



SRINAGAR

REPORT ON DAL LAKE, SRINAGAR, KASHMIR WITH SUGGESTIONS FOR DEVELOPMENT OF ITS FISHERY



BULLETIN No. 24

CENTRAL INLAND FISHERIES RESEARCH INSTITUTE
(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)
BARRACKPORE • WEST BENGAL • INDIA

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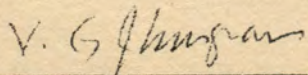
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JANUARY, 1977

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FOREWORD

The cold freshwater fishery resources of selected sections of the State of Jammu and Kashmir have been attempted to be assessed by the Srinagar Research Centre of the Central Inland Fisheries Research Institute, Barrackpore. One of the water areas surveyed by the Centre was the Dal lake in Srinagar. The Dal, which has added to the scenic beauty of Srinagar city, caters primarily to the needs of fishing and tourism industries of the State. The investigations carried out by the Research Centre during 1969-72 related to the estimation of essential physico-chemical and biological parameters, food analysis of commercially important lake fishes, fecundity of common schizothoracid fishes found in the lake, fishing methods and fish catch composition. The research project was completed under the supervision of Dr. K.L. Sehgal, the then Officer Incharge, Srinagar Research Centre with Shri K.V. Ramakrishna, Scientist - S₁ as Project Leader and Sarvashri M.J. Bhagat, Senior Research Assistant, C.B. Joshi, Scientist - S and Shyam Sunder, Scientist - S as associates.

The 15TH JANUARY 1977



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REPORT ON DAL LAKE, SRINAGAR, KASHMIR WITH SUGGESTIONS
FOR DEVELOPMENT OF ITS FISHERY

INTRODUCTION

Situated in Srinagar city, Dal lake is of great interest from both tourist and fishery point of view. The approximate area of the lake is 25.0 sq km. As per the classification of Das and Subla (1973) the lake is eutrophic in nature. The lake may be described as irregularly 'U' shaped, the left limb connected to the river Jhelum by a lock (Dal gate) and the right joined by 'Arh' stream. There are innumerable houseboats stationed in Dal discharging their wastes into the lake. In addition there are innumerable islands inhabited by the local people engaged in horticulture. These islands are all man-made built by piling of the bottom soil of the lake.

Except for the faunistic enumeration by Hutchinson (1939) no work on the lake and its fishery seems to have been done in the past. A study of the ecology and fishery of the lake was undertaken by the Cold Water Fisheries Research Unit of the Central Inland Fisheries Research Institute, Harwan with a view to suggesting ways and means for its improvement. The present report embodies the results of the work done in two phases during the period 1969-1972. In the first phase the work was focussed at two stations, Hazratbal and Saidakadal where the fish catches from the lake are assembled. The second phase included the sampling of the whole lake at 48 stations, each station being covered once in each of the three seasons, summer, autumn and winter (Fig. 1). Under both the phases, observations were made on physico-chemical factors of water and soil, surface plankton, lake vegetation and associated biota, bottom fauna, fish catch statistics, species composition, food of the common species of fish and fecundity and spawning of commercial species.

A. First phase (April, 1969 - May, 1971)

As stated above, the observations were made at two fish assembly centres, Saidakadal and Hazratbal. The two stations located at the Northern bank of the lake end, are, in fact, the only two spots where the fish catches from the lake are landed every day. The results of analyses of weekly sampling at the two stations are described below :

1. Physico-chemical factors

The physico-chemical factors of the surface water during 1969-71 at 8.00-10.00 hrs. were in the ranges : Depth, 1-37-4.02 m, turbidity, 0.60-3.50 m, water temperature, 0.5-30.5°C, pH, 7.2-8.8, Dissolved oxygen, 7.6-12.4 ppm, free carbondioxide, nil-6.0 ppm, total alkalinity, 50.0-168.0 ppm, and silicates, 0.375-1.250 ppm at Saidakadal against depth, 2.60-6.0 m, turbidity, 0.50-3.08 m, water temperature, 3.5-28.0°C, pH, 7.4-8.8, D.G., 7.8-12.0 ppm, free carbondioxide, nil-8.0 ppm, total alkalinity, 74.0-180.0 ppm, and silicates, 0.318-1.250 ppm at Hazratbal. The analysis of the soil collections at the two stations done with the help of State Agriculture Department indicated values of carbon to be 0.47-0.61%; medium to high value of phosphorus (12-52.0 lbs/acre) and medium to high value of potassium (15.0-51.0 lbs/acre).

2. Plankton

The surface plankton was collected by (a) filtering 100 litres of lake water through a net of bolting silk No.21 and (b) by towing a 0.5 m ring net of organdie cloth for a duration of 10 minutes from a country boat at as uniform a speed as possible. The surface net plankton ranged 1-4,333 units/litre at Saidakadal against 23-35,183 units/litre at Hazratbal. The concentration of net plankton at Saidakadal was at its maximum in April 1969 and June 1971 and minimum in January during 1970 and 1971. However, at Hazratbal only one peak in September, 1970 was observed. The minimum concentration at Hazratbal was in April, 1970.

The concentration of plankton in the tow net ranged 816-4,43,574 units/minute at Saidakadal and 4,795-2,39,145 units/minute at Hazratbal. The peak period of plankton concentration at Saidakadal was in May, 1970 while the minimum was in January, 1970. At Hazratbal the peak period was in October, 1970 but the minimum corresponded with the Saidakadal concentration during January, 1970.

The common forms encountered in the plankton were : Amphora, Navicula, Gomphonema, Cymbella, Asterionella, Trachelomonas, Cosmarium, Melosira and Anabaena among the phytoplankton and Asplanchna, Brachionus, Lecane, Polyarthra, Chydorus, Cyclops and nauplii of copepods among the zooplankton.

3. Lake vegetation and the associated biota

The lake vegetation at both the stations consisted mainly of submerged plants like Myriophyllum, Ceratophyllum, Potamogeton,

Nymphaea, Hydrilla and Salvinia. The fauna which inhabits these vegetation consisted mainly of nematodes, cladocerans, copepods and insects. The group-wise percentage of vegetation - inhabiting-fauna at Saidakadal and Hazratbal are shown in Table I. The common genera of animals encountered in the vegetation were Chydorus, Alonella, Alona, Diaphanosoma, larvae of Chironomidae and Leptidae, nymphs of Epeorus, Ephemera and Heptagenidae and naids of Agrionidae and Libellulidae.

TABLE - I

Vegetation inhabiting fauna of Dal Lake, Srinagar, Jammu & Kashmir

Station	Nematoda	Cladocera	Copepoda	Larvae of Diptera	Misc. *1
Saidakadal	14.47*2	37.41	7.82	29.65	10.65
Hazratbal	15.42	40.15	9.34	30.39	4.70

*1 Includes amphipods, may fly nymphs, naids of dragonfly, molluscs, oligochaets and fish.

*2 Percentage of numerical occurrence.

The analysis of periphytic organisms on the lake vegetation was also done. They consisted mainly of diatoms, desmids, green algae, protozoans, and rotifers. The occurrence of periphytic organisms are shown in Table II. The predominant genera which occurred as periphyton were : Amphora, Navicula, Gomphonema, Synedra, Pinnularia, Cymbella, Closterium, Cośmarium, Centropyxis, Conochilus and Brachionus.

TABLE - II

Periphyton of Dal Lake, Srinagar, Jammu & Kashmir

Station	Myxophyceae	Chlorophyceae	Desmidiaceae	Bacillariophyceae	Protozoa	Rotifera
Saidakadal	1.02*	2.96	5.96	86.81	1.36	1.89
Hazratbal	0.47	3.73	3.07	89.42	1.19	2.12

* Percentage of numerical occurrence.

4. Bottom fauna

The analysis of bottom fauna indicated that Naididae and Tubificidae among Oligochaeta and larvae of Chironomidae among Diptera dominated in the samples. The average percentage of Naididae, Tubificidae and Chironomidae by number at Saidakadal were 22.95, 40.85 and 28.85. The remaining 7.35% consisted of nematodes, molluscs and nymphs of Odonata and Ephemeroptera. At Hazratbal their respective percentages were 76.30, 16.47 and 5.00. The remaining 2.23% consisted of the same biotic composition as at Saidakadal.

5. Fish catches

The existing fishing methods in the lake may be termed as primitive. The main fishing gear is the cast net made of six pieces of the dimensions given in Table III. The other methods of fishing are the scoop net, Narsoo (multi-headed spear) rod and line and long lines. The fish catch per man-hour ranged from 156-978 gm at Saidakadal and 117-797 gm at Hazratbal. The species which constituted commercial fishery in the lake were C. carpio, Schizothorax niger, S. esocinus, S. curvifrons and Crossocheilus latius. The monthly fluctuation in species composition at the two stations during 1969, 1970 and 1971 are shown in Table IV, while Table V portrays the size-variations of commercial species at Saidakadal and Hazratbal during 1969-71.

TABLE - III

Dimensions of the cast net used in Dal Lake, Srinagar,
Jammu & Kashmir

Length of cast net, when hung - 4.0 m
Diameter of the net when spread - 4.8 m

Piece Number	Length (m)	Mesh bar to bar (mm)
First	1.20	15.0
Second	0.40	10.0
Third	0.40	10.0
Fourth	0.20	10.0
Fifth	0.20	12.0
Sixth	0.40	15.0

Maturity and spawning of Schizothorax niger and S. esocinus

In total eight fully ripe specimens of S. niger and six specimens of S. esocinus were analysed for ova diameter. In both the species the ova diameter shown multimodal trends indicating a prolonged spawning season. However, the fertilised eggs of the two species were collected during May-June in 'Arh' stream.

TABLE - IV

Monthly fluctuations in species composition of fish catches in Dal Lake, Srinagar, Jammu & Kashmir

Month	HAZRATBAL					SAIDAKADAL				
	Catch/ man hr. (gm)	Schi- zotho- rax spp.	Cypri- nus carpio	Cross- ochei- lus latus	Misc- ella- neous	Catch/ man hr.	Schizo- thorax spp.	Cyp- rinus car- pio	Cross- ochei- lus latus	Misc.
1	2	3	4	5	6	7	8	9	10	11
<u>1969</u>										
April	379.0	39.30	37.10	22.50	1.10	557.0	33.40	60.80	5.10	0.70
May	601.3	10.36	88.82	0.34	0.48	316.0	2.06	93.06	3.76	1.12
June	435.0	6.90	86.00	5.00	2.10	363.0	0.60	98.26	0.84	0.30
July	408.5	17.14	61.51	20.87	0.48	479.0	26.45	51.75	19.65	2.15
Aug.	797.7	14.59	64.57	17.08	3.76	696.0	12.23	55.45	27.45	4.87
Sept.	299.2	4.66	61.14	27.33	6.87	978.0	1.66	90.43	4.57	3.34
Oct.	152.9	1.80	40.10	57.50	0.60	250.0	4.02	60.25	26.08	9.65
Nov.	341.8	3.92	68.12	27.46	0.50	402.0	16.76	78.60	1.63	3.01
Dec.	207.9	40.08	46.69	11.22	2.01	363.0	18.73	71.22	6.93	3.12
AVERAGE	404.2	15.46	61.52	21.00	2.02	489.0	12.88	73.41	10.64	3.07
<u>1970</u>										
Jan.	117.0	14.88	39.36	46.49	9.27	N O - T R I P				
Feb.	133.0	16.78	69.47	12.58	1.17	263.0	15.97	54.39	29.64	
March	N O T R I P									
April	181.0	14.67	38.22	43.56	3.55	597.0	8.06	48.99	37.57	5.38
May	513.0	6.02	74.76	13.99	5.23	480.0	4.34	94.40	0.44	0.82
June	558.0	12.16	70.71	12.66	4.47	638.0	2.75	87.27	6.52	3.46

	1	2	3	4	5	6	7	8	9	10	11
July	289.0	4.06	80.57	4.98	10.39	211.0	7.64	48.85	42.88	0.63	
Aug.	542.0	5.34	57.65	22.28	14.73	441.0	3.30	72.00	15.53	8.27	
Sept.	366.7	3.73	55.30	36.45	4.52	634.0	13.29	78.40	3.23	5.08	
Oct.	297.0	12.84	79.05	6.08	2.03	500.0	44.74	42.10	13.16	-	
Nov.	239.0	6.67	56.31	26.12	10.90	376.0	7.50	53.04	39.46	-	
Dec.	320.0	5.80	62.18	24.83	7.19	250.0	18.04	81.96	-	-	
AVERAGE	305.0	9.31	62.17	22.76	5.76	441.0	12.51	66.23	18.90	2.36	

1971

Jan.	167.6	-	100.00	-	-	303.0	1.07	24.05	74.88	-	
Feb.	303.0	1.64	90.16	8.20	-	156.0	10.00	80.91	9.09	-	
March	371.7	6.51	33.57	59.74	0.18	342.0	3.49	52.95	43.26	0.30	
April	376.1	5.25	52.77	36.79	5.19	321.0	2.30	34.76	62.69	0.25	
May	239.0	3.32	67.29	29.23	0.16	364.0	3.44	61.50	26.54	8.52	
June	387.6	7.59	56.89	28.91	6.61	231.0	7.72	59.95	17.69	14.64	
AVERAGE	291.00	4.05	66.78	27.15	2.02	286.0	4.63	52.35	39.07	3.95	

Miscellaneous : Includes Botia birdi, Barbus conchonis, Gambusia affinis and Labeo dero.

S. niger and S. esocinus lay their eggs in running water under stones, gravel, sand etc. during May-June (Sehgal, unpublished). There is only one stream the 'Arh' which flows at the north-eastern bank of the lake. This stream is seasonal and carries snow-melt water during April-June every year. In the remaining months, there is practically no water and the stream remains cut off from the lake.

TABLE - V

Average annual lengths in mm of the commercial species of fish at Dal Lake, Srinagar, Jammu & Kashmir

Year	HAZRATBAL				
	<u>S. niger</u>	<u>S. esocinus</u>	<u>S. curvifrons</u>	<u>C. carpio</u>	<u>Crossochilus latius</u>
1969	208	290	174	221	103
1970	190	227	195	123	92
1971	174	181	139	223	85

SAIDAKADAL

Year	<u>S. niger</u>	<u>S. esocinus</u>	<u>S. curnifrons</u>	<u>C. carpio</u>	<u>Crossochilus latius</u>
1969	173	246	180	240	108
1970	184	189	143	231	91
1971	167	130	125	232	100

Table V shows data relevant to maturity and fecundity of S. niger and S. esocinus. Ripe specimens of both the species with multimodal ova diameter were collected throughout the year. Since the fish breeds in running water, the spawning facilities for the lake population of Schizothoracinae are available only during April-June. In other months, the fish does not get the facility of running water.

TABLE - VI

Data on maturity and fecundity of S. niger and S. esocinus

Length of fish (mm)	Wt. of fish (gm)	Wt. of ovary (gm)	Calculated no. of eggs	Gonadial index	Ova diameter range (mm)
<u>S. NIGER</u>					
240	160	17,200	5731	10.6	0.31-1.90
315	200	37.650	9074	18.5	0.10-2.50
315	210	14.220	5815	6.6	0.10-1.70
230	120	16.450	6037	13.3	0.10-1.60
170	80	16.100	5618	20.0	0.10-2.30
300	180	15.400	6268	8.3	0.10-2.10
255	100	17.250	7521	17.0	0.21-1.90
280	250	54.100	17367	21.6	0.71-2.30
Average 260	163	23.546	7929	14.5	0.23-2.07
<u>S. ESOCINUS</u>					
460	880	23.100	9679	2.6	0.10-1.70
318	240	11.870	5934	5.0	0.10-1.70
320	240	14.370	10174	5.8	0.10-1.70
457	840	51.100	19976	6.0	0.10-1.90
485	1000	97.800	19853	9.8	0.10-2.90
194	100	10.370	4573	10.0	0.10-2.10
Average 372	547	34.768	11698	7.8	0.10-2.40

B. Second Phase (May, 1971 - April, 1972)

As mentioned earlier, the second phase consisted of the sampling of lake in a criss-cross manner at 48 stations. The sampling was done in a manner so as to cover each of the stations, at least, once in a season. The 48 sampling stations are marked in Fig. 1.

1. Physico-chemical factors

The physico-chemical features of the lake water during the three seasons between 8.15 and 13.15 hrs. were in the ranges : Depth, 0.75-4.00 m, turbidity, 0.65-3.30 m, Water temperature, 4.0-32.0°C, pH, 7.6-8.8; Dissolved Oxygen, 6.2-11.8 ppm, free carbon dioxide, nil-5.0 ppm, total alkalinity, 40.0-180.0 ppm, and silicates, 0.150-1.0 ppm. The analysis of the soil at 48 stations broadly indicated that 'Bed-Dal Lake' (1-24) has low to high values of carbon (0.50-4.46%), Phosphorus (P) medium to high (12.0-40.0 lbs/acre); Potassium (K) medium (Figures not supplied by the Agriculture Department) and pH, 5.7-7.3. In 'Lokut-Dal Lake' (25-48) the values of Carbon, low to high (0.54-2.54%); Phosphorus, low to medium (3.0-13.9 lbs/acre), Potassium, medium (Fig. not supplied by the Agriculture Department) and pH, 5.3-7.9 were recorded.

2. Plankton

In case of net plankton, the number of units per litre ranged between 6 and 1,576 against 390 and 43,560 units/minute in tow net samples. In both the cases two peaks - the first one in May and the second in August, were noticed. The areas where rich plankton concentration was noticed include stations 1-21 (Bed-dal) during all the three seasons. The minima were observed at stations 37-48 (Lokut Dal) where recreational activities are maximum and the submerged vegetation in very dense. In general the population of phytoplankton was more as compared to the zooplankton. The most common planktonic forms were Amphora, Cymbella, Navicula, Gomphonema, Fragilaria, Trachelomonas and Cosmarium among phytoplankton and Arcella, Brachionus, Lecane, Chydorus, Bosmina, Cyclops and nauplii of copepods among zooplankton.

3. Lake vegetation and the associated biota

The vegetation in the lake consisted mainly of submerged plants. The important genera were Myriophyllum, 38.18%; Ceratophyllum, 24.64%; Potamogeton, 21.28%; Hydrilla, 8.49% and Nymphaea, 3.73% by number. The remaining 3.68% was constituted by miscellaneous sp. including Salvinia and Trapa.

The fauna inhabiting the vegetation included Cladocera, 16.51%; Copepoda, 4.20%; nymphs of Ephemeroptera, 2.19%; larvae of Diptera, 14.32%; Oligochaeta, 3.37%; Mollusca, 4.12% and fish 52.32% by number. The remaining 2.97% included naids of Odonata and amphipods.

4. Bottom fauna

The bottom fauna included Naididae, 26.12%; Tubificidae, 47.84% and Chironomidae, 16.91%. The remaining 9.13% was constituted by molluscs, naids of Odonata and Ephemeroptera and nematodes.

5. Shore sampling

The littoral life of the lake was studied at 18, 24 and 24 selected spots during the summer, autumn and winter seasons respectively. The area of sampling at each station was 2.0 m². The shore vegetation consisted of submerged plants predominantly Myriophyllum, Ceratophyllum, Azolla, Salvinia, Potamogeton, Nymphaea and Hydrilla. The average number of plants during summer, autumn and winter were 144, 182 and 91 per two m² respectively. The fauna associated with littoral vegetation consisted of fish, molluscs, insects, amphipods, etc. Their average number per two m² during summer, autumn and winter was 124, 36 and 38 respectively. Table VII shows the percentage of littoral fauna during the three seasons. The predominant littoral faunal elements were naids of Libellulidae, Agrionidae, Aeshnidae, nymphs of Caenidae, larvae of Chironomidae, Rhyrinidae (Adults), Vivipara, Limnaea and Gyraulus.

TABLE - VII

Littoral Fauna of Dal Lake, Srinagar, Jammu & Kashmir

SEASONS	<u>Crosso-</u> <u>cheilus</u> <u>latus</u>	<u>Gambusia</u> <u>affinis</u>	<u>Barbus</u> <u>concho-</u> <u>nus</u>	Mollusca	Insecta	Misc.*
Summer	3.61	9.86	84.29	0.79	1.05	0.40
Autumn	0.18	3.80	73.69	8.97	5.91	7.45
Winter	0.15	2.32	75.71	4.40	15.82	1.60

* Includes Amphipods, leeches, tadpoles etc.

6. Primary productivity

The primary productivity of the lake as determined by dark and light bottle technique was found to be in the range of 20.996-31.227 mg $6/m^3/hr.$ during the three seasons.

7. Fish catches

The sampling of the lake with a conventional type of cast net (Specifications given in Table III) at 48 stations during each of the seasons was done. The species composition and the average percentage during the three seasons are given in Table VIII. The average catch per man hour during summer, autumn and winter was 171, 106 and 84 gm respectively.

TABLE - VIII

Species composition of fish catches of Dal Lake, Srinagar, Jammu and Kashmir

SEASONS	<u>S. niger</u>	<u>S. esocinus</u>	<u>S. curvifrons</u>	<u>S. micropogon</u>	<u>C. carpio</u>	<u>Botia birdi</u>	<u>Crossocheilus latius</u>	<u>Barbus conchonus</u>
Summer	6.07	0.94	1.87	-	36.91	23.83	14.96	15.42
Autumn	8.06	2.37	0.95	1.89	48.81	3.80	7.11	27.01
Winter	10.42	4.10	10.42	2.08	35.42	16.66	10.42	10.48

8. Feeding habits of the fishes

The analysis of food of common fishes of the lake showed that majority of the species utilised phytoplankton, zooplankton, decaying organic matter and insects. The detailed analysis of the food is shown in Table IX.

TABLE - IX

Gut content of the fishes of Dal Lake, Srinagar, Jammu & Kashmir

Species	Length range (mm)	Wt. range (gm)	No. of specimens	Mud & Sand	Detritus	Insects	Fish matters	Phytoplankton	Zooplankton	Misc.
1	2	3	4	5	6	7	8	9	10	11
<u>S. niger</u>	125-293	10-260	38	28.32	21.34	0.18	7.50	33.41	3.23	6.02
<u>S. esocinus</u>	155-395	30-480	9	48.80	30.00	1.00	5.80	11.00	2.00	1.40

1	2	3	4	5	6	7	8	9	10	11
<u>S. curvifrons</u>	112-212	10-60	10	41.20	21.70	0.30	3.40	29.30	1.10	3.00
<u>S. microgogon</u>	105-241	15-80	10	31.70	23.19	-	6.25	38.23	0.63	-
Average composition of food				37.50	24.06	0.37	5.74	27.98	1.75	2.60
<u>Cyprinus carpio</u>	84-385	10-800	136	29.43	26.83	10.13	-	30.67	1.50	1.44
<u>Crossocheilus latius</u>	60-115	-20	47	53.20	20.40	0.14	-	23.45	1.24	1.57
<u>Botia birdi</u>	60-120	-30	40	43.70	38.40	1.35	-	15.55	1.00	-
<u>Barbus conchonus</u>	10-80	-	18	31.60	34.00	-	-	34.40	-	-

Salient features of the investigations

Dal lake is a comparatively shallow lake, maximum depth being 6 m and it is rarely stratified during summer. Hence it can be classified as a third class lake (Hutchinson, 1957).

The lake waters are found to be alkaline (pH 7.2-8.8) with fairly high dissolved oxygen content (6.2 to 12.4 ppm). These as well as some other characteristics like total alkalinity are congenial for fish life. The oxygen content is highest in winter and least in summer which may be due to the presence of detritus and large standing crop of weeds and phyto-plankton using more oxygen in summer than in winter.

The flora of the lake was found to be very rich and provided a good substratum for periphyton growth. The phyto-plankton percentage in the total plankton was appreciably high and the poor percentage of zoo-plankton may be attributed to heavy growth of macrovegetation.

The analysis of fish catches during 1969-72 has shown that the exotic carp, C. carpio is gaining predominance over the more acceptable indigenous fishes of the sub-family Schizothoracinae. Due to prolonged spawning period, plenty of facilities (Aquatic vegetation) to spawn and higher rate of fecundity, the common carp breed profusely in the lake. Due to excessive rate of reproduction of common carp, the indigenous fish are losing their ground in the lake.

The gut study of Schizothorax niger and S. esocinus revealed that the former consumed fish and insects to the tune of 9.98% while the latter consumed 27.70%, showing that S. esocinus is a carnivore.

The practice of removing of bottom soil from the lake for raising artificial islands to grow vegetables and other farm products seems to be a harmful one. Considerable amount of nutrients in the lake bottom is removed every year. As shown by the analysis of bottom soil of the lake, it is rich in carbon, phosphorus and potassium.

RECOMMENDATIONS ON CONSERVATION AND DEVELOPMENT OF FISHES OF DAL LAKE

1. The fish catch of Dal lake mostly comprises Cyprinus carpio, Schizothorax niger and S. esocinus in order of abundance. The common carp which forms the major share of the catch (60-70%) consists of the size range 80-100 mm. The other two species are small both in numbers and size. With a multi-species fisheries and the various species differing in maximum attainable size, size at first maturity, fecundity etc. it is not an easy task to suggest conservation measures. However, considering the feeding and breeding habits and also the fecundity of different species, it is recommended that S. niger and S. esocinus measuring less than 200 mm caught in the nets be salvaged and returned to the lake alive.

2. Numerically the various species of Schizothorax are very low in the commercial catches at present. In these species, the eggs are laid at the bottom in running water stream under stones, gravel and debris (Sehgal, 1970 and Sehgal et al. unpublished). The fish spawns during May-June. There is only one stream the 'Arh' (Fig.1) which affords spawning facilities for Schizothorax spp. This stream is seasonal carrying snow water during April-June. In July, the stream gets cut off from the lake resulting in trapping of newly emerged fry and fingerlings. These fry and fingerlings ultimately perish due to desiccation, thus reducing the number of recruits every year. No breeding

is possible during winter months due to the drying up of the stream though the females carry eggs during this period also. Hence, to increase the abundance, it is recommended that the fingerlings of S. niger and S. esocinus about 80 mm in total length may be stocked in the lake at a combined rate of 100/ha on a phased basis extended over a period of 5 years. The stocking material may be procured by inducing the fish to breed by fish pituitary hormone administration. The spawners may be collected from the natural stream by using a bag net of type shown in Fig.2 and fixing a bamboo trap at the mouth of the stream. The hatching of the eggs may be done using hatching trays and boxes, (Fig. 3) kept in specially made enclosures at suitable places in the lake. The large number of "arms" of the lake are said to have high secondary production (Bashiruddin, Bali and Quereshi, 1971) and could be used for the purpose.

The supply of fingerlings could also be augmented by collections from other streams of the valley such as Sind, Lidder, Bringhi etc. (Sehgal et al. unpublished). These fingerlings which perish otherwise could be thus utilized for stocking the lake.

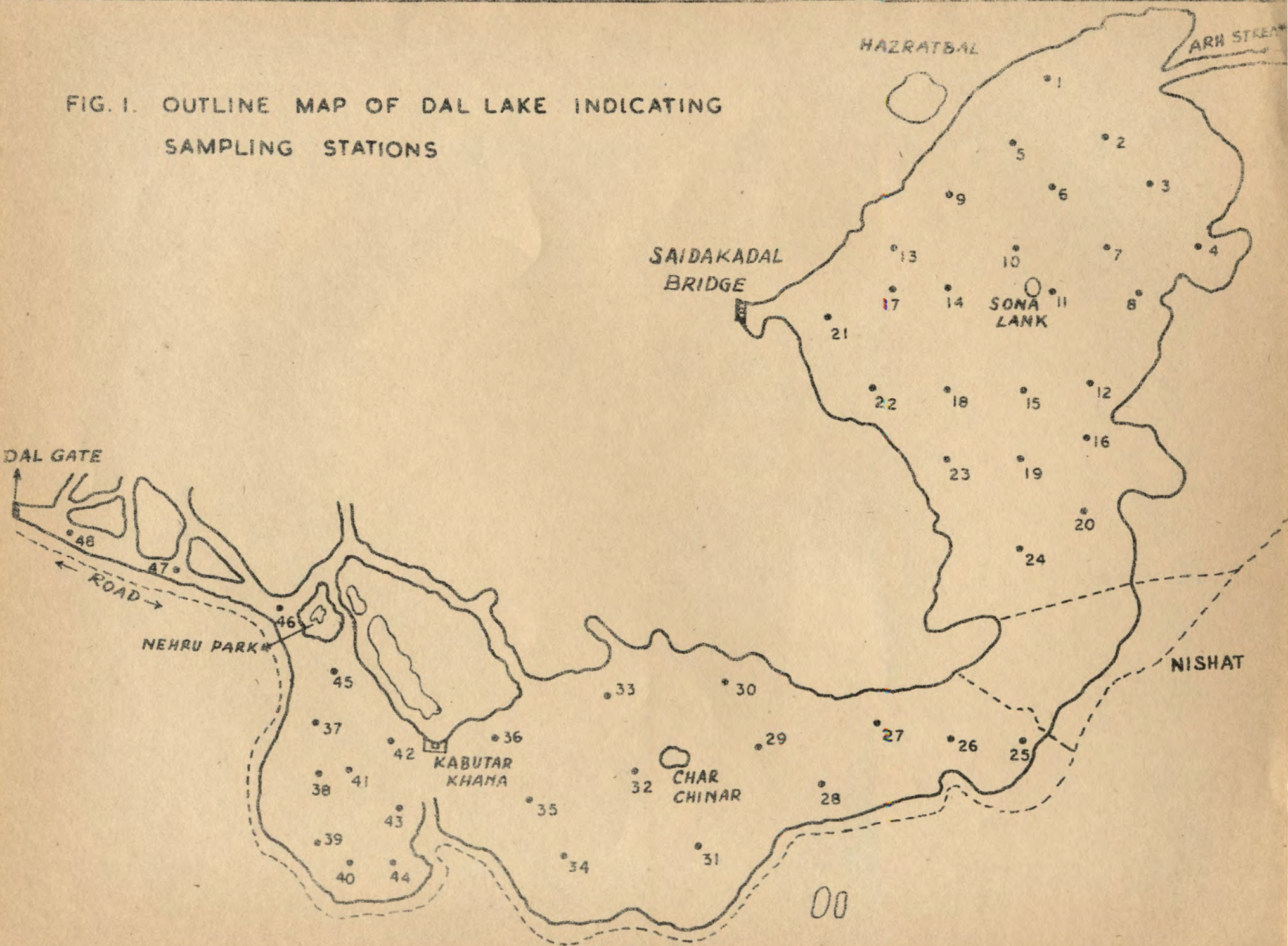
3. The spawning season of the indigenous fish Schizothorax spp. is observed to lie during April-June. These fish are known to ascend the stream 'Arh' for spawning. It is recommended that the restrictions on fishing strictly enforced at present in the 'Arh' stream be extended to an area of at least 1 km radius at the confluence of the stream keeping 'Sonalank' island as the limit.

4. It is evident from plankton studies that phyto-plankton is richly represented in the lake. Hence, it is recommended that the silver carp, Hypophthalmichthys molitrix (C & V) which is a phytoplankton feeder be introduced into the lake on an experimental basis. The suitable size to stock is 60-80 mm total length, and at a trial rate of 10,000/year.

5. The lake abounds in aquatic vegetation particularly Potamogeton, Hydrilla, Myriophyllum etc. These plants could be utilised by the grass carp, Ctenopharyngodon idellus (C & V).

Caution : (Before silver carp and grass carp are introduced into the lake, very careful study is to be made in ponds to study the behaviour of these fish in temperate climate of Kashmir. Considerable experimental work is required to be done under new ecological conditions on growth, maturity and spawning of these fish).

FIG. I. OUTLINE MAP OF DAL LAKE INDICATING SAMPLING STATIONS



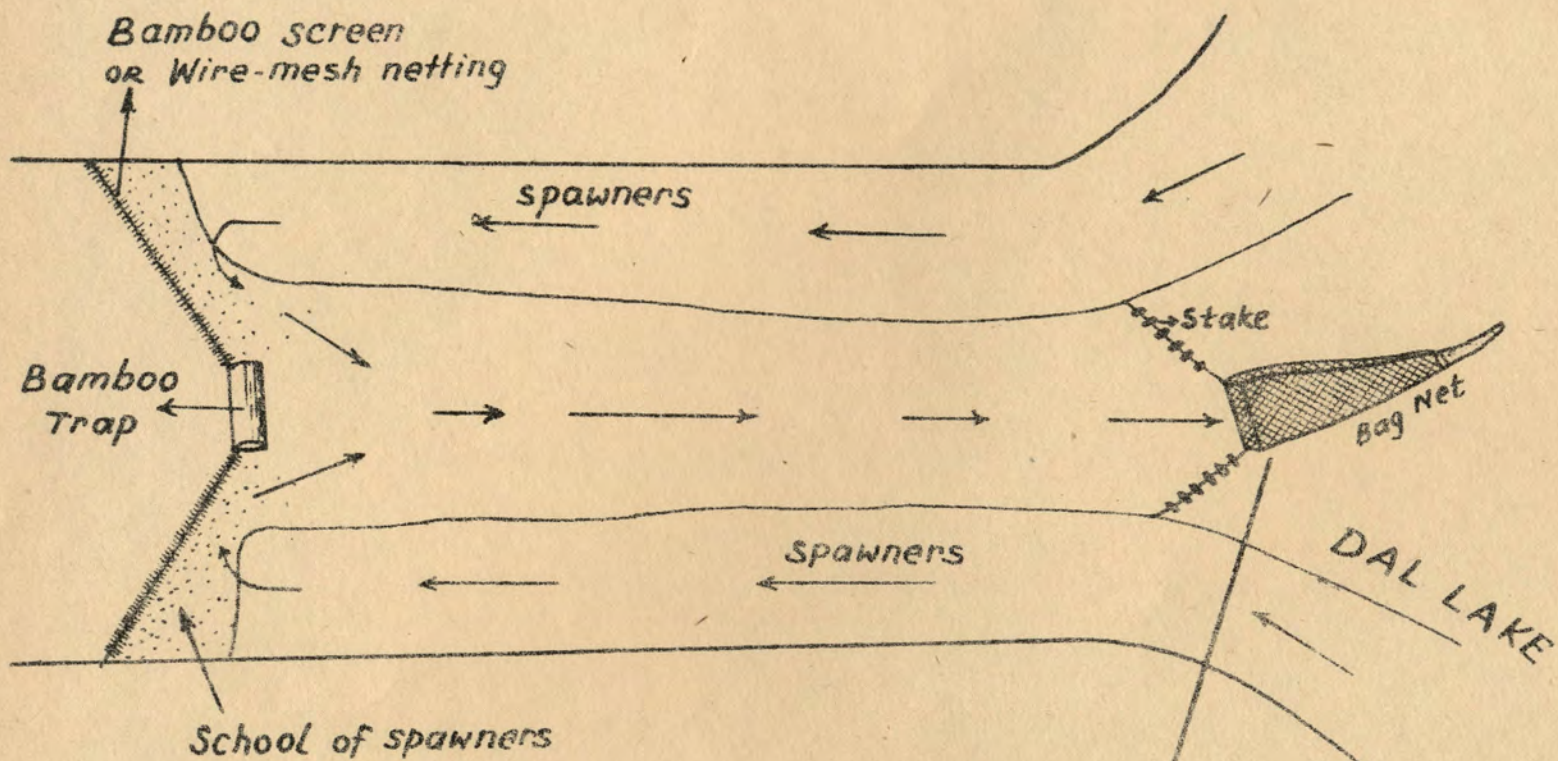
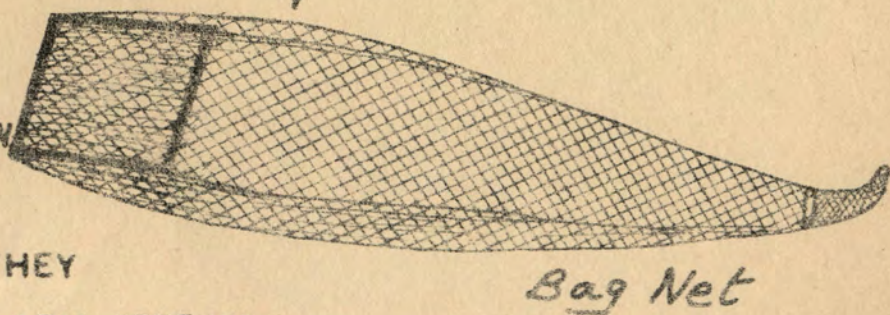


FIG. 2. DIAGRAMMATIC LAY OUT TO SHOW TRAPPING METHOD FOR SCHIZOTHORACID FISHES WHEN THEY MIGRATE FROM DAL LAKE INTO ARH STREAM FOR SPAWNING



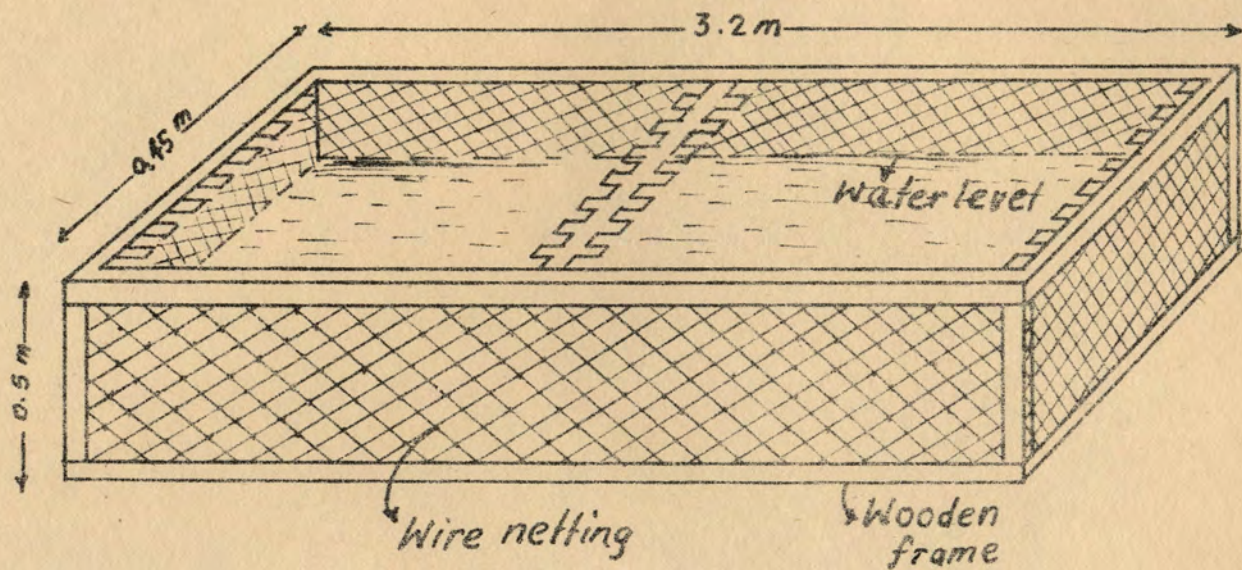


FIG. 3. HATCHING BOX WITH TWO HATCHING TRAYS TO INCUBATE EGGS OF SCHIZOTHORACID FISHES.

