of spawn quantity and quality were found to be 5,560 ml and 2.6% respectively.

The catching efficiencies of the Punjab and Murshidabad nets were 7.2% and 42.9% respectively when compared to that of the standard net. Experiments conducted with nets of different sizes ranging from 5-14 m and made of 1/8" meshed Midnapore-type netting revealed that with the increase in size of nets the rate of efficiency increased parabolically. Experiments conducted with a double-walled net indicated that the

escapement rate from 1/8" meshed Midnapore-type netting ranged from negligible to 66.6%. No noticeable effect on escapement rate could be made out under the observed ranges of turbidity and current velocity.

Of the sites prospected, Rupar was found unsuitable for operating shooting nets due to steep banks while the site at Mattewara, though suitable for shooting net operation, had very poor accessibility. The sites at Gidderpindi on the main river and at Sultanpur Lodi on the western Beyin were found to be suitable and yielded an appreciable quantity of spawn.

As the floods in the river are brought about by the release of water from the Bhakra reservoir (130 km above Loduwal) and not by inflow of freshets from the catchment area, water level in the river rises and recedes abruptly. Moreover, the damming has affected the formation of deep pools in the river as a result of which most of the major carp population of Sutlej are very likely taking shelter in the Harike reservoir, situated down stream of the confluence of Beas and Sutlej, during the pre- and post-monsoon periods. A small seasonal stream, the Western Beyin joins the Sutlej a few miles above the confluence. During the present season, the Western Beyin received the first freshet earlier than the Sutlej and probably for this reason the fishes migrated to the Western Beyin and bred, resulting in a very low percentage of major carps in the spawn of Sutlej. It is likely, therefore, that the release of water from the Bhakra Dam in early June resulting in the Sutlej experiencing its first flood earlier than the Western Beyin, may cause the major carps to migrate from the Harike reservoir to Sutlej for breeding. The presence of suitable breeding grounds of carps upstream of Loduwal has been more than established by the availability of spawn in quantities in the shooting nets at Loduwal.

(ii) River Beas

Wazir Bhullar

Four different spots on a 2 km stretch of river Beas adjoining the village Wazir Bhullar on its western bank, near Beas railway station were selected for detailed spawn prospecting investigations from 1.7.66 to 31.8.66. A survey was also conducted for further location of sites in a stretch of about

120 km south-west of Wazir Bhullar to Harike. This stretch was found to be unsuitable for the operation of shooting nets because of the marshy nature of 5-7 km wide extent of land adjoining the river bank.

During the period of investigations, three floods were recorded in the river. The first flood lasted from the 20th to 30th of July, with the peak on the 27th. There was a slight vacillation during the rising phase of the flood, when from 08.00 hours on the 22nd to 18.00 hours on the 23rd July, the flood level receded from + 1.15 m to + 0.83 m. It was only during this temporary recession of flood level that the season's entire catch of 60 ml of spawn was collected within 4 hours. The yield of spawn from II and III floods was nil.

Analyses of the spawn revealed a total absence of major carp spawn, with 93% of the catch consisting of minor carps and the rest being catfishes, clupeids and gobeids. Nursery rearing also confirmed the above finding.

The entire stretch of river Beas above Harike upto Wazir Bhullar and even beyond was found unsuitable for commercial collection of major carp spawn. While the upper stretch seems to be devied of any sizable major carp population, the lower stretch even though it may be harbouring a good number of them, becomes inaccessible during the monsoon months.

(iii) River Yamuna

Majhawali stretch

A 65 km stretch of the river Yamuna extending from Dadasia to Tappa was selected for spawn prospecting and investigations were conducted at Majhawali centre from July 1 to September 5, 1966. The flooding and discharge rate of the river in this stretch is largely dominated by the headworks upstream at Okhla, Wazirabad and Tajewala. Spawn occurred in two sparts only during the receding phase of the floods, the first occurring in flood I & lasting for 28 hours at the very begining of the season, while the second in flood II lasting for 8 hours only in the last week of July. The total spawn catches in 5 standard and 3 state nets in these spurts were 3,625 ml and 5 ml respectively in the former and 240 ml and

100 ml in the latter. While analyses of spawn samples showed 47.6% and 48.4% major carps respectively in spurts 1 and 2, the reared samples showed a major carp content of 18.6% in the former, with catla and rohu dominating and contributing 7.8% each, and 18.7% in the latter with rohu dominating (being 14.2% in the total).

Two fry spurts also occurred later in the season, the first in the rising phase of flood III, yielding mostly uneconomic species and the second in the vacillation period between floods III & IV and in the rising phase of flood IV. The second spurt yielded 2,07,735 ml of desirable and 3235 ml of undesirable fry in 5 standard nets in 152 hours of fry availability. The major carp content, on analyses of fry samples and on examination of reared samples was found to be 12% and 13% respectively. Calbasu fry, which dominated the fry, were conspicuously absent in the reared samples, probably due to differential mortality.

The indices of spawn quality and quantity for the site were estimated to be 18.65% and 784 ml respectively. The efficiency of the Punjab State net in comparison to the standard net was found to be 40%. Experiments conducted with nets of different sizes made from 5-14 m of 1/8" meshed Midnapore type netting indicated a parabolic rate of increase of efficiency with the increase in size of nets. Experiments carried out with a specially designed double-walled net to determine the extent of spawn escapement from 1/8" meshed Midnapore type netting indicated an escapement of 40%.

(B) Uttar Pradesh

(i) River Yamuna

Mant

The stretch between Sakraya in the south to Shergarh in the north in Mathura district was selected for spawn prospecting investigations from 1st July to 31st August, 1967. In addition to Sakraya and Shergarh on the Western bank, Bijoli, Sureer and Sultanpur on the eastern bank were also selected for investigations. Only undesirable spawn, ranging in quantities from 41 ml to 1996 ml, was available in nine spurts during both the rising as well as the receding phases of the floods. These spurts together lasted over 138 hours and yielded a total of 4636.5 ml of spawn, i.e. 96.7% of the season's catch, in 1-5 standard nets. Of the 94 hours of intervening time between

spurts, spawn occurred during 54 hours only, amounting to 79.5 ml. Of the 40 ml of spawn caught during the period from 30th July to 1st August, as much as 38 ml constituted of desirable spawn.

Analyses of 2 hourly spawn samples revealed 61-100% of Chela spp and Barilius spp while the remaining miscellaneous species were dominated by Mugil spp as against the total absence of major carps. The desirable spawn contained as high as 56.78% of major carps in 4-hourly catches. The indices of spawn quantity and quality were 17.3 ml and 26.3% respectively. Only two floods were recorded in the Yamuna at Mant with intervening vacillation phase of four days' duration. From the 9th day of the commencement of Flood II (i.e. from 2nd August) till about the end of the investigations period the operation of the shooting nets was not feasible as the flood level exceeded 165.5 m. However, 99% of the season's catch were obtained when flood levels ranged between 161.5 m to 162.5 m which revealed the suitability of lower flood levels for spawn collection at Mant. The rising phase of flood II being abnormally long, it is very likely that spawn was washed away during this prolonged rising phase as is clear from the fact that during 30th July to 1st August high quality spawn was available. It could, therefore, be presumed that had the flood been normal, quality spawn in quantities could have been possibily harvested. However, from the current observations it could be surmised that river Yamuna at Mant is most likely to yield desirable spawn in late July and early August. The current velocity at Mant ranging between 0.81 and 1.12 km/hr in connection with low turbidity was conducive to high spawn yield. It was recorded that the nets in the first row facing the current and among these the one nearest to the bank yielded the maximum catch.

(ii) River Ghagra

Ghagraghat

A 40 km stretch of river Ghagra, from Karsa to Demhua, was taken up for spawn prospecting during the period 1.7.66 to 2.9.66. Ghagraghat on the eastern bank of the river in Bahraich district was selected for round-the-clock detailed investigations. Periodical prospecting was also carried out at Kaithi and Sangam in Gonda district on the eastern bank, and at Karsa, Purainpur, Sardaha, Bairagmapur, Lorhemau, Sihorwa,

Chirra and Demhua in Barabanki district on the western bank. No spawn was available at these centres, except only in traces at Kaithi, Sangam and Lorhemau. The accessibility to these sites was, however, quite unsatisfactory.

Though five floods occurred in the river during the period of investigation, only a single spawn spurt lasting for 28 hours was encountered during the receding phase of the first flood on 4th and 5th July. In all, 1,112 ml (c. 3.89 lakhs) of spawn was collected by 5 standard Midnapore nets. During the period of bulk spawn availability it was observed that night collections were much heavier than day collections.

Bulk availability of spawn during the I flood coincided with fairly high turbidity values of about 800 ppm. However, similar high turbidity during subsequent floods failed to bring any spawn. Likewise, no correlation was evident between spawn availability and the observed ranges of current velocity and water and air temperatures. In general, the nets nearer to the banks in shallow waters yielded better spawn catch.

Qualitative analysis of spawn catch revealed 32.45% major carps, 65.0% minor carps and 2.55% others. On the other hand, rearing experiments in nursery and chetty pots revealed a major carp content of only 7.4% and 22.2% respectively. This is evidently due to differential mortality of different species.

The indices of spawn quantity and quality for this centre were found to be 228.4 ml and 7.40% respectively.

The low spawn yield during the 1966 spawn season might have been possibly due to the failure of the monsoon. It may, therefore, be worthwhile to prospect the site again during a normal monsoon for assessing its potentiality accurately.

(C) Bihar

(i) River Burhi Gandak

Khagaria

A 50 km stretch of the river Burhi Gandak from the village Dih in the west to Sansarpur in the east was taken up for spawn prospecting. The stretch of the river near Khagaria town was selected for round-the-clock detailed investigations from 10.6.66 to 31.8.66.

The river is channelised between two embankments almost all along its course and is joined by only two rivulets, one at Samastipur and the other at Dih. Because of the steep nature of the banks, no suitable site was available for the operation of shooting nets along the greater part of its course. Since the slope of the river bed is not very steep, with any rise in the water level of the Ganga, there occurs a back-flow into Burhi Gandak as far as 12-15 km upstream, neutralising its currents and creating almost lagoon conditions for varying periods of time. Although the river had three floods during the period of investigations, on 7th July, 7th August and 26th August the spawn was available only during I flood and the vacillating period following it, when a total of 178 ml of spawn was collected. Spawn analysis revealed that the catch was entirely devoid of major carp spawn, and comprised minor carps (99.0%) and others (1.0%). Rearing experiments conducted in earthern gamlas indicated the percentage composition of minor carps and others to be 65.28 and 34.72 respectively.

The absence of major carp spawn in the river may probably be attributed to the following factors : (1) course of the river resulting in the formation of rotatory currents; (2) absence of any adjacent nallahs or confluent fields where major carps could ascend to breed; (3) creation of lagoon conditions due to back-flow from the Ganga into Burhi Gandak; (4) presence of only two rivulets joining the river, one of which has sluice gates at the point of its confluence with the river and (5) low level of the river during the major part of the year leaving practically no breeders for the monsoon season.

(ii) River Kosi Khanua Dhar

Babuaghat

A 33 km stretch of the Kosi system from Rajanpur Thana on the west to Koparia in the east including the stretch of Kosi Khanua Dhar from Rajanpur Thana to Babuaghat, a 4 km stretch of river Khagna upto Koparia and the intervening and adjacent stretch of river Kosi was selected for prospecting. Detailed round-the-clock investigations were carried out from June 1 to July 12, 1966 at Babuaghat on the Kosi Khanua Dhar located in Simri Bakhtiyarpur, and thereafter at Koparia on the Khagna till July 31. For a brief period, from June 18 to June 25, when the Babuaghat site turned unsuitable due to heavy

silting and changed current pattern, the investigations were carried out at Khanuaghat, about 3 km upstream of Babuaghat. The sites prospected included Rajanpur Thana and Ghogsam on the Kosi Khanua Dhar and Belwara, and Kachot on the Kosi. The river Khagna got flooded only in the later part of the season, when spawn availability was over and only advanced fry and fingerlings were collected.

A total of 7,483 ml (c. 37.4 lakhs) of spawn was collected at Babuaghat and Khanuaghat sites. Of these, 7436 ml of spawn were obtained during the four spurts, while the remaining 47 ml were collected at other times when the catch concentration had fallen below the index of availability. All the four spurts were associated with the rising phase of the floods. The total catch of desirable spawn in five standard nets amounted to 3,320 ml (c. 16 lakhs), which formed 44.7% of the total catch.

While the spawn spurts 1 to 3 yielded mostly undesirable spawn, the 40-hour long 4th spurt, occuring in the rising phase of flood II, contributed 97.6% of the season's total desirable spawn in 16 hours. The remaining 2.4% of desirable spawn occurred during the second flood. The ratio of desirable and undesirable spawn was 1:1.3. Spawn analyses showed major carp contents as 3.3, 19.2, 1.2 and 19.4% in spurts 1, 2, 3 & 4 respectively. However, rearing of composite samples taken from spurts 2 and 4 revealed conspicuously high percentages of 20 and 40 respectively. Of the various factors, flood and current velocity appeared to have a great effect on the availability of spawn. Turbidity along with the current velocity seemed to affect the catching efficiency of nets. The net foremost in position, closest to the bank and operated in shallow regions gave better results. The indices of spawn quantity and quality for this centre were found to be 664 ml and 35.1% respectively.

(iii) River Badua

Mehdi Jhajha

Investigations were carried out at the lowermost stretch of the river near the village Mehdi Jhajha, along with a simultaneous survey of the upper reaches as well. Because of wide fluctuations in water level and current velocity, the actual site of detailed prospecting had to be shifted now and

then between the villages Badharia and Nawadih, to enable proper operation of shooting nets. Although the river had five floods, only two were major floods, one occurring during the last week of June and early first week of July and the other early in August. At this centre only fish eggs were encountered. The eggs started appearing during the I flood on 28.6.66 and continued to be available at different magnitudes during the subsequent floods, yielding a total of 19,095 ml of fertilised eggs. Major carp eggs were available during all the floods except during the III flood. That the availability of fertilised eggs instead of hatchlings was indicative of local spawning was confirmed by actual observation of spawning of both major and minor carps on 28.6.66 and 29.6.66 during the rising phase of the first major flood. The major carps started breeding when the flood level reached 0.76 m and continued till the flood attained a level of 1.40 m. In the subsequent floods of lower magnitude, when the water level did not rise by more than 0.30 m, the major carp egg content was either negligible or nil. When the flood level rose by more than a foot on 20.7.66, major carp eggs reappeared in the collections, but in lesser magnitude. This was probably due to the lesser magnitude and erratic pattern of the rising of this flood. Further, a sudden flood of appreciable magnitude, immediately raising the water level by 1.06 m and more, as observed on the 9th and 10th of August, failed to yield any major carp eggs. As such, it appears that in this particular environment, major carp breeding is prompted by a gradual rise in water level ranging between 0.61-1.40 m, while any further rise, erratic fluctuations and abrupt rise in water level appear to be unfavourable.

Almost all the bulk collections were made when the pH value of the water ranged between 6.8 and 7.4 and turbidity between 1200-2500 ppm. A slightly alkaline medium seemed to favour the breeding of major carps. No distinct correlation between air and water temperature with spawn availability could be made out. Gentle wind and heavily overcast sky with occasional showers were found to be the most favourable conditions for spawn availability in appreciable quantities.

Local enquiries revealed that during years of high rainfall, congregation of breeders was observed over a longer stretch of the river from Badharia up to Dharara. Failure of the normal monsoon during the current year evidently restricted the breeding activities only up to Nawadih, as the breeders could not negotiate the steep fall to migrate upwards due to the low level of water.

The present findings indicate the necessity for organising the collection of eggs and spawn in the river and raising them in farms, before they are lost in the reservoir or through its exit canals.

2. Fisheries of rivers

(A) Ganga river system

(a) Upper sector of the Ganga system

(i) Landings

The estimated landings at the seven assembly centres on the rivers Ganga and Yamuna during the year 1966 were 620.02 tonnes, as against 604.4 tonnes (excluding Ballia) during 1965. Of the total landings, 375.45 tonnes were landed at the five assembly centres on the Ganga and 244.57 tonnes at the two assembly centres on the Yamuna. Hilsa ilisha, which accounted for 18.13% of the total landings, was the dominant species (Tables 7 & 8).

River Ganga :

The estimated landings of fish at the five assembly centres on the Ganga were 375.45 tonnes, as against 317.1 tonnes during 1965. H. ilisha was the dominant species and accounted for 30.68% of the total landings. Catfishes, major carps and miscellaneous fishes accounted for 18.45%, 13.03% and 37.84% respectively of the total catch, as against their respective percentages of 20.87, 13.91 and 44.54 during 1965.

Centre-wise distribution of the landings.

Kanpur : Estimated landings during the year under review were 47.09 tonnes, as against 34.2 tonnes during 1965. The landings were maximum during the summer months of March to June when it ranged from 4.48 to 12.26 tonnes and minimum during the monsoon months, July and August, being 1.08 and 0.30 tonnes respectively. The major carps together accounted for 40.35% of the total landings and were followed by catfishes (32.11%) and miscellaneous fishes (27.54%).

Table 7.

Month-wise landings (in metric tonnes) at various assembly centres in 1966

Centre	January	February	March	April	May	June	July	August	September	October	November	December	Total
						River Ganga							
Kanpur	2.18	2.54	4.48	4.48	4.57	12.26	1.08	0.30	3.78	3.79	4.86	2.77	47.09
Varanasi	7.76	6.58	7.48	7.69	5.64	6.51	18.03	7.05	5.82	8.18	7.81	6.98	95.53
Buxar	0.72	0.84	0.77	0.10	1.39	3.76	6.66	5.27	5.86	22.45	12.89	3.68	64.39
Ballia	0.27	1.03	1.01	1.23	1.75	5.44	1.71	1.36	2.34	4.74	17.47	11.73	50.08
Patna	8.36	11.64	13.82	10.00	9.63	10.53	11.21	7.59	6.19	7.66	12.82	8.91	118.36
Total	19.29	22.63	27.56	23.50	22.98	38.50	38.69	21.57	23.99	46.82	55.85	34.07	375.45
						River Yamuna							
Agra	2.82	3.37	4.48	10.71	8.13	7.41	5.99	0.99	2.04	4.25	3.85	2.46	56.50
Sadiapur	11.78	16.13	21.87	14.52	11.25	9.82	22.83	12.58	15.51	21.81	16.23	13.74	188.07
Total	14.60	19.50	26.35	25.23	19.38	17.23	28.82	13.57	17.55	26.06	20.08	16.20	244.57
Grand Total	33.89	42.13	53.91	48.73	42.36	55.73	67.51	35.14	41.54	72.88	75.93	50.27	620.02

Table 8.

Species-wise annual landings (in metric tonnes) at the assembly centres

Centre	C. mrigala	C. catla	L. rohita	L. calbasu	M. aor	M. seenghala	W. attu	R. rita	H. ilisha	Miscellaneous	Total
					River Ganga						
Kanpur	8.95	3.03	5.90	1.12	4.37	2.75	7.74	0.26	-	12.97	47.09
Varanasi	0.93	2.13	1.70	0.22	11.95	5.74	1.37	9.59	22.93	38.97	95.53
Buxar	0.17	1.36	0.72	0.04	1.64	0.47	0.05	0.11	48.85	10.98	64.39
Ballia	0.64	2.40	1.26	0.17	1.88	1.65	0.41	0.26	33.09	8.32	50.08
Patna	5.69	4.53	7.43	0.57	11.32	4.72	2.88	0.09	10.30	70.83	118.36
Total	16.38	13.45	17.01	2.12	31.16	15.33	12.45	10.31	115.17	142.07	375.45
%	4.36	3.58	4.53	0.56	8.30	4.08	3.32	2.75	30.68	37.84	100.00
					River Yamuna						
Agra	18.38	2.20	4.08	5.80	5.60	7.36	7.00	1.63	0.01	4.44	56.50
Sadiapur	54.43	14.31	10.90	18.10	20.76	12.11	5.14	3.24	13.64	35.44	188.07
Total	72.81	16.51	14.98	23.90	26.36	19.47	12.14	4.87	13.65	39.88	244.57
%	29.77	6.75	6.12	9.77	10.79	7.96	4.96	1.99	5.58	16.31	100.00
Grand Total	89.19	29.96	31.99	26.02	57.52	34.80	24.59	15.18	128.82	181.95	620.02
%	14.38	4.83	5.16	4.20	9.28	5.61	3.97	2.45	20.78	29.34	100.00

Varanasi : 95.53 tonnes of fishes were landed from the Ganga at Varanasi during 1966 as against 107.8 tonnes during 1965. The landings were maximum during July and minimum during May. Cumulatively, catfishes accounted for as much as 29.99% of the total landings, indicating an increase over the carp landings (5.21%) at this centre.

Buxar : The estimated landing during 1966 were 64.39 tonnes, as against 57.1 tonnes during 1965, showing thereby some improvement in the fishery. Unlike as at Kanpur and Varanasi, the landings in the post-monsoon months (September to November) were heavier than in other months. An all round decrease in the landings of major carps (3.56%) was recorded. The catfishes together accounting for 3.53% of the total landings.

Ballia : 50.08 tonnes of fish were landed at Ballia during the year under report. As at Buxar, but unlike Kanpur and Varanasi, maximum landings were during the post-monsoon months of September to December, while the minimum landings were during January to April. As at Varanasi, catfishes were landed in appreciably larger quantities than the carps. Hilsa constituted the most dominant species, with a landing of 33.09 tonnes.

Patna : The estimated landings during 1966 were 118.36 as against 118.0 tonnes of 1965, indicating a stable fishery. The heaviest landing of the year (13.82 tonnes) was recorded in March. It remained fairly steady from April to July, ranging from 9.63 tonnes to 11.21 tonnes and was of comparatively lower magnitude during August to October. 10.3 tonnes of Hilsa were landed at this centre, as against 10.6 tonnes of the previous year. At this centre also catfishes were landed in larger quantities than the carps.

River Yamuna :

At the two centres on the Yamuna, the estimated landings of fish during the year under review were 244.57 tonnes, as against 287.3 tonnes of the previous year. Unlike as in the Ganga, major carps dominated the Yamuna landings, with a contribution of 52.41% to the total, while catfishes and Hilsa respectively contributed only 25.70% and 5.58% respectively. C. mrigala (29.77%) was the dominant carp, followed by M. aor(10.79%), the dominant catfish.

Centre-wise distribution of the landings

Agra : 56.50 tonnes of fish were landed from the Yamuna at Agra by the commercial fishermen as against 60.3 tonnes during 1965. Heavier landings ranging between 5.99 tonnes to 10.71 tonnes were recorded from April to July, while it was minimum from August to December (0.99 tonnes to 3.48 tonnes). Major carps (53.91%) formed the dominant group, followed by catfishes (38.21%) and miscellaneous fishes (7.86%). C. mrigala was the most dominant carp.

Sadiapur : The estimated landings of fish during the year amounted to 188.07 tonnes, as against 227.0 tonnes in the previous year. The landings were maximum during July (22.83 tonnes) and minimum during June (9.82 tonnes). As at Agra, major carps with a contribution of 51.97% were the dominant group, followed by catfishes (21.93%) and Hilsa (7.25%). Miscellaneous fishes together contributed to as much as 18.84% of the total landings. 13.64 tonnes of Hilsa were landed during the year, as against 40.2 tonnes during 1965.

(ii) Fishery biology of economic species

Cirrhinus mrigala : 16.38 and 72.8 tonnes of mrigal were estimated to have been landed from the Ganga and the Yamuna, as against the respective landings of 19.5 and 69.4 tonnes during the previous year. There was a high degree of agreement between lengths at ages derived from scale studies and those computed by other methods, establishing thereby the validity of different methods for ageing the mrigal (Table 9).

Table 9.

Comparison of mean lengths at various ages as estimated by different methods

Age in years	Lengths at age			Von Bertalanffy's fit (mm)
	Scale method (mm)	Peterson's method(mm)	Probability method(mm)	
I	268.0	260.0	240.0	276.4
II	458.4	470.0	471.0	473.9
III	644.2	600.0	620.0	622.8
IV	736.1	740.0	775.0	732.4
V	816.7	840.0	842.0	815.0
VI	867.1	890.0	898.0	876.8
VII	924.0	920.0	-	923.0
VIII	958.6	940.0	948.0	957.0
IX	-	960.0	-	-

Catla catla : The estimated landings of catla from the Ganga and Yamuna were 13.45 and 16.51 tonnes respectively, as against their respective landings of 8.8 and 18.8 tonnes during 1965. Biometric measurements of individual fish, varying from 125 to 860 mm in length, were recorded and data on the scales and vertebrae of fish measuring from 217 to 1040 mm in length are being processed for ageing the fish.

Labeo rohita : The respective landings from the Ganga and the Yamuna were 17.01 and 14.98 tonnes as against the respective landings of 16.6 and 21.6 tonnes in 1965. Analyses of length frequency data of specimens ranging from 101 to 1020 mm in total length indicated that the commercial fishery at Allahabad was represented by 18 size groups, with modal lengths at 135, 200, 280, 335, 400, 445, 505, 545, 625, 675, 715, 765, 815, 845, 885, 915, 935 and 995 mm. Of these, fish with modal lengths of 135 and 200 mm were landed during September-February, while those with modal lengths of 335 mm and above were landed all through the year, being maximum during the monsoon months.

Labeo calbasu : The respective landings from the Ganga and the Yamuna were 2.12 and 23.90 tonnes, as against the respective landings of 2.6 and 25.2 tonnes during 1965. Ageing of this fish was done through scales and the results obtained are being checked by Peterson's method. Fish length-scale length relationship can be expressed as

Fish length = 97.1 + 6.01 scale length

The fish length at various annuli were back calculated by using Lee's formula. Analysis of length frequency distribution and dissection of polymodal frequency curves on a probability paper, along with the estimated lengths arrived at by scale studies are shown in Table 10.

Table 10.

Age groups	Lengths at ages (mm)		
	Scale method	Peterson's method	Probability paper method
I	158	-	155
II	304	326	290
III	397	385	390
IV	475	476	460
V	549	535	545
VI	616	595	615
VII	670	655	680
VIII	721	745	740

Length-weight relationship for the males and females can be expressed by the following equations :

Log weight = - 5.43687 + 3.23881 log length
Log weight = - 6.22502 + 3.51212 log length

Fecundity of L. calbasu (742 - 880 mm in total length) was estimated to range between 2,30,831 and 24,32,390 ova.

(iii) Studies on primary organic production

Observations towards assessing the comparative organic production of the rivers Ganga and Yamuna, initiated in January 1965, were concluded in May 1966. A gradual rise in the primary organic production values was observed with the onset of summer which could be attributed to the increased photosynthetic activity during the summer months, when the river water remains quite clear and the weather is fair.

(B) Lower sector of the Ganga River System

(i) Landings

The total fish landing from riverine sources at Bhagalpur on the Ganga and Lalgola on the Padma during the year 1966 was estimated to be 86.96 and 12.88 tonnes as against 105.24 and 66.21 tonnes during the preceding year, thereby registering a decline by 17.4 and 80.54% respectively over that of 1965. The main reason for low production at Lalgola was the general decline in the production of almost all species, except W. attu and miscellaneous varieties (Tables 11 & 12).

Table 11.

Month-wise landings (in tonnes) at Bhagalpur and Lalgola centres in 1966

Months	Bhagalpur (on river Ganga)	Lalgola (on river Padma)
January	9.45	0.56
February	7.50	0.44
March	7.56	0.24
April	8.04	0.41
May	10.09	0.79
June	6.33	1.91
July	5.87	1.88
August	4.38	1.52
September	7.27	1.26
October	7.14	1.19
November	6.68	1.35
December	6.65	1.33
Total	86.96	12.88

Table 12.

Species-wise annual landings (in tonnes) at Bhagalpur and Lalgola assembly centres

Species	Bhagalpur	Lalgola
C. mrigala	5.69	-
C. catla	8.98	0.11
L. rohita	8.09	0.05
L. calbasu	0.53	0.01
M. aor	3.36	-
M. seenghala	2.83	0.52
W. attu	3.21	0.51
H. ilisha	3.09	5.75
Miscellaneous	51.18	5.93
Total	86.96	12.88

(ii) Biological investigations

Mystus aor

3.36 tonnes of aor was estimated to have been landed from the Ganga at Bhagalpur as against 3.28 tonnes during the preceding year. The maximum landings of M. aor were recorded during February (0.62 tonnes), followed by March (0.56 tonnes) and April (0.38 tonnes), and the minimum landings during August (0.06 tonnes) and November (0.04 tonnes). Length-weight relationship of the juveniles in the size-range of 16-300 mm (divided into three different groups) was established by the method of least squares and was found to be as under :

Size group	N	Length-weight equation
I 16-70 mm	218	Log W = -1.54874+2.62069 log TL 0.969558
II 71-150 mm	132	Log W = -1.98042+2.86383 log TL 0.97336
III 151-300 mm	162	Log W = -1.67185+3.09072 log TL 0.97600

(iii) Studies on primary organic production

Observations towards assessing the comparative organic production of the rivers Ganga and Yamuna, initiated in January 1965, were concluded in May 1966. A gradual rise in the primary organic production values was observed with the onset of summer which could be attributed to the increased photosynthetic activity during the summer months, when the river water remains quite clear and the weather is fair.

(B) Lower sector of the Ganga River System

(i) Landings

The total fish landing from riverine sources at Bhagalpur on the Ganga and Lalgola on the Padma during the year 1966 was estimated to be 86.96 and 12.88 tonnes as against 105.24 and 66.21 tonnes during the preceding year, thereby registering a decline by 17.4 and 80.54% respectively over that of 1965. The main reason for low production at Lalgola was the general decline in the production of almost all species, except W. attu and miscellaneous varieties (Tables 11 & 12).

Table 11.

Month-wise landings (in tonnes) at Bhagalpur and Lalgola centres in 1966

Months	Bhagalpur (on river Ganga)	Lalgola (on river Padma)
January	9.45	0.56
February	7.50	0.44
March	7.56	0.24
April	8.04	0.41
May	10.09	0.79
June	6.33	1.91
July	5.87	1.88
August	4.38	1.52
September	7.27	1.26
October	7.14	1.19
November	6.68	1.35
December	6.65	1.33
Total	86.96	12.88

A comparison of the values of 'b', between the three size-groups, indicates that the growth rate of the young ones in the size-group III (151-300 mm) is faster than the preceding two groups, so also the growth rate of young ones in group II (71-150 mm) as compared to the growth rate of young ones in group I.

Mystus seenghala

A total of 2.83 tonnes was estimated to have been landed at Bhagalpur, as against 4.3 tonnes in 1965 showing thereby a downward trend. The maximum landing of seenghala was recorded during February (0.29 tonnes), March (0.44 tonnes), May (0.55 tonnes) and September (0.41 tonnes) and were observed to be minimum during August (0.02 tonnes) and November (0.07 tonnes). Detailed studies on the growth of the intra-ovarian eggs of M. seenghala were completed and 10 different stages, depending upon the size of the most mature group of ova, as presented below, were demarcated.

Stage of Maturity

Immature	I	With the mode of the most mature group of ova at 0.132 mm.
Intermediate	II	With the mode of most mature group of ova at 0.276 mm
	III	With the mode of most mature group of ova at 0.420 mm
Maturing (Opaque)	IV	With the mode of most mature group of ova at 0.540 mm
	V	With the mode of most mature group of ova at 0.636 mm
	VI	With the mode of most mature group of ova at 0.780 mm
Mature (translucent	VII	With the mode of most mature group of ova at 0.900 mm
	VIII	With the mode of most mature group of ova at 0.996 mm
Ripe (Oozing)	IX	With the mode of most mature group of ova at 1.190 mm
Spent	X	Ovaries with remnants of disintegrating ova

Studies on the progression of modes revealed that the groups of small ova grow to maturity within the same spawning season, the individuals spawning more than once during the breeding season. Immature ovaries were recorded throughout the year with the majority being encountered during September to November and February. Majority of the mature ovaries were recorded during March - June, the breeding season being March-August. Ovaries in spent condition were available in April, June & July. The availability of large number of early larval stages during the periods also supports the above conclusion.

The relationships between (i) fecundity and length, (ii) fecundity and weight (iii) length of ovary and length of fish (iv) length of testis and length of fish and (v) weight of ovary and the number of ova was found to linear.

The fecundity of the fish (844-1107 mm) weighing 4.082-9.979 kg has been found to range between 38550 and 107094 ova.

Annular ring markings present on the vertebral centra of M. seenghala were examined for age determination of the species. Average back calculated lengths derived at along with the modal values of different age groups derived by Peterson's method are presented in Table 13.

Table 13.

Age group	Average back calculated lengths derived by using ring-markings on vertebral centra	Modal values by Peterson's method
I	330 mm	307 mm
II	428 mm	450 mm
III	557 mm	550 mm
IV	646 mm	670 mm
V	756 mm	770 mm
VI	866 mm	870 mm
VII	944 mm	930 mm
VIII	993 mm	990 mm
IX	1042 mm	105 mm
X	-	1090 mm

(b) Kosi river

The estimated total landing of fish for five months' period viz. January-March and November to December was estimated to be 25.66 tonnes as compared to the total landing of Ganga which has been estimated to be 86.96 tonnes (Table 14).

Table 14.

Species	January	February	March	April to October	November	December	Total
C. mrigala	0.16	0.17	0.34	-	-	0.12	0.79
C. catla	0.24	0.08	0.57	-	0.09	0.23	1.21
L. rohita	0.12	0.10	0.31	-	0.04	0.22	0.79
L. calbasu	0.003	-	0.01	-	-	-	0.01
M. aor	0.19	0.15	0.16	-	0.01	0.18	0.69
M. seenghala	0.40	0.53	0.16	-	0.06	0.18	1.33
W. attu	4.90	2.37	1.57	-	0.52	3.30	12.66
Miscellaneous	2.66	0.94	2.10	-	0.41	2.07	8.18
Total	8.67	4.34	5.22	-	1.13	6.30	25.66

(c) Narbada river

(i) Catch statistics and disposition of fisheries of the Narbada at Hoshangabad

35.90 tonnes of fish were estimated to have been landed, as against 33.78 tonnes of fish in the previous year in a section of river Narbada near Hoshangabad. During the year, carps accounted for 57.8%, catfishes 32.6% and other fishes 9.6% of the total catch. The monthly landings of commercially important fishes are shown in Table 15.

Table 15.

Month-wise landings (in kg) of commercially important species

Months	Tor tor	L.fimbriatus	L.calbasu	M.aor	M.seenghala	W.attu	R.pavimentata	C.marulius	Others	Smoked fish	Exported fish	Monthly landings
Jan. 66	467.3	461.1	125.5	155.0	221.1	105.8	23.7	40.1	218.7	32.8	240.6	2091.5
Feb. 66	640.2	549.7	106.5	133.0	196.1	104.0	49.3	130.7	211.7	92.7	308.0	2521.9
Mar. 66	727.6	559.2	111.0	246.8	394.1	207.0	35.2	168.3	251.1	87.6	455.3	3243.2
Apr. 66	621.4	564.6	115.3	86.6	246.8	164.3	9.7	108.1	191.6	69.3	397.8	2575.5
May 66	670.8	463.5	98.4	40.8	217.4	198.1	12.7	160.3	115.7	158.5	265.3	2401.6
June 66	563.7	596.3	117.9	200.5	272.6	131.0	53.9	161.9	195.5	155.2	411.3	2859.8
July 66	329.7	89.0	83.1	65.7	82.2	55.4	277.0	87.1	425.6	113.8	302.9	1911.6
Aug. 66	203.7	43.6	54.2	74.1	157.5	54.1	157.4	129.3	358.0	65.7	552.9	1850.6
Sept.66	593.5	230.8	84.9	302.9	290.2	252.9	327.1	291.1	476.8	162.0	552.2	3564.5
Oct. 66	812.5	701.8	188.2	528.4	701.9	314.0	200.9	194.5	414.9	184.5	605.1	4846.7
Nov. 66	937.9	930.0	230.6	585.2	703.6	280.0	132.2	28.0	479.0	204.5	956.0	5467.0
Dec. 66	700.3	505.5	93.8	92.3	266.9	49.4	9.8	41.4	204.8	135.8	470.0	2570.0

Tor tor, which was the most dominant species in the carp group, made up about 25.6% of the total annual landings. Age groups II - III (281-400 mm) and IV - V (401-505 mm) of this species contributed 26.4% and 41.6% by weight. This species made up 26.3% and 20.5% respectively in the net and long line fisheries. Labeo fimbriatus, the next dominant species, accounted for 19.2% of the total catch. Age groups IV-V (310-411 mm) and VI-VII (412-520 mm) of this species were the most dominant and accounted for 32.9% and 44.6% respectively by weight in the total catch of this species. The other important species in this group were Labeo calbasu (4.9%); Barbus sarana (2.2%); Labeo dyocheilus (2.1%) and Labeo bata (1.2%); Cirrhinus mrigala, Catla catla, Labeo gonius, and Cirrhinus reba were the other carps which together made up 2.6%.

Catfishes, next in the order of importance, contributed to 32.6% of the annual landings, as against 33.4% in the previous year. Mystus seenghala, the most dominant species in the group, accounted for 12.2% of the total annual catches. 48.2% and 41.9% (by weight) of this species were represented by size groups III (471-650 mm) and IV (651 mm and above). Other dominant species were Mystus aor (7.6%), Wallago attu (6.3%), and Rita pavimentata (5.1%). Rita pavimentata constituted an important fishery during July-September and ranked second (11.4%) in the total catch of the quarter. Age groups VI and above (204 mm and above) of this species were most dominant in the catches and made up 60.1%. It ranked first and contributed 27.2% in long line fishery. The remaining catfishes, namely Clupisoma garua, Ompok bimaculatus and Mystus cavasius together made up 1.4% in the landings.

Miscellaneous group comprising Channa marulius, Mastacembelus armatus and Notopterus notopterus, small fish and prawns made up 9.6% in the total landings.

(ii) Age/size composition of important fisheries

The observations on age/size composition of important fisheries were continued during the year 1966. The percentage composition by weight and estimated number of fish of various age groups were determined in respect of Tor tor, Labeo fimbriatus and Rita pavimentata. In the case of Wallago attu, Mystus seenghala, Mystus aor and Labeo calbasu the entire size range was arbitrarily divided into 4 size groups and the percentage composition by weight and estimated number of fish of various size groups were determined. The estimates are given in Table 16.

Table 16

(a) Age composition

Species	Age group	Length range mm	Percentage by weight	Estimated number
Tor tor	0 - I	100 - 280	7.9	4,881
	II - III	281 - 400	26.4	4,668
	IV - V	401 - 505	41.6	3,367
	VI & above	506 & above	24.1	989
Labeo fimbriatus	0 - I	82 - 208	0.5	232
	II - III	209 - 309	12.1	3,258
	IV - V	310 - 411	32.9	3,592
	VI - VII	412 - 520	44.6	2,443
	VIII & above	521 & above	9.9	270
Rita pavimentata	0 - I	75 - 123	7.2	8,520
	II - III	124 - 163	9.4	3,673
	IV - V	164 - 203	23.3	3,454
	VI & above	204 & above	60.1	2,254

(b) Size composition

Mystus seenghala	I	upto 265	0.4	103
	II	266 - 470	9.5	1,190
	III	471 - 650	48.2	1,382
	IV	651 & above	41.9	509
Mystus aor	I	upto 265	2.4	869
	II	266 - 470	15.3	1,450
	III	471 - 650	58.1	1,070
	IV	651 & above	24.2	239
Wallago attu	I	upto 265	Nil	-
	II	266 - 470	2.6	176
	III	471 - 650	43.4	731
	IV	651 & above	54.0	328
Labeo calbasu	I	upto 165	Nil	-
	II	166 - 320	27.9	1,456
	III	321 - 470	63.5	1,288
	IV	471 & above	8.6	109

(iii) Catch per unit of effort

In order to determine the fluctuations in the relative abundance of fish, the observations on catch per unit of fishing effort mainly in respect of cast net and long line operations were continued in the river stretch under investigations. The estimates are given in Table 17.

Table 17.

Cast Net

	Total gear	No.of hours	Catch per gear per hour
January - March 1966	88	375	0.432
April - June 1966	74	313	0.546
July - September '66	221	872	0.607
October - December '66	202	954	0.476

Dominant species: Labeo fimbriatus : 28.6%; Tor tor: 26.3%; Labeo calbasu : 6.9% and Wallago attu: 6.0%.

Long Lines

January - March 1966	37	319	0.125
April - June 1966	22	169	0.156
July - September'66	171	1,165	0.399
October - December '66	165	1,486	0.176

Dominant species : Rita pavimentata: 27.2%; Tor tor: 20.5%; Clupisoma garua : 10.3% and Wallago attu: 7.2%.

(d) Godavari river

(i) Landings

231.0 tonnes of fishes were estimated to have been landed during the year 1966, as against 245.6 tonnes during 1965, from the stretch under investigation. Prawns, forming the bulk of the catch, contributed 71.5 tonnes (30.95%), followed by major carps with 46.5 tonnes (20.14%), Hilsa with 17.8 tonnes (7.72%) and catfishes with 12.3 tonnes (5.34%). Miscellaneous fishes contributed 82.7 tonnes (35.83%)(Table 18).

Table 18.

Estimated annual fish landings of commercially important species during the year 1966 (in kg) in Zone I, II & III of river Godavari.

Name of the species	Zone I		Zone II		Zone III		Total	%
	landings	%	landings	%	landings	%		
C. mrigala	8722	5.35	8915	28.60	1031	2.78	18668	8.08
L. fimbriatus	6176	3.79	6450	20.69	7199	19.47	19825	8.58
C. catla	1948	1.19	1064	3.41	233	0.63	3245	1.41
L. calbasu	507	0.31	1592	5.10	2693	7.28	4792	2.07
M. seenghala	3753	2.30	1478	4.74	2279	6.16	7510	3.25
W. attu	864	0.53	536	1.71	598	1.61	1998	0.87
S. childrenii	1062	0.65	998	3.20	771	2.08	2831	1.22
H. ilisha	17679	10.85	54	0.17	108	0.29	17841	7.72
Prawns	64225	39.43	2686	8.61	4600	12.44	71511	30.95
Miscellaneous	57947	35.57	7390	23.71	17453	47.21	82790	35.83
Total	162883		31163		36965		231011	

Zone I : Though the year's total landing of 162.9 tonnes was the minimum observed during the period 1963 to 1966, it contributed to 70.56% of the total landing of the river stretch under investigation. The landings were maximum in December (23.3 tonnes) and also during the period from April to June with 19.6 tonnes, 14.4 tonnes and 17.6 tonnes respectively. Due to a general failure in Hilsa fishery, the monsoon fishery was minimum for the year. Prawns were the most dominant contributing 39.43% of the total landing of Zone I and were followed by H. ilisha (10.85%), C. mrigala (5.35%), L. fimbriatus (3.79%). Miscellaneous fishes contributed 35.57%. There was a decline in the landings of all fishes, except that of prawns and miscellaneous fishes.

Zone II : 31.2 tonnes of fish were landed in this zone during the year, as against 42.2 tonnes in 1965 and formed 13.42% of the total landings. The decline was owing to the low catches of all species. Maximum landings of the year were during January to April with 4.9 tonnes, 3.8 tonnes, 5.4 tonnes, and 6.5 tonnes respectively. Dominant landings of this zone were of the major carps C. mrigala (8.9 tonnes), L. fimbriatus (6.5 tonnes), L. calbasu (1.5 tonnes) and C. catla (1.1 tonnes).

Zone III : Landings of this zone were 36.97 tonnes, as against 30.2 tonnes of 1965 and contributed 16.0% of the total landings. Unlike as in other zones, there was no great variation in the monthly landings of this zone, the landings ranging from 2.0 to 4.8 tonnes only. L. fimbriatus (7.2 tonnes) and prawns (4.6 tonnes) formed the mainstay of the fishery of this zone. This zone recorded a rise in its landings from that of 1965 in respect of all the groups.

Jaruguvala (shore seine) contributed the maximum catches (88 tonnes, 38.3%) followed by cast net 49.8 tonnes (21.5%), set-gill 33.9 tonnes (14.7%) and large seine 20.0 tonnes (21.5%). The landings of drift-gill nets (74 tonnes, 64%) showed a heavy decline due to operational hazards owing to flood fluctuations. Drag net landed 9.2 tonnes (4.0%), while miscellaneous gear landed 7.3 tonnes (3.2%). It needs to be noted that rangoon net and long line are becoming obsolete. The month-wise estimated fish landings for different type of gears in the Godavari river are presented in Table 19.

Though the total observed effort during 1966 in gill-net was doubled as compared to the effort and catch/man/hour of 1965, the catch/man/hour declined from 0.1076 kg to 0.0893 kg; the effort and catch/man/hour in shore seine (Jaruguvala) remained unchanged, while in case of large seine (Alivivala) there was some rise in effort and considerable decline in catch/man/hour from 0.3482 to 0.2716 kg. Similar changes, as in the Alivivala, were noted in case of long lines, drag nets and miscellaneous nets. In case of cast nets, the effort was found to have declined while the catch/man/hour remained stable. The

Table 19.

Month-wise estimated fish landings (in kg) for different types of gear for the year 1966 in the river Godavari

Month	Gill nets				Stake-net (Kattu-vala)	Seines		Drag net (Konte-vala)	Cast-net	Long-line	Misc-ella-neous	Total
	Nylon set gill	Drag gill (Benduvala)	Nylon drift gill	Rangoon net		Shore seine (Jarugu-vala)	Large seine (Alivi-vala)					
1966												
January	4992	436	-	-	-	8615	1651	150	1237	254	317	17652
February	2720	317	-	-	-	12314	472	349	3329	41	177	19718
March	3633	130	-	-	-	9399	1354	383	5096	-	869	20864
April	4356	91	-	-	-	15408	2343	529	7691	-	457	30875
May	2784	-	-	-	-	7348	899	1299	7213	-	424	19967
June	3981	93	-	-	-	10786	1059	2198	5830	-	537	24484
July	1313	-	1398	-	-	4104	2142	1569	6404	-	743	17673
August	696	-	10656	220	-	142	308	19	2226	34	1030	15331
September	510	-	2369	13	919	70	234	196	1959	111	419	6800
October	1761	400	400	-	2547	-	3652	877	2708	419	113	12877
November	2555	788	-	-	120	5284	3963	539	2689	123	1115	17176
December	4639	173	-	-	35	15110	2013	1137	3379	-	1108	27594
Total	33940	2428	14823	233	3621	88580	20090	9245	49761	982	7308	231011
%	14.69	1.05	6.40	0.10	1.56	38.34	8.69	4.00	21.54	0.43	3.16	

annual observed effort combined for all the gear and all the zones, recorded a rise of 16000 man hours while the catch/man/hour recorded a decline from 0.2459 kg to 0.1909 kg. Observed effort in the sampling centres, combined for all the centres and months, and the catch resulting therefrom are shown in Table 20.

Table 20.

	Total observed effort (hours)	Total observed catch (kg)	Catch/man/hour
Nylon -set gill	47390	4234.2	0.0893
Drift-gill	21985	2066.1	0.0939
Benduvala (drag gill)	1913	374.9	0.1959
Jaruguvala	14827	5142.7	0.3468
Alivivala	13849	3762.57	0.2716
Kontevala	6240	1338.93	0.2145
Cast-net	17566	4481.61	0.2551
Edasavala	2828	594.5	0.2102
Long-lines	2148	132.40	0.0616
Miscellaneous nets	5405	1361.87	0.2519

(ii) Fishery biology of economic species

Labeo fimbriatus : The fishery was composed of 1st to 7th year groups, with the 4th year group having a landing of 6.6 tonnes (33.0%) being the most dominant in all the zones and especially in Zone II. During the post-spawning months of October-December, fresh recruits of the year were observed to have modal lengths at 70-90 mm, while the first year fish were obtained with modal lengths of 110, 130, 150, 170, 190 and 210 mm during January to September. The 2nd year group with modal lengths of 230 mm, 250 mm, 290 mm, 310 mm and 330 mm was present from January to May and October to December and the 3rd year, at modal lengths of 350 mm, 370 mm, 390 mm and 410 mm during all the months. The age groups 4 to 7 could not be sampled properly at the fish landing sites. Fishes with maturity stages I-III were observed in Zone I and as the distribution of the species progressed upstream the stage of maturity increased, with fully ripe females being encountered in Zone III near Bhadrachalam, Dummagudem and beyond. The total mortality coefficient during the

year was 0.2829, as against 0.2886 of 1965. The percentage mortality between 2nd to 3rd year was 65%, 3rd to 4th 26%, 4th to 5th 74% and 5th to 6th 75%. While the mortality rate in the last two groups was identical to that of 1965, that of 2nd to 3rd year had increased.

Cirrhinus mrigala : In the commercial fishery, mrigal was represented by 1 to 8th year groups. The catches of 8th year group were negligible, while the 1st year group was landed from Zone I only. The distribution of all age-groups in Zone III was very negligible. The dominant age-group in the total fishery was 5th year group, with a landing of 5646 kg (30.2%), followed by 6th & 4th year groups with 3907 kg (20.9%) and 3267 kg (17.5%) respectively. The total mortality coefficient for the year was 0.2468, which showed a rise from that 1965 when it was 0.2074.

Mystus seenghala : This species was represented in the fishery by the age-groups 1 to 7. The dominant age-groups in the fishery were 4th, 5th and 6th, with respective landings of 1520 kg (20.2%), 1198 kg (15.9%) and 1178 kg (15.6%). The distribution of all age groups was greater in Zone I and III, although the 4th to 8th year age groups were present in Zone II also. The fish-of-the-year with a modal length at 60 mm entered the fishery in July and September. The first year fish at modal lengths of 100 mm, 140 mm, 180 mm and 260 mm were present during all the months, confirming the observations on prolonged breeding and prolonged recruitment. The second year fish at modal lengths of 300 mm, 340 mm and 380 mm were also seen in all the months. The 3rd year fish at lengths of 420 mm and 460 mm, 4th year at 500 mm and 580 mm; 5th year at 620 mm, 6th year at 660 and 700 mm and 7th year fish at 780 mm entered the fishery only during the main breeding months of January to April and from July to October. The 6th and 7th year fish were seen in November and December also.

During April to June, 50% of the fish were mature. The fecundity to total length relation can be expressed as :

$$\text{Log } F = -4.6044 + 2.1841 \log L$$

Analysis of gut contents showed preponderance of barbels, carp-minnows, prawn and mysids in winter and summer months and carp fry, spratelloids and insects in monsoon months.

The total mortality coefficient for the year was 0.4465, which showed a rise over that of 1965 when it was 0.4427. The percentage mortality was greater in the age-groups 2 to 3, 4 to 5 and 6 to 7. The percentage mortality between 4th & 5th & 6th age groups was relatively higher than that during 1964-65 in the corresponding age-groups.

Metapenaeus malcolmsonii : The fishable biomass during January to June in the Sub-area I was 0.1801 during 1966, being relatively higher than that of 1965 when it was 0.1603, indicating a recovery in the total population. The biomass was greater in sub-area I than in sub-area II, during January to June than during July to December. The total yield from the sub-areas I & II was 72.0 tonnes.

In Sub-area I, the size distribution in the population showed a greater prevalence of size-groups within the length range of 50-100 mm and weighing 120-150 individuals per pound, followed by the size groups 101-130 mm, weighing 18-30 individuals per pound.

The male to female ratio in the post-spawning months of November and December and in the pre-spawning months of January to May was 8.2. However, the reverse ratio occurred from June onwards with males declining and females increasing in number during the spawning months of July to September. Berried individuals were the most abundant in July but the second peak of their abundance in September was absent during this year and the spawning activities also ceased very early by October, unlike as in previous years.

S. childrenii : The landings of this species were estimated to be 2.8 tonnes, contributing to 1.2% of the total landings. The modal lengths, as revealed by length-frequency distribution, were as under :

Age groups	1	2	3	4	5	6
January-March 1966	140	220	-	-	-	-
April -June	140	-	340	-	460	-
July -September	100	-	300	420	500	-
October-December	180	-	300	420	-	540

A study of the food and feeding habits indicated predation by the 1st year age-group on the fry of major carps and on spratelloid fish while the 1st to 3rd year age-groups preyed on juvenile prawn, carp minnows and spratelloids.

Water temperature and dissolved oxygen were recorded at two stations at Rajahmundry for the entire year. The temperature ranged from 28.9° - 30.8° C during January-March; 28.4° to 36.9° C from April to June, 28.8 to 30.2° C during July-September and 27.4 - 29.4° C from October to December. The dissolved oxygen was nominal from January to March in both surface and bottom waters and slowly increased from April to June and reached its maximum from October to December.

The dominant constituent of plankton at the two stations during January-March was Spirogyra, followed by copepods, blue-green algae, diatoms and miscellaneous groups. However, Sprirogyra was almost completely absent from April to June. Macro-zooplankton, with a great number of spratelloids and their larvae, copepods, mysids, carp fry etc. dominated from July to September while Spirogyra again dominated from October to December. The total biomass was greatest during July to September, followed by October-December and January-March, minimum biomass being in the peak summer months of April to June.

2. Fisheries of the estuaries

Hooghly estuarine system

(i) Landings

The total catch during the year was 6766.3 tonnes as against 6516.1 tonnes of last year, 78.4% of the catch having being landed in Zone III (Table 21). The major species contributing to the catch were H. nehereus, H. ilisha, P. pama, T. jella and S. biauritus (Table 22). While the landings for prawns, P. pama, S. biauritus, S. cinereus, S. miles, T. jella, C. borneensis and I. elongata increased considerably, a decline in the catches of H. nehereus, H. ilisha, C. ramcarati and M. parsia was noticed. The maximum contribution as a single species in Zone I was that of H. ilisha, followed by P. pangasius. In Zones II & III, major contributing species was H. nehereus, followed by H. ilisha. In Zone IV again, the landings of H. ilisha were the heaviest followed by C. borneensis. The landings of H. nehereus followed by C. ramcarati occupied the first and second position respectively in Zone V.

Table 21.

Zonewise estimates of catch (in tonnes)
March, 1966 - February, 1967

	Zones	Total catch	Percentage in total catch
I	Nabadwip to Calcutta	777.3	11.5
II	Calcutta to Diamond Harbour	136.1	2.0
III	Lower Sundarbans	5308.0	78.4
IV	Rupnarayan	383.0	5.7
V	Port-Canning	161.9	2.4
	Total	6766.3	100.0

Table 22.

Specieswise catches (in kg):Hooghly-Matla Estuary. March 1966 to February '67

	Species	Total catch	Percentage in the total catch
1.	M. tade	7584	0.1
2.	M. parsia	48870	0.7
3.	L. calcarifer	20859	0.3
4.	S. panijus	26256	0.4
5.	P. paradiseus	40107	0.6
6.	P. indicus	84791	1.3
7.	E. teradactylum	21425	0.3
8.	S. biauritus	156489	2.3
9.	S. miles	30907	0.5
10.	P. pama	361064	5.3
11.	H. ilisha	799189	11.8
12.	H. toli	11790	0.2
13.	I. elongata	99815	1.5
14.	C. ramcarati	86005	1.3

contd.....

contd....Table 22.

Species	Total catch	Percentage in the total catch
15. C. borneensis	31906	0.5
16. S. phasa	*	*
17. S. taty	385814	5.7
18. P. pangasius	58299	0.9
19. T. jella	313354	4.6
20. O. militaris	12944	0.2
21. P. canius	10280	0.1
22. T. savala	*	*
23. T. haumela	156319	2.3
24. H. nehereus	1327934	19.6
25. S. cinereus	29809	0.4
26. Prawns	1049495	15.5
Miscellaneous	1595033	23.6
Total	6766338	100.0

* The figures relate to the combined total S. phasa, S. taty, T. savala and T. haumela respectively.

As usual bagnets were the major contributors followed by large seines, small seines and others (Table 23). The maximum catches of bagnets in Zone III were during September-November, while that of large seines during December-February. The catch during the winter months in Zone III around Fraserganj by bagnets amounted to 1773 tonnes as against 1840 tonnes of last year, the decline being due to the fall in the catches of T. haumela and T. savala, which was partially compensated by the increase in catches of S. biauritus (Table 24).

(ii) Analysis of commercial catches

The total catch as well as the percentage contribution of H. nehereus showed a decline during the year. H. nehereus ranging from 41 - 320 mm, with modes at 69.5 (0-year), 95.5 (0-year), 175.5 (I-year), 240.5 (II-year) and 289.5 mm (III-year) were represented in the fishery. All the specimens observed were immature. The catches of S. panijus increased over that of last year. The specimens ranged from 21 - 330 mm, with modes at 46.5 (0-year), 115.5 (I-year), 175.5 (II-year), 230.5 (III-year) and 280.5 mm (IV-year). During May, females (282-290 mm) from the samples of Zone I were observed to be in the III stage of

Table 23.

Gearwise quarterly catches (in kg)
Hooghly-Matla Estuary

March 1966 - February 1967

Gears	March-May	June-August	September-November	December February	Total	%
1. Trawl	4808	-	64345	92457	161610	2.4
2. a) Large seine	13919	15585	128648	783002	941154	13.9
b) Small seine	67721	54735	132100	637506	892062	13.2
3. Purse	1831	1989	9263	11748	25521	0.4
4. Drift	4852	37409	67333	144409	253703	3.7
5. Lift	8568	4440	17470	23373	53851	0.8
6. Cast	4094	4649	5955	1337	16035	0.2
7. Bag	368786	319960	1840913	1158754	3688413	54.5
8. Set-gill	3027	16593	48130	93566	161316	2.4
9. Set-barrier	29140	30859	64961	39575	164535	2.4
10. Traps	-	12128	11346	-	23474	0.4
11. Hooks & Lines	11665	22274	157681	92484	284104	4.2
12. Unknown & Unclassified	38095	22427	17147	22891	100560	1.5
Total	556506	543048	2565982	3100802	6766338	100.00

Table 24.

Specieswise quarterly catches (in kg) by bagnets at migratory winter fishing camps in Zone III (Lower Sundarbans).

Hooghly-Matla Estuary

Species	September-November	December-February	Total catch	Percentage in the total catch
1. M. tade	-	-	-	-
2. M. parsia	-	2	2	**
3. L. calcarifer	-	-	-	-
4. S. panijus	1190	946	2136	0.1
5. P. paradiseus	1869	2896	4765	0.3
6. P. indicus	-	410	410	**
7. E. tetradactylum	187	58	245	**
8. S. biauritus	95764	35627	131391	7.4
9. S. miles	1768	3174	4942	0.3
10. P. pama	1346	673	2019	0.1
11. H. ilisha	-	60	60	**
12. H. toli	70	285	355	**
13. I. elongata	13793	5000	18793	1.1
14. C. ramcarati	1003	700	1703	0.1
15. C. borneensis	193	-	193	**
16. S. phasa	52979*	64972*	117951*	6.7*
17. S. taty				
18. P. pangasius	252	-	252	**
19. T. jella	-	-	-	-
20. O. militaris	1602	7508	9110	0.5
21. P. canius	-	-	-	-
22. T. savala	33303*	51656*	84959	4.8
23. T. pantulai (T. haumela)				
24. H. nehereus	582291	261873	844164	47.6
25. S. cinereus	-	152	152	**
26. Prawns	80047	62017	142064	8.0
Miscellaneous	213708	193711	407419	23.0
Total	1081365	691720	1773085	100.0

** Indicates less than 0.05%.

* Figures relate to the combined total of S. phasa & S. taty and T. savala & T. haumela respectively.

maturity. T. savala ranged in size from 32-174 mm (V.L.), with modes at 78 and 123 mm. While T. pantulai (reported earlier as T. haumela) ranged in size from 45-204 mm (V.L.) with modes at 60 and 125 mm. Specimens of E. tetradactylum ranging in size from 30 - 409 mm showed two modes at 110 and 250 mm. The catch of P. indicus decreased during the year and the specimens ranged in size from 90 - 430 mm (F.L.), with one mode at 160 mm. The catch of S. miles, ranging in size from 15 to 175 mm with a mode at 65 mm increased considerably during the year. A decrease in the catch of M. parsia, ranging in size from 15.5 - 215.5 mm with modes at 49.5 (0-year), 90.5 (I-year), 123.5 (II-year) and 160.5 mm (III-year) was observed during the year. Smaller individuals belonging to 0-year groups were available throughout the year, probably indicating a prolonged breeding season. Females (125.5-215.5 mm) in the III & IV stages of maturity were observed during December to February in Zone III.

(iii) Hydrobiological studies

The salinity and water temperature conditions of the estuary showed a slight increase both in salinity and surface water temperature than last year, the former ranging from traces to 34.7 ppt and the latter 19.5 - 33.0° C.

The general downward trend in total plankton production observed in previous years continued during the year, but with occasional spurts. Diatoms were the main constituents of the phytoplankton and were represented in Zone I by Melosira granulata, Coscinodiscus granii, Synedra ulna, Nitzschia sp. and Surirella sp. Other algal forms were Spirogyra sp., Microcystis sp., Oscillatoria sp. and Anabaena sp. In Zone IV, while the diatoms were represented by C. granii, S. ulna, Nitzschia sp., Lithodesmium sp. and Biddulphia sp., the dominant algae were Spirogyra spp., Microcystis sp., Pediastrum sp. and Oscillatoria sp. In Zone V, Chaetoceros sp., E. mobiliansis, Skeletonema costatum, Lithodesmium sp., Thalassiothrix sp., C. granii and Coscinossira sp. were the dominant diatoms, algal forms being almost absent. Copepods and nauplii larvae were dominant among the zooplankters, followed by cladocerans. Rotifers were represented in Zone I & IV. The plankton production decreased during the monsoon months but recovered thereafter.

(iv) Studies on larval abundance

A general decline in the larval catches over that of last year was observed. Pama pama larvae being less abundant than that of H. ilisha. The yolked larvae of P. pama (4-5 mm) appeared in the catches in July at Anantpur (Zone IV) but were absent during August and September. Reappearing in October, these showed a peak abundance during January when larvae measuring 8-10 mm were caught in the tow nets.

4. Fisheries of freshwater lakes

Tungabhadra reservoir

(i) Production

The total estimated yield from the reservoir during the year was 183.1 tonnes as against 244 tonnes in 1965-'66. The catches were considerably high from April to July 1966 (3.1-9.3 tonnes) due to low water level of the reservoir, and operation of the shore seines. The declining trend of catches (0.9-1.5 tonnes) during post monsoon months was due to flooded condition of the reservoir. The operation of alivi in the months of January to March contributed better catches (2.3-13.1 tonnes). The species-wise percentage composition of alivi catches are shown in Table 25.

In general, catfishes dominated over carps, the former accounting for 64.8% and the latter 33.8% of the total catches, the miscellaneous group, however, forming 1.3%. Amongst carps, P. kolus continued to be the dominant species constituting 15.1% of the total fishery, next in order of abundance were L. fimbriatus (6.5%), O. vigorsii (3.5%), C. catla (2.4%) and L. calbasu (2.1%). Among catfishes W. attu, M. aor, S. childrenii, M. seenghala, and M. cavasius accounted for 19.0%, 17.7%, 10.6%, 8.2%, 3.1% respectively of the total catches (Table 26).

Table 25.

Monthwise size ranges and composition of alivi net catches in April, May 1966 and January-February 1967 (based on actual examination)

Species	1966						1967					
	APRIL			MAY			JANUARY			FEBRUARY		
	Size range (mm)	Wt.(kg)	%	Size range (mm)	Wt.(kg)	%	Size range (mm)	Wt.(kg)	%	Size range (mm)	Wt.(kg)	%
1	2	3	4	5	6	7	8	9	10	11	12	13
. kolus	140-225	1.640	0.2	126-300	6.750	0.7	96-326	1.160	0.8	68-296	3.585	10.6
. dobsoni	145-148	0.060	-	-	-	-	73-222	3.000	2.1	65-412	1.800	5.3
. sarana	135	0.050	-	116-280	42.200	4.4	95-133	3.700	2.5	-	-	-
. amphibius	-	-	-	-	-	-	68-096	0.500	0.4	-	-	-
. fimbriatus	-	-	-	242-465	2.000	0.2	88-362	13.440	9.2	90-145	1.400	4.2
. calbasu	150	0.050	-	137-250	0.700	-	-	-	-	-	-	-
. potail	150	0.080	-	-	-	-	111-126	0.100	0.1	-	-	-
. porcellus	-	-	-	85-160	0.200	-	-	-	-	-	-	-
. catla	-	-	-	-	-	-	198-306	5.494	3.8	-	-	-
. reba	150-250	1.200	0.2	106-246	12.900	1.3	83-209	13.000	8.9	80-260	5.500	16.2
. vigorsii	62-155	93.500	15.6	65-285	54.800	5.7	53-228	17.100	11.7	75-280	7.800	23.0
. cotio	81-160	1.000	0.2	-	-	-	-	-	-	-	-	-
. seenghala	-	-	-	335-798	73.330	7.6	220-622	6.716	4.6	220-626	2.820	8.3
. aor	187-600	30.360	5.1	366-560	71.900	15.7	22-583	22.760	15.6	310-470	5.150	15.2
. attu	430-815	25.620	4.3	216-930	150.500	15.7	200-580	17.250	11.8	-	-	-
. cavasius	135-245	335.000	55.8	121-280	215.000	22.4	133-265	10.200	7.0	110-210	1.000	2.9
. childrenii	360-480	18.900	3.1	250-467	216.800	22.5	138-335	6.450	4.4	226-422	1.000	2.9
. taakree	186-310	30.000	5.0	110-250	31.200	3.3	95-226	18.200	12.5	95-180	1.400	4.1
. bimaculatus	185-310	30.000	5.0	114-355	62.000	6.6	170-283	1.300	0.9	120-145	1.000	2.9
. punctatus	300-412	5.000	0.8	-	-	-	-	-	-	-	-	-
. pavimentata	-	-	-	100-250	0.700	-	170-186	0.190	0.1	-	-	-
. hastata	-	-	-	-	-	-	72-120	0.500	0.4	-	-	-
. marulius	225-710	8.000	1.3	-	-	-	-	-	-	-	-	-
xygaster spp.	-	-	-	116-186	7.500	0.8	62-208	2.400	1.6	85-110	1.000	2.9
notopterus	108-260	13.000	2.1	-	-	-	-	-	-	-	-	-
. ranga	41-56	2.000	0.3	-	-	-	53-090	2.250	1.6	25-045	0.500	1.5
thers	-	5.000	0.8	-	10.000	1.0	-	-	-	-	-	-
		600.450	100.0		559.500	100.0		145.710	100.0		33.955	100.0

Table 26.

Percentage composition of commercial species at Hospet Fish Market during 1966-67

Species	Estimated total weight	Percentage
P. kolus	8888.694	15.1
P. dobsoni	679.203	1.2
P. pulchellus	86.876	0.2
P. sarana	546.633	0.9
Tor spp.	669.618	1.1
L. fimbriatus	3839.992	6.5
L. calbasu	1251.321	2.1
L. pangusia	8.866	-
L. potail	88.516	0.2
L. rohita	169.459	0.3
L. porcellus	0.589	-
C. catla	1421.818	2.4
C. mrigala	180.594	0.3
C. reba	8.600	-
O. vigorsii	2087.134	3.5
	19927.810	33.8
M. seenghala	4832.558	8.2
M. aor	10433.402	17.7
M. punctatus	528.600	0.9
W. attu	11173.601	19.0
B. bagarius	558.282	1.0
S. childrenii	6258.186	10.6
P. taakree	865.084	1.5
O. bimaculatus	1570.547	2.7
M. cavasius	1804.166	3.1
O. pabo	0.806	0.1
	38059.204	64.8
C. striatus	69.988	0.1
C. marulius	13.292	-
N. notopterus	18.697	-
M. armatus	6.050	-
G. giuris	0.434	-
Miscellaneous	719.125	1.2
	827.586	1.3
Grand Total	58814.600	99.9

Though the occurrence of gangetic major carps was very poor, the fishery of C. catla improved considerably and accounted for (2.4%), L. rohita (0.3%) and C. mrigala (0.3%) still accounting for a very small percentage in the commercial catches. During the year 1966-'67, the total number, size ranges and total weight of each of the three forms recorded are as follows :

Species	Nos.	Length range (mm)	Total weight (kg)
C. catla	311	150 - 1110	351.855
L. rohita	38	120 - 898	41.160
C. mrigala	41	286 - 730	33.195

(ii) Fishing success

Experimental fishing was conducted with surface, bottom, and hobbled gill nets for 2306 net-days landing a total quantity of 720.540 kg of fish, the average catch/net day being 0.312 kg. The catch/net day was the highest in the bottom set nets (0.352 kg), followed by the hobbled gill nets (0.311 kg) and surface nets (0.278 kg) (Table 27). During the first quarter (April-June) the nets were operated in Zone I and IV. Zone I with 0.536 kg/net day proved richer than Zone IV with 0.250 kg/net-day. In the third quarter (September-December) the nets were operated in all the zones. Zone II (0.389 kg/net day) and Zone III (368 kg/net day) were richer than Zone I (0.312 kg/net day) and Zone IV (0.185 kg/net day). In the fourth quarter (January-March) the nets were operated in II and IV zones. Zone II proved richer (0.500 kg/net day) than Zone IV (0.124 kg/net day).

30-50 mm bar mesh continued to be more efficient in gilling fishes than 60-80 mm and 90-120 mm bar mesh ranges. The catch/net day for various gear with different meshes as obtained in the different zones are shown in Table 28.

An analyses of the percentage species composition of fishes by weight in various nets in different zones showed that the carps predominated (55.2-97.3%) over catfishes in the surface nets in all the zones in all quarters excepting the second quarter wherein they were poorly represented in Zone I (10.9%) and Zone IV (31.63%) (Table 29). However, in bottom-set nets,

Table 27.

Zonewise & Gearwise catch per net day in the experimental fishing nets during April 1966-March 1967

Nets	Zones	ZONE I		ZONE II		ZONE III		ZONE IV			Total	Average
	Quarters	2	3	3	4	3	1	2	3	4	No. of net days / Catch in kg	Catch/net day(kg)
Surface	No. of net days	91	36	54	25	36	216	175	271	132	1036	
	Catch in kg	48.840	6.670	14.470	16.205	8.910	90.805	50.855	40.325	10.190	287.700	0.278
Bottom	No. of net days	Not	26	54	25	36	216	150	271	132	920	
	Catch in kg	operated	13.660	21.220	9.680	15.430	177.710	26.245	40.455	19.380	323.780	0.352
Hobbled	No. of net days	"	6	16	25	6	Not	76	85	145	350	
	Catch in kg		4.010	12.250	11.670	4.400	operated	23.110	32.200	21.420	109.060	0.311
Total	Net days	91	78	124	75	78	432	400	627	409	2306	
	Catch in kg	48.840	24.340	48.210	37.555	28.740	268.578	100.210	112.980	50.990	720.540	0.312
Catch/net-day in kg		0.536	0.312	0.389	0.500	0.368	0.621	0.250	0.180	0.124	-	-

Table 28.

Gear efficiency for surface, bottom and hobbled gill nets for the period April '66 to March '67

Mesh bar (mm)	30	40	45	50	60	65	70	80	90-120	Grand Total
A: SURFACE GILL NETS										
Average Total Catch/net day	0.612 / 9	4.829 / 9	2.294 / 5	3.972 / 9	1.456 / 8	0.386 / 1	1.693 / 8	0.202 / 4	0.400 / 4	142 / 1036
Catch/Unit area(sq.m.)/ net day	0.623	0.536	0.459	0.441	0.182	0.386	0.210	0.050	0.100	-
B: BOTTOM GILL NETS										
Average Total Catch/net day	6.018 / 8	4.998 / 8	1.923 / 5	5.277 / 8	2.629 / 8	0.275 / 1	1.726 / 8	1.169 / 4	1.039 / 6	129 / 920
Catch/Unit area (sq m)/ net day	0.752	0.625	0.385	0.659	0.328	0.275	0.216	0.292	0.173	-
C: HOBBLED GILL NETS										
Average Total Catch/net day	3.658 / 7	3.469 / 7	-	3.441 / 7	0.992 / 4	0.993 / 3	-	-	-	92 / 358
Catch/Unit are(sq m)/ net day	0.552	0.496	-	0.491	0.248	0.331	-	-	-	-

Table 29.

Percentage composition of fishes by weight caught in the experimental fishing nets during April 1966-March 1967

Type of net	Zone	Quarters*	Species														
			P. kolus	P. dobsoni	P. sarana	P. tor	L. fimbriatus	L. calbasu	L. bata	L. rohita	L. potail	C. catla	C. mrigala	C. reba	O. vigorsii	Miscellaneous (Minor Carps)
Surface nets	I	2	1.5	-	0.4	-	-	0.2	-	-	-	-	-	-	7.3	1.5
		3	65.8	-	9.1	-	-	-	-	-	-	-	-	-	9.5	-
	II	3	21.3	-	12.6	-	24.2	13.8	-	-	-	-	-	-	8.7	1.9
		4	35.3	9.8	3.6	-	5.8	9.0	-	-	-	24.2	3.9	-	5.7	-
	III	3	8.1	-	5.4	-	28.0	4.4	-	-	-	11.4	-	-	7.1	-
	IV	1	19.9	1.4	18.3	4.5	9.1	0.8	0.5	0.1	-	5.8	-	-	19.8	1.9
		2	9.3	-	0.8	-	2.0	1.7	0.6	-	1.1	12.2	-	0.4	3.3	0.2
		3	23.0	-	3.8	0.5	1.1	1.6	3.5	-	0.5	10.7	28.9	-	5.5	-
		4	3.6	5.0	0.6	-	-	-	14.3	-	2.0	17.2	-	-	12.5	3.0
Bottom nets	I	3	45.6	-	1.6	-	-	-	-	-	-	-	-	-	2.0	-
	II	3	11.1	4.8	4.3	-	22.9	19.7	-	-	-	-	-	-	5.9	-
		4	28.8	-	-	-	12.2	14.2	-	-	-	2.2	-	-	28.7	-
	III	3	13.4	-	2.9	-	20.8	3.4	-	2.8	2.2	1.0	-	-	16.8	-
	IV	1	22.9	1.8	10.5	0.4	11.4	1.0	0.4	-	-	0.5	0.1	-	21.3	1.5
		2	13.4	-	0.6	-	1.8	-	-	-	0.6	8.6	-	-	2.1	-
		3	15.6	-	0.7	10.8	3.2	2.8	-	-	0.7	0.5	-	-	6.8	-
		4	1.4	-	4.0	-	2.1	17.5	9.1	-	-	2.8	-	-	18.5	0.3
Hobbled nets	I	3	72.9	-	7.7	-	7.7	-	-	-	-	-	-	-	4.0	-
	II	3	29.8	-	12.2	-	8.6	8.6	-	-	-	-	3.2	-	8.6	0.7
		4	7.3	-	-	-	12.8	9.7	-	-	-	-	-	-	13.4	-
	III	3	12.6	-	6.7	-	33.8	-	-	-	-	0.7	-	-	20.7	-
	IV	2	24.0	-	0.4	-	2.8	-	-	-	4.6	0.8	-	-	5.2	0.5
		3	20.4	-	0.5	-	21.4	11.4	0.5	-	0.7	-	-	-	3.3	-
		4	2.5	-	0.7	6.8	-	11.1	0.7	-	-	1.5	-	-	13.6	-

contd.....

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Type of net	Zone	Quarters *	M. aor	M. seenghala	M. punctatus	S. childrenii	W. attu	R. pavimentata	P. taakree	N. notopterus	O. bimaculatus	Miscellaneous (Catfishes)	Total No. of fish
			SPECIES										
Surface nets	I	2	13.9	-	-	70.1	1.4	-	2.3	-	1.4	-	124
		3	-	7.1	-	-	1.2	4.5	0.9	1.9	-	-	30
	II	3	-	-	-	17.0	-	-	0.5	-	-	-	49
		4	-	-	-	0.1	1.2	-	1.1	-	-	-	67
	III	3	-	-	-	8.6	26.4	-	-	-	-	0.6	30
	IV	1	0.9	0.3	-	3.8	3.1	0.5	3.7	-	0.3	0.3	486
		2	1.0	-	-	63.1	2.6	-	1.4	-	-	-	117
		3	4.7	-	-	9.0	-	1.5	4.9	-	0.5	0.3	109
		4	7.1	6.9	-	-	13.2	-	14.6	-	-	-	41
Bottom nets	I	3	6.8	-	2.0	11.7	28.0	-	-	2.3	-	-	36
	II	3	8.5	5.5	-	6.8	10.4	9.1	1.0	-	-	-	58
		4	5.3	-	-	-	-	-	-	-	8.6	-	42
	III	3	8.4	-	-	9.6	11.5	2.3	4.9	-	-	-	50
	IV	1	6.5	1.8	-	14.1	1.7	0.6	2.3	-	0.3	0.2	728
		2	-	-	-	63.4	-	8.1	1.4	-	0.3	-	68
		3	4.6	1.7	-	12.7	3.9	34.2	1.4	-	0.4	-	122
		4	14.8	-	-	1.8	21.2	2.3	4.0	-	-	-	64
Hobbled nets	I	3	-	-	-	7.7	-	-	-	-	-	-	16
	II	3	12.2	-	-	1.7	-	12.2	2.2	-	-	-	49
		4	-	30.0	-	8.2	1.6	14.9	-	-	2.1	-	30
	III	3	-	-	-	17.2	1.4	-	-	-	-	0.9	24
	IV	2	2.2	-	-	51.8	-	6.6	0.9	-	-	0.1	74
		3	1.4	3.0	-	7.9	9.9	18.7	0.9	-	-	-	82
		4	27.4	5.6	-	6.6	17.8	1.5	3.8	1.0	0.4	-	54

* Quarters are 1st quarter - April-June 1966
2nd " - July -September 1966
3rd " - October-December 1966
4th " - January-February 1967

the carps predominated (55.4-86.1%) in Zones II and III throughout the year whearas in Zones I and IV, the catfishes predominated (50.8-72.9%) in general except during the first quarter in Zone II where the catfishes were poorly represented (27.8%). The hobbled nets operated from the second quarter revealed a dominance of carps (58.2-92.3%) during the third quarter in all the zones. The catfishes dominated in Zone II (56.8%) during the fourth quarter, and in Zone IV during the second (61.6%) and the fourth quarters (63.1%).

(iii) Limnological studies

The reservoir level, reduced considerably during the summers, showed different physical features than the other quarters. Increased turbulences due to wind and rain between June and August caused a high turbidity (380-700 ppm), at some centres like Mudalighatti and Hampasagar it was as high as 1000-2000 ppm. pH varied from 8.2-8.4.

Faunal studies conducted from April-December, '66 showed that the littoral fauna consisted of 82,000 units/40,000 gm/ha unlike the bottom fauna which comprised 17,80,000 units/ 25,200 gm/ha (wet weight). The littoral fauna of the reservoir in general showed predominance of insects (37.6%) by numbers and of fishes (35.2%) by weight. The Transitional Zone (Zone II) was the richest in respect of littoral fauna both by numbers (45.4%) and by weight (38.6%) followed by the Shallow Zone (Zone III) recording 23.0% by numbers and 27.2% by weight. Bivalves (43.2%) predominated the bottom fauna of the reservoir by numbers and gastropods (43.7%) by weight. Zone I (Riverine) was the richest (40.6%) in numbers, followed by Zone III (21.6%) and II and IV (18.9% each).

Studies on the plankton of the reservoir during April-December, 1966 showed the predominance of zoo- over phytoplankton (1.6:1). Zooplankton forming 62% of the plankton by numbers comprised mainly copepods (30.6%), rotifers (14.0%), protozoans (10.7%) and cladocerans (6.7%). Myxophyceae (19.0%) formed the most dominant group of the phytoplankton. Zones IV and III with 45.7 and 32.0% of the zoo- and 24.0 and 26.0% of the phytoplankton of the entire reservoir were the first and second in respect of plankton abundance. While Zones I (60.0%) and II (56.2%) were rich in phytoplankton in terms of the zonal plankton content, Zones III (66.7%) and IV (76.1%) were rich in zooplankton.

(iv) Biological studies

The analysis of food of young fishes showed significant differences in the composition of the food of the adult and juveniles. The juveniles of P. kolus were found to feed on copepods (23.2%), insects (19.6%), cladocerans (3.0%) and ostracods (2.7%), detritus, however, accounting for 34.8%. While the adults of P. dobsoni revealed a dominance of Chara, Hydrilla and Vallisneria, the juveniles preferred to feed on detritus (32.2%) insects (19.3%), cladocerans (7.2%) and copepods (3.7%). No difference was observed in the gut contents of the adult and juvenile L. fimbriatus, mud (49.6%), detritus (24.6%), bacillariophyceae (16.8%) and chlorophyceae (1.8%) being the main food items. The food of L. porcellus was similar to that of L. fimbriatus, detritus (31.8%), mud (30.0%), bacillariophyceae (23.9%) and chlorophyceae (5.0%) being the main constituents of the gut contents. Unlike the adults which subsisted on fishes and insects, the juveniles of O. vigorsii mostly fed on insects (20.0%), ostracods (16.5%), copepods (11.8%), cladocerans (10.6%) besides fish (11.2%) and detritus (25.6%). A study of the food of the juveniles of O. cotio, P. stigma, P. ticto, A. morar, Oxygaster spp., R. daniconius, A. ranga and B. barila also indicated detritus to be the most predominant item followed by copepods, insects, diatoms, cladocerans, algae, mud etc.

A study of the fecundity of S. childrenii (510-555 mm), O. bimaculatus (285-314 mm), & R. pavimentata (308-376 mm) showed it to range from 1,12,156-1,19,584, 5,400-13,051 and 1,010-10,450 respectively. W. attu and M. aor at an average length of 711 and 655 mm showed respectively a fecundity of 31,808 and 15,532. Of the carps, the fecundity of L. bata (140-241 mm), P. sarana (201-245 mm), P. kolus (240-410 mm) and O. vigorsii was found to range from 16,848-18,579, 7,252-11,280, 3,667-35,693 and 2,310-41,280 respectively. C. reba showed the highest fecundity of 76,470 at an average length of 260 mm.

With a view to explore the natural fish seed resources of important fishes and also to assess the extent of recruitment of fish population into the reservoir, spawn collections were made at the Mudalighatti centre for a period of 45 days. The species composition of the eggs and larvae collected at this centre on rearing was found to be L. porcellus (61.2%), L. fimbriatus (8.5%), Oxygaster spp. (6.0%), C. reba (5.9%), O. bimaculatus (5.0%), P. taakree (4.6%), P. kolus (2.1%), M. punctatus (1.8%), O. vigorsii (0.9%), L. bata (0.6%), Puntius spp. (0.4%) and others (3.0%).

10,776 fishes (catla, rohu, mrigal and C. carpio) ranging in size from 100-240 mm were tagged and released in the different zones of the reservoir during October and November, 1966 in cooperation with the Tungbhadra Fisheries Board. There have been only isolated recoveries.

The availability of the juveniles of catla (C. catla) during September-December, 1966 indicates the probability of the species having acclimatised and bred in the vicinity of the reservoir. However, this needs to be further substantiated by the collection of eggs, larvae and fingerlings from the reservoir.

A preliminary survey of the 800 acre Loni reservoir in Madhya Pradesh was made with a view to drawing up of a suitable research programme.

5. Fisheries of brackishwater lakes

(a) Chilka lake

(i) Fish production

The total fish production from the lake from April '66 to March '67 was estimated to be 3728 tonnes, comprising 60.20% fishes and 39.80% prawns.

Among fishes, the mullets contributed 17.44%, catfishes 9.95%, clupeids 9.39%, perches 6.24%, sciaenids 6.15%, threadfins 4.28%, beloniforms 0.19% and miscellaneous fishes 3.2%. M. cephalus, forming 9.51% (354.52 tonnes) of the total catch, was the most dominant species and ranged in size from 50-775 mm though 225-425 mm specimens formed the bulk of the catch. L. macrolepis, ranging in size from 100-700 mm, formed 6.31% (235.3 tonnes) of the total catch. H. ilisha (125-550 mm) formed 2.46% (91.85 tonnes) of the total catches with 275-425 mm specimens dominating and contributing to about 75% of the catch. While the central sector contributed to the bulk of the catches of M. cephalus (354.5 tonnes), the northern sector contributed to the bulk of the catches of L. macrolepis (151.4 tonnes) and H. ilisha (77.1 tonnes). The southern sector recorded a heavy landing of N. nasus (87.30 tonnes) which formed 4.24% (158 tonnes) of the total catches from the lake, the specimens ranging from 120-210 mm forming 85.1% of the catch. The bulk of the fishery of M. gulio (60-230 mm), E. tetradactylum (100-900 mm), E. suratensis (60-255 mm) and P. coibor (175-900 mm) was contributed by the northern sector, the respective landings being 267.1 tonnes (7.16%), 159.71 tonnes (4.28%), 41.95 tonnes (1.13%) and 229.62 tonnes (6.15%).

L. calcarifer (225-1225 mm) and G. setifer (45-210 mm) formed a good fishery in the central sector and comprised 3.62% (134.90 tonnes) and 0.77% (28.93 tonnes).

Prawn fisheries of the lake is dealt with under Section III, 10.

(ii) Hydrographical studies

The air and water temperature ranged from 16° .5-29°.5 C and 21°.0-31°.0 C for the main lake and 16°.0-31°.5 C and 20.0-31°. 0 C for the outer channel area respectively. The depth, transparency, pH, DO, free CO2, total alkalinity, salinity, phosphates, nitrates, silicates and ferric iron ranged from 21.0-234.0 cm, 19.5-128.0 cm, 7.5-8.8, 6.3-12.5 ppm, nil-13.0 ppm, 48.5-108.5 ppm, 1.47-33.82‰ , 0.04-0.07 ppm, 0.05-0.08 ppm, 2.0-5.5 ppm and 0.002-0.004 ppm respectively for the main lake and 100.0-433.0 cm, 24.0-207.0 cm, 8.0-8.7, 8.2-10.5 ppm, nil-3.0 ppm, 78.9-116.4 ppm, 4.62-34.52‰ , 0.04-0.06 ppm, 0.03-0.07 ppm 1.5-5.0 ppm and traces to 0.004 ppm respectively for the outer channel area.

(b) Pulicat lake

(i) Fish production

The total fish production (986 tonnes) recorded a decrease of 15.92% over that of last year as a result of the fall in the catches of mullets, catfishes and crabs. Maximum landings were recorded during May-July (311 tonnes) and February-March (219 tonnes). While prawns formed the major catch (52.57%) followed by mullets (20.73%) for the whole lake, the mullets dominated the catches in the northern zone followed by prawns, clupeids and perches. The average catch/acre in the northern and southern zones was 4.79 and 75.35 kg respectively. Of the gear employed in the lake, Suthuvalai landed the maximum catches followed by kondavalai, badivalai, kattuvalai, panthavalai and oivalai.

(ii) Fishery and biological studies

For 'prawns fisheries' of the lake, please refer to Section III, 10.

Amongst fishes, M. cephalus was the most dominant species and contributed greatly during April, June-July, December and March, the dominant size group being 206-425 mm. Fish length-scale radius relation was found to be $L = 6.042\ R^{0.9449}$ or $R = 0.1136\ L^{1.099}$. On the basis of length frequency and scale studies, the lengths at ages 1 to 3 years were found to be 290, 390 and 480 mm respectively and L_∞ was calculated to be 750 mm. The length-weight relationship could be expressed by $W = 2.483 \times 10^{-5} L^{2.844}$. The fish were found to be mature from November onwards with an average fecundity of 2.72-3.84 million eggs. Ova diameter studies have revealed a prolonged breeding season for the species. It was observed that the recruitment to the fishery started in January with a mode at 70 mm.

About 57.74% of the catches of L. macrolepis, which was abundant during August and December-February, were immature and were mainly caught by siruvalai and kondavalai, the dominant size group being 141-265 mm. The length-weight relationship for males, females and juveniles respectively could be expressed as

(i) $W = 24.89 \times 10^{-6} L^{2.8285}$
(ii) $W = 68.39 \times 10^{-6} L^{2.7943}$
(iii) $W = 14.45 \times 10^{-6} L^{2.9443}$

The size at first maturity was found to 145 and 216 mm for males and females respectively. Studies on sex ratio revealed a female predominance in the northern zone with an increasing number of males towards the lake mouth indicating probably the earlier migration of the males to the sea. Ova diameter measurements indicated two modes at 78 and 449 μ. The fecundity of the specimens ranging from 261-323 mm was found to vary from 45×10^4 to 65×10^4 eggs.

Maximum catches of M. parsia were landed during May-August and November, the dominant size group being 136-190 mm. The specimens caught near lake mouth were mature and with empty

stomachs. The length-weight relationship of the males, females and juveniles respectively could be expressed as

(i) $W = 23.02 \times 10^{-6} L^{2.8497}$

(ii) $W = 18.65 \times 10^{-6} L^{2.9005}$

(iii) $W = 15.74 \times 10^{-6} L^{2.9355}$

The size at first maturity was 140 and 143 mm for males and females respectively. Sex ratio studies revealed the predominance of males towards the lake mouth. Two modes at 78 and 499 µ were observed during ova diameter studies. Fecundity was found to range from 83 x 10^3- 334 x 10^3 eggs for specimens measuring 143-241 mm.

Spemimens of S. sihama, mainly 171-265 mm in size and most abundant during May, July-August, December-February, were caught mainly by hook and line. The food of the fry (21-30 mm) was found to be copepod nauplii, amphipods and small bivalves and while the juveniles (41-120 mm) fed on polychaetes, amphipods, copepods, hermit crabs, mysids, gastropods, other crustaceans, the adults subsisted mainly on polychaetes, mysids, gastropods and hermit crabs. Polychaetes formed 62.2% of the diet of adults from the southern zone, 33.4% in the northern zone, 12% in the Adyar and ennore backwaters and 6% in the sea. Young gobeids and crustaceans formed 38.8% of the food of the adults in the northern zone and 7% in the southern. Four modes at 115 (0-year), 159(I-year), 222(II-year) and 280 mm (III-year) were observed. Specimens from the sea were heavier than those from lake, throughout the size range observed. The length-weight relationship could be expressed as

Lake Log W = -5.6176438 + 3.19138414 log L.
Sea Log W = -4.47623800 + 2.76344300 log L.

Size at maturity for males and females was 178 and 208 mm respectively. Sex ratio showed a male predominance towards the sea. Fully mature individuals were encountered during June-September and December-March (peaks in August and December) in the southern zone. The fry (10-30 mm) was available at lake-mouth and Dhonirevukuppam during October, January and February.

The dominant size of G. oyena ranged between 116 - 200 mm. The food in general consisted of polychaetes, bivalves, gastropods, amphipods and hermit crabs, while the guts of fishes from the sea had a predominance of bivalves (90.85%). Seven modes at 52.5, 73.0, 120.0, 162.0, 200.0, 245.0 and 275.0 mm were observed. An average growth rate of 12.5 mm/month was indicated by modal progression. Length-weight relationship could be expressed by $W = 0.9471 \times 10^{-5} L^{3.0919}$. Males and females were 120 and 155 mm respectively at the time of first maturity. Generally, females outnumbered males. Mature males were available during May, June and August while females during July to September, a high gonadosomatic index during July-September indicating the spawning season. Post-larvae (8-20 mm) entered the lake during November-March. Ova attained the largest size by September; the fecundity was found to vary from 4.65×10^5 - 14.43×10^5 ova for fishes ranging in size from 226-282 mm.

G. filamentosus, with the dominant size group ranging from 76-130 mm subsisted mainly on amphipods, bivalves, polychaetes, ostracods and other crustaceans and exhibited five modes at 56, 99, 146, 185 and 211 mm. The length-weight relationship expressed by $W = 0.112 \times 10^{-4} L^{3.0404}$. Few specimens from lake were mature. Bimodal nature of ova diameter frequency at 196 and 315 μ indicated more than one spawning. Juveniles measuring 45 mm and above were found in February.

N. nasus was abundantly available from July-March with the dominant size group ranging from 96-200 mm. It subsisted on detritus, diatoms, algae, foraminiferans, crustaceans and gastropods. Two modes at 125 and 195 mm were observed. Length-weight relationship was established as log W = -5.20081731 + 3.10596411 log L. Size at first maturity was about 110 mm. Females outnumbered males, mature ones being noticed during April, August and September. Post-larvae were encountered during July at Annamalaicheri and in February near the lighthouse. C. chanos were found to be abundant during April-June and September-November, the dominant size being 51-285 mm. However, the fry of chanos entered the lake from late March onwards.

(iii) Studies on fish eggs, larvae and juveniles

The distribution and period of availability of fish eggs and larvae of the economically important fishes was as shown below :-

Species	Locality	Period of occurrence
Thrissocles sp	Lake-mouth, Northern zone (abundant at Pulinjeri)	March - June, August - October
K. coval	Off Sunnambukulam Northern & Southern zones	April, July-August, November
A. bengalensis	Northern sector (abundant at Pulinjeri)	March, April, June, August
Strongylura strongylura	Northern zone	May - October
Nematolosa nasus	Prolarvae(1.33-1.47mm) Moosamani & Pallapadu	July - August
Chanos chanos	Larvae (9-26 mm) Lake mouth	April- September
Elops saurus	Larvae (15-40 mm) Lake mouth	May-October, January
Sillago sihama	Larvae (10-20 mm) Lake mouth	December-March
Mugil sp	Fry (6-16 mm) Lake mouth	Throughout the year except June & March
Gerres sp	Fry (8-20 mm) Dhonirevu & Lake mouth	November-March

Fish eggs were abundant in the collections made at lake-mouth at night low tide during the full moon period. The larvae on the contrary were abundant at high tide during the full moon period. The variety of larvae entering the lake was, however,

rich at night. The nature of the majority of the eggs in the night collections (with embryonal discs) indicated that they were spawned at night. The only exception being Cynoglossus sp which appeared to spawn during the day.

The post larvae and juveniles of many fishes were comparatively rich in the night collection except those of Chanos chanos which were rich during the day at lake-mouth. They were found relatively rich in the high tide collections. The ingress of the post larvae and juveniles was seasonal in case of some fishes viz., Chanos chanos (April & August), Elops saurus (June, August & October) mullet fry (May and September), Sillago sihama (December), Thrissocles sp (October and March), while in others viz., Ambassis gymnocephalus, the ingress was allround the year. The ingress of post larvae and juveniles was found to have a correlation with the plankton maxima.

(iv) Hydrobiological studies

The surface water temperature, pH, salinity, total alkalinity, DO., phosphates and silicates ranged from 23°.0-31°.3 C, 7.1-8.4, 2.4-39.8‰, 62.0-152.0 ppm, 4.6-11.2 ppm, traces to 0.01 ppm and 0.1-40.0 µg atom/litre respectively in the southern sector and from 24°.0-33°.8 C, 7.1-7.8, 1.0-41.3‰, 56.0-168.0 ppm, 6.6-11.2 ppm, 0.005-0.01 ppm and 3.0-28.0 µg atom/litre respectively in the northern sector of the lake.

Diatoms which dominated the phytoplankton were represented by Rhizosolenia, Chaetoceros, Coscinodiscus, Biddulphia, Asterionella, Thallasiothrix, Thallasionema, Nitzschia, Ditylum, Bacteriastrum and Streptotheca while Ceratium, Peridinium and Dinophysis represented the dinoflagellates. Several freshwater planktonic forms were observed during early November due to the discharge of the River Araniyar into the lake, represented by Pediastrum, Microcystis, Pandorina, Oscillatoria, Synedra, Spirogyra and Euglena. Copepods, represented by calonoid and a few cyclopoid genera, were dominant among the zooplankters. Longipedia, Microsetella, Euterpina and Metis represented the harpacticoids, while the copepods were represented by

Acartia, Acaritella, Labidocera, Calanopia, Acrocalanus, Corycaeus and Oithona. Copepod and nauplii larvae were generally present. Gastropod and lamellibranch larvae were observed during July-September and January-March. Ctenophores, chaetognaths, mysids, Noctiluca and other crustacean larvae occured sporadically. Acartia spinicauda was the dominant copepod drom April to July, Acrocalanus and Calanopia elliptica from August-October, and Acartiella southwelli and Acartia chilkensis from November to February.

(c) Adyar estuary & ennore backwaters

Hydrobiological studies of the Adyar estuary and Ennore backwaters were also conducted. Water temperature, salinity, pH, total alkalinity, D.O., inorganic phosphates and silicates in the Adyar estuary were found to range from 23°.0-32°.9 C, 0.3-30.0‰, 6.9-7.9, 83-304 ppm, 1.6-14.8 ppm, 0.005-0.050 ppm and traces to 55.0 µg atom/litre respectively. Microcystis, Scenedesmus, Oscillatoria, Merismopedia, Asterionella, Coscinodiscus, Campylodiscus and Skeletonema were the common phytoplankters, the latter five genera being available only during October-March. Zooplankton was generally poor, a single rotifer species, Brachionus rubens, being abundant during most of the months.

Water temperature, salinity, pH, total alkalinity, D.O., phosphates and silicates of Ennore backwaters ranged from 23°.5-29°.6 C, 0.24-33.5‰, 6.9-7.8, 90-238 ppm, 4.2-11.6 ppm, 0.001-0.010 ppm and 2.0-50.0 µg atom/litre respectively. Coscinodiscus, Oscillatoria, Lyngbya, Anabaena, Synedra, Ditylum and Skeletonema represented the common phyto-plankters. During November and December freshwater genera like Spirogyra, Pediastrum and Microcystis were also recorded. Oithona was the common form amongst zooplankters during July-September. However, freshwater forms such as Brachionus angularis, B. falcatus, Keratella tropica, Polyarthra sp and Lecane were observed during the north-east monsoon, while from January onwards marine forms like Euterpina, Oithona, Cyttarocyclis and nauplii were again dominant.

6. Exploratory fishing in Sunderbans

The departmental fishing vessel Sunderbans made eleven cruises during the year 1966-67 for conducting gill netting in the lower and upper reaches of the Hooghly estuary. Of the cruises made, two were in the upper reaches of the Hooghly river from Bally bridge to Balagarh, two in the Rupnarain river and the rest in the Saptamukhi and Thakuran distributaries and in the Frazergunj, Haldia and Diamond Harbour areas. In all, seventy five days were spent in fishing as compared to thirty nine days in the previous year.

Bottom set gill nets (length, 200 fathoms; mesh size 2½"-7"), made of nylon yarn (code No. 5-7), were operated in a combination of different mesh sizes using cement sinkers (1 kg each) and round polythene floats and ½" thick Manila rope as head and foot rope. The distance between sinkers attached to the foot rope of the nets was 3 fathoms while the floats were tied at intervals of 2 fathoms. Drift gill net (600 fathoms; 2½"-6"; code No.2) operations were conducted using both cement sinkers (1 kg each) and burnt clay sinkers (500 gm each). The manila rope used as head rope and foot rope was ¼" in diameter. The distance between sinkers in the rigged nets was 5 fathoms in case of cement sinkers and 3 fathoms when burnt clay sinkers were used. Polythene floats were tied at intervals of 2 fathoms on the float line or head rope.

A total of 504 hrs. 5 mts. were spent in gill netting and a total catch of 1806.710 kg of fish was obtained. The dominant species in the catches from the lower estuary comprised sharks, Hilsa ilisha, H. sinensis, P. argenteus, C. dorab, S. guttatus, M. talabon and cat fishes.

7. Hilsa fisheries

(a) Ganga river system

(i) Landings

The landings of Hilsa during the year at five selected assembly centres on the Ganga (115.17 tonnes) and two on the Yamuna (13.65 tonnes) was estimated to be 128.82 tonnes as against 108.21 tonnes and 62.5 tonnes during 1965 and 1964 respectively. At Lalgola on river Padma, 5.75 tonnes of Hilsa were estimated to have been landed. Compared to the estimated production during the preceding year, Hilsa landing in 1966 registered an increase of 50.5 tonnes in the total landings in the upper sector of Ganga due to improved fishing at Buxar and partly due to the inclusion of Ballia assembly centre.

At Bhagalpur, a decline of 10.17% was registered when compared to Hilsa landing of the previous year. River Yamuna also showed a decline in the Hilsa fishery. At Lalgola, the tremendous decline of 90.78% was due to extremely low yields during the monsoon season. Both at Bhagalpur on river Ganga and Lalgola on river Padma, the mean size of Hilsa exhibited a continuous decline from 1963 through 1966.

(ii) Delimitation of the spawning grounds

Intensive collections were made in the Ganga river system between Allahabad and Ballia. The observations towards delimiting the breeding grounds of Hilsa ilisha revealed the occurrence of Hilsa larvae in the entire stretch, except between Ghauspur and Gahmar. Three spawning areas were noticed in the Mirzapur belt, the first one between Chunarghat and Barapatharghat, the second in the vicinity of Keotali and the third between Puranebada and Narasinghpur. In the Varanasi belt there appear to be four major spawning areas, the first between Seyahadghat and Kundaghat, the second between Bijaipuraghat and Sarsoval, the third in the vicinity of Newlight and the fourth between Chota Mirzapur and Gangpur. The important spawning area in the Ghazipur belt were observed to be in the stretch between Bhagirathpur and Tarighat, and the Korahatpur stretch. And lastly, in the Buxar-Ballia belt the spawning areas appeared to be between Ballia and Rudrapur and in the vicinity of Buxar.

In the river Yamuna, the spawning area was observed to be between Mohobatganj and Arail. However, the maximum concentration appeared to be in the vicinity of the Naini bridge.

(iii) Fishery biological investigations

Ganga river system

Upper sector .

Based on the length frequency data the estimated landings from the river Ganga and Yamuna were dissected out and group-wise landings from both the rivers during different months were estimated. It was found that the catches in both the rivers were dominated by size group II, followed by size group III, corresponding to fish in 2-2½ years of age. It has further been observed that larger specimens of Hilsa were available mostly during monsoon and winter months.

With a view to studying the age and growth of Hilsa in the upper stretch of the Ganga river system, length frequency data collected from different centres were analysed. An analysis of the length-frequency data collected at Sadiapur showed three prominent modes in January, first at 295 mm, second at 335 mm and third at 385 mm, representing the fish in 2nd and 3rd year in age. While the first mode could be traced throughout the year, and showed an annual growth of 90 mm, the other two modes, however, could not be traced in subsequent months. In February a new mode was observed at a median length of 205 mm. This mode could be traced upto October, when it attained a median length of 335 mm, showing a growth of 130 mm during a period of 9 months. During May, another two modes were observed at 145 and 215 mm. Though the first mode could not be traced any further, the second could be traced upto December, when it attained a median length of 335 mm, showing a total increment of 120 mm in length during the 8 months.

The length frequency data collected at Buxar centre were also analysed and during January 1966 two prominent modes were noticed in the catches, first at 340 mm and second at 380 mm, representing the fish in the third year of age. The first mode at 340 mm could not be traced during February, but reappeared in March at a median length of 360 mm showing a growth of 20 mm. This mode could not be traced subsequently. The second mode at 380 mm was traceable upto October at a median length of 490 mm, showing a growth of 110 mm in 10 months' time. In the month of August a new mode at a median length of 310 mm was observed. This mode could be traced upto October, when it attained a median length of 350 mm showing a growth of 20 mm in 3 months' time.

The age and growth studies were further substantiated with the aid of otoliths and the average number of rings observed in them and the length of fish were as follows :

Length range in mm	Centres	
	Allahabad (Average No. of rings)	Varanasi (Average No. of rings)
- 200	2	2
201 - 320	4	4
321 - 385	4	4
386 - 465	5	5
466 - 505	6	6
506 - 525	-	7

Lower sector

Hilsa ilisha ranging in total length from 41 - 540 mm were available in the commercial fish landings at Bhagalpur fish assembly centre. The length frequency analysis of 2,256 fish revealed the presence of following modal groups :

Group	Modal size (in mm)
1	75
2	285
3	355
4	405
5	455
6	495

Compared with the modal values for the year 1965, it was observed that while in the preceding year the juveniles were represented by two modal values at 35 and 95 mm, they presented a single modal value at 75 mm during the year under report. The adult fish were also represented by a new set of modal values compared to those of 1965. The bulk of the catch comprised of second size group and concentrated around the modal point at 285 mm. The strength of the later modal values was considerably lower.

In river Padma, fish ranging from 26 to 520 mm were available during the year and analysis of the length frequency distribution for a total sample size of 3,836 fish indicated the presence of the following modes :

Group	Modal size (in mm)
1	65,175
2	205
3	235
4	265
5	295
6	335
7	375
8	465

When compared to 1965, it was observed that modal values at 205, 265, 335, 375 and 465 mm were maintained through this year while two new modes represented by 235 and 295 mm appreared during the year and the mode at 505 mm disappeared.

The length-weight relationship of the adult fish (184-522 mm) belonging to the three subpopulations available in Bhagalpur sector of the Ganga, segregated with the help of discriminant scores, was estimated by the method of least squares and the results obtained are as follows :

"Slender" variety :

$$\text{Log Wt.} = -5.06462 + 2.99954 \log \text{T.L.}$$
$$r = 0.96343$$

"Broad" variety :

$$\text{Log Wt.} = -4.97604 + 3.00218 \log \text{T.L.}$$
$$r = 0.96846$$

"Broader" variety :

$$\text{Log Wt.} = -5.12753 + 3.09097 \log \text{T.L.}$$
$$r = 0.98041$$

The average weights of different subpopulations of fish of identical size are being tested statistically to find out whether the differences observed among them are significant.

Studies on the maturity of different subpopulations of Hilsa were conducted by obtaining samples from the 45 mile stretch of the river Ganga between Sultanganj and Pirpainti. It was observed that while the 'slender' and 'broad' varieties breed during the monsoon . months ('slender' variety from June to September, 'broad' variety between July and October), the fully mature females of 'broader' variety were available during the winter season between January and March and again during late monsoon and post-monsoon months between August and November. The monthwise average gonado-somatic index for female fish of different subpopulations also corroborated this finding.

Size-specific fecundity of maturing and mature fish indicated a distinct difference in the total fecundity between individual subpopulations. While the fecundity of "slender" variety ranged from 1.15 - 7.00 lakhs, that of "broad" variety from 3.5-12.0 lakhs and of the "broader" variety from 4.5-17.00 lakhs. Analysis of the data on comparative size-specific fecundity of these three subpopulations is under way to test whether the difference is significant.

The monthly pattern of intermingling between the three subpopulations in a 45-mile stretch between Sultanganj and Pirpainti of Ganga river system was estimated. The results are presented in Table 30.

Table 30.

Months	Slender	Broad	Broader
January	53.16	34.18	12.66
February	40.48	33.33	26.19
March	60.00	21.25	18.75
April	66.67	15.00	18.33
May	50.98	33.33	15.69
June	73.08	15.38	11.54
July	72.34	14.90	12.76
August	33.33	40.00	26.67
September	59.26	33.33	7.41
October	46.55	34.48	18.97
November	25.00	47.50	27.50
December	41.67	40.83	17.50

The data presented above indicated the dominance of the "slender" variety throughout the year, excepting the months of August and November.

(b) Godavari river system

17.84 tonnes of Hilsa were estimated to have been landed during the year, as against 46.3 tonnes during 1965.

The decline in Hilsa fishery below the anicuts at Dowleishwaram was probably due to high fluctuations and short durations of flood, having a direct effect both on the operation of drift nets and on the countinuity of sufficient water level for upward migration of the species. In Zone I the maximum landings were observed in August (10.8 tonnes), followed by September (3.3 tonnes), October (2.8 tonnes), July (0.6 tonnes) and June (0.02 tonnes). The group-wise landing (in kg) is given below:

Age Group	Zone I	Zone II	Zone III	Total	%
1	119	4	1	124	0.6
2	3	-	-	3	0.1
3	2667	12	9	2688	15.0
4	11502	38	98	11	
5	3388	-	-		

During the period from January to June and November to December, the landings were from the lacustrine Zones I to III and mostly comprised of juveniles. The recuruits entered commercial fishery during February and March with modal lengths at 62.5 and 112.5 mm. The total mortality coefficient calculated for the year 1965-66 was +1.1353 as against -1.0128 of 1964-65. The value was maximum in the age-groups IV to V. The values between the age groups are as under:

	III/IV	IV/V	Mean
1965-66	-0.3083	2.5789	+1.1353

Drift-gill, stake-net (Urakavala), Rangoon net accounted for the catches of Hilsa. Drift gill landed 2066 kg, stake net 739 kg and Rangoon net 34 kg. While the total observed effort expanded in drift gill net and stake net was greater than that of 1965, the catch and catch/man/hour had declined by 50%.

Studies of the length frequency distribution of Godavari Hilsa showed a greater occurrence of the smaller age-group in the monsoon fishery, unlike the previous years. The juvenile fishery occurred from April onwards during 1966 with modal lengths at 136.5 and 212.5 mm.

The total mortality coefficient between the age-groups 3 to 4 and 4 to 5 were :

	III/IV	IV/V	Mean
1965-66	-0.3083	2.5789	+1.1353

An analysis of gut contents indicated full feeding conditions in the juveniles of the lacustrine zone during February-March. The predominant food items were rotifers (Keratella spp), copepods, Sprirogyra, cladocerans, diatoms and debris. In the adults except for mucus, no food items were observed.

(c) Hooghly estuary

The total landing of H. ilisha from the Hooghly during 1966-67 amounted to 799.2 tonnes as against 887.8 tonnes during 1965-66, accounting for 11.8% of the total catch from the estuary.

Hilsa larvae (5-6 mm) were available in the estuary at Uchitpur and Medgachi (Zone I) from May onwards with a peak abundance during the monsoon months (July-August), the maximum size of the larvae being 14 mm. Hilsa larvae were not available at Khusigoli this year. 7-11 mm larvae were available during October, the winter peak. However, 5-6 mm larvae were available throughout the year though only a few in numbers. Again, hilsa larvae were absent in the Rupnarain (Zone IV).

8. Tank fisheries

Limnological studies in a tank and there village ponds were undertaken during the period under report.

(i) Hutchammankere tank

The Hutchammankere tank (3 acres in water spread area), exhibited significantly productive qualities, the nutrients being in fairly good concentrations (Nitrate - 0.196-0.256 mg/l; silicate - 11.1-13.9 mg/l and iron - 0.956-3.92 mg/l). The presence of rich electrolytic character due mainly to dissolved salts was responsible for greater specific conductivity values (160-575 x 10^{-6} mhos at 25°C), while temperature ranging from 22.8°-30.8°C provided optimum conditions for rich diatom growth. Utilization of available silicate by these diatoms kept silica at less than 14 mg/l (described as optimum by various workers). Increased temperature during summer months (February-May '66) exhibited an inverse relation with total alkalinity. This was probably due to the breaking up of bicarbonate ions into carbon-dioxide which in turn was utilised by phytoplankton and weed for enhanced photosynthetic activity as reflected by the increased range of dissolved oxygen (6.48-10.32 mg/l).

Turbidity normally remaining at less than 100 mg/l increased to 120 mg/l during December 66 due to incursion of rain water. Iron exhibited a positive direct relationship with turbidity. Iron in the presence of adequate oxygen remained in ferric state which readily formed ferric complexes with phosphorus. The non-detection of phosphorus in the tank was also due to the formation of calcium phosphate (calcium values in soil were between 1000-2000 lb /acre). The acidic (pH 6.2-6.8) nature of soil held back phosphorus.

Nitrate fluctuated between 0.196 and 0.256 mg/l. The increased values of nitrate between October and December were probably due to the oxidation of ammonia as a result of organic decomposition at the bottom, nitrite brought into the tank being oxidised and non-utilisation of nitrate by zooplankton.

In the soil phase, phosphate was not detected while potassium (40 lb/acre) & magnesium (80 lb/acre) were present in low and moderate quantities respectively. Decomposition at the bottom resulted in high ammonia values (100 lb/acre).

Zooplankton dominated over phytoplankton during April-July, September and December, '66. Phytoplankton comprised Myxophyceae (26.74%), Bacillariophyceae (48.3%) and Chlorophyceae (24.92%). Diatoms formed the bulk in peaks in August (2975 units/litre) and October '66 (820 units/litre) while Myxophyceae (Microcystis, Anabaena and Coelosphaerium) contributed to the peak in May (156 units/litre). Diatoms constituted 16.04-96.32% of phytoplankton. Epiphytic diatoms ranged in number from 416563 to 1192428 thousand units on weeds in a single square meter. Spirogyra and Mugeotia were the dominant forms of Chlorophyceae. Rotifers (Keratella, Filinia), Protozoa (Phacus, Astasia, Difflugia, Arcella), Copepoda (Cyclops, Diaptomus with Nauplii), Cladocera (Diaphanosoma, Chydorus, Daphnia, Alona), Ostracoda (Cypris) and Nematodes constituted 39.29, 43.09, 15.21, 2.22, 0.08 and 0.18% respectively of the zooplankton. The subdued presence of phytoplankton indicates the grazing of holophytic phytoplankton by holozoic zooplankton. Utilization of phosphorus by rooted vegetation and the bound state of phosphorus were also responsible for the low density of phytoplankton excluding diatoms. Iron, and nitrate also helped in the abundant growth of diatoms besides silicate. Nitrate exhibited positive correlation with zooplankton.

Molluscs (Melanoides, Viviparus, Gyraulus, Lymnae, Pisidium) - 14.82%, Insects (Corixa, Notonecta, Nepa, Ranatra, Libellula, Tachopteryx, Macronia Coenagnian, Ischnuria, Hexogenia, Caenis, Ceratopogon, Chaoobaus) - 53.18%, Oligochaetes (Stylaria) - 23.15%, Chironomids, forage fishes and prawns (Leander spp.) constituted the littoral biota of the tank. The average density of littoral and benthic biota was 49.7 and 792.98/sq m. Large scale availability of Chironomid larvae and Stylaria indicated the saprobic conditions existing in the tank. Chironomids drifted from the littoral regions into the deeper benthic areas along with the oncoming water during May and June '66 which was reflected by the increased number of chironomids (75.30%, by number) in the bottom biota.

(ii) Kadagrahara pond

Kadagrahara, a perennial pond with a water spread area of 0.4 acres, recorded high turbidity (120-225 mg/l) upto September '66 when owing to entry of clear water, turbidity lowered to less than 100 mg/l from October '66 onwards. Iron

exhibited a direct relation with turbidity both of which increased during the rainy months (Iron - 18.9-2.25 mg/l, Turbidity - 165-225 mg/l between May and September '66). Dissolved oxygen content (5.4-8.64 mg/l) being considerable, Iron remained in ferric state binding phosphorus which was in trace values. While the sub-soil leachings enriched the nutrients of the pond (Nitrate- 0.120-0.224 mg/l; Silicate, 9.0-14.3 mg/l), repeated dilution lowered the values from July onwards.

The pH of the soil varied from 6.6-7.7 with calcium (1000-2000 lb/acre) and magnesium (80 lb/acre) being in moderate concentrations while potassium was in low concentrations (40 lb/acre and less), ammonia concentration was high upto September (50-100 lb/acre) but from October onwards its value lowered to 15-25 lb/acre.

Zooplankton (88.42%) dominated over phytoplankton (11.58%), the latter ranging from 3 units (April '66) to 148 units/l (June '66). While Myxophyceae (Coelosphaerium, Microcystis) occurred in May and November, the diatoms were abundant in December. Zooplankton varying in density from 44-400 units/litre exhibited peaks in April (270 units) and September (400 units). From June onwards, the concentration dwindled due to dilution effected by incoming rain water. Protozoa (Phacus, Paranema, Difflugia), Rotifera (Keratella, Brachionus, Polyarthra), Cladocera (Diaphanosoma, Chydorus), Copepoda (Cyclops, Diaptomus and their nauplii) constituted the zooplankton. As turbidity affected the growth of phytoplankton, it was only in October when the water became clear that phytoplankton increased utilising available phosphorus. In the absence of any detritus formed of decaying vegetation, zooplankton wholly depended on phytoplankton for their sustenance and hence the low production of phytoplankton in the pond.

The pond being devoid of vegetation and with sandy littoral area did not present littoral fauna of any importance except that constituted by Pisidium, Melanoides and Chironomids. Density of littoral and benthic biota collectively ranged from 15.9-400.64 units/sq m. While by numbers the chironomid larvae dominated the biota (53.27%), the molluscs dominated (47.73%) by weight. Dragonfly and damselfly nymphs constituted insects which formed 2.82% of the biota by number and 1.75% by weight. Chironomids formed 11.77%-90.61% of the biota by number, the density of which however thinned away by December.

(iii) Someswara pond

The water spread area of this perennial pond is 0.25 acres. Colloidal mineral suspension was responsible for the slight milky appearance of water in the pond. The temperature and pH ranged from 21.9°C-28.1°C and 7.8-8.5. Turbidity which normally remained less than 100 mg/l, increased from August onwards to 110 mg/l, along with which silica (18.0-20.8 mg/l) and iron (1.0-4.1 mg/l) also registered a rise. High specific conductivity values (319-599 x 10^{-6} mhos) indicated the richness of dissolved solids.

pH of the soil ranged from 7.7-8.5. Potassium (80-160 lb/acre) and ammonia (25 lb/acre) were present in moderate quantities while calcium (6000 lb/acre) was richly present. However, magnesium was observed in low concentrations while phosphorus was present in traces only.

Minimum number of phytoplankton (0.18-39.79% of the total plankton) was encountered in May (3 units) while maximum was observed in November (252 units). Dilution by inflow of rain water resulted in a fall in phytoplankton concentration in August after which with rise in alkalinity value, phytoplankton concentration steadily increased. Chlorophyceae (Oedogonium, Spirogyra) constituted the bulk of phytoplankton peaks in November while Myxophyceae contributed to the peak in July.

Protozoa, Rotifera, Cladocera, and Copepoda formed the dominant zooplankton, which ranged in density from 52 to 1592 units/litre. Continued occurrence of Cladocerans in particular indicated the non-toxicity of ammonia. Indigenous prawns (Leander spp.) formed 56.23% by number of the littoral biota (12.69-279.50 units/sq m), bottom biota (179.38-1892 units/sq m) being richer in density. Molluscs dominated both by weight and by number in the bottom biota. Inpushing of chironomids from the littoral areas to deeper benthic area was reflected by the rise in the number of their larvae.

(iv) Narayanaghatta pond

Narayanaghatta pond, with a water spread area of 0.4 acres, had clear water which became turbid from May onwards with the draining in of rain water (less than 100-310 mg/l). Silicate (12.5-23.7 mg/l) and Iron (0.76-10.25 mg/l) increased with the rise in turbidity, exhibiting a direct relationship. Repeated

dilutions brought down the concentration of nutrients like nitrate (0.168-0.228 mg/l) and phosphate (in traces). Iron in the presence of adequate oxygen (dissolved oxygen being 2.4-7.12 mg/l) remained in the ferric state while the specific conductivity value (260-642 x 10^{-6} mhos) which had registered a rise in April lowered sharply in May indicating dilution by rain water. Subsequent sub-soil leachings, however, contributed to the rise in specific conductivity.

The soil was poor in nutrients, with the concentration of calcium (500-1000 lb/acre), potassium (40 lb/acre and less) and ammonia (25-50 lb/acre) being from low to moderate levels. However, the pH ranged from 7.8-8.0.

Zooplankton dominated over phytoplankton (52-632 units/l). Chlorophyceae contributed to the peak of 180 units in May, while Bacillariophyceae constituted the bulk of 186 units in November. Zooplankton exhibited inverse relation with alkalinity and a direct relationship with nitrate. Cypris and Nematodes were of infrequent occurrence.

Chironomids accounted for 39.08% of the littoral fauna, the density of which ranged from 1.29-301.68 units/sq m and 58.63% of bottom biota (15-258 units/sq m), thus dominating over the other constituents of the littoral and bottom biota. A direct relation between the increasing iron and increase in the number of chironomids was observed up to June. Molluscs (Viviparus only) dominated both the littoral (45.48%) and benthic (58.84%) biota by weight. Insects (Corixa, Notonecta, Nepa, Berosus and mosquito larvae) were an important component of littoral biota constituting 28.50%. Lepidocephalichthys thermalis, Mystus vittatus and crabs were the other components of littoral biota, prawns (Leander spp.) being absent in the pond.

A study of the growth of fishes (C. catla, L. rohita, and C. carpio var. communis) introduced into the ponds indicated a good growth of all the three species in the Hutchmmaankere tank C. catla, L. rohita and C. carpio respectively recording an increment of 433, 358 and 420 mm in an year.

9. Water pollution

(a) Physichemical studies of Bagh canal industrial wastes

The pullutional effects of the effluents of the Bagh canal (which receives wastes from the Alkali & Chemical Corporation of India Ltd., Rishra, and from certain other factories and the municipality) on the river Hooghly were studied at various points. Samples were collected from the canal (i) before and after it received the Alkali & Chemical Corporation of India factory effluents (ii) before it received the estate sewage of Presidency Jute Mill and (iii) before it met the river, as also from the Polythene Unit, Rubber Chemical Unit, Paints & Varnish Unit, Chlorine Unit and from upstream, midstream and downstream stations of the Hooghly estuary adjacent to the Bagh canal outfall.

The temperature of the Chlorine Plant effluent was as high as the air temperature (36°C), the rest of the effluents having temperature lower than the air temperature. While the turbidity (silica scale) of the Bagh canal effluent was 111 and 345 before meeting the factory wastes and the river respectively, the highest turbidity (346) was observed in the effluent of Chlorine Plant. D.O. was found to be nil in the effluent of Bagh canal before it met the factory wastes but a value of 1.03 mg/l of D.O. was recorded at the point where the Bagh canal received the waste from Chlorine Plant and the effluent of other units, the increase in D.O. being due to the discharge of condensate water. The up-stream, mid-stream and down-stream stations of the Hooghly near Bagh canal outfall recorded a D.O. range of 3.8-5.0 mg/l, 4.0-5.2 mg/l and 2.8-5.0 mg/l respectively. However, 2.8 mg/l of D.O. was found at a distance of 2.0 km downstream of the outfall. The C.O.D. value of the Bagh canal effluent before it received the factory wastes, that of the factory wastes and of the canal effluent near the outfall were 704, 384-2880 mg/l and 4880 mg/l respectively. The Bagh canal effluent just before it met the river water had 82.6 mg/l of 5-day B.O.D. at 35°C-0.5 °C while at up-stream, mid-stream and down-stream stations, the values were 7.6, 6.1-11.5 and 10.5-22.0 mg/l respectively. A B.O.D. of 22.0 mg/l was noticed at a distance of 2.0 km down-stream of the outfall. The pH of the factory effluents was in the range of 8.1 to 9.6, the highest pH being of the effluent of the Chlorine Plant. Total and

suspended solids in the factory effluent ranged from 854-1954 and 66-810 mg/l respectively. While the total and suspended solids of the Bagh canal effluent just before it met the river were 1910 & 580 mg/l respectively. A value of 8.0-12.5 mg/l of free and saline ammonia was found in the Bagh canal effluent just before it met the river water. The nitrite - nitrogen content of the Bagh canal before it received the factory wastes and that of the various effluents of the factory were nil and traces - 0.56 mg/l respectively, the nitrite - nitrogen content of the effluent of Paint and Varnish Unit being 0.56 mg/l.

The physico-chemical conditions of the effluent of Serampore Distillery outfall and that of the adjoining points upstream, midstream and downstream of the Hooghly were as follows:

The distillery waste was brownish in colour, highly turbid, with a smell of molasses and a temperature of 60°C. pH of the waste was 6.8 and at the up-stream, mid-stream and down-stream stations of the Hooghly, the pH values were 7.8-7.9, 7.9 and 7.9-8.1 respectively. D.O. was nil in the waste, while the up-stream, mid-stream and down-stream stations recorded 4.4-5.0, 5.0 and 3.6-4.8 mg/l of D.O. respectively. Very high C.O.D. value to the extent of 53,280 mg/l was noticed in the waste, whereas at the down-stream station on the Hooghly it was 388.8 mg/l. Nitrite-nitrogen was found to be nil in the distillery waste as well as in the river water.

Pollutional effects of the waste of Dunlop Rubber Co. (India) Ltd., on the river Hooghly were studied. Samples were collected from (1) Dunlo-pillow Section, (2) Belting & House Section, (3) Mill Dept., (4) South point of the jetty discharing factory waste and estate sewage, (5) North point of the jetty discharging factory wastes mainly and domestic washings and (6) from the Cycle rim Section. The appearance of the combined factory effluent with estate sewage was yellowish-green (sometimes pinkish to hazy whitish) with a faint smell of rubber. Belting and Hose Section effluent had a high temperature (43°.0C), the range of temperature of the various effluents being 29.5° -43°C. pH of the final effluent discharged from the South and North points of the jelly was in the range of 8.0-8.2, while the pH of the river water was 8.2. The pH of the waste from the Cycle Rim Section was higher than 9.6. The maximum amount of total solids in the river water and in the combined effluent was 1006 and 1120 mg/l respectively, whereas the maximum amount of suspended solids was 444 and 980 mg/l respectively. A very high value of

total and suspended solids to the extent of 142050 and 14,816 mg/l. respectively was observed in the cyanide waste of Cycle Rim Unit. D.O. in the final discharge point was 2.2-5.6 mg/l, whereas in the river water it was in the range of 5.2-6.0 mg/l. D.O. in the waste of Dunlo-pillow Section was found to be nil. The final discharge point was having a C.O.D. value of 72-360 mg/l, whereas the C.O.D. value in the river water was 24.0-72.0 mg/l. The highest C.O.D. value to the extent of 528.0 mg/l was obtained in the waste of Dunlop-pillow Section. Although a high value of nitrite-nitrogen to the extent of 0.3-0.4 mg/l was found in the South point and Dunlop-pillow waste, the river water was void of nitrite-nitrogen. A higher proportion of albuminoid ammonia was found in the waste of Mill Dept., South point and in the river water.

(b) Bio-assay experiments

Wastes (alkali-cyanide) collected from the Cycle Rim Section of the Dunlop Rubber Factory varied in their physico-chemical characters. The colour varied from chromic yellow to greenish blue, which on oxygenation turned to deep blue. The waste was highly alkaline with pH 9.6. While phenolpthalein alkalinity ranged from 510-12, 100 mg/l as $CaCO_3$, the methyl orange alkalinity was 900-2,500 mg/l as Ca Co_3. Suspended solids ranged from 14,816-51,060 mg/l and dissolved solids 111,426-127,234 mg/l.

Preliminary bioassay experiments with this waste with *Catla catla* (40-45 mm) as a test fish revealed that LD_{50} was 0.65% for 24 hours' exposure (D.O. 5-7 ppm; temperature 28.0 to 28.5° C and pH 9.3-9.6). LD_{50} in case of *L. rohita* (60-70 mm), with an initial D.O. value of 6 ppm and temperature 20-21°C, was found to be 0.90% for 24 hours' exposure .

10. Cold Water fisheries

(i) Investigations on the causes of high rate of mortality in the young and adult stages of trout.

Investigations on the large scale mortality of trout eggs, alevins and fry in the trout hatcheries at Barot in Himachal Pradesh and Achabal in Kashmir were undertaken.

Barot Trout Farm : The details of investigations at this farm have already been reported earlier. Use of improvised and modern techniques in the stripping and rearing of eggs, alevins and fry of brown trout and the timely control of various diseases resulted in increasing their rate of survival from 33.50 to 52.30%. The factors responsible for the mortality of young stages of trout included 'white spot' and 'soft egg' deseases in the green egg and eyed-ova stages; 'blue sac' and 'whirling disease' caused by myxosporidian parasites at the alevin stage; and 'Octomitiasis' and whirling disease, over crowding and deficiency of dissolved oxygen at the fry stage. A comprehensive report on the observations made at the Barot Farm with particular reference to remedial measures in each case has been sent to the Department of Fisheries, Himachal Pradesh.

Achabal Trout Farm : Detailed studies on the stripping and handling of eggs and the factors responsible for the high mortality of green eggs, eyed-ova, alevins and fry of both brown and rainbow trout were made. The physico-chemical conditions of spring water and the dissolved oxygen content in the R.C.C. troughs were also studied.

Brown Trout (Salmo trutta)

As hundreds of fish died every year during the spawning season on account of various bacterial and other diseases, studies on proper handling and stripping of eggs were made by stripping 50 hen fish using sterlised gloves and collecting the eggs in enamel wares instead of earthen pots. Care was taken to select proper breeders and they were dipped in 3% salt solution after stripping. As a result of these measures not a single spent fish out of the fifty hen and an equal number of cocks died.

Preliminary experiments made at Harwan and Laribal Trout Farms in Kashmir on the effect of a 3% Sodium Chloride bath on spent fish, immediately after stripping, resulted in checking the mortality of spent fish due to bacterial diseases accompanied by secondary attacks of Saprolegenia at the two farms.

The average percentage of mortality of green eggs in all the experimental trays was 39.13 though in fifty percent of the trays it ranged from 0.56 to 9.81%. The main factors responsible for the mortality were silt, soft egg disease, fungus and 'flaccid'. The latter condition was unique. These eggs were eggs characterised by having an orange coloured spot but this condition occurred in a few specimens only. The problem of silt was an acute one because the spring feeding the hatchery is not a true spring but an underground seepage water of Bringhi drainage. As no silt traps are put up at Achabal, slight rains in that region bring heavy loads of silt in the hatchery, the worst affected trays being the first two in each trough. It was found that the fungus trouble started after 3-4 days of keeping the eggs in trays, first growing over the dead eggs and then spreading to the adjacent good eggs in the tray. Mortality due to fungus, which occurred for the first four days, was subsequently checked completely by flushing the green eggs twice a week with Malachite green (1:20,000) for one minute (a trough where no flushing was done was maintained as a control). In control series where the dead eggs were removed only after eyeing and no malachite green treatment was given, the trays had a cloudy appearance and the percentage of mortality in total green eggs was 62.35 against 12.88 percent in the experimental troughs. as

The average percentage of mortality of eyed-ova was 52.80, the main factor responsible for this high percentage of mortality being the 'soft egg' disease. This happened at the time of hatching. In several trays the percentage of mortality ranged form 1.10 to 14.53.

The average percentage of mortality at the alevin stage was 10.25, the factors responsible for it being the blue-sac disease, fungus infection and the appearance of white patches on the yolk sac. Overcrowding and deficiency of dissolved oxygen in the troughs added to the percentage of mortality. The ova house is fed by spring water which is itself deficient in dissolved oxygen; no aerating device is, however, employed at the farm. The R.C.C. troughs in the ova house being arranged in

series of four, the water from the first trough has to flow to the second and so on resulting in the deficiency of dissolved oxygen by the time it reaches the fourth trough (from 8.6 to 6.0 ppm). Mortality of the alevins, which were already crowded in the trays, was prevented by thinning operations in the trays.

At harwan, large scale mortality of alevins occurred due to overcrowding and deficiency of dissolved oxygen. Here too, the source of water supply of the ova house was a spring. However, arrangements to augment the dissolved oxygen by releasing water from a natural stream were made and the ova house troughs were supplied with mixed spring and stream water. Within two days of the release of stream water the mortality was reduced considerably.

Rainbow Trout (Salmo gairdneri)

Twenty hen rainbow trout (383-560 mm) were stripped in the same manner as the brown trout and on an average 1146 eggs/kg of body weight were obtained.

The average mortality of green eggs was 18.22%, though in 8 of the 18 trays having rainbow trout eggs the mortality ranged from 0.75 to 6.55%. Mortality was found to be due to white spot disease and deposition of silt.

In the eyed-ova stage, the maximum mortality occurred in the last week of February due to considerable silt deposition caused by heavy rains and the 'soft egg' condition which occurred about the time of hatching. The average percentage of mortality was 41.66.

Studies on the factors responsible for the mortality of the alevins and fry are being continued.

At the instance of the Director of Fisheries, Jammu and Kashmir, investigations were made on the causes of large scale mortality of rainbow and brown trouts in the various farms during May-June '66. Large scale mortality of adult rainbow and brown trouts was reported at various farms, particularly Laribal and Harwan on account of the 'whirling' disease. This disease was quite different from that of parasitic infections in that the fish lost its balance and swam on the side followed by cessation

of feeding, the infected specimens turning dark in colour. It is felt that deficiency of vitamin B_1 is responsible for the prevalance of this disease.

(ii) Biology Oreinus plagiostoms in Kangra Valley

Adult and juvenile specimens of O. plagiostomus were collected from Baner, Nigal, Awa and Binwa Khads of the Kangra Valley the catches being poor during the first quarter at Dadh, Paror, Dhraman and Baijnath, sampling stations on the four streams respectively due to high water temperature. During the second quarter, the catches were good at all the stations but again in the second half of the third quarter they were poor as the fish had migrated downstream due to low water temperature. However, O. plagiostomus was collected as far downstream as Ranital during December-January from the Baner stream, the place being warmer than Dadh does not hold snow trout at any other time of the year. The catches were fair during the last quarter. The fish was found to be a phytoplankton feeder, Bacillariophyceae (73.27%), Chlorophyceae (10.90%) and Cyanophyceae (15.83%) constituting the gut contents. However, juveniles were found to consume insects (mainly dipteran and coleopteran larvae and corixid bugs) in addition to the phytoplanktonic forms.. The species was found to be breeding twice in a year, during September-October when the intensity of breeding was low and during January-February when the intensity of spawning was high. Studies on the length-weight relationship, fecundity, maturity and age and growth (by means of scales and dorsal spine) are in progress.

(iii) Observations on eggs, larvae and fry of cold water species of fish

In order to determine the potentialities of the hill torrents of Kangra Valley for seed collection of commercially important species, intensive collections of eggs, larvae and fry were made from July to September and it was noticed that there are rich potentials of the seed of Labeo dero, Tor putitora and Oreinns plogiostomus in all the major streams of the Valley. In all, eggs, larvae and fry of seven species viz. Barilius bendelesis chedra, B. ragra, Labeo dero, Tor putitora, Oreinus plagiostonus, Glyptothorox stoliczkae and G. conirostris, were collected during the period. Fertilised eggs were reared in the

laboratory to determine the characteristic features of various species at different stages of life. This is for the first time that such an intensive collection was made and the life history stages of these species studied. The average diameter of the fertilised eggs of Barilius/ L. dero, T. putitora, O. plagiostomus and Glyptothorax spp was 1.8, 2.4, 3.0, 3.4, 3.6 and 2.4 mm respectively.

/bendelisis, B. vagra,

(iv) Survey of the trout and mahseer streams of Himachal Pradesh and trout streams of Kashmir

A survey of the insect fauna of the trout and mahseer streams of Himachal Pradesh, covering a few streams of Mandi, Mahasu and Kinnaur districts, indicated that it comprised the nymphs and larvae of Ephemeroptera (67.85%), Plecoptera(7.14%), Trichoptera (10.73%), Diptera (7.14%) and larvae and adults of Coleoptera (7.14%). Among Ephemeroptera, nymphs of Baetis, Epeorus and Ephimerella were the dominant forms, while the Plecopteran nymphs belonged to the family Perlidae. The caseless form, Rhyacophila, dominated the trichopterans while the dipteran larvae belonged to Blepharoceridae and Leptidae. Beetles were represented by larvae and adults of Gyrinidae and Psephenidae.

The insect life in the mahseer streams was quite different because of higher water temperature and moderate current. In these streams the insect fauna consisted of nymphs and larvae of Ephemeroptera (30.76%), Odonata (7.69%), Plecoptera (3.85%), Trichoptera (30.76%), Diptera (11.56%) and larvae and adults of Coleoptera (15.38%).

A detailed survey of the trout streams in Kashmir Valley was undertaken during May-June, '66 and covered R. Jhelum and its tributaries viz. Verinag spring stream, R. Bringhi, R. Liddor R. Sind, Erin N., and Madhmati N. on the right bank and R. Vishar and Ferozepore N. on the right bank. A detailed report on the survey was prepared and submitted to the State Fisheries Department.

The fish life in trout streams of Kashmir Valley was constituted mainly by Schizothorax progastus, S. micropogon, S. planifrons, S. esocinus, Oreinus plagiostomus, Nemacheilus yarkinensis, N. rupicola, Diptychus maculatus and Glyptosternum reticulatum. Nymphs of Ephemeroptera and Plecoptera/larvae of /and Trichoptera and Diptera were the dominant forms comprising insect

life. The other aquatic organisms recorded from the trout streams were leeches of the genus Eropdella, amphipod (Gammarus pulex) and ice-worms belonging to the family Euchytraeidae (Oligochaeta).

The distribution of insect and other aquatic organisms in trout streams was interesting. For instance Isonychia, Baetis, Isoperla, Chloroperla, Blepharoceridae and Tipulidae were the major contributors to the insect population where the water temperature ranged from 8.0° to 11.0°C and current was turbulent. In spring-fed streams like Kokernag (tributary of R. Bringhi) the population of Gammarus pulex was as high as 73.71% in total population of insect and other aquatic organisms.

11. Prawn fisheries

(a) Hooghly estuary

A total of 1049.5 tonnes of prawns were landed during the year as against 857.4 tonnes of last year, constituting 15.5% of the total catch.

P. sculptilis ranged in length from 88 to 147 mm, males and females exhibiting two modes at 50.0 (I-year) and 74 mm (II-year) and 49.0 (0-year) and 85.0 mm (I-year) respectively. Mature females (100 mm and above) were observed in Zone III during December and January indicating the probable spawning season. Sex ratio was male : female : : 1.0:2.5. Specimens of M. brevicornis, ranging in length from 24-100 mm, with a mode at 47.0 mm (I-year) in case of males and two modes at 49.0 (I-year) and 63.0 mm (II-year) in females, were caught from all the zones except Zone I. Sex ratio was ♂ : ♀ : : 1.0:2.2. Males and females of P. styliferus (25-100 mm) with modes at 44.0 (0-year) and 65.0 mm (I-year) and 45.0 (0-year) and 60.0 mm (I-year) respectively were caught in Zones II-V. Females (above 70 mm) in advanced stages of maturity and egg-bearing condition were encountered in Zones II and III from November-January. Sex ratio was Male:Female:: 1.0:1.5. M. mirabile (9.57 mm) was available in Zones III & V with a single mode at 32.0 mm in males, and two modes at 32 and 44 mm (I-year) in females. Berried females (above 40 mm) were observed throughout the year, sex ratio being Male:Female:: 1.0:1.2. M. rosenbergii (30-200 mm)

was, however, confined to Zones I & II only. Females (150-200 mm), in berried condition were available in Zone II from March to May. M. villosimanus varied in size from 19-121 mm and were available mainly in Zone I. Males showed modes at 62 and 95 mm, while the females at 42 and 86 mm. Mature females (above 80 mm) were observed during May-August. Sex ratio was Male:Female:: 1.0:1.8. M. malcolmsonii (19-165 mm) showed two modes each at 45 (0-year) and 128 mm (III-year) in males, and at 35.0 (0-year) and 86 mm (I-year) in females. Females (above 100 mm) were found to be breeding in Zone I during May-August. Sex ratio was Male: Female:: 1.0:1.1.

(b) Chilka lake

Prawns formed about 40% of the total fish production of 3728 tonnes of the lake, P. indicus alone accounting for 22.71% (846.8 tonnes) of the prawn catches.

The fishery of P. indicus was quite extended (May to November) and composed of two waves of juveniles. The modal size at detection of the first wave was 60 mm in April and the same continued up to June reaching a size of 110 mm. The other wave commenced in July/August at a modal size of 70 mm and continued up to November reaching a size of 110 mm. Though individuals 35-195 mm in size occurred in the catches, specimens measuring 70-120 mm formed 86.34% of the catches. P. semisulcatus (135-195 mm) formed 6.73% (251 m. tonnes) of the total catch. The fishery was dominant from April-June, northern sector alone contributing 164.24 tonnes. M. monoceros (35-145 mm) formed 5.77% (215.26 tonnes) of the total catch, northern sector alone contributing 137.31 tonnes. Individuals (60-100 mm in size formed 92.82% of the catch. M. dobsoni (35-185 mm) formed 4.58% (170.86 tonnes) of the total catch, the northern and central sectors contributing 112.42 and 50.14 tonnes respectively. Specimens forming 91.63% of the catch ranged from 50-70 mm in size.

(c) Pulicat lake

The prawns (518.62 tonnes) contributing to about 52.6% of the total yield showed an increase over that of last year (478.8 tonnes).

P. indicus dominated the catches during May-July, October and March. Suthuvalai (223.44 tonnes), kattuvalai (17.39 tonnes) and kondavalai (24.27 tonnes) were the main gear that contributed to the catches. 66-120 mm individuals forming 74.43% of the catches belonged to the 0-year class (3-7 month old). Heavy recruitment of juveniles with a mode at 65 mm occurred in April which grew to 115 mm by September. Three more waves of juvenile recruitment were observed in July-August, November and March. Females were found to be slightly predominant (males:females:: 1.000:1.114). Post-larval recruitment during the current year (75.12/hr) was poorer than that of last year (672.9/hour of townet). Studies on the comparative growth rate in two closed systems, Adyar and Ennore and Pulicat lake revealed a poorer growth in the Adyar system, mean sizes in August being 103.75, 112.70 and 110 mm in Adyar, Ennore and Pulicat respectively; the poor growth in Adyar being probably due to sewage pollution. Observations at the Adyar Fish Farm showed that the younger size groups grow faster (1.13 mm/day) than the medium (0.696 mm/day) and older (0.15-0.21 mm/day) size groups, and that the females grow faster than males. P. monodon was abundant during May-July and February-March. Suthuvalai, kattuvalai and kondavalai landed 32.28 tonnes, 2.72 tonnes and 5.63 tonnes respectively. The dominant size groups (111-185 mm) comprised 73.39% of the catch and corresponded to the 0-year class (4-8 month old). Juveniles were common during November-February. While the sex ratio was almost unity, females outnumbered males over 170 mm. Two peak periods of migration towards the sea were observed during May-July and February-March. Post-larval incursion was poor as compared to that of P. indicus, the tow-net collections during August, October, November and January being from 12-52/hour. Suthuvalai, kattuvalai and kondavalai landed 26.90, 24.85 and 13.8 tonnes respectively of M. monoceros which, like P. monodon, was abundant during May-July & February-March. The dominant size groups (51-80 mm) corresponded with 8-9 months' old prawns. Female dominated the males (1.11:1.00). The period of migration was found to be during May-June, November-December and March. M. dobsonii was abundant during June-July and October-November. Suthuvalai (21.01 tonnes), Kattuvalai (19.60 tonnes) and kondavalai (2.66 tonnes) were the main gear employed for fishing the prawns in general. The dominant size group (46-65 mm) belonged to the 0-year class. Females slightly exceeded males. It was observed to migrate to the sea in maximum numbers during June-July and October-November. M. burkenroadi was abundant during May-July and Kattuvalai and suthuvalai respectively

landed 12.82 and 7.56 tonnes of its total catch. Dominant size range was 56-85 mm (0-year). A bimodal distribution in older individuals indicated a difference in the rate of growth of the two sexes, females being fast growing. The fishery declined after August and was scarce by March. Juvenile entry was observed in April and July. Unlike other species, mature specimens were observed in the lake. Males attained maturity at smaller sizes, the minimum for females being 58 mm while the majority ranged from 76-95 mm. Males migrated to the sea during April-July, the females following in August. Suthuvalai caught 9.43 tonnes, kattuvalai 4.8 tonnes and kondavalai 3.26 tonnes of P. semisulcatus, which was abundant during June-July, '0-year' group (51-100 mm) being the most predominant. Juveniles entered the commercial catches during April, July-September and February-March. Females outnumbered the males (1.000:1.265). Individuals with a modal size of 85 mm migrated to sea during May-June and October.

IV. ANCILLARY PROJECTS

1. Investigations on fish pathology

(i) Spoilage of fish in Calcutta fish markets and surrounding industrial belts.

A new programme of work on the spoilage of fish was initiated during the year 1965-'66 and was completed during the year under report. Isolation of 32 strains of bacteria from the pond water (habitat of the fish), surface of freshly caught live fish, fish intestine and the fluid from "rotting" fish were reported earlier. Of the 32 strains obtained in pure culture, 6 were able to produce conditions considered to be spoilage of fish. The degree of spoilage was very much marked with 2 of the strains at ½ dilution. The same two strains at 1/1 dilution caused spoilage in 24 hours. Particulars of the 4 more strains responsible for the spoilage of fish flesh are furnished below :-

	Source	Morphology	Media Used	Chemistry
1	Fish surface	Gram - rod	Mcconkey (Non-lactose fermenter)	Glucose, Lactose, Salicine, Suchrose and Dalcitoal positive and produces gas. V.P. and Urea positive.
2	Pond water	Gram - rod	Desoxy Chocolate Agar(N.L.F)	Glucose, Maltose, Lactose, Suchrose and Salicine positive and gas forming. V.P. positive.
3	Fish surface	Gram - rod	D.C.A. (N.L.F)	Glucose, Maltose, Suchrose positive and gas forming MR and Indol positive.
4	Fish Intestine	Gram + Cocci	D.C.A. (N.L.F)	-

Experiments were conducted with all these six strains which caused rotting within 24 hrs. and it was found that a bacterial load numbering 2 to 10 x 10^{7} to 9 was needed to rot the fish.

Identification of bacteria isolated from the environment, body surface, body fluid and intestine of the test fish Cyprinus carpio (var. communis) was also done. Eleven strains of bacteria belonging to the Gram positive Cocci group was identified as Micrococci. Strains belonging to the gram positive rod group were identified as either Bacillus sp or Corynbacterium sp. Among the strains, belonging to gram negative rod group Klebsiella sp is common. Identification of a few more strains are yet to be confirmed.

(ii) Investigations on diseases of cultured fishes

Further observations on the etiological/morphological /and aspects of infectious dropsy affecting major carps were made and heavy losses among medium sized fish (rohu and mrigal) in a stocking pond were prevented taking suitable prophylactic measures. Malachite green was successfully used for the control of gill rot disease of carps caused by the fungus Branchiomyces sp.

(iii) Fish diseases of nursery ponds

Investigations on fish diseases in nursery ponds in the 24-Parganas and Hooghly districts of West Bengal were conducted. Infections of sporozoan and monogenetic trematode parasites were commonly met with on major carp fry and fingerlings. Attack of myxosporidians viz. Myxobolus sp and Thelohanellus sp started in the post monsoon period and the peak of infection was reached in November and December. Attack of Myxobolus sp was commonly found on Catla catla, Labeo rohita and Cirrhina mrigala where as the attack of Thelohanellus sp was never met in the last species. Complete disappearance of these parasites in the nursery ponds is noticed during the monsoon months. The minimum size of the fish when it receives the infection of these host is found to be 5 cm.

Infestation with Gyrodactylus spp., Dactylogyrus spp. and Paradactylogyrus sp was often encountered amongst the fry and fingerlings of Indian major carps, the parasites attacking their respective hosts, being generally host-specific, when the latter were about 4-5 cm in size. The intensity of infection was highest in winter and lowest in the pre-monsoon months. Complete disappearance of the parasite was noticed in early monsoon months. Infection of Trichodina sp was also common amongst the fry and fingerlings of C. catla, L. rohita and C. mrigala. Trichodina indica was often encountered during the winter months. 3% saline bath for 3-5 minutes, depending on the size of the host was found to be effective for the control of these parasites.

2. Research training scheme

Two of the four research scholars viz. Shri R.K. Das and Shri S.P. Bhunya resigned on the 13th May, '66 and the third viz. Kumari Kuldip Kaur also resigned on 22nd August, '66. The details of the work done by the research scholars are given below :

(i) Investigations on the anatomy and histology of the organs of ingestion and digestion of fishes, Pseudosciaena coibor, and three species of the genus Oxygaster, with reference to their food and selected aspect of their biology.

240 specimens of P. coibor (46-202 mm), in various stages of maturity, and 292 of Oxygaster spp. (60-175 mm), in earlier stages of maturity or spent, were examined in fresh condition for recording their morphometric details and for the determination of their food and feeding habits, age, growth, maturity and fecundity. Histological studies on the organs of ingestion and digestion were also conducted.

(ii) Experimental and observational studies on the influence of light and temperature on the gonadial cycle of Indian carps.

Experimental studies on the effects of photoperiodism and temperature on the gonadial cycle of Cirrhinus reba indicated enhanced growth of ovaries and testes in specimens which were subjected to artificial light for a period of 14 to 18 hours per day. Oozing males and females were also found in a cistern which was subjected to a varying light period from 4 to 20 hours per day, with constant and rather high water temperature. The control set did not show any sign of advanced maturity. Average growth rate of experimental fish was observed to be 2-5 mm per month. Studies on the effect of feed supplements such as yeast, terramycin and cobalt nitrate on the growth of C. reba showed an average growth of 10.25, 4.1 and 5.4 mm with the three combinations of (a) yeast, terramycin and cobalt nitrate, (b) yeast alone and (c) terramycin and cobalt nitrate respectively.

3. Documentation

78 books, 157 reprints, 65 miscellaneous publications and a total of 1200 journals were added to the library covering about 200 titles of journals, including 32 foreign and 27 Indian journals, subscribed by the Institute. The unit continued to compile and publish the annotated 'Bibliography of Indian Fisheries' and Vol.5(1-4) covering about 575 articles on Indian fisheries was brought out. The unit also edited and published three departmental reports under the Bulletin series (Bulletin Nos. 7-9). A total of 55 requests, both from India and abroad, on technical as well as general matters were attended to by the Unit.

The library holdings have been estimated to comprise 1919 books, 1831 reprints (excluding departmental reprints), 831 miscellaneous publications and 1103 bound periodicals. These apart, the library possesses a large number of pamphlets, departmental publications and loose issue of the journals. The library stock shows that a total of about 500 titles of the journals are available.

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