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REPORT ON
THE FISHERIES OF THE CHILKA LAKE
1957 – 1960

CENTRAL INLAND FISHERIES
RESEARCH INSTITUTE, BARRACKPORE
WEST BENGAL, INDIA.

C O N T E N T S

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F O R E W O R D

This report embodies, in a general way, the results of investigations carried out on Chilka lake fisheries by the Chilka Investigation Unit of the Central Inland Fisheries Research Institute, Barrackpore, West Bengal during the Second Five-Year Plan period (April 1956 to March 1961). The report has been prepared by Dr. V.G. Jhingran who was directly in charge of the investigations on Chilka fisheries. The investigations were carried out by a team of workers under the supervision and guidance of Dr. V.G. Jhingran who also personally actively participated in the various studies. The names of persons who carried out the work and their specific assignments during the course of investigations are given below :

Sarvashri K.H. Sujansingani, S.K. Mazumdar and H. Choudary.	Compilation and analysis of fish landing statistics.
S.J. Karamchandani, S. Patnaik, K.V. Ayyangar, S. Rajan and K.N. Mishra	Fishery biological investigations.
N.C. Roychoudhury & A.C. Banerji	Chemical analysis of water.
K.N. Mishra, S. Jena S.N. Das Mohapatra, D.K. Bhowmick, S.N. Mishra and N.C. Basu	Fishery survey work.
K.L. Shah	Planktological investigations.

Biological work on the mullets of the Chilka lake was carried out by Sarvashri J.C. Roy, N. Sahu and D.A. Patnaik of the Chilka Biological Station, Government of Orissa. Sarvashri J.C. Patra and Md. K. Ahmed of the same department also participated in the tagging programme.

The detailed reports on specific investigations are under preparation and will be published elsewhere.

These investigations have contributed considerably to our knowledge of the nature and composition of the specific fisheries of the Chilka lake. The present report embodies results of the first phase of investigations in the Chilka lake. Further work is being carried out to get comprehensive information on the exact nature of the fisheries of the lake. Attempts have, however, been made in this report to make some preliminary recommendations in regard to conservation and management of the Chilka lake fisheries.

These investigations were carried out with effective cooperation from the Department of Fisheries, Orissa State. This Institute is indebted to Shri G.N. Mitra, Director of Fisheries, Orissa, for active cooperation, many facilities provided in connection with the investigations and also for his stimulating discussions on various aspects of Chilka lake fisheries on several occasions.

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I. INTRODUCTION

Chilka lake (fig.1) is a pear-shaped brackishwater lagoon situated between latitudes 19° 28' 19° 54' N and longitudes 85° 67' and 85° 35' E on the East coast of India in Puri and Ganjam districts of the State of Orissa. The lake is about 1040 Sq. Km. in area (65 Km. x 16 Km. approximately) and is connected with the sea at a single point by means of a 29 Km. long and averagely about 365 M wide, outer channel, through an opening, the lake mouth, which, in recent years is only about 135 M. wide in low tide. The maximum depth of the lake during summer months rarely exceeds 3 M. with vast areas, especially in the North-East, remaining only a few decimetres deep. In monsoon, depending upon its intensity, all depths increase by about 1.5 M. or more. Rivers Daya and Bhargavi, two branches of the Mahanadi River System, meet the North-eastern part of the lake. At the extreme South-western end lie the remnants of the now defunct man-made Palur Canal (also called Ganjam canal) which once used to connect South Chilka with the sea adjacent to Rishikulya estuary.

IA. STATEMENT OF PROBLEM

The fisheries of the lake have been subjected to an increasing degree of exploitation by indigenous methods which have continuously been in use from ancient times till to-day. Trade of fresh Chilka fish developed at about the end of the first World War and the exploitation of the fisheries appears to have been intensified after the opening of the lucrative export business to Calcutta with the establishment of an ice factory at Kaluparaghat in 1928 and two additional ice factories at Balugaon in 1948 and 1950.

There has, in recent times, developed a belief among local people that the fisheries of the lake have undergone 'depletion' which, should it be found to have actually occurred, needs application of urgent remedies. Even otherwise the need to develop the fisheries of the lake to a level of optimum productivity has been widely felt. The Chilka Investigation Unit of the Central Inland Fisheries Research Institute was set up late in 1956, with headquarters at Balugaon on the lake shore, with the following twin objectives :

IB. AIMS AND OBJECTS

(I) To investigate whether the fisheries of the lake have undergone depletion, and

(II) To elucidate significant facts relating to the biology of the lake's commercial species and such fishing practices in the present day exploitation of the resource as have a bearing on evolving developmental measures to step up fish production of the lake to an optimum level of productivity.

IC. APPROACH TO PROBLEM

Demonstration of the occurrence of depletion or otherwise in a fish population, to mention only the essentials, requires a comparative scrutiny of records on:

(1) Total catches in relation with total fishing effort;

(2) Observations on catch-per-unit-of-effort;

(3) Average sizes of fish landed, and, acquiring an understanding of the causes of fluctuations in abundance of fish and more especially the appraisal of the role of fishing mortality with due cognisance to fluctuations in abundance on account of natural causes as distinct from those inflicted by human agencies.

While the investigations into the state of fisheries of the lake by the Chilka Investigation Unit are outlined in the following pages, it is to be borne in mind that abundance of fish, as measured in most capture fishery investigations of our time, being relative, corresponding quantitative observations for any earlier date are not available for comparison with those gathered in the present investigations. Notwithstanding the difficulties of collecting the data essentially required for investigating a case of suspected depletion in the existing exploitation pattern of the lake, which are fully discussed in this communication, the studies conducted during this brief period merely show trends, and in the absence of earlier data, remain inconclusive for the time being. One important factor, which greatly affected the course of the present investigation, was a virtual absence of factual knowledge of the stocks and biology of practically all commercially important species, notably in regard to their area of spread, age, growth, migration, breeding, and food which are pre-requisites for an investigation on a problem of fish depletion. This fact necessitated diversion of considerable effort to the task of first acquiring basic knowledge on the biology and geographical distribution of the stocks of economically important species.

To fulfil the aims stated above and to channelise the efforts of the available staff, limited as it was, along fruitful lines, strict priorities were laid in the execution of work. Work was exclusively confined to the elucidation of the following aspects, as fully as possible, in respect of each of the 15 species of proven economic value selected for investigation and listed further in this report.

1. Total catches in relation to total fishing effort expended.
2. Catches per-unit-of-effort.
3. Precise relationship obtaining between the stocks of fish found in Chilka and those in the Bay of Bengal with which the lake is confluent, and the streams discharging into the lake.

4. The exact patterns of to and fro migrations of the various species in respect of size, age and season between the lake and its connected waters as well as any regular pattern of movement within the lake.
5. Location of breeding grounds and study of survival rates upto recruitment.
6. Size and age-class composition of commercial catches in relation with gears used in their capture.
7. Rates of growth, survival, fishing and natural mortalities.
8. The food and feeding habits.
9. Assessment of fish food resources.
10. Interaction of different econonic species upon one another.
11. Correlation of fisheries with physico-chemical and hydro-biological charactors.

ID. SPECIES SELECTED FOR INVESTIGATION

The fauna of Chilka lake was surveyed by Zoological Survey of India in 1914 (Annandale and Kemp and others 1915 to 1924). Chaudhuri (1916 a, 1916 b, 1917 and 1923) and Hora (1923), who worked on the fish collection of the 1914 survey of the Zoological Survey of India, described 118 species of fish from the lake, six of which were later regarded as synonyms of already recorded forms. Koumans (1941) added one new Goby and Jones and Sujansingani (1954) added 25 new records of fishes. Roy and Sahoo (1957) found 14 additional species in the lake raising the total number of hitherto recorded species of fish from the Chilka lake to 152. Kemp (1915) has recorded 21 species of prawns from the lake. In view of the limitations of personnel, detailed biological investigations were confined to only the fifteen forms given in Table 1 the criteria of selection mainly being the economic value of the species concerned. Mullets, Clupeids, perches, thread-fins, Sciaenids and cat fishes among fishes and penaeids among prawns are the main groups of organisms which form the commercial fisheries of the Chilka lake. Published literature (notably : Mitra, 1945; Devasundaram, 1954; and Jones and Sujansingani, 1954) gave sufficient information to choose the commercially important fishes for detailed investigation. However, to make assurances doubly sure and for the sake of thoroughness, the relative importance of all species within each group of fishes found to occur in Chilka lake was studied over the years 1957 - 1960 in a routine manner. A few extra cat-fishes, not very important commercially, were also included in the list of fish to be studied in view of their likely importance as predators of economic forms.

TABLE 1.

SPECIES SELECTED FOR INVESTIGATION

Group	Family	Scientific name	Local name
Mullets	Mugilidae	1. Mugil cephalus Linnaeus	Khainga-Kabla
	Mugilidae	2. Liza troschelli Bleeker	Dangla
Clupeids	Clupeidae	3. Nematalosa nasus (Bloch)	Balangi
	Clupeidae	4. Hilsa ilisha (Hamilton)	Ilish
Perches	Centropomidae	5. Lates calcarifer (Bloch)	Bekti
	Gerridae	6. Gerres setifer (Hamilton)	Jagili
	Sparidae	7. Sparus sarba Forskal	Khuranti
Threadfins	Polynemidae	8. Eleutheronema-tetradactylum (Shaw)	Sahal
Sciaenids	Sciaenidae	9. Pseudosciaena-coibor (Hamilton)	Borogo
Cat-fishes	Bagridae	10. Mystus gulio (Hamilton)	Kantia
	Tachysuridae	11. Osteogeneiosus-militaris (Linnaeus)	Sunga
	Tachysuridae	12. Tachysurus arius (Hamilton)	Singda
	Plotosidae	13. Plotosus canius (Hamilton)	Kamda
Prawns	Penaeidae	14. Penaeus indicus Milne-Edwards	Kantla chinguri
	Penaeidae	15. Penaeus semisulcatus De Haan	Bagda

IE. MATERIAL AND METHODS

For the purpose of fisheries survey the lake has been divided into 5 sectors stated in Table 2 and shown in Figure 1.

TABLE 2.

SECTORS OF THE CHILKA LAKE AND THEIR USUAL LANDING SITES

Name of the sector	Usual landing centre of fresh fish
1. Southern Sector	Rambha and Khallikota
2. Central Sector I (Parikud sector)	Balugaon and Gangadharpur
3. Central Sector II (Satpara sector)	
4. Northern Sector	Kuhuri, Kaluparaghat and Bhusundpur
5. Outer Channel Sector	Puri, Balugaon, Kaluparaghat.

The catches from the lake-end side of the outer-channel are landed in fresh state usually at Balugaon or Kaluparaghat and those from the sea-end side, when marketed fresh, are usually taken to Puri by coastal route on slings, where, there flourishes a lucrative trade of Chilka fish. When marketed dry the catches from the sea-end of the outer channel are taken to Bhusundpur in the Northern Sector (Figure 1).

In general there are 3 main types of fishing to take into account in each sector, dealt with in detail under the heading "Commercial Fisheries of the Chilka lake".

A. Bahani operations or net fishing.

B. "Jano" Fisheries (Huge split bamboo barricades enclosing large fish populations).

C. Trap fishery to capture prawns.

Sources of data and sampling procedures :

Species and size composition of landings : Total catches :

There are six definite landing grounds (Table 2, and Figure 1) for the lake's commercial catches with well established trade practices and channels of commerce. Data on species and size composition of landings were gathered by pursuing a regular programme of sampling at landing centres from the beginning of the work in 1956. Early in the study the landing grounds were strafified into 3 categories, depending upon the volume of fish traffic. Sampling was done on 6 to 9, 4 to 5 and 3 to 4 number of days in a month in large, medium and small landing grounds respectively. In godown sampling several fish godowns were visited in succession where economic species were quickly measured and estimates of species-wise landings made (Proforma used for godown sampling is

~~attached in appendix II~~ which were later checked by varifying from the day's records of actual landings maintained by the merchants.

In the Chilka area about 90% of the fish produced is exported by rail and the remaining 10% is estimated to be locally consumed and dried. Jones and Sujansingani (1954) have given the amounts of fish dried and locally consumed for the years 1948-1950 as under :

Year	Local consumption	Drying
1948	5.1 %	19.2 %
1949	5.9 %	15.7 %
1950	6.5 %	7.4 %

As already stated, two ice factories were set up at Balugaon in 1948 and 1950 and the figures stated in the table above show a progressive decline in fish drying while local fish consumption remained practically steady. Judging from the increase in population of the Puri and Ganjam Districts in the decade 1951-60, the local fish consumption and drying have been arbitrarily put at 8% and 2% of total yield respectively. Dry fish is mainly exported from Bhusandpur and the fish exported include dry fish imported there from Bombay and Madras states (possibly due to the name Chilka fish has in dry fish markets). Records of quantities of dry fish exported and imported at Bhusandpur reveal that more dry fish was imported in 1959, indicating that in the Chilka area drying of fish for the purpose of export as an industry, is vanishing. Complete day to day data of fresh-fish export by rail, with due allowances for the weights of ice used in packing, basket and local consumption and the drying, have continued to furnish an estimate of total landings. Fresh fish export data from all the export centres were regularly procured by personal visits every six months. (Sampling methods for estimating total catches unsuccessfully attempted are described elsewhere in this report). The estimates of total production thus obtained have been split up into their contributing agencies viz. Jano's, net fishing and trapping operations. In a general way a year has been divided into seasons in which one or the other mode of fishing preponderates. The seasonal fluctuations in the intensity of net fishing operations observed in the field and observations on fish catches in traps and prawn catches in netting operations provided a clue in the dissection of total landings. These are discussed under "Observations of Catch-per-unit-of-effort" in this report.

Estimates of total production based on rail export data combined with godown sampling, described above, furnished information on species and size composition of the total landings without specificity to type of fishing, gear etc. used to capture them. However, species and size composition of fish catches in relation with different modes of fishing and different kinds of nets have been studied in great detail and are described in ths report.

Observations on Catch-per-unit-of-effort :

Net fishing : The propriety of conducting such studies in the existing state of gear and fishing practices is discussed in Section II (3) of this report where the results of the studies conducted are presented. For reasons mentioned there observations on catch-per-unit-of-effort, which were commenced in April, 1957, were discontinued in September, 1959. The sampling procedure adopted for these observations was first an approximate demarcation of each sector into several zones and then making net fishing observations of as many fishing units operating in each zone as could be contacted by a Survey Assistant on a country boat. In most of the cases 50% to 75% of the Units, which could be seen by the naked eye in a zone could be contacted. The frequency of net fishing observations was 6 to 8 days in a month in each of the four sectors. In each contact with a fishing party in the lake, data on a wide variety of items ~~(not finishing from forms given in Appendix 2)~~ notably on kind of net, with dimensions and mesh; number of men; hour spent on fishing; species-wise weights of catches; sizes of commercial species available to each gear etc. were recorded. In this manner fish catches made with practically all the different kinds of nets employed in Chilka lake were observed.

"Jano" Fisheries : "Janos" are huge split bamboo barricades often running into miles where large fish populations mostly of mullets, are enclosed during autumn (when the level of the lake water starts receding after filling in monsoon) and which are gradually exploited during the following winter months. The object of work of this Unit in the Janos was to elucidate the precise role of "Jano" fishing in the overall exploitation of the fishery resource of the lake rather than a relative evaluation of the ecology and productivity of the different "Janos" of the lake.

In the sampling of "Janos", first of all, depending upon their lease values, the "Janos" located in the different sectors of the lake were stratified into three categories viz. good, medium and poor. The yield of each "Jano" was planned to be totally enumerated by procuring exact species-wise production figures from the respective lessees. From this and with the knowledge of the approximate area of each "Jano", catches per unit area for each category of "Jano" were to be worked out. The production figures, however, furnished by the lessees for the years 1957 and 1958 proved completely un-reliable and hence this approach was abandoned. Species and size composition of catches from each of the 3 categories of "Janos" from each sector were obtained by field observations, once at the commencement of a "Jano" second time during the middle of its tenure of seasonal operation and for a third time during the terminal phase of its operation for the years 1957 and 1958 (Proforma used for Jano observations is attached in Appendix 3).

Trap Fishing for Prawns : The frequency of sampling for prawn trap catches was 6 days in a month. The fishing grounds were randomly selected. On each day of visit to a prawn ground a wide variety of observations were recorded ([illegible]) in the proforma especially designed for the study. In this manner species composition and observation on catch-per-trap were obtained. The observed value of catch-per-trap was compared with the calculated values for corresponding years and a fairly close fit was found to occur between the two. The procedure adopted is described in section II-3-c of this report.

Sampling procedure in the lake mouth work :

While sampling procedures (described in the foregoing) followed in the four sectors of the main area of the lake have remained common to them, altogether different methods of work had to be adopted for work in the lake mouth centre. In fact the lake-mouth end of the outer-channel, by virtue of its strategic geographical location, has been of special interest in the work of the Chilka Investigation Unit and observations made there have largely thrown light on the pattern of fish migration between the lake and the sea. Catches of certain departmental nets and regular monthly observations of commercial catches made in the Outer channel, lake mouth proper and sea, contrasted with those in the main area of the lake and visual observations of actual migration through lake mouth, had, during the years 1957-1959, elucidated the broad qualitative features of the migrations of migratory species. In 1960-1961 quantitative methods to assess ingress and egress through lake mouth for different fish were experimented upon in the field.

(i) For directional movement of fishes by number :

One unit of multi-meshed gill net (described in section X)and 2 gill nets received under T.C.M., one each of the mesh 127 mm. and 190.5 mm. were installed, on 6 nights in a month for 12 hours from dusk to dawn, across the main channel off Arkakuda (see figure 1) and catches separately recorded for each tide. Directions of fish heads were carefully noted and entries were made in specific proforma. ([illegible]). The results obtained in this work are discussed under "Suggestions on Future Programme of Research" Section X.

(ii) For Resident Organisms :

One hand seine each of terylene and velon material of meshes 13 mm. and 16 per inch respectively were operated for one hour in high and low tides. Two high and two low tide collections were made in each stay. The result of the study are described under "Outer Channel Sector" Section II-B-4.

(iii) For macro-organisms drifted by tide :

a) Spawn collection nets of the type used to catch carp fry in rivers were operated slightly inward at the lake mouth for 2 hours each in the peak of high and low tides with mouth of the net reversed to face the tide. Collections made were sorted, counted and weighed. Two high tide and two low tide observations were made in each stay at the lake mouth centre.

b) One half metre tow net was plied in high and low tide for 15 minutes and catches analysed. Two such observations were made in each trip to the lake mouth centre. The results obtained of methods under a and b are discussed under "Suggestions on Future Programme of Work" Section X.

c) In certain seasons prawns migrate to the sea in low tide in great numbers which are commercially exploited. In such cases catch-per-man-per-tide are computed on daily basis and observations recorded in respect of the phase of the moon. The results obtained are described under "Outer Channel Sector" (II-B-4).

II. COMMERCIAL FISHERIES OF CHILKA LAKE

A. FISHERIES OF THE LAKE AS A WHOLE

1. TYPES OF FISHERIES : THEIR DESCRIPTION & LOCATION :

a) Net Fishing :

Net fishing operations are known by the name of "Bahani", and the entire lake constitutes the Bahani area. With the exception of Bahani grounds, which are leased out fisheries, the rest of the Bahani areas are unleased waters where payment of a nominal fee (Chulhamunda Tax) entitles any one to fish. "Bahani" fishing is done throughout the year with varying degree of intensity. It generally has two minima (winter and summer) when "Jano" and Prawn trap fisheries respectively are in vogue and two maxima in the course of a year.

Status of fishing nets :

A lucid understanding of the status* of existing fishing nets is an essential pre-requisite for utilising catches made by them as a measure of fish abundance. During the extensive field work intensively carried out by this Unit nets with 54 different names (annotated list attached in Appendix I) were encountered. These include a few cases where the same type of net is known by several different names (e.g. 1. Khadi Jal, Chingudi Jal, Kabla Jal, Khoinga Jal; 2. Muni Jal and Gania Jal) and different nets known by the same name (e.g. Khoinga Jal, Chagunda Jal, Dosta Jal etc., all known by Noli Jal vide Table 5).

Reference to literature revealed that there is a conflict in the status of a number of nets among different authors of earlier publications. Several of the 54 nets encountered by this Unit are also omitted by earlier workers. Table 3 presents the names of sixteen common nets with their classification (as to net types) stated in earlier publications, clearly showing the divergence in opinion in regard to the status of many nets.

Mitra and Mohapatra (1957) have listed Chilka fishing nets under nine categories viz. Khepa, Patua, Bekti, Bhida, Noli, Khadi, Muni, Hilsa and Miscellaneous. A more compact classification of nets has been attempted by the present workers. Depending upon the mode of operation, manner of fish capture, net design and material, the existing Chilka nets have been classified under 6 minor and 3 major heads. The emergent classification, showing also some prominent diagnostic characters of each of the six major net heads, under which individual nets are arranged, is given in Table 4. Only 14 net types are listed in the classification shown in Table 4 but the annotated list of nets given in Appendix 6 will easily enable one to fix the position of each of the 54 nets at its appropriate position in the classification.

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* The word 'status' is used to signify its position as to net type such as gill net, drag net, drift net, seine, cast etc. so that each net may be assigned its appropriate place in the classification of nets.

In view of the divergence of opinion on the status of some of the Chilka nets a brief description of the major net types is believed to be desirable and follows immediately. In the classification attempted a gill net is considered as one in which the fish are principally enmeshed individually by their opercula and a drag net, one, in which the fish are mostly herded together although a few invariably get gilled in the process of hauling. A drag net may or may not have a bag but a gill net never has one. A gill net may be dragged under certain situations but the fish being enmeshed within its walls does not entitle it to be called a drag net merely because it is dragged.

TABLE 3

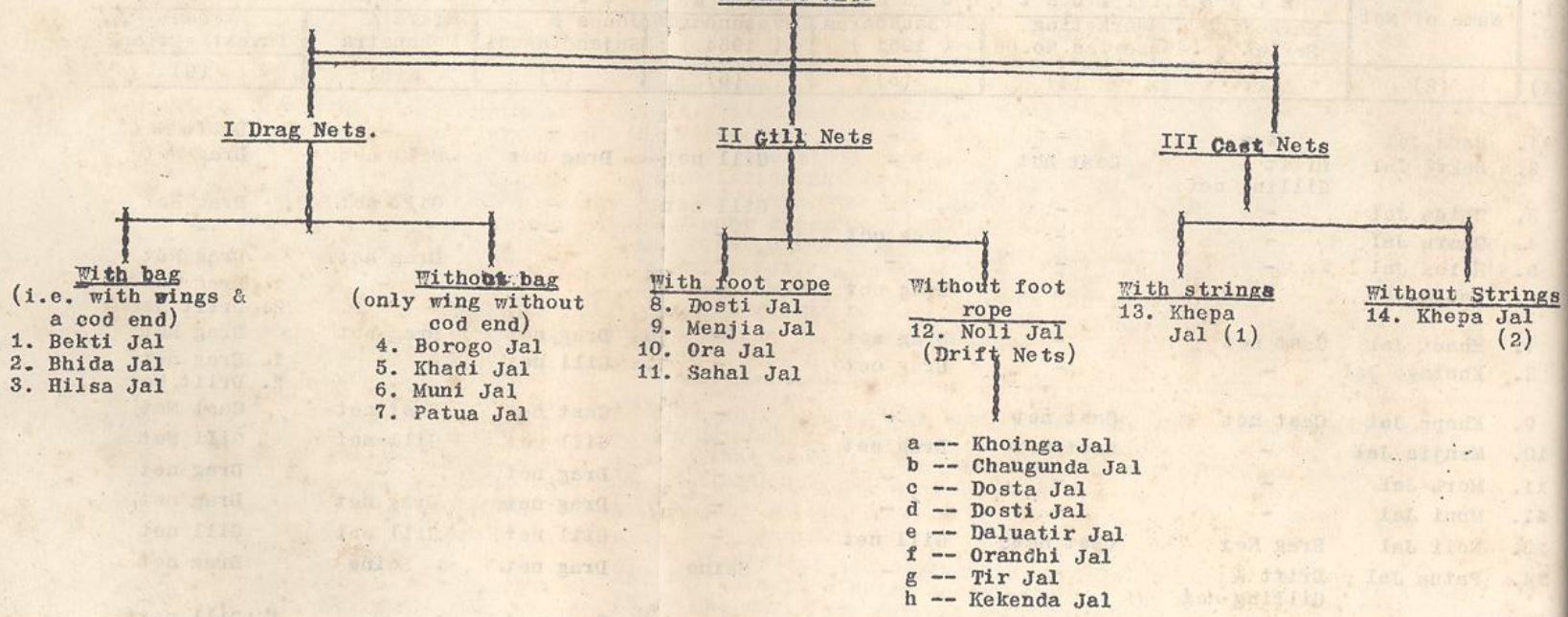
CLASSIFICATION OF SOME NETS USED IN CHILKA LAKE.

Sl. No.	Name of Net	Classification according to different authors.						
		Marketing Series No.65	Marketing Series No.66	Devasundaram (1951)	Devasundaram (1954)	Jones & Sujansingani	Mitra & Mohapatra	Present Investigation.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1.	Bada Jal	Seine	-	-	-	-	-	Drift Net
2.	Bekti Jal	Drift & Gilling net	Cast net	-	Gill net	Drag net	Gill net	Drag Net
3.	Bhida Jal	-	-	-	Gill net	-	Gill net	Drag Net
4.	Charu Jal	-	-	Drag net	-	-	-	-
5.	Hilsa Jal	-	-	-	-	-	Drag net	Drag Net
6.	Kabla Jal	-	-	Drag net	-	-	-	1. Drag Net 2. Drift Net
7.	Khadi Jal	Cast net	-	Drag net	-	Drag net	Drag net	Drag Net
8.	Khoinga Jal	-	-	Drag net	-	Gill net	-	1. Drag net 2. Drift Net
9.	Khepa Jal	Cast net	Cast net	-	-	Cast net	Cast net	Cast Net
10.	Menjia Jal	-	Cast net	Drag net	-	Gill net	Gill net	Gill Net
11.	Mori Jal	-	-	-	-	Drag net	-	Drag net
12.	Muni Jal	-	-	-	-	Drag net	Drag net	Drag net
13.	Noli Jal	Drag Net	Cast net	Gill net	-	Gill net	Gill net	Gill net
14.	Patua Jal	Drift & Gilling net	-	-	Seine	Drag net	Seine	Drag net
15.	Sahal Jal	-	-	-	-	Drag net	-	1. Gill net 2. Drag net
16.	Siru Vallas	Pouch net	Pouch net	-	-	-	-	-

In the rest of the drag nets

TABLE 4

CLASSIFICATION OF CHILKA LAKE FISHING NETS



i) Drag Nets :

Bekti, Bhida and Hilsa Jals are included under one category of this net-head. Made of thickish hemp, Bekti Jal is usually composed of several pieces each 4.5 M to 9.0 M long and 3.0 M to 5.0 M wide, joined to form a total length 183 M to 2740 M with a mesh range 61-155 mm. though the common mesh range is only 125-155 mm. Being usually a large meshed net it is quite selective and is mainly used to catch only large sized Bekti and Sahal. Bekti Jal has a large bag in the middle. Devasundaram (1954 p. 9) states the stretched mesh of Bekti Jal as 2½" to 3", which, if it were to be a gill net, cannot possibly gill large sized Bakti which require a mesh of 4" to 7". From the mode of its operation (dragging) and presence of a bag, where most fish are herded into (cod end), this net has been classified here as a drag net. Mitra & Mohapatra (1957) call it a gilling net. Jones & Sujansingani (1954) have classified it in the category of drag nets with which the workers of the present investigation agree. Bhida Jal made of cotton yarn or hemp, composed of individual pieces 4.5 M to 6.0 M long and 3.0 M to 4.5 M wide, joined together to form a total length 95 M to several Km. is a finer meshed net than Bekti Jal, the meshes varying from 16 mm. to 125 mm. Here again Devasundaram (1954, p.10) states the mesh as 1½" which is obviously too small to "gill" even medium sized fish. Bhida Jal often running into miles, covers huge areas, takes at times a few days to pay and haul, catches a wide variety of large and medium sized fish like Boroge, Sahal, Bekti, Magar etc. By virtue of its possessing head and foot ropes and a huge bag of very fine meshes this net has been classified as a drag net in this report. It is commonly used by Satpara fishermen in the Soroua Nadi area opposite Tua and Gambhari villages.

ii) Hilsa Jal :

While appreciable amount of Hilsa are caught by encircling gill nets especially by Dosti Bhida to the accompanyment of drum beating and noise making, the net which goes by the name of Hilsa Jal is actually a drag net and is largely operated in the Northern Sector of the lake in the region of Daya River mouth. This net has head and foot ropes and is a variety of Bhida Jal described above. It is classified as drag net by Mitra and Mohapatra with which the participants of the present work agree. It is not mentioned by any other worker.

The three drag nets described above have a bag to herd fish in. In the rest of the drag nets, whose description follows, there is no bag and the fishes are either herded in the general pouch like area enclosed by the net wall as in Borogo, Khadi and Patua Jals or in a series of small pouches as in Muni Jal, a net specific for Beloniform fishes. Borogo Jal is not described by any previous worker. In the operation of this net a scare line of palm leaves, suspended through water column, is dragged to scare Borogo and herd them together when, with simultaneous operation of a drag net from a direction opposite to that of scare line, the herded Borogo are caught in the drag net.

The details of this method are described by Rajan (unpublished). Khadi Jal is easily the commenest net of the lake and is described by all previous workers as a drag net. Very fine meshed Khadi Jals used to catch prawns are called Chingudi Jals. Other Khadi Jals, covering a wide range of meshes, are variously called Khoinga (2), Kabla (2), Charu, Menjia (2), Sahal (2) and Bekti (2) Jals (Appendix I). Practically all the net names mentioned in the preceding paragraph are identical with those of certain others which work on the principle of gilling nets and are entirely different from Khadi Jals. Such a loose nomenclature gives rise to a lot of confusion in terminology. Whereever such a synonymy has been encountered, the nets have been numbered as (1) and (2) to distinguish them from one another. Patua Jal is described as a shore seine by Devasundaram (1954), a seine net by Mitra and Mohapatra (1954) and a drag net by Jones and Sujansingani (1954). The manner of use of this net justifies its classification under all these heads though basically remaining a drag net. Patua Jal is very commonly plied in the lake to catch mostly Engraulids and other small fish. Individual pieces of this net often vary in width and mesh and the composite net, resulting by lashing different pieces together for actual use in water, generally has broader and finer meshed pieces towards the middle and narrower and bigger meshed pieces towards the two ends.

iii) Gill Nets :

Gill nets used in the lake may be classified under two broad groups : (1) those with a foot rope and (2) those without a foot rope (Drift nets). In the operation of the former, generally the shoals of fish are partly or entirely surrounded and the encircled fishes driven or chased towards the net for getting gilled. While the manner of encirclement somewhat varies with different nets, the bigger meshed nets of this category, made to hemp, are grouped under Sahal Jal and the finer meshed ones of cotton are called Menjia Jal (or Baria Jal, Meji Jal, Chanara Jal). In both these nets the encirclement of a shoal is often partial. Fuller encirclement is often accomplished in Dosti Bhida. In such situations fishes are driven towards the surrounding net wall to the accompaniment of a great deal of humdrum and noise which one often hears in the lake. In Ora Jal, a gill net used by fishermen of village Pathara to catch Bekti, the stretched net is pushed from two boats while the fishes are driven from the opposite end towards the net.

The gill nets without foot rope, loosely called Noli Jals by Chilka fishermen, are, in fact, narrow drift nets and are widely used to catch mullets. Seven varieties of Noli Jals each with different mesh arrangement and width are used in the lake to catch different species of mullets. Table 5 gives the details of each of these nets. Devasundaram (1951) has not described any of these varieties of Noli Jal in his paper on "Fishing Methods for Chilka Mullets".

iv) Cast Nets :

Cast nets or Khepa Jal are largely used for commercial fishing by fishermen of Gangadharpur village of the outer channel to catch passing shoals of mullets (generally Mugil cephalus), Hilsa or Nematalosa nasus in their appropriate seasons. The migration of these species either sea-ward or lake-ward is associated with rising or ebbing tides and fishermen use a series of cast nets in quick succession to catch them after first locating the passing shoals.

The classification of nets given in Table 4 is made use of in the logical presentation of observations on catch-per-unit-of-effort in a consolidated manner.

Work was directed for about two and a half years (April 1957 to August 1959) to discern the relative importance, species and size selectivities of the more important Chilka fishing nets (Marked with Asterisk in Appendix I). Meshes of different nets which were critically scrutinised by this Unit are discussed under "Catch-per-Unit-of-effort". In this section species selection is considered irrespective of their meshes.

Table 6 presents (for the years 1957-1959) catch record by percentages of fish weights for nets which were randomly encountered by survey parties in the lake. It is seen that Patua Jal followed by Khadi Jal, and Menji Jal are most effective gears in the lake catching 40.6%, 23.7% & 11.4% of catches taken by net fishing. Amongst the rest Borogo Jal, Bhida Jal and Noli Jal closely follow in the sequence stated taking 6.6, 5.6 & 5.5% of the catches.

Column 12 of Table 6 shows an analysis as to percentage of different economic species caught by net fishing. Discounting miscellaneous fish (49.8%), Borogo (9.8%) followed by Kabla (7.5%) Sahal (6.9%), Balangi (5.3%) and Hilsa (4.4%) are the more important species which are net fished. It is worthy of note that Borogo is mostly caught by net fishing and is quite uncommonly encountered in Janos.

While the percentage of catches in net fishing in respect of any species may be inspected in Table 6, the analysis shown in this table brings out the following points :

1. Patua, Khadi, Bhida and Menji Jals catch all fish in general without showing any especially marked selectivity.

2. Noli Jal is more selective in respect of mullets and Balangi.

3. Bekti, Borogo, Hilsa and Sahal Jals are more selective in respect of fish after which they are named.

4. Khepa Jal does not appear to catch much of Jagili, Khuranti and Borogo but catches all the rest.

TABLE - 5

NOLI JALS OF THE CHILKA LAKE

Sl. No.	Name	Mesh size in mm.	No. of rows in top piece	No. of rows in bottom piece	Species generally caught.
(1)	(2)	(3)	(4)	(5)	(6)
1.	Khoinga Jal	127 mm.	5 rows	3 rows	Mugil cephalus Liza troschelli
2.	Chaugunda Jal	102 mm.	6 rows	3 rows	Mugil cephalus Liza troschelli
3.	Dosta Jal	90 mm.	7 rows	3 rows	Nematalosa nasus Mugil cephalus Liza troschelli
4.	Dosti Jal	76 mm.	8 rows	4 rows	Nematalosa nasus Mugil cephalus Liza troschelli
5.	Daluatir Jal	64 mm.	9 rows	3 rows	Mugil cephalus Liza troschelli Liza ceoruleoma-culata
6.	Orandhi Jal	38 mm.	13 rows	4 rows	Mugil speigleri Thrissocles spp. Pseudosciaena spp. (Juveniles)
7.	Tir Jal	38 mm.	16 rows	3 rows	Sciaena russelli
8.	Kekenda Jal	20-30 mm.	-	-	Liza coeruleoma-culatus Mugil subviridis & Mugil corsula and other small mullets

TABLE - 6

SELECTIVITY OF TEN IMPORTANT NETS IN RESPECT OF SPECIES SHOWN AS PERCENTAGE OF POOLED NET CATCHES FOR THE YEARS 1957-59.

Species/Gear	Bhida Jal	Khadi Jal	Patua Jal	Noli Jal	Menjia Jal	Bekti Jal	Borogo Jal	Hilsa Jal	Khepa Jal	Sahal Jal	All nets
1	2	3	4	5	6	7	8	9	10	11	12
Mugil cephalus	3.0	17.3	1.0	45.5	0.7	-	-	2.2	20.7	2.4	7.5
L. troschelli	0.5	3.6	0.1	5.9	0.4	-	-	0.3	3.3	-	1.3
E. tetradactylum	15.0	6.1	6.7	6.1	9.0	4.0	1.3	2.0	15.0	25.3	6.9
Hilsa ilisha	9.5	0.2	0.2	0.5	5.6	-	-	80.0	-	5.7	4.4
N. nasus	5.0	3.4	2.2	11.0	14.3	-	-	0.7	41.2	12.0	5.3
Lates calcarifer	11.0	0.5	0.7	0.9	0.2	59.3	-	-	6.1	-	2.1
G. setifer	2.3	3.1	0.3	0.2	1.2	-	-	-	0.4	-	1.1
Sp. sarba	3.2	0.5	0.2	0.2	0.2	0.7	-	-	-	-	0.4
Ps. coibor	8.3	3.5	5.5	4.2	3.9	4.6	79.8	6.0	1.3	6.7	9.8
Mystus gulio	0.1	7.0	7.0	1.3	0.4	-	-	-	1.7	1.7	4.6
Pl. canius	1.5	1.7	0.7	0.1	0.02	-	-	-	0.2	-	0.8
Arius arius	1.3	0.4	0.6	0.9	0.1	-	0.8	-	0.3	0.2	0.5
Ost. militaris	3.1	3.1	1.2	0.7	0.37	-	-	0.04	-	1.4	1.5
P. semisulcatus	-	1.6	0.1	-	-	-	-	-	-	-	0.4
P. indicus	0.1	12.0	1.9	-	0.01	-	-	-	-	-	3.6
Miscellaneous	36.2	36.0	69.6	22.5	63.6	31.4	18.1	8.76	9.8	44.6	49.8
Total (Kg)	3982.6	16753.2	28709.7	3919.6	8043.3	1078.2	4672.6	2460.8	567.5	441.9	70629.4
Percentage of net catch	5.64	23.71	40.65	5.55	11.39	1.53	6.62	3.48	0.80	0.63	-

b) "Jano" Fisheries :

A total of 112 "Janos" are exclusively leased out fisheries in the Chilka lake. An alphabatical list of Janos showing their sectoral allocation and approximate area is given in Appendix II.

Mention has already been made that the lessees of the "Janos" failed to furnish reliable records of production, and the species composition of the Jano catches over the years 1957-1958 and 1958-1959 was determined by sampling the catches on the spot at 3 stages of the operation of a Jano. To provide coverage of the whole lake the Janos selected for such a study were Nalban, Gerasar and Talachatra in the Central Sector; Kerandia, Diwankhar and Gopata in the Northern and Kandakhai, Maleshwari and Jharnadi in the Southern Sector, stated in each case in the order of categories Good, Medium and Poor respectively. ~~While species composition of individual Janos are given under their respective sectors~~ A pooling of the data, from all the Janos stated above, is believed to furnish a representative species composition of the Jano catches from the lake notwithstanding certain special Janos like the Marai Jano in the Outer channel where the overwhelming catches are of a particular species (Khuranti in this case).

Table 7 furnishes species composition of the Jano catches separately for the season 1957-1958 and 1958-1959. An accurate record of sizes of each species exploited in "Jano" has been made for both the years which for Kabla and Dangla are presented and discussed under the "Biology" of these species in this report. This study was discontinued in 1960 firstly because it had served its purpose and further, because the available staff were required for more urgent investigations in 1960 and 1961.

c) Prawn Trap Fisheries :

A total of 67 prawn fisheries like "Janos" are exclusively leased out fisheries. Besides, unauthorised prawn fishing by traps is conducted in a large number of unleased areas. An alphabatical list of prawn fisheries showing their sectoral allocation is given in Appendix 8.

Species composition of prawns captured by trapping are tabulated in Table 8. In general it is seen that Penaeus indicus is the most abundant species followed by Penaeus semisulcatus, Metapenaeus monoceros and Metapenaeus dobsoni. Metapenaeous affinis is encountered in small numbers mostly in the Southern Sector of the lake.

TABLE 7

COMPOSITION OF THE JANO CATCHES

Species	1957 - 1958 Percentage	1958 - 1959 Percentage
Mugil cephalus	61.4	24.8
M. subviridis	0.8	1.3
Liza troschelli	22.4	8.5
L. borneensis	0.3	0.2
L. coeruleomaculatus	0.6	2.9
E. tetradactylum	0.4	4.5
Hilsa ilisha	-	0.04
N. nasus	0.5	2.5
Chanos chanos	0.1	15.4
L. calcarifer	0.5	8.5
G. setifer	0.8	12.1
Sparus sarba	0.1	0.6
Ps. coibor	-	0.4
Mystus gulio	3.4	6.4
Pl. canius	-	0.3
Rays	-	4.5
Miscellaneous fishes	0.02	5.6
P. semisulcatus	1.5	2.0
P. indicus	7.2	0.4
Total (Kg.)	6565	3192

TABLE 8

SPECIES COMPOSITION OF PRAWNS TAKEN BY TRAPPING

Species / Year	1957*	1958	1959	1960
Penaeus indicus	66.1	71.8	73.7	62.1
Penaeus semisulcatus	7.8	20.0	17.6	33.1
Metapenaeus monoceros	26.1	5.8	7.8	3.0
Metapenaeus affinis	-	0.1	0.1	0.1
Metapenaeus dobsoni	-	-	0.8	0.1
Small prawns	-	2.3	-	1.6

* Analysis for 1957 is available for July and August where as for the other years it is from April - August which is the full prawn season.

II A 2. TOTAL LANDINGS

Sampling Procedures Unsuccessfully Attempted :

Attempts were made at the outset to estimate total catches and total effort in Chilka lake by sampling method applied by the Central Marine Fisheries Research Institute and the Estuarine Division of the Central Inland Fisheries Research Institute to Hooghly - Matlah Estuary. A close scrutiny of the fishing practices, trade pattern and state of gear revealed that this sampling method was inapplicable to the Chilka lake as even the basic tenets of such a method were unfulfilled. The prevalence of the following practices made this method inoperable in Chilka lake.

1. There is an extensive system of carrier boats operated by a large number of commission agents whereby catches are collected at fishing sites and brought to shore without the fishermen themselves having to land their catches in their boats.

2. There is no regular periodicity of the return of fishermen to their villages since they go on fishing trips lasting for one to several days.

3. There is no means of knowing the ratio between the nets used in fishing and the nets possessed by fishermen of a village.

4. There are no means of knowing the actual fishing effort.

5. There is no known correlation between the fishing effort of one village with that of another.

6. There is a completely unstandardised state of fishing nets (see under "Observations On Catch-per-Unit-of-effort : Net Fishing" Section II-A-3).

7. In the case of prawn fishing by traps there is no means to discern the total number of traps used on a given day.

8. Jano fishing involves no effort either static or active and the lessees were unprepared to furnish reliable figures of fish production from their Janos.

Another sampling method viz. Estimation of a day's catch from certain specified water areas after their stratification, was unsuccessfully attempted. This method could not work because : (1) There is frequent nocturnal fishing when the catches made cannot be estimated, (2) Lack of sufficient number of motorised boats to be able to contact adequate number of fishing parties, and (3) Paucity of staff.

The method finally adopted to estimate total catches has been described in the "Introduction" (Section I).

II A 2(a) Monthly Estimates of Total Landings :

Table 9 shows the monthly total landings for the years 1957-60. A close scrutiny of the monthly figures of production showsthat there are two main seasons of fish production in the lake during the course of a year viz. the Jano season in autumn-winter months in which the mullet fishery preponderates and the prawn trapping season in summer months. The prominence of these seasons in the monthly production curve depends upon the success of mullet and prawn fisheries in the lake. 1957 was a rich mullet year and there is a prominent peak of production in October-December in that year. 1960 was a rich prawn year when there are to be seen very prominent peaks in the months of May and June. Net fishing operations, which are practiced all the year round with fluctuating intensity, are the main source of fish capture, in the remaining seasons of the year.

II A 2(b) Annual Estimates of Total Landings :

Table 10 shows the estimates of annual fish yield over the years 1930-1960 compiled from various sources stated at the foot of the table including those secured in the present investigation.

Devasundaram (1954) has furnished fish landings for 1948-1952 as 2859.3, 2997.7, 2925.2, 3120.0 and 3324.0 Tonnes respectively which somewhat vary from those given by Jones and Sujansingani (1954) for the years 1948-1950. Since the 'Permit System' which enabled Devasundaram to compile catch statistics was discontinued in 1952 and for following years up-to-date, only rail export data could be relied upon, the total production even for the years 1948-1952, based on rail export figures, [as done by Jones and Sujansingani (1954) for 1948-1950] have been taken in Table 10 for the sake of uniformity and mutual comparability.

Table 10 shows two levels of fish production viz. Pre-1948 when the yield ranged from 1098.3 Tonnes in 1942 to 2667.7 Tonnes in 1944 and post-1948 period when the yield fluctuated between 2837.6 Tonnes in 1954 to 4455.7 Tonnes in 1957, the latter being an all time peak record of production. Partition of the country, especially Bengal, in 1947, followed perhaps by more intensive exploitation, less of drying and more export occasioned by establishment of ice factories at Balugaon in 1948-1950 and discontinuation of Civil Supplies Scheme after the cessation of second world war are believed to be main reasons for sudden rise in production from 1948 onwards.

TABLE 9

TOTAL MONTHLY LANDINGS IN TONNES IN THE YEARS 1957-1960

Month	1957		1958		1959		1960	
	Land-ings	Percen-tage	Land-ings	Percen-tage	Land-ings	Percen-tage	Land-ings.	Per-centage
January	330.1	7.41	311.7	8.12	382.6	10.08	213.1	8.18
February	230.3	5.17	221.6	5.77	233.0	6. 14	187.1	7.19
March	268.3	6.02	305.3	7.95	282.5	7.44	184.1	7.08
April	302.3	6.78	384.3	10.01	270.4	7.12	205.3	7.89
May	342.2	7.68	406.9	10.60	323.4	8.52	319.7	12.28
June	311.0	6.98	335.4	8.74	320.1	8.43	358.8	13.78
July	337.3	7.57	423.2	11.03	358.6	9.45	226.4	8.69
August	384.6	8.63	388.0	10,11	436.6	11.50	148.0	5.68
September	334.0	7.50	227.5	5.93	277.2	7.30	112.3	4.31
October	593.2	13.31	137.3	3.58	262.6	6.92	161.9	6.22
November	612.4	13.74	262.8	6.85	347.8	9.15	275.0	10.56
December	410.1	9.21	433.9	11.31	302.2	7.95	211.9	8.14
Total	4455.7	-	3837.9	-	3796.7	-	2603.6	-

TABLE 10

TOTAL ANNUAL LANDINGS IN TONNES OVER THE YEARS 1930-1960 AND RELATIVE INDICES (BASE YEAR 1930 = 100 FOR 1930-1947: AND ARITHMETIC MEAN OF PERIOD 1948-1952 AS BASE = 100 FOR 1948-1960)

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Year	Landings	Relative index	Year	Landings	Relative index
(1)	(2)	(3)	(4)	(5)	(6)
1930	1732.7	100	1946	2426.1	140
1931	1437.7	83	1947	2612.7	150
1932	1164.2	67			
1933	1534.7	88	1948	4003.81	
1934	1456.8	84	1949	3667.2	
1935	1436.7	83	1950	3460.4	100
1936	1900.4	109	1951	3632.1	
1937	1652.3	95	1952	3818.4	
1938	1744.2	101	1953	3322.4	89.4
1939	2038.9	117	1954	2837.6	76.4
1940	1768.0	102	1955	3287.5	88.5
1941	1443.9	83	1956	3334.2	89 .7
1942	1098.3	63	1957	4455.7	119.9
1943	1803.7	104	1958	3837.7	103.3
1944	2667.7	154	1959	3796.7	102.2
1945	1624.7	94	1960	2603.6	70.1

1930-1945 Mitra (1945)
1946-1947 - - - -
1948-1952 Jones & Sujansingani (1954)
1953-1956 - - - -
1957-1960 Present Investigations.

Total catches from any fishery all by themselves give no indication of over-fishing or otherwise unless they are correlated with the intensity of exploitation operating over unit fisheries in terms of species into which the total catches have to be split up and the area of spread of the comprising stocks. The question of species, their stocks and distribution over space will be considered along with tagging at a further point in this report. In the Chilka lake, for reasons already explained, the actual total fishing effort and its rise and fall with the passage of time has not been possible to know. The reasons stated were, for the time being, quite beyond the Chilka Investigation Unit to counteract and remedy. It is believed, however that an approximate idea of the rise in total fishing effort with advance in time, is got with reference to rise in male population of Puri District (in which most of Chilka lake is located) which is estimated to have risen from 6,48,029 men in 1931 to 6,99,396 men in 1941 (a rise by 8%), to 7,74,830 men in 1951 (a rise by 12%) and to 9,31,331 men in 1961 (a rise by 20% over the 1951 census). The assumption is that the fishing intensity has steadily risen in some proportionate manner with the rise in male population of Puri District i.e., (population growth as one element of annual production). Accepting this assumption as valid, fixed base relative index of total fish yield and total fishing effort for the pre-1948 and post-1948 periods have been separately worked out. Male population as well as the fish production for the year 1930 have been considered as the base year for effort and yield respectively. For the 13 year period 1948-1960, with which we are more directly concerned, the mean production of the 5 year period 1948-1952 has been treated as the base to avoid chance abnormality of any particular year and relative indices of production for all subsequent years have been worked out. The relative indices as for production thus derived are shown in Columns 3 and 6 of Table 10.

In regard to the pre-1948 period, the fluctuations in relative yield are quite evenly distributed, there being two high peaks (for 1944 and 1947) and 2 minor peaks (for 1936 and 1939) above and 2 deep lows (for 1932 and 1942) and 3 minor lows (for 1935, 1937 and 1945) below the base line of production. While the general level of production has elevated itself in the post 1948 period the yield fluctuates evenly there being one high peak (for 1957) and one very deep low, (for 1960) on either side of the base line. When the amplitude of fluctuations of production are even and of about equal magnitude on either side of the base, the yield may be considered to be steady in this sense. Total catches of a very wide variety of mixed species are, however, too heterogeneous to throw any conclusive light on the state of exploitation of the stocks involved.

II A 2(c) Species-wise Estimates of Landings :

The following account is devoted to the elucidation of production pattern of individual species.

TABLE 11

ANNUAL LANDINGS OF COMMERCIALLY IMPORTANT SPECIES IN THE YEARS 1957-1960 IN TONNES.

Name of Fish	1957		1958		1959		1960	
	Land-ings.	Percen-tage.	Land-ings.	Percen-tage.	Land-ings.	Percen-tage.	Land-ings.	Percen-tage.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Mugil cephalus	893.7	20.06	557.3	14.52	338.5	8.92	180.7	6.94
Liza troschelli	65.9	1.48	134.9	3.51	61.5	1.62	33.8	1.30
E. tetradactylum	256.7	5.76	216.0	5.63	364.4	9.60	193.0	7.41
Hilsa ilisha	166.2	3.73	267.4	6.97	116.2	3.06	100.6	3.86
N. nasus	161.4	3.62	198.5	5.17	190.9	5.03	124.1	4.77
Lates calcarifer	174.3	3.91	136.2	3.55	150.8	3.97	102.2	3.93
G. setifer	50.7	1.14	63.9	1.66	54.4	1.43	37.0	1.42
Sparus sarba	21.6	0.48	2.0	0.05	20.8	0.55	26.4	1.01
Ps. albida	247.0	5.54	224.9	5.86	139.5	3.67	128.3	4.93
Plotosus canius	58.7	1.32	26.8	0.70	27.1	0.71	21.7	0.83
Arius arius	12.5	0.28	47 .4	1.24	65.9	1.74	49.3	1.89
Ost. militaris	69.9	1.57	72.5	1.89	11.7	0.31	11.9	0.46
Mystus gulio	484.6	10.88	251.4	6.55	284.5	7.49	188.9	7.26
P. semisulcatus	213.0	4.78	258.7	6.74	251.0	6.61	298.3	11.46
Penious indicus	741.0	16.63	815.8	21.26	865.1	22.79	575.1	22.09
Miscellaneous	838.5	18.82	564.2	14.70	854.4	22.50	532.3	20.44
Total :	4455.7	-	3837.9	-	3796.7	-	2603.6	-

Table 11 shows the landings of 15 selected economic species in each of the years 1957-1960 all together accounting for 81.2, 85.3, 77.5 and 79.6 percent of total production in each year respectively.

Table 12 showing landings of only selected species for the years 1948-1952 was prepared by further processing the data furnished by Devasundaram (1954). Devasundaram has presented total landings of economic species in absolute terms but the percentage of each species in relevant year's total landings are not worked out. These were calculated from the data published by him and were then utilised to break up the total landings estimated by rail export for the years 1948-1952 for reasons already given under

TABLE 12

SPECIES-WISE PRODUCTION OF COMMERCIALLY IMPORTANT FISHES IN TONNES DURING THE YEARS 1948-1952

Name of fish	1948	1949	1950	1951	1952
M. cephalus	537.1	421.4	330.3	413.7	439.0
L. troschelli	17.8	2.1	0.4	2.0	12.5
E. tetradactylum	184.9	180.7	230.3	193.1	104.7
H. ilisha	200.3	73.4	52.7	56.2	84.4
N. nasus	86.2	140.7	200.1	123.6	158.9
L. calcarifer	311.9	237.6	150.9	119.8	204.9
G. setifer	31.8	39.8	89.8	44.8	54.7
sarba	58.4	24.2	13.6	91.1	152.7
Ps. coibor	530.0	184.7	100.9	108.0	213.1
Pl. canius	10.0	2.1	3.4	8.0	22.6
A. arius	193.8	87.8	12.4	1.7	-
Ost. militaris	102.7	43.2	32.9	11.2	26.4
Mystus gulio	403.1	204.3	67.8	90.4	141.9
P. semisulcatus	122.8	260.2	265.8	532.2	523.6
P. indicus	371.7	696.7	752.9	872.9	631.7
Miscellaneous	841.3	1068.3	1156.2	963.4	1047.3
Total :	4003.8	3667.2	3460.4	3632.1	3818.4

"Annual Estimates of total landings". The data gathered in the present investigation furnished species-wise records of production for the years 1957-1960. Construction of indices of production are discussed along with the description of the salient biological features of different economic species (Section IV A). Future development of the fisheries of each species of Chilka lake also are discussed further on.

TABLE 13

Fishing intensity in terms of percentage of man hours observed in net fishing during 1957-'59.

onth	Janu-ary.	Febru-ary.	March	Apr-il.	May	June	July	Aug-ust.	Sep-tem-ber.	Oct-ober.	Nov-em-ber.	Dec-em-ber.
ercen-age.	8.9	12.4	9.3	8.2	8.9	7.7	7.5	13.0	10.8	3.8	4.9	4.6

Total manhours = 53072

II A 3. OBSERVATIONS ON CATCH-PER-UNIT-OF-EFFORT

Reference has been made under "Introduction" to the dissection of total landings into their contributing agencies viz. Jano, trapping and net fishing operations. Table 13 presents the average fluctuations in the intensity of net fishing operations stated as percentages of randomly encountered man-hours of net fishing in different months of a year. It is seen that the frequency of netting operations go down to 40% in the Jano season. Basing on this 60% of the total catches in the Jano season are treated to be the output from the Janos. Contributions from Jano fishing and trapping have been determined in their respective seasons by giving an allowance for net fishing in total landings in the relevant months. By subtracting the sum of these two from the total annual production one gets an idea of the exclusive contribution by net fishing. The theoretical details of computations necessary to estimate net fishing and trapping contributions are given in the foot-note.* Table 14 shows the relative contributions from these three modes of fishing.

II A 3(a) Net Fishing :

In Table 14 it is seen that net fishing contributes about 50% to 66% of the annual production of the Chilka lake. The share of different types of nets to this total contribution (of net fishing) is also known and in fact has even been discussed before. This section deals with the catch-per-unit-of-effort in respect of different nets. Status of various Chilka nets and their species selectively having been discussed in the preceding sections, consideration of their meshes follows, vitally important as they are, in connection with the studies on catch-per-unit-of-effort.

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* Let x and y be total landings and prawn catches respectively during prawn trap season from April to August which are known : x - y = z given the fish catches for the season. Percentages of fishes in trap (called a) and prawns in net fishing (called b) were observed in the field. Let p be the amount of fish caught in traps out of 2 Tonnes of fish production.

Then z - p becomes the amount of fishes caught in nets.

This equals to 100 - b % of net fishing production because b % is prawns.

(100 - b) equals to z - p

$100 = ? = \frac{100\ (z - p)}{100 - b}$ is the net fishing amount.

$x - \frac{100\ (z - p)}{100 - b}$ is the trap production.

a % of fishes are caught in traps.

If the catch is 100 then are fishes

$x - \frac{100\ (z - p)}{100 - b} = ?$

$x - \frac{100\ (z - p)}{100 - b} \times \frac{a}{100} = p$ . . p is the amount of fish assumed to be caught in traps.

$(100 - b)\ x - 100\ (z - p)\ a = 100\ p\ (100 - b)$

$100\ xa - bxa - 100\ za = 100\ p\ (100 - b - a)$

except p all the other variables are known so value of p is obtained by solving the equation.

$\frac{100\ (z - p)}{100 - b}$ is the net fishing contribution.

$\frac{x - 100\ (z - p)}{100 \quad b}$ is from prawn traps.

TABLE 14

Contributions of each mode of fishing.

	1957		1958		1959		1960	
	Tonnes	%	Tonnes	%	Tonnes	%	Tonnes	%
"Jano"	969.4	21.8	500.4	13.0	547.6	14.4	389.2	14.9
"Trap"	860.4	19.3	812.4	21.2	927.6	24.4	843.7	32.4
"Jahani"	2625.9	58.9	2525.1	65.8	2321.5	61.2	1370.7	52.7
Total :	4455.7		3837.9		3796.7		2603.6	

TABLE 15

NETS WITH THEIR MESH RANGE AND NUMBER OF 5 mm. CLASSES FORMED

Name of net	Mesh range in mm.	Number of classes
Bhekti Jal	61 - 155	13
Bhida Jal	16 - 125	15
Khadi Jal	6 - 65	10
Borogo Jal	21 - 45	4
Hilsa Jal	26 - 65	5
Patua Jal	6 - 55	1
Menjia Jal	26 - 45	4
Sahal Jal	46 - 60	3
Noli Jal	16 - 125	21
Khepa Jal	166 - 65	10
Muni Jal	6 - 25	4

TABLE 16

CATCH PER MAN HOUR IN GRAMS.

Month / Gear	Khadi Jal Mesh 11-15 mm.	Khadi Jal Mesh 16-20 mm.	Khadi Jal Mesh 21-25 mm.	Monji Jal Mesh 31 - 35 mm.	Patua Jal
April'57	258	147	227	206	989
May	195	872	-	838	328
June	163	1285	-	363	235
July	238	-	302	262	146
August	157	236	106	-	209
September	359	918	424	122	424
October	89	-	-	-	720
November	-	-	-	-	1440
December'57	1115	-	454	236	1002
January'58	680	226	486	239	1399
February'58	-	379	-	472	762
March	525	436	-	454	576
April	374	580	522	507	1008
May	320	413	295	484	504
June	608	587	412	304	894
July	266	1337	127	252	479
August	1659	580	461	703	655
September	361	225	1078	-	732
October	-	328	411	246	476
November	326	230	572	210	1619
December'58	1074	454	303	391	844
January'59	233	91	408	355	726
February	325	256	782	291	895
March	322	594	419	198	405
April	299	259	316	442	624
May	517	642	174	272	596
June	587	711	567	391	555
July	310	1199	907	565	997
August'59	503	547	457	279	804

Studies were directed for about 2½ years (April, 1957 - August, 1959) to recording catches per-man-hour in regard to fishing units by actual contact at the fishing sites in the belief that the collected data would at least serve as a measure of fish abundance. These hopes, however, did not materialise since it was found that in net fishing operations in Chilka lake the fundamental tenets of "Unit Concept" in catch-per-Unit-of-effort studies remained unfulfilled. Detailed observations are available in regard to catches made by Bekti Jal, Bhida Jal, Hilsa Jal, Borogo Jal, Khadi Jal, Muni Jal, Patua Jal, Menji Jal, Sahal Jal, Noli Jal, and Khepa Jal. In all these nets such a widely divergent array of meshes were encountered in the field that it became necessary to serriate them. This was immediately done and 5 mm. class intervals were set up. Table 15 shows the number of classes with their range which had to be set up to accommodate the observed net meshes. As each net had to be subdivided into a large number of mesh classes the frequency of encounter of nets of indentical or same mesh-class with any regular periodicity is quite restricted. Only in 3 mesh-classes of Khadi Jal (viz. of mesh ranges 11 - 15 mm., 16 - 20 mm. and 21- 25 mm.) one of Menji Jal (of mesh class 31 - 35 mm.) and Patua Jal (multi meshed seine by design) are a fairly continuous record of observations on catch-per-man-hour available which are presented in Table 16 on monthly basis and in Table 17 on annual basis. In other nets the divergence in meshes proved too formidable and frequency of encounter of nets of comparable meshes too irregular. This necessitated consolidation of nets of similar types. Seven categories of nets were thus formed viz. 1. Large drag nets by pooling Bekti, Bhida, Borogo and Hilsa Jals, 2. Small drag nets including only Khadi Jal, 3. Gill nets including Menji and Sahal Jals, 4. Drift nets including Noli Jals, 5. Seine including Patua Jal, 6. Cast net including Khepa Jal and 7. Pouch net including Muni Jal. Table 18 presents the mean monthly catch-per-man-hour values for the duration April, 1957 to August, 1959, the period over which observations were run. These were further consolidated into annual values and Table 19 shows catch-per-man-hour for three principal categories of nets viz. Drag nets, Gill nets and Drift nets. The irregular fluctuations in monthly as well as annual values of catch-per-man-hour are believed to be due to unstandardised state of gear and do not reflect any changes in fish abundance. A suspicion is cast on the role of wide fluctuation in fishing effort as well. The effort from net to net and nets of different sizes, as is well known, varies very widely. The relation between catches of nets of different lengths and in the cases of drag nets and seines with different number of men needs elaborate study. Whether, the computation of catch-per-man-hour values from nets of different lengths with varying man power on the assumption of arithmatic

TABLE 17

CATCH-PER MAN HOUR IN KILOGRAMS

Gear	Mesh	1957	1958	1959
Khadi Jal	11 - 15 mm.	0.221	0.435	0.371
	16 - 20 mm.	0.581	0.437	0.609
	21 - 25 mm.	0.229	0.382	0.415
Menji Jal	31 - 35 mm.	0.207	0.428	0.325
Patua Jal	-	0.593	0.790	0.667

TABLE 18

CATCH PER MAN HOUR IN GRAMS FOR SIMILAR NET TYPES POOLED TOGETHER IRRESPECTIVE OF MESHES.

Month	Large Drag nets.	Small Drag nets.	Gill nets.	Drift nets.	Seine nets.	Cast nets.	Pouch nets.
April'57	435	247	196	151	989	45	136
May	87	191	838	121	328	144	110
June	132	262	363	376	235	114	255
July	181	233	262	478	146	338	216
August	432	186	527	505	209	-	153
September	602	359	184	568	424	124	-
October	567	190	-	220	720	-	-
November	307	-	380	151	1440	-	-
December'57	181	68	236	340	1002	-	159
January'58	1775	314	1444	583	1399	448	-
February	247	357	540	-	762	599	123
March	240	264	395	282	576	340	197
April	-	594	505	616	1008	-	-

Contd. Table 18

Month	Large Drag nets.	Small Drag nets.	Gill nets.	Drift nets.	Seine nets.	Cast nets.	Pouch nets.
May	111	321	589	434	504	-	-
June	956	553	352	277	894	504	-
July	1270	235	193	1044	479	616	-
August	523	479	703	353	655	118	-
September	1383	557	-	-	732	61	-
October	-	416	246	389	476	-	-
November	169	403	199	219	1619	-	298
December'58	399	373	391	-	844	151	-
January'59	661	324	355	-	726	-	671
February	1913	338	291	113	895	-	-
March	966	349	234	238	405	-	-
April	702	400	449	585	624	-	234
May	339	393	284	954	596	-	-
June	427	1261	391	515	555	291	-
July	724	1049	479	339	997	620	-
August'59	892	506	399	392	804	366	-

T A B L E 19

CATCH PER MAN HOUR IN KILOGRAMS FOR PRINCIPAL CATEGORIES OF NET TYPES

Net/Year	1957	1958	1959
Drag nets	0.359	0.642	0.623
Gill nets	0.250	0.663	0.336
Drift nets	0.436	0.531	0.459

ratio and proportion results in strictly mutually comparable values or not deserves to be especially looked into. All this obviously could not be done with the resources at hand.

The situation obtaining about the state of Chilka lake nets in respect of mesh, dimensions and effort was reviewed after net fishing observations were made for two and half years. A thorough scrutiny revealed the futility of the study under the prevalent circumstances. The catch-per-man-hour value with unstandardised nets and irregular effort merely furnishes at best an economic index of fishermen's earnings but cannot act as a measure of fish abundance. Being unproductive and unrewarding these studies were given up in September 1959 and efforts channelised towards different pursuits. However, the observations made in 2½ years have been presented. There are no corresponding observations for any earlier period to compare them with. The observations presented besides their significance (in proving the futility) of such studies, may be of some use should any body need them for comparison with corresponding observations at a future date.

From April, 1960 onwards the relative abundance of populations of Sahal, Borogo, Kantia, Singda, Balangi upto certain specified size limits was experimentally attempted to be sampled by departmental operation of multiple - meshed gill nets in all the sectors of the lake. These gill nets are identical in all respects and are 1.8 M. wide, and 152 M. long comprising 5 pieces each 1.8 M. x 30.4 M. and of meshes 25 mm., 38 mm., 51 mm., 64 mm and 76 mm. respectively. They are set at night at several selected sites which are kept constant. It is proposed to evolve in future, nets which will adequately sample all size-groups of each one of the economic species of the lake. To what extent the fluctuations of various species represented by the catches of such a sampling net represent fish abundance remains to be investigated and it is too premature at the present stage to comment on the success or otherwise of the experiment (see "Suggestions on Future Programme of Research" Section X).

TABLE 20

CATCH-PER-TRAP IN GRAMS.

Name of Trap	Observed				Calculated			
	1957	1958	1959	1960	1957	1958	1959	1960
Dhaudi	61	132	138	144	-	-	-	-
Baza	48	54	88	44	-	-	-	-
Dhaudi + Baza*	*	99	111	88	101	95	108	99

* Observations are not available for full seasons.

II A 3(b) "Jano" Fisheries :

In the absence of reliable data on the yield of "Jano" fisheries from the lessess, productivity of "Janos" in terms of catch per "Jano" hectare was determined by indirect means as already described. With the knowledge of the approximate area of the "Janos", catch per hectare was computed. Yield per "Jano" hectare when thus computed works out to be 57.8, 91.1, 57.5 and 53.2 Kg. for the season 1956-1957, 1957-1958, 1958-1959 and 1959-1960 respectively.

II A 3(c) Prawn Traps :

Catch-per-trap-per night was chosen as a Unit of effort for prawn trap fisheries. Two types of traps viz. Dhaudi and Baza (Job and Pantulu, 1953) are used in the lake. Average catch per trap for the years 1957, 1958, 1959 and 1960 for both Daudi and Baza are given in Table 20. These data show that Dhaudi is a more effective trap than Baza possibly due to its feasibility for operation in deeper waters also and provision of values preventing escape of prawns from inside.

For purpose of checking the accuracy of observed values of catches per trap, catch records for both the types of traps were pooled and an average value of catch per trap was determined. From the knowledge of total number of traps present in the lake (Mitra and Mohapatra, 1957) and the total prawn catches in the trapping season determined by method already described above, calculated values of catch-per-trap were obtained for the whole season for each of the years 1957-1960. Table 20 furnishes the observed and calculated values of catch per trap for the whole lake for the years 1957-1960. The closeness of observed and calculated values of catch-per-trap is worthy of notice for each year of observation.

III. TAGGING OPERATIONS IN CHILKA LAKE

The purpose of tagging was to elucidate the following in regard to the species tagged :

1. Delimitation of the stocks involved so as to delineate the Unit fisheries geographically.
2. Migration, its season, purpose and sizes involved.
3. Rate of exploitation.
4. Growth and if feasible,
5. Estimation of the size of total population.

Six most commercially important species of fish were selected for tagging and the salient features of the tagging conducted and results obtained by way of returns during the years 1957-1959 are presented in Table 35.

The pictorial representation of the geographical details of sites of tagging and recovery depicting fish migration along with analysis of data on sizes tagged and recovered, sexes and maturity of recovered specimens and other aspects of work related to tagging are given and fully discussed in another publication (Jhingran and Mishra : unpublished). As tagging operations are not an end by themselves but only means to an end, the conclusions drawn after analysis of data, have been synthesised and interwoven, as it were, in building up the life histories of some of the economic species tagged which are described under "Salient features of the Biology of Economic Species". However, an account of the salient features of tagging done and the results achieved follows immediately. Only Mugil cephalus was tagged in 1957 (Jhingran and Patro, 1959), and the tags were of Petersen's type, each Unit consisting of a celluloid and a silver disc both bearing an identical number joined together by a silver pin. On account of development of septic wound at the site of tagging in many fish tagged in 1957 the tag was changed to streamer type in the tagging operations of 1959 (Jhingran and Mishra : unpublished) in which terylene twine was looped through a segment of fish body. These latter proved entirely satisfactory. Six commercial species including Mugil cephalus were tagged in 1959 (see Table 21). In both the years tagging was done only in the lake and hence recoveries made throw conclusive light on fish movement only in one direction. Had tagging been done, for example, in the sea also and recoveries made in the lake, one would have been sure of reciprocal movement also.

Among the positive results of the tagging operations were that a fair idea was gained of the fish movement within the lake and, as in the case of mullets and sparus, their movement into the Outer-channel and the sea close to Chilka mouth. These in conjunction with records on size, age, sex and maturity of recovered specimens gave valuable information on migration and its probable purpose. Some idea was also gained, especially in the case of mullets recovered several months after tagging, on growth rates which helped to check the picture theoretically eludicated by Petersen's length-frequency distribution method. As specimens recovered within 3-4 months after tagging appeared to show adverse affects of tagging on growth, and majority of our specimens fall in that category, not much could be gained in that direction. The tagging conducted throws little light on the rates of exploitation (mortality rates) and are of no help in estimation of population sizes since a large number of recoveries

TABLE 21

SALIENT FEATURES OF TAGGING CONDUCTED BY THE CHILKA INVESTIGATION UNIT

Sl. No.	Name of fish	Year of tagging	No. of stations	Nos. tagged	Nos. recovered	Over all % of recovery	Range of % of recoveries at different tagging station
1	2	3	4	5	6	7	8
1.	Mugil cephalus	1957*	2	998	50	5.0	--
?.	Mugil cephalus	1959	39	2355	202	8.6	0-16.7
2.	Liza troschelli	1959	34	2872	182	6.3	0-66.7
3.	Eleutheronema-tetradactylum	1959	24	544	43	7.9	0-33.3
4.	Lates calcarifer	1959	23	206	14	6.8	0-100.0
5.	Sprarus sarba	1959	12	691	13	1.9	0-2.5
6.	Pseudosciaena-coibor	1959	6	44	Nil	-	--
	Total	1957		998	50	5.0	--
		1959		6712	454	6.8	--
	Grand Total			7710	504	6.5	

* A paper entitled "A Preliminary Tagging Experiment on the Mullet Mugil cephalus linnaeus in Chilka Lake" by V.G. Jhingran and J.C. Patro. Journal of Bombay Natural History Society, 56 No. 2, August, 1959.

TABLE 22

RELATIVE INDICES OF PRODUCTION OF DIFFERENT ECONOMIC SPECIES WITH ARITHMETIC MEAN OF 1948 - 1952 CATCHES AS BASE (100)

Species/Year	1957	1958	1959	1960
M. cephalus	208.7	130.1	79.0	42.2
L. troschelli	941.4	1927.1	878.6	482.9
El. tetradactylum	143.6	120.9	203.9	108.0
H. ilisha	177.9	286.3	124.4	107.7
N. nasus	113.7	139.9	134.5	87.5
L. calcarifer	85.0	66.4	73.6	49.9
G. setifer	97.1	122.4	104.2	70.9
Sp. sarba	31.8	2.9	30.6	38.8
Ps. coibor	108.7	98.9	61.4	56.4
Mystus gulio	267.0	138.5	156.7	104.1
Pl. canius	638.0	291.3	294.6	235.9
Ost. militaris	161.4	167.4	27.0	27.5
P. semisulcatus	62.5	75.9	73.6	87.5
P. indicus	111.4	122.6	130.1	86.5
Misc.	82.6	55.6	84.2	52.4

are known not to have been reported. The results of tagging only tend to show a homogenity of stocks, especially of mullets, as shown by their distribution of tagged fish practically throughout the lake but tagging has to be done in future on a much larger scale to throw conclusive light thereon.

IV A. SALIENT FEATURES OF THE FISHERIES AND BIOLOGY OF ECONOMIC SPECIES*

In the following account of the salient features of the fisheries and biology of different economic species, the average catch of the various species over the years 1948-1952 was taken as fixed base and relative indices of production for the years 1957-1960 worked out for the sake of mutual comparison of the catches of the species described over different years. Table 22 shows the relative indices of each economic species over the years 1957-1960.

(a) MULLETS :

1. MUGIL CEPHALUS LINNAEUS (OR KHOINGA OR KABLA) :

Commercial Fishery : The production of Kabla ranged from 330.3 to 537.1 Tonnes during the period 1948-1952** but soared to 893.7 Tonnes in 1957, the ever recorded peak of production. From 1957 onwards there has been a decline in yield reaching its minimum of 180.7 Tonnes in 1960. It is seen in Table 22 that in the years 1957 and 1960. the indices of Kabla production were 208.7 and 42.2 respectively.

Susceptibility of different gear : Two principal modes of fishing yield the catches of Mugil cephalus viz. Jano and "Bahani". Among the different nets used, Khadi Jal and Noli Jal are the most important.

Sizes in commercial catches : For the sake of recording sizes in commercial catches Mugil cephalus has been divided into five size groups viz. small, medium, large, very large and huge with length limits as indicated in Table 23. The Approximate age of each size group is also indicated in Table 23.

* The information furnished under biology of different economic species is mostly in abstract form based on work done on individual species by different workers of the Chilka Investigation Unit who are separately publishing the detailed accounts of their work. The detailed study of the biology of the mullets of Chilka lake was taken up by the Orissa Fisheries Department personnel and aspects of work arising out of examination of commercial fisheries and tagging of mullets by the Central Fisheries staff.

** Kabla production figures over the period 1948 - 1952 are likely to be lower than those given by Devasundaram (1954) since they are perhaps mixed with those of Dangla. Please see description under Liza troschelli.

TABLE 23

SIZE GROUPS OF MUGIL CEPHALUS

Name of size group	Total length limits	Approximate age
Small	Upto 200 mm.	6 months
Medium	201 mm. to 350 mm.	12 "
Large	351 mm. to 500 mm.	24 "
Very Large	501 mm. to 625 mm.	36 "
Huge	626 mm. and above	More than 36 months

Sizes in 'Janos' : 'Medium' sized fish form the bulk of the jano catches overwhelmingly (62 to 92 %), followed by 'large' fish (3 to 33%). Fishes of categories small (0.1 to 4.5%) and 'very large' (0.2 to 4.3%) and above occur in small numbers in the Janos.

Sizes in net fishing : Khadi Jal and Patua Jal are the only two nets which catch small sized Kabla in appreciable numbers during the period April-September. All the other nets viz. Noli, Menji, Hilsa and Bhida jals catch 'medium', and larger fishes, Patua Jal and Noli Jal catching 'very large' fish in appreciable numbers.

Determiniation of the annual average length of a fish in commercial landings is an important item of work in a study on depletion of a fishery and, as already stated under "Material and Methods", that measurements of fish lengths of random samples were taken on a large scale throughout the study in godown sampling operations irrespective of their mode of capture. A total of 38,456 measurements of Kabla are on record in the years 1956-1960. The average lengths of M.cephalus in the years 1957-1960 are stated under "Vital statistics". A scrutiny of the data at hand shows that recruitment of Kabla into the fishery of the lake occurs in the spring months and there is a special abundance of very large sized fish in the main lake and outer channel during the months June, July and August. 'Large' and 'Very Large' fish are also especially abundant in the outer channel and the sea during the months October-December. Fishing for Kabla is carried out in the sea, adjoining the Chilka shore, only during the months : October-December. Only maturing and nature (but mostly unspent) specimens are encountered in the Outer channel and the sea during the months October-December. A feature of especial interest is that the males and females of Kabla are of different size groups which evidently belong to different age-groups as well. Further interpretations regarding modal locations of size groups in different parts of the lake and the sea during different months, sex ratio and tagging work are given under "Discussion" in this section.

Vital statistics : Table 24 shows (1) the numbers in different size groups (n) (2) their percentage in total numbers (3) average length of individual group (4) overall average length (5) the weight of fish of average length of group (6) percentage of group in total by

T A B L E 24

VITAL STATISTICAL COMPUTATIONS OF MUGIL CEPHALUS

Size group	No.in group (n)	% of n in total	Average length of group in mm(l)	Overall average length in mm.	Weight of average length in Gms.(w)	% by weight in total	Annual mortality rate.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			1 9 5 7				
Medium	7668	81.50	259.6		173	53.90	
Large	1492	15.90	413.2		586	35.53	0.8055
Very Large	242	2.60	520.5		1075	10.57	0.8378
	9402			290.7			0.8222

Contd. TABLE 24

VITAL STATISTICAL COMPUTATIONS OF MUGIL CEPHALUS

Size group	No.in group (n)	% of n in total	Average length of group in mm(1)	Overall average length in mm.	Weight of average length in Gms.(w)	% by weight in total	Annual mortality rate.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			1 9 5 8				
Medium	5525	63.40	271.8		196	32.89	
Large	2624	30.20	409.0		571	45.51	0.5251
Very Large	528	6.00	547.0		1224	19.63	0.7988
Huge	34	0.40	647.6		1907	1.97	0.9356
	8711			331.3			0.8170
			1 9 5 9				
Medium	5987	65.00	295.6		243	43.28	
Large	2918	31.50	398.0		531	46.09	0.5126
Very Large	310	3.30	532.3		1140	10.51	0.8937
Huge	2	0.20	663.0		2029	0.12	0.9935
	9217			336.0			0.9306
			1 9 6 0				
Medium	6442	70.74	285.2		222	46.97	
Large	2528	27.76	411.0		578	48.00	0.6076
Very Large	136	1.49	527.3		1112	4.97	0.9462
Huge	1	0.01	638.0		1834	0.06	0.9906
	9107			323.8			0.9463

weight and (7) annual mortality rates, separately for each of the years 1957-1960. The annual average length (L) of M. cephalus was 290.7, 331.3, 336.0 and 323.8 in the years 1957-1960 respectively. The rather sudden decline, of the numbers of 'Very Large' and 'Huge' groups as shown by high 'Mortality Rates' is due to the migration of the species of these sizes to another habitat (the sea), and does not reflect mortality due to fishing or any natural cause. Such a phenomenon is to be expected in a katadromous species like M.cephalus. The detailed biology of Mugil cephalus is being separately published by Pathaik, D.A. (unpublished).

Discussion : From the economic fisheries point of view the specific questions in regard to M. cephalus are : (1) Confirmation of statements of earlier workers on its breeding and migration, (2) How long does it stay in the lake before migrating to the sea for breeding ?, (3) What are the sizes and ages of migrants ?, and (4) What percentage, if any, return to the lake from the sea after breeding along with or independent of the fingerlings. The answers to those questions as far as known to-day are discussed below.

Field observations in the lake, outer channel and the sea combined with tagging have confirmed that M.cephalus performs regular seaward breeding migration during the months October-December. The place of breeding in the sea is unknown. Mostly small and medium sized specimens were tagged in the lake. An overwhelming majority of recovered specimens in the lake, from January onwards, were immature females indicating their stay in the lake. One ripe medium sized male was recovered in the sea. These results of tagging show that large females, believed to be about 2 years old, migrate to the sea. Such a hypothesis explains the numerical superiority of males over females among the migrating individuals. The answer to question No.2, posed above, is, that after migrating into the lake in spring as fingerlings the males ripen that very year and perform seaward migration, whereas the females stay back for another year. The males thus stay in the lake for a period varying from 6-10 months and the females for a period varying from 18-22 months.

Table 25 shows the details and descriptive statistics of the migrating specimens of Mugil cephalus in the Outer channel and those encountered in the sea in 1957. It may be noted in Table 25 that the size of the migrating fish reduces as the season advances. From the mean lengths of 534.24 mm. and 538.26 mm. in females from the outer-channel and sea respectively in October it comes down to 482.16 mm./ and 493.98 mm. in December. In the case of the males the corresponding mean lengths come down from 375.5 mm. and 396.1 mm. to 352.6 mm. and 357.42 mm. from the outer channel and sea respectively from October to December. The numerical superiority of the males over females in the outer channel is also obvious. There is no corresponding numerical superiority discernible in the case of the sea catches which is due to the selectivity of the Khadi Jal which are operated on the beach to catch the mullets. Ages are approximately ascribed as mostly 2 and mostly 1 years in the case of females and males respectively. Due to prolonged breeding season running over 3-4 months it is difficult to ascribe the ages more accurately although there is little doubt that a few of the small females, especially of the later phase of migration, and a few of the very large females, especially of the early phase of migration, are more than one and two years old respectively. Similarly a few of the large migrating males, especially in the early phase of migration, are more than one year old.

There is little doubt that some adults, especially females, return to the lake from the sea along with the fingerlings. In one

TABLE 25

OBSERVATIONS ON THE SIZES OF MATURE M.CEPHALUS CAPTURED IN THE OUTER CHANNEL AND THE SEA IN 1957.

Month of the year 1957	Outer-channel			Sea			Approximate age in years.
	Size range in mm.	Mean length	No.of Speci-men	Size range in mm.	Mean length	No.of speci-men	
1	2	3	4	5	6	7	8
			FEMALE				
October	464-587	534.24 ± 4.3	48	465-663	538.26± 2.7	196	Mostly 2
November	440-556	505.24 ± 6.6	19	450-606	513.98± 1.9	247	-do-
December	403-551	482.16 ± 5.1	36	423-581	493.98± 8.9	23	-do-
			MALE				
October	284-456	373.5 ± 2.15	180	350-472	396.1± 4.8	53	Mostly 1
November	300-430	360.5 ± 1.8	160	334-446	362.7± 2.7	59	-do-
December	305-397	352.6 ± 3.0	57	320-403	357.47± 4.0	26	-do-
Total			500			604	

day's catch in June, 1958, ten such large females, showing recovering ovaries, were encountered in the lake mouth area in a haul estimated to have about 1,320 advanced fingerlings. Further, there is a sudden influx of very large female M. cephalus in the months of May-July. This phenomenon was observed every year without variation. These individuals are interpreted as those which are returning to the lake after their breeding sojurn in the sea. However, the final confirmation of this can only be proved by tagging of large mullets in the sea and the recovery of a few in the lake if one is lucky.

The numbers of adult fish migrating to the sea for breeding and the numbers of juveniles and spent adults entering the lake year after year is not fully known. It can reasonably be supposed that if proper quantitative assessment can be made in the lake mouth region a system of forecasting the intensity of Kabla fishery in the lake can be worked out. This is further discussed under "Suggestions on Future Programme of Research".

IV A a 2. LIZA TROSCHELLI or 'DANGLA' :

Commercial fishery : The production of Dangla over the years 1948-1952, as given by Devasundaram (1954), ranges only between 0.4 Tonnes in 1950 to 17.8 Tonnes in 1948. This is a very low record of production and has possibly been caused by the fish dealers recording Dangla catches under the name of Kabla. Such a tendency among merchants was noticed by the present workers early in this work and since the production figures stated for 1957-1960 are based on actual godown sampling and are not based on merchant data such a mix up has been avoided in the current investigation. The production of Dangla in 1957 was 65.9 Tonnes, it rose to 134.9 in 1958 and has shown a decline to 61.5 Tonnes in 1959 and to 33.8 Tonnes in 1960. In view of the unreliability of the production figures during the base period of 1948-1952 the fixed base relative index comparisons in this species have not been attempted.

Susceptibility of different gear : As in the case of Kabla, Jano and Net fishing are the principal modes of fishing which yield the catches of Dangla. Khadi Jal and Noli Jal are the more important nets which take this fish.

Sizes in commercial catches : Four size-groups of Liza troschelli are encountered in commercial catches. The length limits and approximate age of these groups are shown in Table 26.

TABLE 26

SIZE-GROUPS OF LIZA TROSCHELLI

Name of size group	Total length limits	Approximate age
Small	upto 150 mm.	6 - 7 months
Medium	151 - 260 mm.	12 months
Large	261 - 420 mm.	24 months
Very Large	421 mm. and above	more than 24 months

Sizes in Janos : 'Medium' and 'Large' sized fish form bulk of the Jano catches constituting 45.1% and 50.8% of the Jano catches respectively. 'Very large' fish form 3.3% in the catches taken from the Janos. The percentages of 'Large' and 'Very Large' Dangla in the Janos is higher in the case of this species than in Mugil cephalus because of its late breeding relative to Kabla. While Kabla undertakes its peak breeding migration in November Dangla does so in January as is reflected in the record of percentage of landings of this species in the lake-mouth area and the numbers encountered there.

Sizes in net fishing : As in the case of Kabla, Khadi and Patua Jals catch small sized fish in appreciable number, the former in much larger numbers than the latter. Bulk of the catches are made in the period July-September. Noli Jal catches 'medium', 'large' and 'very large' Dangla in fairly large numbers. Bhida and Hilsa Jals catch only 'large' sized fish during the period April-June.

Sizes encountered in pooled commercial landings and in different regions : Measurements of 12,849 randomly sampled Dangla were taken at the fish assembly centres in the years 1956-1960 regardless of their mode of capture. The average size of the fish in the commercial landings in each year of study is given under "Vital Statistics" (Table 27). Peak migration of this species occurs in December-January. The sea-shore catches of Dangla are not so abundant as those of Kabla which is probably due to difference in habitat in its sea sojourn. The species is smaller in size than Kabla and paucity of sea catches may probably be due to net selection as in the case of Kabla males.

Further interpretations of data regarding modal locations of size groups, sex ratio and tagging work are given under "Discussion" in this section.

Vital statistics : Table 27 shows the same aspects of vital statistics of Dangla as those stated for Kabla in the previous section. The average length of Dangla in the pooled commercial landings during the years 1957-1960 was 226.7, 320.9, 325.7 and 283.9 mm. respectively. The rather inordinate paucity of numbers of 'huge' size-group is indicative of Katadromous migration, although the pattern thereof is not as clear cut as in the case of Kabla. The detailed biology of Liza tröschelli is being separately published by Roy, J.C. (unpublished).

Discussion : Similar questions as those stated under M. cephalus pose themselves for Dangla as well. Field observations as well as tagging have confirmed the katadromous nature of this species but, as stated earlier, the time of sea-ward migration of Dangla is later than that of Kabla. Completely spent large sized specimens of Dangla are not uncommonly encountered in the outer channel area in January-March which is not the case with Kabla. These are interpreted to be such forms as re-enter the lake after breeding in the sea. The breeding areas of Dangla appear to be closer to Chilka mouth than in the case of Kabla. A clear cut sex difference in the sizes of mature males and females, which are interpreted as pertaining to different age groups, was noticed in the case of Kabla. Such a size difference in the two sexes is not evident in Dangla. In this case the sea-ward migrating shoals are a heterogenous lot comprising at least 3 age-groups, there being no apparent difference in the ages of the migrating sexes. Table 28 shows the available details and descriptive statistics of the migrating specimens of Liza troschelli in the outer channel and the sea in 1957.

While there is a suggestion of the reduction in the size of sea-ward migrating forms with the advancement of season as in the case of Kabla, the position is by no means clear cut. Large scale inward migration of the fingerlings of Liza troschelli from the sea has not been observed in any year so far investigated.

IV A b. CLUPEIDS :

3. Nematalosa nasus or "Balangi" :

During the nine years over which catch statistics of Balangi are available, peak production of 200.1 Tonnes was recorded in 1950 and the lowest of 86.2 Tonnes in 1948. Taking the mean yield of the base period (1948-1952 = 100) its indices of production in the years 1957-1960 were 113.7, 139.9, 134.5 and 87.5 respectively (Table 22). Balangi is the most dominant species of the Southern sector of Chilka lake.

Balangi is a species largely caught by net fishing. Stated in sequence of efficiency, Menji, Patua, Khadi and Noli Jals take bulk of the catches, fishing 30.8, 28.7, 15.4 and 11.5% respectively of the species.

TABLE 27

VITAL STATISTICAL COMPUTATIONS OF LIZA TROSCHELLI

Size Group	No. in group (n)	% of n in total	Average length of group in mm. (l)	Overall average length in mm.	Weight of average length in Gms. (w)	% by weight in total	Annual mortality rate.
1	2	3	4	5	6	7	8
			1 9 5 7				
Medium	1587	70.94	198.6	-	77	44.94	
Large	648	28.97	295.0	-	229	54.58	0.5917
Very Large	2	0.09	430.5	-	647	0.48	0.9969
	2237	-	-	226.7	-	-	0.9684
			1 9 5 8				
Medium	606	18.50	212.1	-	92	5.51	-
Large	2536	77.44	340.3	-	339	85.00	-
Very Large	131	4.00	446.4	-	715	9.26	0.9485
Huge	2	0.06	530.5	-	1150	0.23	0.9847
	3275	-	-	320.9	-	-	0.9719
			1 9 5 9				
Medium	1023	28.63	219.0	-	108	8.97	-
Large	2001	56.00	344.1	-	350	56.86	-
Very Large	537	15.03	455.6	-	757	33.00	0.7316
Huge	12	0.34	538.8	-	1199	1.17	0.9776
	3573	-	-	325.7	-	-	0.9225
			1 9 6 0				
Medium	1616	48.25	219.0	-	101	20.16	-
Large	1440	43.00	320.4	-	287	51.06	0.1087
Very Large	269	8.03	456.0	-	758	25.19	0.8132
Huge	24	0.72	540.5	-	1211	3.59	0.9108
	3349	-	-	283.9	-	-	0.7542

TABLE 28

OBSERVATIONS ON THE SIZES OF MATURE LIZA TROSCHELLI CAPTURED IN THE OUTER CHANNEL AND THE SEA IN 1957

- - - - -

Month	Outer channel		Sea		Approximate age in year
	Size range in mm.	Mean length	Size range in mm.	Mean Length	
1	2	3	4	5	6
		FEMALE			
November 1957	375-534	Heterogeneous	407-539	482.5	2 & 3
December 1957	-	-	-	-	-
January 1958	177-555	287.9 (Two modes) 410.7	-	-	1,2 & 3
		MALE			
November 1957	278-380	339.9 ± 3.9	-	-	Mostly 2
December 1957	-	-	254 - 283	-	-
January 1958	151-480	Heterogeneous	-	-	1-3

Balangi breeds in the southern sector of the Chilka lake in the shallow sandy areas at the eastern end. The breeding season extends from February-July, the peak period being June-July. It attains a size of 135, 215 and 260 mm. at the end of the first three years of its life. Minimum recorded size at maturity of male and female are 124 and 116 mm. respectively. Ripening adults of Balangi enter the lake from the sea and add to the Chilka stocks of the species during the period January-June. On certain occasions during the period of influx, the fishermen of the lake mouth area catch them in very large numbers and the species form bulk of the fishery of that region during those periods.

The food of Balangi comprises, decayed organic matter (63.5%); a wide assembly of animal groups (Copepods : Longipedia, caunella, Acartia etc; Conchostracans etc.) termed miscellaneous matter (11.0%); diatoms (4.5% : Ten genera of Centracea and 8 of Pennatae) and algae (3.6% : Spirogyra, Lingbya, Zygnema, Oscillatoria, Anabaena etc.).

56,567 length measurements of Balangi were recorded in the godown sampling during the years 1957-1960. The average length of the species in commercial landings was 157.2, 169.7, 139.2 and 150.4 mm. during the years 1957-1960 respectively. By numbers zero and first year classes formed 17.3 and 67.0; 11.5 and 71.0; 34.3 and 56.7 and 8.0 and 70.5% of the total commercial landings of Balangi in the years 1957-1960 respectively. The detailed biology and population dynamics of the species is being separately published (Mishra and Ayyangar : unpublished).

IV A b 4. Hilsa ilisha or 'Ilish' :

During the years for which catch statistics of Hilsa are available, peak production of 267.4 Tonnes was attained in 1958 and the lowest of 52.7 Tonnes was attained in 1950. The average annual production of Hilsa during the years 1948-1952 was 93.4 Tonnes and with that as the base (100) the production indices during the years 1957-1960 were 177.9, 286.3, 124.4 and 107.7.

Hilsa is a species largely caught by net fishing. 44 to 67% of the catches are made in Hilsa Jal, which is the most effective gear in the lake to catch this species. In 1957 Hilsa Jal was followed by Patua Jal (25.5%), Bhida Jal (15.9%) and Menji Jal (12.1 and 12.0% respectively). Catch-per-man-hour-values of Hilsa Jal were higher than those of other nets in 1957-1959, followed by Bhida Jal and Khadi Jal in 1958 and 1959.

A record of the sizes of Hilsa taken by different nets pooled over the years 1957-1959 shows that the catches of Patua and Menji Jals constitute 68.3 and 38.9% of the zero-year-class; those of Menji and Noli Jals form 36.0 and 22.0% of the first year class; those of Bhida, Hilsa, Noli and Menji Jals, 67.7, 63.8, 74.2 and 22.8% respectively of the second-year-class; those of Hilsa and Bhida Jals 24.9 and 19.4% of the third-year-class and the catches of Hilsa Jal 4.2% of the fishes older than 3 years.

Hilsa is available in the lake throughout the year but is most abundant during the period : January-August in the Northern and Central Sectors. From the co-occurrence of fully ripe and spent individuals in the Northern sector of the lake it is inferred that the fish breeds in the lake and/or in the rivers discharging into the lake in July-September (Jones and Sujansingani, 1951, Mitra and Devasundaram, 1954). Zero to third year class of Hilsa have been estimated to grow to 150 mm., 265 mm., 350 mm. and 420 mm., respectively by December. Hilsa is known to be a plankton feeder and its food was not investigated.

18,575 specimens of randomly sampled Hilsa were measured during the course of the current investigations to determine its annual average length which along with other information on vital statistics are stated in Table 29. The average length of Hilsa in the commercial landings was 291.4, 256.1, 267.0 and 262.1 mm., in the years 1957-1960 respectively.

Like its ally Balangi, Hilsa occurs in the commercial landings of the lake mouth area quite abundantly during the period January-June. During these months, the Hilsa which are largely 2 year old (some 3 year old), are known to enter the lake from the sea on way to the rivers for breeding. Reference to Table 29 shows that 2 year old Hilsa is numerically much superior than one year old, though that is not the case with 3 year old Hilsa. Such a phenomenon is rather unusual in unregulated fisheries (where there is no minimum legal size limit) and is attributed to the addition of the Chilka stocks of Hilsa by ingress from the sea as is characteristic of anadromous species. There is no evidence of the migration of the fingerlings or the adults of Hilsa at any time of the year to the sea. Hilsa kanagurta commonly called "Dahal" is very abundant in certain seasons in the outer channel.

TABLE 29

VITAL STATISTICAL COMPUTATIONS OF HILSA ILISHA

- - -

Age Class in years	Number in class (n)	percentage of n in total	Average length in mm. (l)	Overall average length in mm.	Weight of average length in mm. GMS (w)	Percentage by weight in total	Annual mortality rate.
1	2	3	4	5	6	7	8
			1957				
Zero	16	2.40	138.0	-	19	0.18	--
I	142	21.32	238.7	-	118	9.94	--
II	462	69.37	307.4	-	272	74.45	--
III	42	6.31	376.0	-	528	13.16	0.0910
7 III	4	0.60	450.0	-	955	2.27	0.9905
	666	-	-	291.4	-	-	0.9170

Contd. T A B L E 29

VITAL STATISTICAL COMPUTATIONS OF HILSA ILISHA

Age Class in years	Number in class (n)	Percentage of n in total	Average length in mm. (l)	Overall average length in mm.	Weight of average length in mm. GMS (w)	Percentage by weight in total.	Annual mortality rate.
1	2	3	4	5	6	7	8
			1 9 5 8				
Zero	676	12.91	133.0	-	17	1.11	--
I	2307	44.05	216.3	-	85	18.80	--
II	1588	30.32	312.5	-	287	43.55	0.3115
III	620	11.84	380.0	-	547	32.43	0.6096
7 III	46	0.88	447.0	-	934	4.11	0.9258
	5237	-	-	256.1	-	-	0.7288
			1 9 5 9				
Zero	864	16.30	131.2	-	16	1.17	--
I	1525	28.76	220.4	-	91	11.39	--
II	2139	40.34	311.0	-	279	49.24	--
III	700	13.20	382.0	-	556	32.09	0.6727
7 III	74	1.40	456.6	-	1002	6.11	0.8943
	5302	-	-	267.0	-	-	0.8140
			1 9 6 0				
Zero	1161	15.75	125.6	-	14	1.10	--
I	2518	34.17	244.0	-	127	21.40	--
II	2977	40.39	302.5	-	257	51.40	--
III	692	9.39	377.0	-	532	24.71	0.7675
7 III	22	0.30	448.2	-	943	1.39	0.9682
	7370	-	-	262.1	-	-	0.9140

IV A c. PERCHES :

5. LATES CALCARIFER OR 'BEKTI' ;

The peak production of 311.9 Tonnes was attained in 1948 and and lowest of 102.2 Tonnes in 1960, there being a general decline in its catches. Its production indices over the years 1957-1960 were only 85.0, 66.4, 73.6 and 49.9% of the production average of 205.0 Tonnes of the base period 1948-1952 taken as 100.

Bekti is procured in the Chilka lake largely from Net fishing and only small sized fish are generally caught in the Janos in small numbers. Bekti, Bhida, Khadi and Patua Jals are the principal nets which catch the species. In 1957 the percentage of catch among these nets was 53.9, 30.4, 6.9 and 3.6 respectively. The percentages of catches for corresponding nets in 1958 was 43.7, 24.8, 6.0 and 17.2. Noli Jal caught 4.9% of the catch in 1958. In 1959 Bulk of the catches came from Bhida Jal (40.3%) which was followed by Bekti Jal (33.9%), Patua Jal (17.5%) and Khadi Jal (5.9%).

5,797 specimens of randomly encountered Lates calcarifer were measured and it has been estimated that the fish attains a length of 400, 550, 688 and 800 mm. in the first four years of its life.

The food of Chilka Lates calcarifer consists of fish, 51.2% (Thrissocles, Anchoviella, Mystus, Barbus etc.); Prawns, 39.3% (Penaeus and Metapenaeus sp.); Stomatopods, 7.0% and other miscellaneous items like crustacean remains, weeds etc. (2.5%).

The precise pattern of migration of Lates calcarifer is not understood. It was possible to tag only 206 small Bekti and the few recoveries, which were made, were all from the lake. However, very large specimens (over 625 mm. total length) in ripe condition are encountered in the lake mouth area in the months of May to June. Advanced fry are also encountered in the lake mouth area during July-August. These observations combined with those on maturity cycle fix the breeding time of the fish as about June-July. The very large specimens, caught in the lake mouth in May-June, are believed to be migrating to the sea. Bekti is believed to be a sea breeding fish. No freshly spent forms have been met within the lake. Advance fingerlings occur in the commercial catches in fair numbers in September-October.

IV A c 6. GERRES SETIFER OR 'JAGILI' :

The peak landing of 89.8 Tonnes was recorded in 1950 and the lowest in 1948. The relative indices of the production of Jagili over the years 1957-1960 were 97.1, 122.4, 104.2 and 70.9 respectively. Jagili abounds most in the Southern sector of the Chilka lake.

Jagili is small fish and bulk of the catches are got by net fishing. Among the nets plied in Chilka lake to take Jagili, Khadi Jal is the most effective which caught 91.7%, 59.2% and 65.3% of the net fishing catches of the species. Menji Jal and Patua Jal caught 28.2% and 9.7% of the amual net-fished catches of Jagili in 1958. In 1959, 10.5% of the year's catch came from Bhida Jal. Jagili is also caught by a special type of fishing by palm leaves described by Patnaik, S. (unpublished) in detail.

Jagili breeds in the southern sector of the Chilka lake in the shallow sandy areas at the eastern end. The breeding season extends from May-August the peak month of breeding being June. It attains a size of 110 and 175 mm. in the first two years of its life. Minimum recorded size at maturity of males and females are 73 and 86 mm. respectively.

The food of Jagili consists of 42% crustacea (Amphipods, Isopods, Copepods, Mysids and Ostracods), 31% Molluscs (Gastropods and Bivalaves), 6% Algae (Spirogyra, Lyngbya, Tribonema), 13% decayed organic matter and 8% miscellaneous matters.

28,847 measurements of random samples of Jagili were made at different landing centres during the course of observations. The average length of the species in commercial landings was 111, 110, 110, and 107 annual mortality rates were found to be 0.69, 0.58, 0.84 and 0.59 in the year 1957-1960 respectively. The commercial catches of Jagili during the years 1957-1960 contained 43.1 and 43.6%; 49.7 and 41.5%; 44.8 and 47.7%; and 48.4 and 44.1% of the individuals by numbers of the zero and first year class respectively.

IV A c 7. SPARUS SARBA or 'DHALA KHURANTI' :

The peak landings of the species of 152.7 Tonnes was recorded in 1952 and the lowest of 2.0 Tonnes in 1958. The average annual yield during the base period (1948-1952) was 68.0 Tonnes and the relative indices during the years 1957-1960 with reference to fixed base were 31.8, 2.9, 30.6 and 38.8 respectively. Sparus sarba forms fisheries of only minor importance in the Northern and Southern sectors. Catches in appreciable bulk come from the Outer channel during the months October-March. The catches of the Morai Jano in the Outer channel comprise largely of Khuranti.

Khuranti is caught in Janos, net fishing, hook and line and palm leaf fishing operations. Interesting methods of fishing Khuranti in the lake mouth are by towing a carcass/shark; 'black earth' fishing (Jhingran and Patnaik : unpublished). Khadi, Patua and Bhida Jals are the principal nets employed for fishing Khuranti. Khadi and Patua Jals caught 48.3% and 27.4% of Khuranti in netting operations in 1957. Patua Jal (32.8%) led the catches in 1958 and Bhida Jal (87.1%) in 1959.

Khuranti breeds in the sea during the months November-January, the peak month of breeding being December. It attains a size of 175, 250, and 325 mm. in the first 3 years of its life. The minimum recorded sizes of mature male and female Khuranti are 153 and 172 mm.

The food of Khuranti consists of 31% Algae (Polysiphonia, Tribonema, Gracilaria); 20% of Molluscs (Gastropods and Bivalves); 17% Crustacea (Amphipods, Isopods and Decapods); 12% decayed organic matter, 11% other weeds (Aalophyla, Potamogeton) and 9% miscellaneous matters.

Catches of Khuranti are made in the outer-channel at the time of the sea-ward migration of the species during the winter months. Such a migration has been confirmed by tagging. A few Khuranti tagged at Morai Jano were recovered close to the lake mouth. Some tagged recovered specimens were taken by head load carriers to Puri and the tags were procured from the Puri Municipal fish market through the courtesy of the Executive Officer of the Puri Municipality. Fry and fingerlings of Khuranti were procured in the lake mouth region in practically all the years of observation during the months January-May. These gradually move into the lake at that time.

5,463 specimens of Khuranti were measured at the landing centres during the course of the years 1957-1960. The average lengths of Khuranti in the commercial catches were 196, 181, 197 and 173 mm. in the years 1957-1960 respectively. The commercial landings of Khuranti contained 32.6, 57.8, 57.9 and 69.1% of the specimens by numbers of the zero-first year class. Details of the biology of Sparus sarba and certain aspects of its population dynamics are being separately published (Patnaik, S. - unpublished).

IV A d. THREADFINS :

8. ELEUTHERONEMA TETRADACTYLUM or 'SAHAL' :

The peak production of 364.4 Tonnes during these years was reached in 1959 and the lowest of 104.7 Tonnes in 1952. The average catch of Sahal during the period 1948-1952 was 178.7 Tonnes and with that as base (100) the production indices during the years 1957-1960 were 143.6, 120.9, 203.9 and 108.0 respectively.

Sahal is caught both in the 'Janos' and by net fishing. In the outer channel Sahal is commonly caught by hook and line also. Patua, Bhida, Khadi, Menji, Sahal, Noli and Khepa Jals are the principal nets used to capture Sahal. In 1957 bulk of the net fishing catches came from Patua (33.6%), Khadi (16.9%), Bhida (14.3%), Menji (14.7%) and Noli Jals (13.7%). In 1958, Patua, Khadi, Menji and Khepa Jals caught 45.6, 26.6 and 14.0 and 4.3% of the catches. In 1959 bulk of the catches came from Patua Jal (37.4%) followed by Bhida Jal (20.3%) and Khadi Jal (18.9%).

Sahal is believed to breed in the Northern sector of the Chilka lake at a short distance opposite Daya River mouth during the period January to June with two peaks of breeding in March and June. The minimum size of mature male and female Sahal encountered in the lake was 243 and 285 mm. respectively. The March brood attains a length of 300, 475 and 600 mm. In the first three years of its life. The June brood attains a length of 263, 430 and 570 mm. in the first three years of life.

The food of Sahal consists of Prawns 49.5%; Fishes (Mystus, Barbus, Anchoviella) 26.1%; Mysids, (Macropsis, Ropalophthalmus) 9.8%; Stomatopods 2.9%, Isopods 2.1%, Amphipods 1.3% and miscellaneous matter 8.3%.

No regular pattern of migration through the lake mouth is discernible in the case of Sahal. 43 recoveries of tagged small Sahal (total tagged were 544) were all made within the lake. Both spent and mature large-sized specimens of Sahal are encountered in the lake (mostly in Northern sector) as well as in the Outer channel which gives rise to the belief that the species breeds both in the sea and the lake and performs irregular inter sea-Chilka movements.

48,611 specimens of Sahal were measured during the period 1957-1960 in godown sampling operations. The average length of the species in commercial landings was 192, 199, 230 and 250 mm. in the years 1957-1960 respectively. Sahal is a species which grows to a size of over 1000 mm. and the range of its average length 192-250 mm. in commercial catches indicates the high rate of exploitation of the young of the species. 67.7 to 91.4% of the catches of Sahal by numbers come from the Zero year class of the species. Annual mortality rates were found to be 0.91, 0.85, 0.71 and 0.71 in the years 1957-1960 respectively. The details of the biology of Eleutheronema tetradactylum and certain aspects of its population dynamics are being separately published (Patnaik, S. - unpublished).

IV A e. SCIAENIDS :

9. PSEUDOSCIAENA COIBOR or 'BOROGO' :

The peak of production of 530.0 Tonnes was reached in 1948 and the lowest of 100.9 Tonnes in 1950. The average landings during the years 1948-1952 were 227.3 Tonnes and with that as base (100) the indices of production during the period 1957-1960 were 108.7, 98.9, 61.4 and 56.4% respectively.

Borogo is a species largely caught by net fishing. It is caught in the Janos only occasionally. Borogo Jal, Patua, Khadi and Bhida Jals are the principal nets employed in Chilka lake to capture Borogo. In 1957 bulk of the net fishing catches came from Patua (42.7%), Borogo Jal (39.8%), Bhida (6.1%) and Khadi Jals (6.1%). In 1958 the contribution of Borogo Jal, was 63.6% and Patua Jal 18.4% of the net fishing catch. In 1959 Borogo Jal, Khadi, Bhida and Patua Jals contributed 46.4, 23.8, 13.1 and 8.6% of the net fishing catches of Borogo respectively. Borogo Jal is a specialised drag net employed to take catches of Pseudosciaena in large numbers (Rajan, S.; unpublished). Borogo, especially large sized ones, are also taken in appreciable numbers, by hook and line in the northern sector. The 'Poholo' catch is also considerable.

Borogo is believed to breed in the Northern sector of the Chilka lake at a short distance opposite Daya River mouth during the period April-July, May being the peak month of breeding. The minimum size of mature male and female Borogo was 176 and 213 mm. respectively. The species attains a length of 260, 410 and 510 mm. in the first three years of its life.

The food of Borogo consists of Prawns (35 %) Fish (20.7%); Amphipods (15.1%); Isopods (8.2%); Stomatopods (6.1%); Debris (4.1%); Higher Plant matter (2.5%); Algae (2.2%); Crabs and Lamellibranchs (1.6% each); Hermit crabs (1.1%); Cumacea (0.5%); Mysids (0.16%), Annelids (0.4%) and Gastropods (0.1%).

No regular pattern of migration through the lake mouth is discernible in the case of Borogo. Borogo being a fish largely taken by net fishing and as our source of fish for tagging were the Janos it was possible to tag only 43 specimens of this fish. The recoveries of tagged Borogo were nil. Juveniles of Pseudosciaena are at no time caught in the lake mouth area. Fry and fingerlings of Borogo are available in very large numbers during the months July-September in the Northern sector. There is no evidence of any regular influx of Borogo into the lake from the sea.

16,813 specimens of randomly encountered Borogo were measured in the period 1957-1960 to determine its average annual length which was found to be 244.5, 293.9, 277.6 and 286.4 respectively. By numbers zero and first year class groups formed 17.5 and 65.5; 19.1 and 47.0; 38.9 and 26.8; and 72.5 and 17.6% of the landings in the years 1957-1960 respectively. The annual mortality rates were found to be 0.87, 0.52, 0.53 and 0.67 in the years 1957-1960 respectively. The details of biology and certain aspects of the population dynamics of Pseudosciaena coibor are being separately published (Rajan, S. - unpublished).

IV A f. CAT FISHES :

The catfishes attempted to be investigated were Mystus gulio or Kantia, Tachysurus arius or Singda, Osteogeneiosus militaris or Sunga and Plotosus canius or Kanda. The breeding habits and food of all the four species have been worked out. Osteogeneiosus and Plotosus could not be sampled in sifficiently large numbers to enable either their growth or average size in commercial fisheries to be determined.

IV A f 10. MYSTUS GULIO or 'KONTIA' ;

484.6 Tonnes, which were an years maximum landings during this period, were caught in 1957. Minimum landings (67.8 Tonnes) were taken in the the year 1950. The average annual landings of Kontia in the period 1948-1952 was 181.5 Tonnes and with that as fixed base (100) the relative indices of production in each of the years 1957-1960 were 267.0, 138.5, 156.7, 104.1 respectively.

Kontia is captured in the Janos (especially in their later phases of operation) as well as by net fishing. Patua Jal caught 65.1, 62.6 and 49.8% of the net fishing catches in 1957-1958 respectively. Khadi Jal catches consisted of 26.3, 35.3 and 48.3% of Kontia in the corresponding years stated above. Bulk of Kontia catches come from these two nets and a small percentage by rod and line for which observations are not available.

Kontia breeds throughout the lake during the period June-November, August being the peak month of breeding. The fish attains a length of 90 mm., 160 mm. and 205 mm. by December of zero, first and second year of its life. The minimum recorded size of mature male or female was 100 mm.

The food of Kontia consists of Amphipods 30.8%; Miscellaneous items 17.3%; Prawns 13.1%; Algae 12.6%; Debris 8%; Higher plant matters 5.3%; Fish 4.8%; Mysids 3.8%; Gastropods 3.6%; Isopods 3%; Insects 2.3%; Copepods 1.7%; Lamellibranchs 1.3%; Annelids 0.9%; Crabs 0.7%; Cladocera 0.6%, and Decapod larvae 0.2%.

25,646 specimens of Mystus gulio were measured in the current investigations. The average length of Kontia in the commercial landings were 128.4, 122.8, 128.3 and 135.6 in each of the years 1957-1960 respectively.

Kontia is endemic in the lake and does not perform any inter Chilka-sea migrations.

IV A f 11. TACHYSURUS ARIUS or 'SINGDA' :

The maximum landings of 193.8 Tonnes of Singda occurred in the year 1948. Devasundaram's records show negligible catches of the species in the year 1952. It is suspected that the species might have got mixed up in the godown with some other species of catfish that year. The annual production during the years 1957-1960 was 12.5, 47.4, 65.9 and 49.3 Tonnes respectively. Fixed base relative indices for these years have not been worked out because of unreliability of catch statistics of the species for the years 1948-1952.

Singda is caught in the Janos especially in their terminal phases of operation. It is, however, largely taken by net fishing.

In the net fishing catches recorded in the years 1957-1959 it is seen that Patua, Khadi and Bhida Jals take bulk of the catches of Singda. Patua and Khadi Jals took 88.4% and 37.4% of the net fishing catches in 1958 and 1959. Contribution of Patua Jals in 1959 was 13.4%. In 1957 Bhida and Patua Jals took 76.3 and 15.8% of the Singda catch in net fishing operations. Hook and line catches of Singda, especially in the Northern sector, are appreciable for which there is no catch record.

Singda breeds in the Northern and Central Sectors of the Chilka lake in the period June-September the peak month of breeding being July. Minimum size at maturity recorded for the females was 238 mm. Zero to three year classes of Singda attain a length of 140 mm., 250 mm., 325 mm., and 400 mm. respectively by December. The species shows buccal incubation with male tending the developing eggs.

The food of Singda consists of lamellibranchs 23.3%; Prawns 18.3%; Debris 17.9%; Annelids 8.5%; Higher plant matters 6.4%; Fish 6%; Crabs 5.5%; Miscellaneous matter 5.3%; Hermit crabs 2.2%; Algae 2%; Gastropods 1.4%; Isopods 1.4%; Amphipods 1.2%; Echiuroids 0.5%; and Stomatopods 0.1%.

5,551 specimens of Tachysurus arius were measured during the period 1957-1960 for studies on the average length of the species in commercial landings which was found to be 274.7 mm., 295.3 mm., 302.5 mm. and 263.9 mm. during these years respectively.

Large catches of Singda in the lake mouth centre occurred during the months January, February and July. The species is believed to enter the lake from the sea and add to the Chilka stocks.

IV A f 12. OSTEOGENEIOSUS MILITARIS or 'SUNGA' :

Maximum landings of Sunga of 102.7 Tonnes during this period took place in the year 1948 and the minimum of 11.2 Tonnes in 1951. The average annual landings of the period 1948-1952 were 43.3 Tonnes. With this as fixed base (100) the relative indices of production during the years 1957-1960 were 161.4, 167.4, 27.0 and 27.5 respectively.

Maximum landings of Sunga of 102.7 Tonnes during this period took place in the year 1948 and the minimum of 11.2 Tonnes in 1951. The average annual landings of the period 1948-1952 were 43.3 Tonnes. With this as fixed base (100) the relative indices of production during the years 1957-1960 were 161.4, 167.4, 27.0 and 27.5 respectively.

Sunga is fish largely caught by nets though it is taken from Jano also in their terminal operations. Of the Chilka nets, Bhida, Khadi and Patua Jals are the principal gear used to catch Sunga. In 1957 the contributions of Bhida and Patua Jal were 45.7 and 40.6% of the catches of this species by net fishing. In 1958 Patua Jal caught 57.3% and in 1959, Khadi Jal caught 77.6% of the catches. Hook and line take appreicable catches of this species especially in the shallow northern sector but no record of catches by this gear are available.

Osteogeniosus breeds in the Northern and Central sectors of the Chilka lake in the period January-June, the peak months of breeding being March and April. The minimum size of mature female recorded was 265 mm. The species shows buccal incubation with the male tending the developing eggs and the young ones.

Sunga could not be adequately sampled to throw light on the average annual lengths in its commercial landings. Nor could its age and growth be studied for paucity of length-frequency data.

Sunga is a species endemic in the lake and there is no evidence to demonstrate its inter sea-Chilka migrations. Its catches in the lake mouth area are occasional.

IV A f 13. PLOTOSUS CANIUS or 'KAMDA' :

Maximum landings of 58.7 tonnes occured in the year 1957 and minimum of 2.1 Tonnes in 1949. The average annual catch during the period 1948-1952 was 9.2 Tonnes. With this as fixed base (100) the relative indices of production during the years 1957-1960 were 638.0, 291.3, 294.6 and 235.9. The annual average catch of just 9.2 Tonnes in the period 1948-1952 does not, however, appear to be reliable possibly due to a mix up with other catfishes.

Kanda occurs in the Janos and is also taken by netting. In the Janos, along with other catfishes it occurs in their terminal phases. Bhida, Khadi and Patua Jals are the principal nets used to catch Kanda. These nets, in the order stated, took 43.6, 34.5 and 18.2% of Kanda catches in 1957. In 1958 catches of Patua and Khadi Jals, Kanda formed 80.6 and 84.4% of the catches among the different nets. Kanda is also taken in appreciable numbers, especially in the Northern sector, by hook and line for which no catch records are available.

Plotosus breeds in the Northern and Central sectors of the Chilka lake during the period May-September with July being the month of peak breeding. The minimum recorded size of mature female Plotosus was 400 mm.

Kanda could not be adequately sampled to enable light to be thrown on its growth and average lengths in the commercial catches over the different years. Kanda is endemic in the lake and there is no evidence of any definite pattern of migration in or out of Chilka. Its catches in the lake mouth area are only occasional. Detailed observations on maturity and spawning of some Chilka catfishes are being separately published by Karamchandani, S.J. (unpublished).

IV A g. PRAWNS :

The prawns investigated were the two major Penaeid prawns : Penaeus indicus and Penaeus semisulcatus. Sea breeding habits of the Penaeid prawns have long been very well known. At no time have any mature Penaeids been recorded in the lake or outer channel during the current investigations. The sea-ward migration of these prawns have been confirmed and their seasons elucidated. It was not possible to study the food of Penaeid prawns of Chilka lake in the present investigations.

IV A g 14. PENAEUS INDICUS or 'KANTLA CHINGUDI' ;

Peak landings of this species of 872.9 Tonnes were recorded in the year 1951 and the lowest of 371.7 Tonnes in 1948. The average annual landings during the base period 1948-1952 was 665.2 Tonnes. Relative indices of production of P. indicus over the years 1957-1960 were 111.4, 122.6, 130.1 and 86.5 respectively.

Chingudi are taken largely by traps already mentioned before. Chingudi also occurs in Janos but are not very abundant there. Net fishing also yields appreciable quantities of Chingudi. Khadi Jal (Chingudi Jal) and Patua Jals are the only nets used to take Chingudi

by net fishing, the former net catching them in by far the largest quantities as far as net fishing goes. It is noticed that in general Chingudi catches in the post full and new moon weeks are the heaviest.

P. indicus undertakes large scale sea-ward migration in the period April-August when the fishermen of the Outer-channel area take huge catches. The sizes in commercial catches in the above period cluster round 100 mm. - class. The Velon net catches indicate that lake-ward movement of post larvae of P. indicus occurs practically throughout the year though perhaps the peak may be during the period February to May.

50,126 measurements of P. indicus were taken in the period 1957-1960 to determine its average size in these years which was calculated to be 105, 86.8, 85.6 and 113.4 mm. respectively. Because of year-round influx of its post larvae from the sea the size-frequency distribution do not yield to analysis. Its age and growth are therefore indeterminable by this method.

IV A g 15. PENAEUS SEMISULCATUS or 'BAGDA' ;

Maximum yield of 532.2 Tonnes was recorded in the year 1951 and the minimum of 122.8 Tonnes in 1948. The average annual yield during the period 1948-1952 was 340.9 Tonnes and the relative indices during the years 1957-1960 were 62.5, 75.9, 73.6 and 87.5 respectively.

The remark made in regard to the mode of capture and lunar periodicity under P. indicus are also valid for P. semisulcatus.

P. semisulcatus also undertakes seaward migrations along with P. indicus, but the main period of seaward migration in the case of P. semisulcatus appears to be in autumn months in certain years. Sizes in commercial catches in the above period cluster round 150 mm. class. The lakeward movement of post-larvae occurs along with those of P. indicus all round the year though, migratory peaks are observed in January-February and June-October.

47,163 measurements of P. semisulcatus were taken in the period 1957-1960 for determination of its average length which was found to be 178.9, 167.5, 156.6 and 153.0 mm. respectively. Because of year round influx of its post-larvae from the sea the size-frequency distributions do not yield to analysis as in the case of P. indicus.

IV B. SUMMARY OF BIOLOGICAL OBSERVATIONS

Table 30 summarises the salient features of the biology of the 15 commercial species described in the preceding section.

TABLE 30

MATURITY BREEDING AGE AND GROWTH OF 15 ECONOMIC SPECIES OF FISH OF CHILKA LAKE

	Maturity	Breeding					Age and Growth						
	Minimum size in mm.	Season	Peak Months	Habitat	Sector	Site	1 Tl. in mm.	2 Avr. Wt. in Grams.	3 Tl. in mm.	4 Avr. Wt. in Gms.	5 Tl. in mm.	6 Avr Wt. in Gms.	7 Tl. in mm.
Mugil cephalus	-	-	Oct.-Jan.	Nov.	Sea	-	-	-	-	-	-	-	-
L. troschelli	-	-	Nov.-Jan.	Jan.	Sea	-	-	-	-	-	-	-	-
E. tetradactylum	243	285	Jan.-June (Two peaks)	March & June	Lake	Northern	Near Daya river mouth	300	197	460	723	600	1624	-
								263	132	430	590	-	-	-
Pseudosciaena-coibor	176	213	Apr.-July	May	Lake	-do-	-do-	260	107	410	607	510	1127	-
Nematalosa nasus	124	116	Feb.-July	June	Lake	Southern	Shallow regions	135	25	215	100	260	178	-
Hilsa ilisha	200	279	June-Sept.	Aug.	Daya river	-	Daya river	150	26	265	166	350	417	420
Sparus sarba	153	172	Nov.-Jan.	Dec.	Sea	Vicinity of Chilka mouth		175	88	250	243	325	513	-
Gerres setifer	73	86	May-Aug.	June	Lake	Southern & central	Shallow regions	110	19	175	81	-	-	-
Lates calcarifer	UNCERTAIN		Apr.-June	June	probably Sea	-	-	-	-	-	-	-	-	-
Mystus gulio	ABOUT 100 mm		June-Nov.	Aug.	Lake	Northern Central & Southern	-	135	-	195	-	-	-	-
Tachysurus arius	-	238	June-Sept.	July	Lake	Northern, & Central.	-	240	-	320	-	390	-	-

Contd.....2

Osteogeneiosus-militaris	-	265	Jan.-June	March April	Lake	Northern & Central.	-	-	-	-	-	-	-	-
Plotosus canius	-	400	May-Sept.	July	Lake	Northern Central & Southern	-	-	-	-	-	-	-	-
Penaeus indicus	DOES NOT MATURE IN LAKE				Sea		Attempted but found largely indeterminable							
Penaeus semisulcatus	-do-				Sea		-	do	-					

V. PHYSICO-CHEMICAL FEATURES

Water samples from six sampling stations (Figure 1), three situated in the main lake and three on way to and including the Outer channel have been analysed from April, 1957 to March, 1961 in respect of Dissolved Oxygen, pH, Salinity, Total Alkalinity, Silica and for Phosphates from July 1957. Analysis for Nitrate-Nitrogen and Iron were included in the work with effect from December, 1959 and August 1958 respectively. Air and water temperatures, depth and transparency were the principal physical features examined. The periodicity of Sampling has been once a fortnight in the main lake and once a month at the remaining stations. The hour of observations has been kept constant throughout the study (Between 5.30 A.M. to 6.30 A.M.) and weather conditions were also recorded. From the basic fortnightly observations monthly average values of different observations for different stations have been determined. Pooled seasonal and annual averages for individual stations as well as for the whole lake have been computed wherever necessary for comparative studies. These are especially stated at relevant places to avoid confusion. In the following description of physico-chemical characters the year is taken from April-March.

V A. PHYSICAL CHARACTERS

1. Water Temperature :

Average monthly water temperature of the lake fluctuated between 19°C. (January, 1960 - Station I) to 32°C. (June, 1958 - Station III). The lowest temperature (18°C.) was observed at Kaluparaghat (Station I) on 20.1.1960 and the highest (32°C.) at Rambha (Station III) and Balugaon (Station II) on 10.6.1958 and 18.8.1960 respectively. The annual average pooled temperature for the whole lake was 28.5°C, 27.5°C, 26.8°C and 27.1°C for the years 1957-1958, 1958-1959, 1959-1960 and 1960-1961 respectively. Summer (April-July) and winter (October-January) temperatures in the year 1957-1958 were 30°C and 26.5°C respectively against those of the corresponding seasons of the years 1958-1959, 1959-1960, 1960-1961 which were 28.8°C and 24.0°C; 28.7°C and 23.9°C; and 28.8°C and 24.0°C respectively. The year 1957-1958 may be taken as warm year.

2. Air Temperature :

Average monthly air temperature of the lake fluctuated between 17°C. (December, 1959 & January, 1960 at Station VI and January, 1960 at Station I) to 31°C. (June, 1959 at Station V and August, 1960 at Station VI) during the period of observations from April, 1957 to March, 1961. The lowest temperature (15°C.) was observed at Station I on 20.1.1960 and highest (33°C) at Station II on 18.8.1960. The annual average pooled air temperature for the whole lake was 25°C. in 1959-1960 and 25.7°C in 1960-1961.

3. Transparency :

The average monthly transparency varied from 2.0 cm. to 500 c Low transparency values were observed in the months May-September with Secchi Disc readings ranging from 2 cm. to 11.9 cm. which is d to prevailing southerly wind in summer and silt brought through riv discharges in Rainy season. Low transparency in summer through rain is generally due to silt and in winter to plankton.

V B. CHEMICAL CHARACTERS

1. Dissolved Oxygen :

The range of average monthly dissolved oxygen was from 3.3 pp in April, 1958 (Kaluparaghat - Station I) to 11.4 ppm. in August 19 (Satpara - Station IV).

2. Salinity :

The selective influence of salinity on the biota is well know Anandale and Kemp (1915) have described the cycles of fresh water and tidal sea water influx into the Chilka lake. Roy, J.C. (1954) observed cyclic changes of salinity in the lake.

Monthly salinity of the lake fluctuated between 0.29‰ (Octob 1958 at Station I) to 36.02‰ (April, 1957 at Station IV) during th period of observations. The lowest salinity (0.16‰) was observed a Station I on 5.10.1958 and the highest 36.02‰ at Station IV on 27.4.1957. A station-wise record of monthly salinity values of Chil lake during the years 1957-1958 to 1960-1961 is presented in Table It is seen in Table 31 that taken on the basis of individual stati as well as the whole lake, the salinity of the lake has, on the wh progressively declined during the period of observations.

Low salinity values in the main area of the lake are general encountered in the months : September and October and high in the months : April-July. Station I is the area of widest variation of salinity in a year where the range of salinity was from 0.29‰ to 35.19‰ in 1958-1959. Station III is the area of lowest variation where the range of salinity was from 6.49‰ to 29.65‰ in 1958-195

Devasundaram and Roy (1954) observed salinity at 5 stations (Kaluparaghat, Balugaon, Rambha, Satpara and Arkakuda) in the year 1950 and 1951 and have published station-wise records on salinity these years. The annual average salinity of the lake for the years 1950 and 1951 work out to be 13.10‰ and 12.53‰ respectively. Com parable observations on salinity for the years 1957-1960 are 19.18 18.16, 13.72 and 12.23‰ respectively. The data on record thus sh that the salinity in the years 1950 and 1951 are almost the same a during the years 1959 and 1960. 1957 was, however, the year of hig salinity followed by 1958.