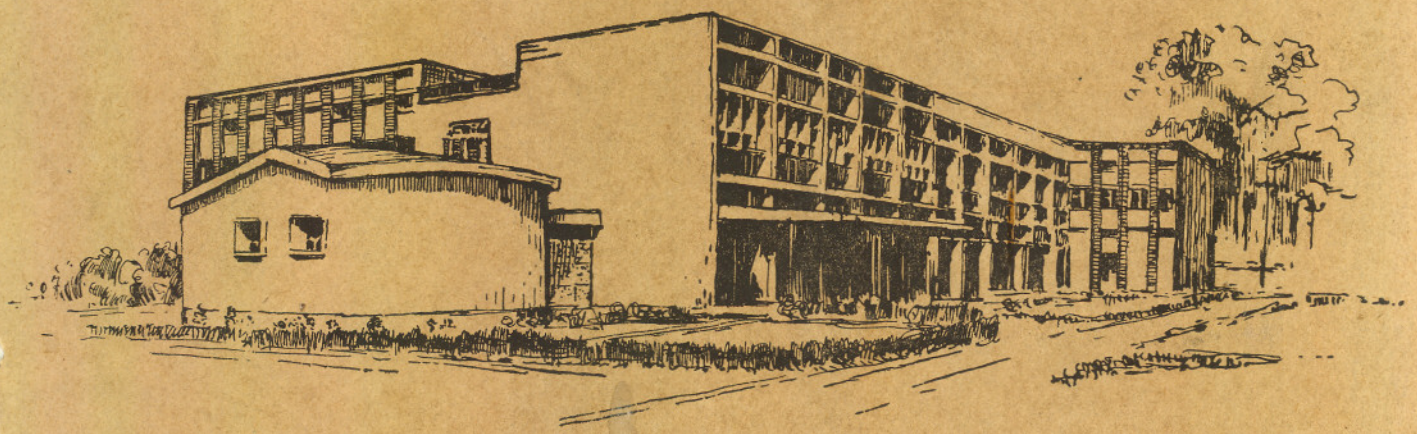
PRELIMINARY SURVEY REPORT ON THE HYDROBIOLOGY AND FISHERIES OF NAGARJUNASAGAR, ANDHRA PRADESH



Survey Report No. 5
June, 1969

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
CENTRAL INLAND FISHERIES RESEARCH INSTITUTE
BARRACKPORE, WEST BENGAL
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CONTENTS

1 INTRODUCTION

Nagarjunasagar is proposed to be the main co-ordinating centre under the Co-ordinated Research Project Programme of the Indian Council of Agricultural Research to be undertaken during 1969-74 by the Central Inland Fisheries Research Institute jointly with the Directorate of Fisheries, Andhra Pradesh, for "Studies on the ecology and fisheries of fresh-water reservoirs". Proper development of the fisheries of 300 and odd reservoirs in India can perhaps best be done by a detailed study of the behaviour of fish population under the diverse ecological conditions obtaining in selected reservoirs. Though preliminary experimental and developmental measures have led to increased fish production in certain reservoirs, in view of the varied results obtained from place to place, it has so far not been possible to formulate standard developmental techniques and recommend management practices based on the ecology of the reservoirs. With a view to developing the fisheries of the reservoirs to the best possible extent, such studies are intended to be initiated to start with in Nagarjunasagar in Andhra Pradesh, Bhavanisagar in Tamil Nadu and Rihand Dam in Uttar Pradesh. Preliminary investigations of Nagarjunasagar were conducted during 12.2.1969 to 12.3.1969 by the author with the help of members of the staff attached to Tank Fisheries Research Unit of the Institute at Bangalore for assessing the fishery potential and for formulating a research programme taking into congnizance the existing conditions of this reservoir. Information on various hydrographical, hydrobiological and fishery potential of Nagarjunasagar, presented here, were collected by actual field investigations. The reservoir, being a deep one, presents certain unique features which require special consideration in drawing a technical research programme.

2 DESCRIPTION OF THE RESERVOIR

Nagarjunasagar reservoir is formed as a result of impounding the waters of the perennial river, Krishna, traversing the deep ravines of the Nallamalai hill ranges, at a place half-a-mile downstream of Nandikonda village (now submerged) in Miryalguda Taluk of Nalagonda district of Andhra Pradesh. It is situated at Latitude 16°34' North and Longitude 79°19' East. The impoundment of the reservoir was started in 1962, after the closure of construction sluices. The concrete type dam is 367 ft (111.86 m) high with a length of 4,756 ft (1,447.6 m), with a non-overflow masonry dam of 3,211 ft (978.7 m) comprising both right and left flanks.

The left earthen dam is 8,400 ft (2,560.3 m) in length and the right one 2,800 ft (853.4 m). Seasonal Peddavagu and Dindi are the two streams draining into the reservoir during floods.

The reservoir has a maximum water spread area of 110 sq miles (28,490 ha) at full level (i.e. at E.L. 590) when the water storage capacity would be at 9.3 m. ac. ft. (4,05,201 m.c.ft.). While the live storage is 5.47 m.ac.ft. (2,38,327.9 m.c.ft.), the minimum or dead-storage is assessed to be 3.8 m.ac.ft. (1,65,566 m.c.ft.), which implies that the storage potential of the reservoir is the highest of any reservoir in India and even at dead storage, the reservoir is the deepest in India (150 ft or 45.72 m). The reservoir is situated in a deep ravine 60 miles (96 km) long with abrupt margins at a slope of 45-60°. Owing to ravinous nature of the terrain, rise in water level can only be noticed in depth variations, the extended shallow areas being greatly limited exhibiting restricted inundated margins.

Since an average depth of 197.7 ft (60.35 m) is observed (at level E.L. 531) right from the reservoir portion to the original river junction (tail end) extending upto Srishailam, shallow areas totalling 5-8 sq miles are limited and restricted to bay like extensions in pockets at Peddamonagal, Right Bank extension (Shinkishela) and Eleswaran (Fig. 1). The total length of the reservoir at full reservoir level (E.L. 590) is about 60 miles (96 km) extending right upto Srishailam where a dam is under construction. During the survey period, when the reservoir level stood at E.L. 513.82, the lacustrine limit extended upto a point 3 miles (4.8 km) downstream of Srishailam. The river descends at this point from a considerable height through rapids.

There are two tributaries of the Krishna, the Dindi and Peddavagu, both of minor importance, Dindi being a seasonal river and Peddavagu a seasonal stream (Fig. 1).

Only the Nagarjunakonda, Peddamonagal and Shinkishela Bays are accessible by road. No other portion of the reservoir is approachable, owing to the deep ravines, except through water.

3 HYDROGRAPHICAL FEATURES

Meteorological conditions of the reservoir appear to be unlike Tungabhadra reservoir. The reservoir is free from wind and wave action for major part of the year. The reservoir comes under the influence of the south-west monsoon and receives rain during the period June/July-August. The mean annual rainfall of the area is 35" (87.5 cm), with a catchment area of 83,087 sq miles (2,15,19,533 ha). The silt-laden inflowing rain water has already resulted in the deposition of 60-70 ft (18.29-21.33 m) of silt in the reservoir.

While the minimum discharge at the dam site during dry weather is estimated at 100 cusecs, the maximum discharge so far observed was 11,70,000 cusecs in 1964 (Table 1). Major influx of water into the reservoir comes from the main Krishna river. The quantities brought in by the two tributaries, the Dindi and Peddavagu appear to be low, their actual inflows having not been assessed. The average draw-down of water is 4" (10 cm) per day through the two right and left canals and the diversion tunnel, which regulates the water supply to the river below the dam for deltaic cultivation of the Krishna. This draw-down will probably increase after the installation of 8 generators is completed.

4 HYDROBIOLOGICAL CONDITIONS OF THE RESERVOIR

Division of the reservoir into distinctive zones as in Tungabhadra reservoir, such as deep, transitional, shallow, and riverine portions, is not possible owing to the uniformly deep and ravinous nature of the reservoir resembling in this respect the Gobindasagar Reservoir of the Panjab (Bhakra-Nangal). Hence littoral and benthic features of the reservoir are not distinct. However, in order to have a preliminary understanding of the biogenic factors and their interaction, 9 stations, covering the major part of the reservoir, were arbitrarily selected for hydrological and biological observations and experimental fishing.

The centres so chosen were :

I. Reservoir portion	Max. Depth
1. Pump House	60 m (196.8 ft)
2. Pylon Colony	56 m (183.0 ft)
3. Mid Reservoir	65 m (213.3 ft)
4. Nagarjunakonda	60 m (196.8 ft)

II. Bays	5. Shinkishela	5 m (16.4 ft)
	6. Nagarjunakonda Bay	30 m (98.5 ft)
	7. Peddamonagal	5 m (16.4 ft)
	8. Eleswaram	2 m (6.6 ft)
III. Tail-end	9. River joining point	60 m (194.8 ft)

4.1 Hydrological conditions

4.1.1 Physico-chemical conditions of water

At most of the stations, samples from surface to 10-20 m at 5 m intervals, were collected. In the bays, only surface and bottom collections were made. The ranges in the various chemical constituents of water are shown in Table 2.

It was observed that bathymetric temperature variation is not significant indicating non-existence of a thermocline. pH of the water is on the alkaline side. The alkalinity range of 48.0-157.0 mg/l, with hardness varying from 29.6-109.2 mg/l, indicates moderate bicarbonate hardness and a congenial medium for the subsistence of fish life. Dissolved oxygen concentration (5.28-8.0 mg/l) is at a satisfactory level. Specific conductivity values (383-536 x 10^{-6} mhos at 25°C) reveal fair concentration of dissolved salts. The values are almost at par with those of corresponding months in the Tungabhadra reservoir. The nutrients-phosphate and iron are poor but nitrate is comparatively high.

Primary productivity values ranged from 250.0 to 709.2 mg C/m^3/day (10.46 to 29.54 mg C/m^3/hr). Dam site (Pump House), Pylon Colony (with algal patches) and Peddamonagal exhibited greater numbers (concentration/density) of phytoplankters and showed correspondingly higher productivity values. In view of high clarity of water and favourable temperatures with relatively denser phytoplankton, gross productivity was observed to be more at 5-10 m depths at almost all the centres of observations than at surface and deeper layers.

4.1.2 Soil phase

Chemical conditions of soil are shown in Table 2A. It is seen that the soil pH ranges from 7.2 to 7.6 showing neutral to slightly alkaline reaction. Available phosphorus is extremely poor at all sampling centres except that of Pylon colony (11.8 mg/100 gm) and Eleswaram (3.8 mg/100 gm) where it is fairly high and medium respectively. The soil is comparatively rich in nitrogen content except at Dam site (0.04 mg/100 gm) and River mouth (0.04 mg/100 gm). Total nitrogen is highest at Nagarjunkonda (0.22 mg/100 gm), where organic carbon is also maximum (2.42%). Like soil phase, corresponding water phase (Table 2) has shown extremely low phosphate (Traces - 0.006 mg/l) and fairly high nitrogen content (0.08-0.20 mg/l). In general, organic carbon and exchangeable calcium range from medium to high values. C/N ratio at each centre is within a favourable limit (8.3-11.0) except that at River mouth (19.8 where it is comparatively wide.

Based on soil characteristics, the fertility status at each centre is indicated in Table 2A.

4.2 Biomass structure

4.2.1 Vegetation

The reservoir, being ravinous and full of rubbles and stones with precipitous banks, appears to be devoid of higher aquatic vegetation. Even in the shallower bays, save for algal filamentous formations, no vegetation of higher types was noticed.

Algae are found along the margin at Pump House and Pylon Colony side areas. Floating scum and algae found along the margins, consisted of Mougeotia (75%), Oscillatoria (15%), Oedogonium and Spirogyra (10%) on the Pylon Colony side and the scrapings from submerged substrata revealed diatoms comprising Synedra, Fragillaria, Tabellaria, etc. Sparse algae formation along the Pump House marginal areas consisted only of Spirogyra. Dislodged algal filaments contribute to the food source for fishes at these places. Microcystis concentration was significant at Peddamonagal Bay area. It occurred in stray numbers in Nagarjunakonda.

4.2.2 Benthic and littoral biota

Benthic and littoral biotal composition is very poor comprising only chironomids in stray numbers in the silty benthic areas of the origianal river course. Bottom and littoral areas being sandy in other places, invertebrates are virtually absent. Insect life is very poor. Sparse insect life mainly comprising corixids (Corixa sp.) was observed at Eleswaram Bay region and mayfly nymphs at Peddamonagal area, the only areas where some kind of bottom organisms were recorded. Very rarely encountered dead gastropod molluscan shells indicate the occurrence of such forms as Pleurocera, Gyraulus, Horatia (?), etc., in Peddamonagal area. Peddamonagal, with disintegrating organic mucky bottom, may serve as sustaining ground for mulluscan fauna at a later stage.

4.2.3 Plankton

Table 3 indicates group-wise plankton constituents at various centres of observations at different depths. The reservoir as a whole presents a poor plankton structure with a density range of 12 to 320 units/litre. 5 m and 10 m depths exhibited greater densities of phytoplankton.

Phytoplankton dominated at Dam site (Pump House) (80.9%), Pylon Colony (82.82%) and Nagarjunakonda Bay (59.8%) where algal strands developed along the margin, and on being dislodged from the submerged rocks/pebbles etc., entered the plankton net. While Myxophyceae (Microcystis) constituted the phytoplankton at Peddamonagal, Chlorophyceae (Oedogonium, Ulothrix, Mougeotia, Spirogyra) formed the major constituent at Pylon Colony, Pump House and Nagarjunasagar Bay. Diatoms, developing on the algal strands and submerged substrata, comprised Pennales like Synedra, Fragillaria, Diatoma, Asterionella. Microcystis with Centrales like Melosira and Cyclotella were observed to be in abundance in Paddamonagal Bay where organic disintegration at the mucky bottom must have favoured their growth and multiplication.

Among the zooplankters, Protozoa were observed to be poorly represented in the samples with comparatively greater numbers at Peddamonagal area largely comprising Ceratium. Copepods consisted of Cyclops, Diaptomus and nauplii (40.0% in Peddamonagal to 100.0% in Pump House and Eleswaram Bay).

Daphnia and Diaphanosoma constituted the Cladocera which formed the important group next to Copepoda at Pylon Colony (35.3%), Nagarjunakonda (28.6%), Mid Reservoir (20.0%) and Nagarjunakonda Bay (13.3%). March, being the summer month recording higher temperatures, should have favoured abundant growth of zooplankters. The overall zooplankton density ranged on the average between 8 and 250 units per litre.

The following were the various planktonic genera observed during this investigation.

PHYTOPLANKTON

Myxophyceae :	Oscillatoria	
	Microcystis	
Bacillariophyceae :	Synedra	Pannales
	Tabellaria	Pannales
	Navicula	Pannales
	Fragillaria	Pannales
	Diatoma	Pannales
	Asterionella	Pannales
	Cyclotella	Centrales
	Melosira	Centrales
Chlorophyceae :	Ulothrix	
	Mougeotia	
	Spirogyra	

ZOOPLANKTON

Protozoa :	Ceratium
Rotifera :	Keratella
	Brachionus
Copepoda :	Diaptomus
	Cyclops
Cladocera :	Daphnia
	Diaphanosoma

5 FISH AND FISHERIES

5.1 Fish fauna

A complete list of 38 species of fish recorded together with their observed size ranges is given in Table 4. The fish fauna is similar to that of Tungabhadra reservoir. As in Tungabhadra reservoir catfishes dominate over the carps both by numbers (53.1%) and weight (69.4%) in the catches, the rest being carps (42.9% by number and 26.4% by weight) and miscellaneous forms (Anguilla sp., Notopterus notopterus, etc.) (4.0% by number and 4.2% by weight)(Table 5). While by numbers, Silonia childrenii (24.99%), Mystus aor (23.52%), and M. seenghala (19.14%) were observed to constitute the bulk among catfishes, by weight M. seenghala (33.35%), Mystus aor (23.55%), Wallago attu (17.17%) and Mystus punctatus (16.47%) dominated. Osteobrama cotio, Barilius bendelesis, Garra gotyla, etc. which are riverine in habitat, were not observed in the reservoir proper but were available in Peddamonagal (Peddavagu River) Bay and the river below the dam.

Kontivala catches are used for bait and are sundried when not disposed of in fresh condition. Samples together with cast-net operations revealed the following young fish composition. Kontivala are miniature 'alivi' nets. But, unlike in Tungabhadra reservoir, where 'alivi' is employed in shore-seining, in Nagarjunasagar , Kontivala is used as a surface seine owing to the absence of even bottom and hauled up very quickly with the help of coracles. The net helps in capturing shoaling fishes.

Place	Species	Nos.	Percentage
Nagarjunakonda	Oxygaster phulo	33	97.05
	Pseudeutropius taakree	1	2.95
Paddamonagal	Garra gotyla	1	4.35
	Osteobrama cotio	8	34.95
	Osteobrama vigorsii	2	8.60
	Glossogobius giuris	2	8.60
	Ambassis ranga	5	21.25
	Prawns (Leander sp.)	5	21.25

Pylon Colony	Pseudeutropius taakree	12	34.29
	Oxygaster phulo	16	45.81
	Ambassis ranga	4	11.43
	Glossogobius giuris	3	8.57
Eleswaram	Rita hastata	3	3.40
	Glossogobius giuris	12	13.62
	Osteobrama cotio	16	18.18
	Ambassis ranga	52	59.10
	Oxygaster phulo	3	3.40
	Barilius bendelesis	1	1.10
	Pseudeutropius taakree	1	1.10
River below the Dam	Puntius ticto	5	17.26
	Ambassis ranga	4	13.79
	Barilius bendelesis	6	20.69
	Haplocheilus lineatus	12	41.38
	Mastocembelus armatus	1	3.44
	Channa sp.	1	3.44

Concentration of catfishes in Eleswaram Bay and other Bays is due to the young-fish prey "pasture" available to predators.

The river below the dam should have harboured riverine fishes in abundance but in view of the reported large-scale endrin poisoning, sometime prior to the survey, the stretch below was denuded of fishes.

Fish catch composition of the reservoir indicates that the existing fishes are all relict riverine fishes trapped in the wake of the reservoir formation in the past 7 years. They are still continuing to thrive. A stabilised reservoir fish population is yet to be established, when the picture may change.

The eel (Anguilla bengalensis), in particular, is one such which may in course of time disappear from the fishery as scope for migration of elvers up the reservoir faciliatating recruitment is impossible. Instances of disappearance of mahseers (Tor sp.), Labeo fambriatus/ Puntius dubius with /and the onset of lacustrine conditions are on record in India. With the establishment and stabilisation of the reservoir fish fauna, Puntius kolus is likely to contribute considerably to fish yield in course of time as it can breed in the reservoir and has a prolonged breeding period as observed in the Tungabhadra reservoir. If adequate molluscan fauna can be made to establish, then a fishery of Pangasius pangasius, as in Mettur reservoir, can be expected in the reservoir at a later date.

5.2 Commercial fishing

Though licencing for various types of gears is in vogue since 1965, it is reported that active fishing in the reservoir proper commenced only from 1968 onwards. Fishermen, to start with, were all reported to be confining fishing operations to the river below where fish catches were encouraging. With the reported endrin poisoning of the river below the Dam in November, 1968, the riverine fish fauna got denuded and as such fishermen were obliged to fish in the reservoir.

There are no boats in the reservoir but the migrant fishermen from the deltaic areas use coracles and a few local fishermen, as at Peddamonagal, employ rafts, numbering 28 during the survey, made of sealed tins covered with gunny cloth.

The following are the different fishing gears employed in the reservoir :

	No. of units licenced during 1968-1969	
Cast Nets	44	
Rangoon nets/Uduvala	18	(One coracle consisting of 4 nets of 28 m x 1 m of 30 mm bar mesh.)
Drag nets (Kontivala)	15	(50 m long x 2 m high of 60 mm mesh with 50 m ropes on either side)
Triangular nets (Toplavala)	4	Operated only during floods along the margins.
Long-lines (100 hooks/unit)		

Fishermen employ mostly 'Uduvala' (bottom-set gill nets) and are reported to fish throughout the year. The peak period of fishing lasts for about 3-4 months during turbid water conditions of the flood season (June-October). As fishing in the main reservoir is not possible during monsoon, fishermen congregate in areas beyond Eleswaram, Peddamonagal, where ascending Catla catla are reported to have been captured. Labeo fambriatus and Labeo calbasu, with well developed gonads, dominate the catches during floods. Comparatively poorer catch between March and May is attributed to sporadic winds.

Table 4 indicates the fishes recorded during the period of survey. 38 species belonging to 8 families were encountered.

5.3 Estimated fish production

Observations on the fish landing on 15 days during the period 12.2.1969 and 12.3.1969 revealed that, on an average, 80 kg of fish are landed, being the catches of uduvala, Rangoon gill nets and hooks, the latter two units being sparsely employed. Active fishing days can be taken as 350 days in a year at present.

Fishing with uduvala, Rangoon nets and hooks @ 80 kg/day for 245 days in a year	.. 19,600 kg or 19.6 tonnes
@ 160 kg/day for 105 days during monsoon season	.. 16,800 kg or 16.8 tonnes
Catch computed based on 'Kontivala' fishery @ 8 kg/day for 90 days for 10 units	.. 7,200 kg or 7.2 tonnes
	43,600 kg or 43.2 tonnes

Maximum water-spread area 110 sq miles or 28,490 ha

Annual fish production at present (calculated) 1.53 kg/ha

In a newly-formed, virgin reservoir, a production of 1.53 kg/ha is quite encouraging. In this contest, it is interesting to note the fish production of other reservoirs like Tungabhadra (6.2 kg/ha), Bhavanisagar (12.7 kg/ha), Mettur (39.0 kg/ha) and Keetham (250 kg/ha). With the stabilisation of a reservoir fish fauna, the yield can be expected to increase considerably in the next few years.

Analysis of fish landings has revealed that predatory catfish population dominated over carps (Table 5) as in several reservoirs elsewhere in India like Matatila, Sardasagar, Bhainsura, Latifsha and Tungabhadra. Catfishes are to be effectively controlled to ensure the self-perpetuation of economically important carp varieties feeding on lower food chains.

Fishermen fish in far-flung areas (Peddamonagal, Rayavaram, Eleswaram and Pendotta) in the reservoir at present and daily commute 6 to 8 hours in coracles for landing their catches on the right bank Pump House centre between 7.30 and 9.00 A.M. This is because there are no proper landing and marketing centres except near the Dam site. As such, the reservoir has no scattered assembly or landing centres unlike Tungabhadra Reservoir. Fishes thus landed are bought by Pylon Colony fish merchants at Rs. 1.25 per kg who, in turn, transport them to Hyderabad and elsewhere by bus from the left bank (about 11 km) disposing a part through vendors, locally. As the catches are small in quantity and in the event of refusal by bus authorities due to packing in ice, fishes are sent in baskets without ice-packing. If the catches are less or cannot be disposed of in fresh condition, they are degutted and fillets sundried at the fishing centres for disposal later on.

Fishermen operating in Peddamonagal area can easily transport their catches to Hyderabad as buses touch a nearby point. Rehabilitation of fishermen in that area may facilitate disposal of catches directly to Hyderabad. A fast-moving motor-boat can, however, collect catches from the fishing centres and bring them to the landing centre at the Pump House which will be an impetus for better fishing to the fishermen.

5.4 Experimental fishing

5.4.1 Gear efficiency

"Rangoon" gill nets of varying mesh sizes (30-60 mm bar) were employed for experimental fishing to assess the relative efficiency of the gears. Experimental fishing was conducted at 7 centres for a period of 12 days using 7 nets (175 m in total length and 3 m height), thus making a total net area of 525 sq m (details are indicated in Table 6). Nets were employed at the sub-surface and mid-column levels.

While the total yield was 0.026 kg/sq m for all the nets collectively, a maximum of 0.009 kg/sq m (54.2% of the total catch) was from the net having a mesh-size of 30 mm bar which hence proved to be the most efficient. 60 mm (0.007 kg/sq m) and 50 mm (0.005 kg/sq m) bar nets were observed to be more effective than 40 mm (0.004 kg/sq m) bar net. However, nets with 40 mm mesh superseded over 50 mm and 60 mm bar nets, when numbers of fish caught were taken into consideration.

Osteobrama vigorsii comprised bulk of the catches by number in 30-mm (55.44%) and 40-mm (47.64%) bar nets, while Labeo fimbriatus dominated both by weight and number in 50-mm (41.16%) and 60-mm (62.5%) bar nets. Silonia childreni, together with Osteobrama vigorsii, comprised the bulk of catches, by weight, in 30-mm meshed nets while Osteobrama vigorsii and Labeo fimbriatus contributed to the bulk of 40-mm net catch. Carps dominated (71.4% by number and 66.7% by weight) over catfishes (27.9% by number and 33.0% by weight) in the experimental fishing nets. Because of differences in gears employed, commercial fishermen using mainly uduvala and hooks and lines, a catfish dominance in commercial fish catch was observed.

Table 7 indicates the relative abundance of fishes both quantitatively and qualitatively in the different areas of experimental fishing. Paddamonagal and Eleswaram, the two shallow bays, showed the maximum fish catch of 0.005 kg/sq m net area/day, while the other zones i.e. reservoir portion (Pump House, Pylon Colony, and Mid-reservoir) exhibited a catch of 0.002 kg/sq m net area/day. The lowest catch recorded was from Nagarjunakonda Bay with 0.0012 kg/sq m net area/day. Qualitatively, not much of a variation was observed between the various zones, though assorted species were caught in Pylon Colony, Peddamonagal areas. These experiments were highly preliminary and as such the conclusions are only tentative.

5.5 Canal fisheries

The right canal of Nagarjunasagar runs a total length of 247 miles (397.5 km) and the left one for 218 miles (350.8 km). Buggavagu, on the right canal, and Devalapalli, across the left bank, are the two pick-up reservoirs which greatly help in the development of canal fisheries. Since escapement of fishes from the reservoir into the canals owing to their low off-take levels is limited and since no connections betwen streams and the canal are observed, the canals do not hold fish in quantity at present in contrast to Tungabhadra reservoir canals. Examination of a fishing unit (cast-net) in the canal showed only Oxygaster spp. For capturing 4 kg

of this fish, the fishermen had to cover 6-8 miles (9.6-12.8 km) of the canal. Stocking of the canal with fast-current forms of fishes and bottom scrapers (Labeo spp., mahseers, etc.) between the Dam and the Pick-up reservoir portions, will greatly contribute to the fish yield from the otherwise fallow canals.

As breeding of fishes does not take place in canals, there cannot be any auto-stocking and hence stocking will have to be a recurring feature.

6 REMARKS

The reservoir holds clear water of low nutrient value. Heavily silt-laden Krishna river water may add to the basic fertility of the reservoir in course of time and this is expected to build up fertility in the deeper areas. Cultivated fields in patches around Peddamonagal and Eleswaram Bays enrich only those bays.

Shallower areas being highly limited in area, maintenance of abaundant invertebrate fauna within the reservoir is ruled out. In the deeper silty areas, only stray chironomids are at present observed. Elsewhere the benthic organisms are still to be established. Only a few insect representations could be noticed in patches, as already stated.

The reservoir holds only limited juvenile population which at present comprises Oxygaster spp. and young Pseudeutropius taakree. The existing 'forage' fish population is very poor as compared to Tungabhadra reservoir.

The harvested fish stock is assessed to be at 46 metric tonnes per year at present based on factual observations and computations during the survey. Even with natural 'wild' population, the reservoir has shown a production of almost 1.53 kg/ha. With the stabilisation of reservoir fisheries, production can be expected to go up considerably. Catfishes are likely to establish better than the carps as their large-scale recruitment from above, as in Tungabhadra reservoir, is possible.

With regard to fish composition and improvement of stocks, the reservoir fish composition exhibits an abundance of catfish (53.1% by numbers and 69.4% by weight), with carps forming only 42.9% by numbers and 26.4% by weight. L. fimbriatus, L. calbasu, Cirrhina reba, C. horai, Puntius sarana constitute the carps with stray Puntius pulchellus, P. dobsonii, P. tor, Thynnichthys sandkhol, Labeo bata and L. pangusia. O. vigorsii also contributes considerably to the reservoir fishes. Juvenile and immature catfishes are found in the bays.

Replacement and replenishment of the fish stock in the reservoir by desirable carp varieties would help in increased fish production.

Breeding of riverine fishes within the reservoir is rare with the exception of Labeo dero, Puntius kolus, P. sarana, O. vigorsii and perhaps some Mystus spp. and probably T. sandkhol. Fishes are known to ascend up the riverine limits of reservoirs for breeding, being attracted by floods as in Tilaiya, Tungabhadra, Mettur and Bhavanisagar reservoirs.

As established in Tungabhadra reservoir, initial floods attract catfishes and this is also the case in Nagarjunasagar. Any stocked breeders ascending in Nagarjunasagar cannot escape above because of the Srishailam Dam on the Krishna and Dindi Dam above the Dindi Bay. Inflowing rain water may attract some fishes into Peddavagu river where mature specimens in running condition are reported to have been caught at Peddamonagal as also in Dindi river portions. Fishes may breed in these seasonal tributaries where shallow breeding grounds are available. Ravinous nature of the main Krishna river may not offer any grounds for breeding except in blind creeks like Pendotta and others. Even if breeding takes place in the river above, recruitment possibilities appear to be far less owing to the settling of eggs at the bottom and consequent destruction. After the construction of Srishailam Dam, even the limited recruitment from the river above will disappear.

Gut contents of 67 specimens of 10 species captured in experimental nets from different localities were examined the details of which are given in Table 8.

Guts of predators (catfishes) were observed to be invariably empty due probably to degurgitation at the time of capture. However, a few guts showed the remnants of 'forage' fishes like Oxygaster spp. and Ambassis spp.

All Labeo spp. were observed to subsist on the algal filaments and diatoms growing on loose soil at the bottom. L. fimbriatus and L. calbasu feeding at the bottom exhibited sand. Significantly, zooplankters in the feed were never encountered. Fishes such as O. vigorsii, P. taakree and other varieties showed insect remains in places where no insect life was noticed and the insects in the feed may hence be terrestial forms falling into the water (swarms of mayfly were noticed around the reservoir during the period of the study). Guts of P. pulchellus showed exclusively filamentous algae constituting 0.150 kg (17.6%) on the average body weight of 0.850 kg. Guts of T. sandkhol revealed a composition of diatoms only from Eleswaram Bay area.

7 RECOMMENDED DEVELOPMENTAL MEASURES

1. To ensure better marketing facilities, catches should be collected at fishing sites and brought to the landing centre by employing a power-boat.

2. Ice should be supplied to fishing parties to ensure quality.

3. Effective gear such as 30-40 mm gill nets, surface-seining, drag-nettingetc., should be popularised.

4. The reservoir should be intensively stocked with major carp fingerlings besides rescuing breeders and fingerlings of indigenous species. Exotic varieties like Puntius dubius, Cirrhina cirrhosa, Labeo dero (known to breed in Bhakra-Nangal), the fresh-water prawn Macrobrachium malcolmsonii should also be introduced for improving the fish fauna.

Adequate number of fingerlings for stocking of both Gangetic major carps and indigenous carps like Tor spp., Labeo fimbriatus, etc., should be raised by induced breeding.

5. Breeders should be protected by declaring 'closed' seasons during monsoon months when they are reported to ascend and/or enforce mesh regulations during the breeding period, to be ascertained by detailed biological studies.

6. Shallower and deeper fishing areas should be cleared of obstructions (tree-stumps, rocks ,etc.) after charting with echo-sounders during minimum reservoir level.

8 RECOMMENDED RESEARCH PROGRAMMES

1. Fertility trends should be studied by an analyses of inflowing nutrients, leaching, utilisation by biomass, etc.

- Organic fertilisers should be applied in bays to ensure increased fertility. Exposable marginal fields around shallow bays (Peddamonagal, Eleswaram) should be ploughed and fertilisers integrated into the soil for later leaching. The mode of dissemination of nutrients and losses, if any, from such bays into the reservoir and from the reservoir proper, should be ascertained by a study on the disposal by employing radioactive elements such as C_{14}, P_{32} etc. On an experimental basis, this study can be initiated in Shinkishela Bay close to the Dam.

2. Utilisation of nutrients by the biomass should be known by a correlated study on the quality of water and plankton and invertebrate organisms production (i.e. hydrobiological studies) influenced by edaphic factors.

- Fertilisers would help increase plankton production.

- Biotal organisms and aquatic higher plants which are absent at present are to be introduced for building up invertebrate fish food organisms. Their survival trends should be studied, and correlated with fish production considering their quality and numbers per unit area.

- Limnological and primary productivity studies now being done at 7 centres by the Department of Fisheries, Andhra Pradesh, should be continued and extended to other centres. Influence of hydro-graphical, biological, climatic and meteorological features on plankton production should be studied in detail.

3. Survival, migration and growth of fishes introduced in the reservoir should be studied by marking and tagging experiments.

4. Breeding periodicities and breeding potential of fishes should to be ascertained and spawning grounds located. Protection facilities for self-replenishment of the stock should be offered.

5. Ascent of breeders, breeding and recruitment should be studied at Srishailam during floods to ascertain the spawning success. This study should be correlated with the trends in the availability of limnetic larvae and young of fishes in the reservoir.

6. Loss by way of predation should be known by food studies of predators and prey-predator ratios.

- It is necessary to build up stocks of fishes feeding on lower food chains as predation means long-drawn, indirect conversion of available basic food into fish-flesh.

7. Detailed general biological studies on economic varieties of fishes as well as group of 'forage' fishes have to be made for an appraisal of their inter-relationships and role in conservation.

8. Experimental fishing with improvised gear should be undertaken to ascertain the efficacies of various gears and tackles for advocating correctly designed gears aimed at increased fish yield.

a) Net fishing - by employing different meshes (30 mm, 40 mm, 50 mm, 60 mm & 75 mm) with varied hanging co-efficients, floats, sinkers, etc.

b) Trials on bottom-set gill-nets after locating deeper fishing grounds and even bottom surfaces

c) Experiments on surface seining with the establishment of any shoaling fishery

d) As several fishes are sight-feeders, light fishing by employing powerful light in combination with surface gill-nets should be experimented upon

e) Trials in electric fishing

f) Designing and operating surface traps for shoaling fishes

9 SUMMARY

A preliminary investigational study to assess the fishery potential of the newly-formed reservoir, Nagarjunasagar, in Andhra Pradesh was undertaken in February-March, 1969. The reservoir is one of the deepest in India with an average depth 250 ft (76.20 m) at full reservoir level, holding maximum quantity of water (4,05,201 m.cu.ft.) amongst Indian reservoirs.

Observations at 9 stations were made for hydro-biological qualities, productivity, commercial fishing as well as experimental fishing.

Water quality and primary productivity were poor as compared to other reservoirs in India. Aquatic vegetation is virtually absent. Plankton density was very thin. Littoral area, which is of primary importance in a reservoir's productivity, is very negligible as the sides are precipitous and constituted by rubbles and rocks.

38 species of fish belonging to 8 families were recorded of which 16-18 species are of commercial importance. Catfishes dominated both by weight (69.4%) and number (53.1%) in commercial catches which were mainly from gill nets and long lines. In experimental gill nets, however, carps dominated (71.4% by number and 66.7% by weight) over catfishes (27.9% by number and 33.0% by weight).

Fishes recorded belong to the relict population of the earlier riverine fishery rather than any newly recruited or stocked fishes within the past 7 years.

The reservoir has very poor self-recruitment potentialities due mainly to its distinctive morphological and hydrographical features.

Food of 67 fishes exhibited very poor food intake because of lack of sufficient plankton as well as invertebrate organisms.

Recommendations for increasing the fertility and fish food organisms of the water and soil are made for which the reservoir offers ample scope.

Commercial fisheries of the reservoir have been studied and recommendations on the developmental, management and conservational measures discussed and scope for further research on several aspects indicated.

Table 1

HYDROGRAPHICAL FEATURES OF NAGARJUNASAGAR

Area	110 square miles (28, 490 ha)
Maximun length (effective length)	60 miles (96 km)
Maximum depth	350 ft (106.68 m) at E.L. 590
Minimum depth	150 ft (45.72 m)
Gross volume	9.3 m.a.ft. (4,06,201.0 m.cu.ft)
Live storage	5.47 m.a.ft (2,38,379.9 m. cu.ft)
Dead storage	3.86 m.a.ft (1,68,180.2 m.cu.ft)
Maximum flood discharge (observed)	11,70,000 cusec
Average height of the Dam above river bed	367 ft (111.86 m)
Maximum outflow	Data not available.
Minimum outflow	
Maximum inflow	
Minimum inflow	

Table 2

PHYSICO-CHEMICAL CONDITIONS OF WATER (RANGES) OBSERVED AT VARIOUS CENTRES IN NAGARJUNASAGAR

	Reservoir Portion				Bays				Tail-end
	Pump House	Pylon Colony	Mid Reservoir	Nagarjuna-konda	Shinki-shela	Nagarjuna-konda Bay	Peddamo-nagal	Eleswa-ram	River joining point
Temperature (°C)	24.0 -24.3	26.2 -26.4	25.0-27.0	25.5 -26.6	24.6-24.7	24.8-24.9	26.8-27.0	29.2	24.6 -24.8
Dissolved oxygen (mg/l)	6.56-7.28	6.48-6.88	5.28-7.36	7.36-7.60	7.28-7.60	7.61-8.00	7.04-7.52	7.68	7.12-7.20
Alkalinity (mg/l)	136.0-157.2	104.0-112.0	48.0-120.0	84.0-84.80	100.0-112.0	100.0-120.0	80.0	120.0	80.0-120.0
Hardness (mg/l)	84.0-109.2	29.6-66.0	64.8-71.2	68.0-68.4	66.0-72.0	68.0-72.0	82.0	71.6	74.0-80.0
pH	8.3	8.3	8.2-8.3	8.1-8.5	8.5	8.3	8.0-8.1	8.3	8.1-8.3
Specific conductivity ($\times 10^{-6}$ mhos at 25°C)	403-418	418	434-479	479-536	450-469	434-443	333-410	426	450-469
Phosphate (mg/l)	0.004	0.006	0.004	*	*	0.004	0.004	*	*
Nitrate (mg/l)	0.176	0.176	0.080	0.160	0.140	0.200	0.200	0.176	0.176
Iron (mg/l)	0.080	0.040	*	*	*	*	*	*	0.040
Primary Productivity (mg C/m^3/day)	437.4	325.0	709.2	-	-	324.9	424.9	-	280.0

* Traces

Table 2A

CHEMICAL CONDITIONS OF SILT-MUD IN NAGARJUNA SAGAR

Sampling points	pH	Available P_2O_5 (mg/100 gm)	NH_4 - N (mg/100 gm)	NO_3 - N (mg/100 gm)	Total N (%)	Organic C (%)	Exchangeable Ca (m.e./100 gm)	Exchangeable Mg (m.e./100 gm)	C/N	REMARKS (Indicating fertility status)
1. Pylon Colony	7.3	11.8	8.90	1.59	0.06	0.52	19.43	3.68	8.7	High Rich in available phosphorus, medium in total nitrogen, organic carbon and exchangeable Ca, favourable C/N ratio.
2. Dam Site (Nagarjunasagar)	7.4	1.2	3.70	Nil	0.04	0.38	6.30	2.10	9.5	Very Low Poor in nutrient elements like P, N, C and Ca
3. Peddamonagal	7.3	1.2	8.90	3.86	0.11	0.88	23.1	4.2	8.0	Medium High in total nitrogen, medium inorganic content, but poor in available phosphorus.
4. Nagarjunkonda	7.2	1.2	12.56	2.15	0.22	2.42	25.73	3.68	11.0	Medium Maximum in total nitrogen and organic carbon of all the places but low in available phosphorus.
5. Eleswaram	7.6	3.8	5.66	0.50	0.08	0.66	17.85	2.10	8.3	Medium Available phosphorus, nitrogen and organic carbon values are within medium productive ranges.

Contd... Table 2A

1	2	3	4	5	6	7	8	9	10	11
6. River mouth (Eleswaram)	T 7.3	1.2	9.52	1.79	0.04	0.79	65.63	21.0	19.8	Low Poor in both available phosphorus and total N, but very rich in Ca and Mg indicating maximum values of all places, comparatively wide C/N ratio, less favourable for microbial activity.
7. Peddamonagal Dried Silt	7.6	1.2	3.69	1.12	0.08	0.88	25.20	2.10	11.0	Medium C and N values within medium productive range, but low in phosphorus.

R - Reservoir

B - Bays

T - Tail-end at junction of river with the reservoir.

* Soil pH ranges from neutral to slightly alkaline, suitable for fish culture.

Table 3

PLANKTON CONSTITUENTS AT DIFFERENT CENTRES OF OBSERVATIONS IN NAGARJUNASAGAR (UNITS/LITRE)

Depth	Pump House				Pylon Colony					Mid-reservoir					Nagarjunakonda				Shinkishela		
	S	5m	10m	%	S	5m	10m	20m	%	S	10m	20m	30m	40m	%	S	5m	10m	%	S	B	%
PHYTOPLANKTON																						
Myxophyceae	-	50	-	10.64	-	-	16	-	7.0	-	4	4	-	-	40.0	4	4	16	100	6	4	12.5
Bacillario-phyceae	20	20	20	12.76	-	4	4	-	3.5	-	-	-	-	-	-	-	-	-	-	8	4	15.0
Chlorophy-ceae	90	130	140	76.60	28	100	36	40	89.5	4	-	-	8	-	60.0	-	-	-	-	22	46	72.5
Average density of phytoplankton at each centre		156.7				57.0					4.0						8.0				45.0	
ZOOPLANKTON																						
Protozoa	-	-	-		4	-	-	-	11.77	-	-	-	-	-		-	-	-		-	-	
Rotifera	-	-	-		-	-	-	-		-	4	-	-	-	2.5	-	-	8	28.6	8	14	34.4
Copepoda	10	20	80	100.0	4	8	4	2	52.93	28	28	48	12	8	77.5	-	-	12	43.8	12	24	56.2
Cladocera	-	-	-		-	-	-	12	35.30	8	8	12	-	4	20.0	4	4	-	28.6	2	4	9.4
Average density of zooplank-ton at each centre		36.7				11.0					32.0						9.3				32.0	
Percentages of Phytoplankton		80.9				83.82					11.1						47.06				58.44	
Zooplankton		19.1				16.18					88.9						52.94				41.56	

Contd... Table 3

Depth	Nagarjunakonda Bay S	5m	10m	20m	%	Peddamonagal S	B	%	Eleswaram S	B	%	River Joining Point S	5m	10m	%
PHYTOPLANKTON															
Myxophyceae	-	8	4	10	5.6	40	100	100.0	-	-		-	4	-	14.3
Bacillario-phyceae	-	-	4	-	1.0	-	-		-	-		4	-	8	42.8
Chlorophyceae	4	4	60	300	93.4	-	-		4	-	100.0	4	8	-	42.9
Average density of phytoplank-ton at each centre		98.5					70.0			4.0			9.3		
ZOOPLANKTON															
Protozoa	-	-	-	-		-	60	12.0	-	-		-	-	-	
Rotifera	-	-	-	-		32	200	46.4	-	-		-	-	4	6.3
Copepoda	24	56	64	90	86.7	40	160	40.0	8	-	100.0	12	8	36	87.4
Cladocera	-	32	4	-	13.3	8	-	1.6	-	-		-	-	4	63.0
Average density of zooplankton at each centre		67.5					250.0			8.0			21.3		
Percentages of Phytoplankton		59.3					21.89			33.3			30.0		
Zooplankton		40.7					78.11			66.7			70.0		

Table 4

LIST OF FISHES RECORDED IN NAGARJUNASAGAR DURING THE SURVEY

		Scientific Name
Sub-order	: Notopteroidei	
Family	: Notopteridae	1. Notopterus notopterus (Pallas)
Order	: Cypriniformes	
Division	: Cyprini	
Sub-order	: Cyprinoidei	
Family	: Cyprinidae	2. Oxygaster phulo (Hamilton)
		3. Barilius bendelisis (Hamilton)
		4. Osteobrama vigorsii (Sykes)
		5. Osteobrama neilli (Day)
		6. Osteobrama cotio (Hamilton)
		7. Thynnichthys sandkhol (Sykes)
		8. Puntius pulchelus (Day)
		9. Puntius dobsoni (Day)
		10. Puntius sarana (Hamilton)
		11. Puntius kolus (Sykes)
		12. Tor khudree (Sykes)
		13. Labeo fimbriatus (Bloch)
		14. Labeo calbasu (Hamilton)
		15. Labeo boggut (Sykes)
		16. Labeo bata (Hamilton)
		17. Labeo potail (Sykes)
		18. Labeo pangusia (Hamilton)
		19. Cirrhina reba (Hamilton)
		20. Cirrhina horai
		21. Garra gotyla (Gray)

Contd.. Table 4

		22. Catla catla (Hamilton)
		23. Labeo rohita (Hamilton)
		24. Cirrhina mrigala (Hamilton)
Division	: Siluri	
Sub-order	: Siluroidei	
Family	: Siluridae	25. Ompok bimaculatus (Bleeker)
		26. Wallago attu (Schneider)
Family	: Bagridae	27. Mystus aor (Hamilton)
		28. Mystus seenghala (Sykes)
		29. Mystus punctatus (Jerdon)
		30. Rita pavimentata (Gunther)
		31. Rita hastata (Gunther)
Family	: Sisoridae	32. Bagarius bagarius (Hamilton)
Family	: Schilbeidae	33. Pseudeutropius taakree (Day)
		34. Silonia childrenii (Bleeker)
		35. Pangasius pangasius (Hamilton)
Order	: Anguilliformes	
Sub-order	: Anguilloidei	
Family	: Anguillidae	36. Anguilla bengalensis (Gray)
Order	: Perciformes	
Sub-order	: Percoidei	
Family	: Ambassidae	37. Ambassis ranga (Hamilton)
Sub-order	: Gobiodei	
Family	: Gobidae	38. Glossogobius giuris (Hamilton)

Table 5

COMPOSITION OF COMMERCIAL CATCH FROM NAGARJUNASAGAR

Species	Percentage composition by No.	Wt.	Range in Total length (mm)	Weight (kg)	Percentage by No. (In each group)	Wt.
Carps	42.9	26.4				
Labeo fimbriatus			320-490	0.350-0.800	27.26	66.30
Labeo calbasu			258-395	0.200-0.350	5.48	4.60
Labeo bata			225-282	0.150-0.250	3.64	1.63
Tor khudree			302	0.300	5.43	8.02
Puntius kolus			275-324	0.250-0.400	7.24	5.49
Puntius sarana			206		1.84	0.20
Puntius pulchellus						
Puntius dobsonii					1.84	4.60
Cirrhina reba			220	0.050	5.48	1.48
Cirrhina horai			150-200	0.050-0.100	1.84	0.42
Oxygaster phulo			228-275	0.050-0.150	3.65	0.84
Osteobrama vigorsii					27.15	4.75
Thinmichthys sandkhol			208-220	0.050-0.100	9.15	1.63
Catfishes	53.1	69.4				
Silonia childrenii			230-505	0.200-0.500	24.99	6.64
Mystus aor			360-760	0.150-2.400	23.52	23.55

Contd... Table 5

Species	Percentage composition by No.	Wt.	Range in Total length (mm)	Weight (kg)	Percentage by No. (In each group)	Wt.
Mystus seenghala			380-830	0.200-0.500	19.14	33.35
Wallago attu			620-665	0.850-1.500	2.94	17.17
Pseudeutropius taakree			182-320	0.050-0.150	5.88	0.64
Ompok bimaculatus			215-295	0.100-0.150	5.88	0.72
Pangasius pangasius					2.94	0.72
Rita pavimentata			280	0.200	1.47	0.32
Rita hastata			205	0.150	1.47	0.40
Mystus punctatus			390-1840	0.550-5.250	1.47	16.47
Bagarius bagarius			622	0.900	1.47	0.32
Miscellaneous	4.0	4.2				
Anguilla bengalensis			700-1000	1.000-1.900	40.0	11.71
Notopterus notopterus			98-126	0.050	60.0	88.29

Table 6

DETAILS OF EXPERIMENTAL FISHING CONDUCTED AT VARIOUS CENTRES TO INDICATE THE RELATIVE EFFICIENCY OF GEARS

Mesh size	No. of fishing days	Species caught	No.	% by number	Wt. in kg	% by weight	Total length range (mm)	Head girth range (mm)	Body girth range (mm)	Area of net	Catch per sq m
30 mm	12 (2 nets)	Silonia childrenii	30	29.71	7.450	45.02	274-400	82-126	130-185	150 sq m each day	0.009
		Labeo bata	1	0.99	0.200	1.21	245	-	-		
		Osteobrama vigorsii	56	55.44	5.755	34.77	210-307	62-110	119-190		
		Labeo potail	1	0.99	0.150	0.90	247	94	164	1800 sq m	
		Labeo calbasu	1	0.99	0.300	1.81	310	110	184		
		Mystus seenghala	1	0.99	0.550	3.32	505	95	152		
		Osteobrama neilli	1	0.99	0.040	0.24	130	96	122		
		Cirrhina reba	8	7.92	1.800	10.63	253-310	92-106	146-191		
		Pseudeutropius taakree	1	0.99	0.200	1.21	302	102	151		
		Notopterus notopterus	1	0.99	0.100	0.60	232	-	-		
			101		16.545						
40 mm	12 (2 nets)	Labeo fimbriatus	2	9.52	1.300	20.71	366-400	115	245	150 sq m	0.004
		Labeo calbasu	1	4.76	0.500	8.00	330	-	-		
		Cirrhina reba	1	4.76	0.350	5.60	330	97	182		
		Tor khudree	1	4.76	0.450	7.20	342	158	201		

Contd... Table 6

1	2	3	4	5	6	7	8	9	10	11	12
		Silonia childrenii	3	14.28	0.850	13.50	360-380	98-120	155-180		
		Mystus seenghala	1	4.76	0.700	11.20	585	128	200		
		Osteobrama vigorsii	10	47.64	1.375	21.82	225-305	102-117	153-185		
		Puntius kolus	2	9.52	0.750	12.00	300-312	128-140	175-201		
			21		6.275						
50 mm	12 (2 nets)	Puntius pulchellus	2	11.76	1.700	16.40	382-462	117-128	285-320	150	
		Labeo fimbriatus	7	41.16	4.000	38.59	340-408	130-155	218-280	sq m	0.006
		Labeo calbasu	4	23.52	2.350	22.67	320-430	132-164	206-282		
		Pseudeutropius taakree	1	5.88	0.050	0.44	234	65	93		
		Mystus aor	1	5.88	0.820	7.91	583	195	260		
		Mystus seenghala	1	5.88	0.850	8.20	640	-	-		
		Silonia childrenii	1	5.88	0.600	5.79	460	142	210		
			17		10.370						
60 mm	12 (2 nets)	Labeo fimbriatus	5	62.50	3.830	62.99	340-465	130-172	255-325	75	
		Labeo calbasu	2	25.00	1.350	22.20	335-400	130-156	191-247	sq m	0.007
		Mystus seenghala	1	12.50	0.900	14.81	605	147	225	900 sq m	
			8		6.080						0.026

PERCENTAGE OF CARPS, CATFISHES, AND MISCELLANEOUS FISHES IN THE TOTAL EXPERIMENTAL CATCHES

	Total numbers captured	Percentage by number	Total weight caught (kg)	Percentage by weight.
Carps	105	71.4	26.200	66.7
Catfishes	41	27.9	12.970	33.0
Miscellaneous	1	0.7	0.100	0.3

Table 7

CATCH COMPOSITION AND RELATIVE ABUNDANCE AT AT VARIOUS CENTRES OF EXPERIMENTAL FISHING

Place	Total number of days of fishing/dates	Total catch (kg)	Catch per sq m net area per day (kg)	Species	No.	%
Pump House	2 16.2.1969 to 17.2.1969	2.800	0.002	Oxygaster phulo	2	15.38
				Silonia childrenii	2	15.38
				Labeo bata	1	7.69
				Labeo fimbriatus	1	7.69
				Labeo calbasu	1	7.69
				Osteobrama vigorsii	5	38.48
				Notopterus notopterus	1	7.69
Pylon Colony	3 18.2.1969 to 20.2.1969	10.180	0.002 (1575 sq m)	Labeo calbasu	1	3.57
				Labeo potail	1	3.57
				Labeo fimbriatus	7	24.99
				Cirrhina reba	2	7.14
				Labeo pangusia	1	3.57
				Silonia childrenii	6	21.42
				Mystus seenghala	1	3.57
				Osteobrama vigorsii	6	21.42
				Pseudeutropius taakree	1	3.57
				Puntius pulchellus	2	7.14
Nagarjunakonda Bay	1 24.2.1969	0.650	0.0012 (5255 sq m)	Cirrhina reba	1	33.3
				Silonia childrenii	1	33.3
				Osteobrama vigorsii	1	33.3

Contd... Table 7

1	2	3	4	5	6	7
Peddamonagal	2 26.2.1969 to 27.1.1969	11.165	0.005 (1050 sq m)	Mystus aor	1	1.66
				Silonia childrenii	4	6.64
				Mystus seenghala	3	4.98
				Labeo fimbriatus	2	3.32
				Osteobrama vigorsii	44	72.44
				Cirrhina reba	5	8.30
				Osteobrama neilli	1	1.66
Eleswaram	2 28.2.1969 1.3.1969	10.650	0.005 (1050 sq m)	Labeo calbasu	5	14.65
				Labeo fimbriatus	1	2.93
				Silonia childrenii	18	53.12
				Osteobrama vigorsii	9	26.37
				Puntius kolus	1	2.93
Mid-Reservoir	2 5.3.1969 to 6.3.1969	4.650	0.002 (1050 sq m)	Puntius kolus	1	9.09
				Labeo calbasu	1	9.09
				Labeo fimbriatus	3	27.28
				Tor khudree	1	9.09
				Silonia childrenii	2	18.18
				Psedeutropius taakree	1	9.09
				Cirrhina reba	1	9.09
				Osteobrama vigorsii	1	9.09

Table 8

THE FOOD ITEMS ENCOUNTERED IN THE GUTS OF FISHES

Place	Species	No. of guts examined	Contents of the guts.	
Dam site (Pump House)	Labeo fimbriatus	1	Mud & Sand	
			Melosira Navicula Tabellaria	95%
			Ulothrix Pediastrum	5%
	Labeo calbasu	1	Navicula Tabellaria Diatoma	
	Osteobrama vigorsii	4	Insect remains only	
	Silonia childrenii	2	Insect heads Spores	80% 20%
	Oxygaster phulo	2	Insect remains only	
Pylon Colony	Labeo potail	1	Navicula Synedra Asterionella Diatoma	97%
			Ulothrix	3%
	Labeo calbasu	1	Algal mass Diatoma	50% 50%
	Puntius pulchëlus	2	Oedogonium Ulothrix	80% 20%

Contd... Table 8

1	2	3	4	
	Labeo fimbriatus	7	Diatoma	45%
			Oedogonium Ulothrix	55%
	Osteobrama vigorsii	6	Greenish mass only	
	Labeo pangusia	1	Mougeotia Ulothrix Oedogonium	50%
			Diatoma	40%
			Insect remains	10%
River mouth (Tail end)	Labeo fimbriatus	1	Ulothrix	95%
			Fragillaria Synedra	5%
			Oedogonium Mougeotia Ulothrix	75%
			Fragillaria Synedra	25%
	Pseudeutropius taakree	9	Mud	45%
			Fish remains	55%
Dam site (Pump House)	Puntius kolus	1	Synedra	25%
			Oedogonium	40%
			Protozoa	15%
			Digested organic matter	10%
River mouth (Tail end)	Labeo calbasu	5	Oedogonium + Ulothrix	85%
			Protozoa	5%
Peddamonagal	Cirrhina reba	5	Miscellaneous Digested organic matter only	10%
	Osteobrama vigorsii	18	Insect remains only	

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NAGARJUNASAGAR RESERVOIR

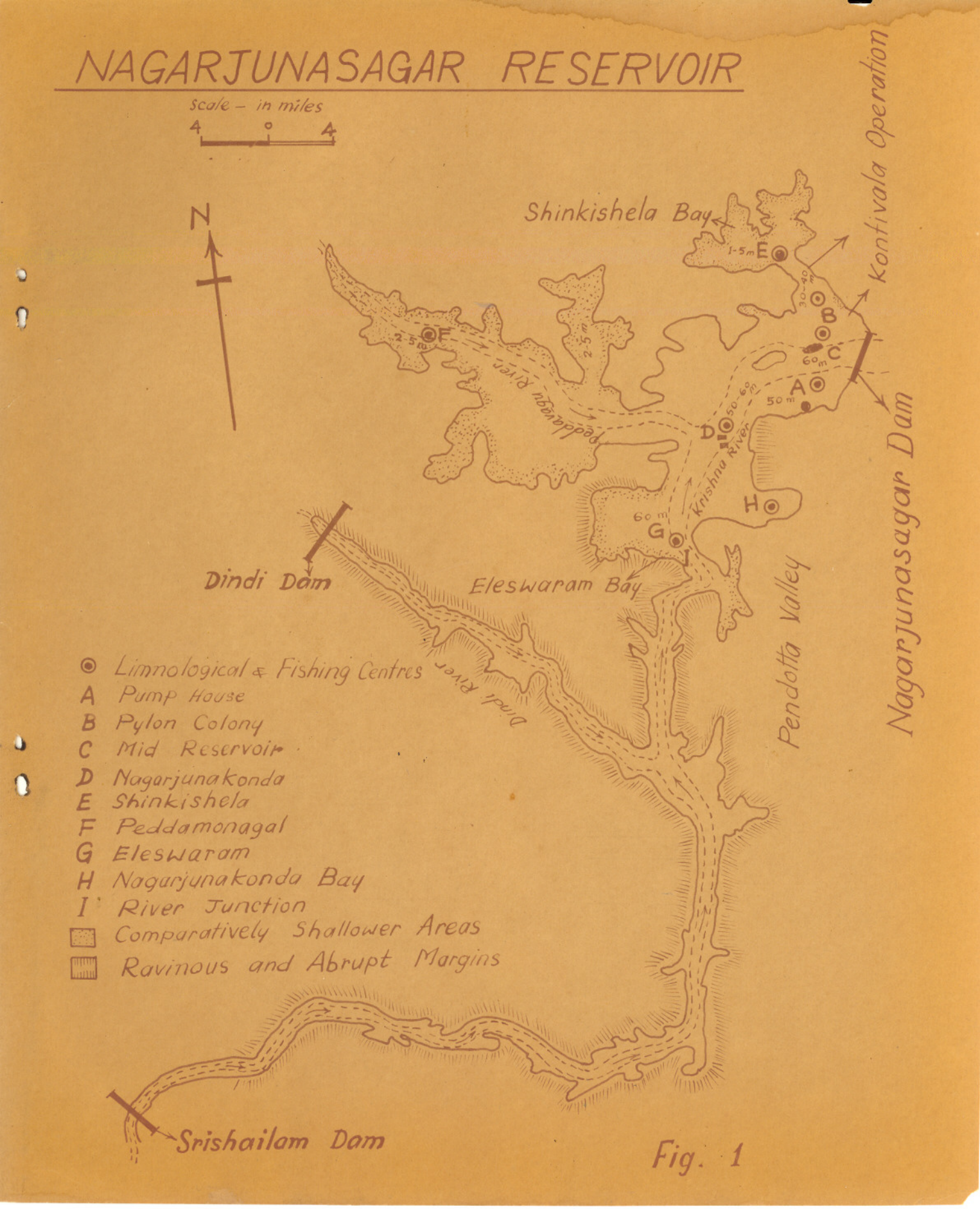

Fig. 1