

**FISH AND FISHERIES OF THE CHILKA LAKE
WITH STATISTICS OF FISH CATCHES
FOR THE YEARS 1948-1950**

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I. INTRODUCTION

THE faunistic investigations of the Chilka Lake conducted during 1914-15 by the Zoological Survey of India under the direction of late Dr. Nelson Annandale brought out the richness and variety of the fauna and the very remarkable ecological features associated with it. An exhaustive collection of fishes made during the survey was described by Chaudhury (1916 *a*, 1916 *b*; 1917 and 1923) and Hora (1923) and of the prawns and crabs by Kemp (1915). Being an essentially faunistic survey little work was done from the point of view of fisheries, which were then of local importance only, as all the surplus catches of fish were converted into cured or dried fish

and sent to districts in the interior, mainly the former "Native States" of the Orissa State. The growing demand for fresh fish from Calcutta market since World War I, however, has made the Chilka Lake a very important fishing centre, and with the use of ice as a preservative, curing and drying declined considerably, the greater part of the catches being exported in fresh condition. The growth of the fish trade since the pre-war days and the various factors influencing it have been described by Mitra (1946) in his scheme for the development of the Chilka Lake, but our knowledge of the biology of the fish and the fisheries of the Lake has remained very meagre. The Chilka Lake was chosen as one of the centres of estuarine fishery observations, because of the existence of certain favourable conditions, *viz.*, the compactness of the area, the very low local demand resulting in the export of almost the entire catches in fresh condition, the existence of only a single channel and route of export (*i.e.*, rail) facilitating the collection of statistics, and the co-operation of the State Fisheries Department.

In this account a revised list of fishes so far recorded from the Lake is given including the additional records made by us. The important groups of the fishes (*sensu lato*) are described with their seasonal fluctuations and the probable causes thereof with reference to the biology of the respective groups and the general environmental conditions. The fishing industry is described briefly, with suggestions for its improvement. Statistics of exports of fresh and dry fish for the years 1948-50 are given to indicate the production capacity of the Lake as a whole and its different sectors.

Regular observations during 1948-50 were made on periodical visits to the Lake and its fish marketing centres. An analysis of the fish export-figures for the period 1948-50 collected from the records of the Orissa Fisheries Department and of the Bengal Nagpur Railway forms part of the important data presented in this account. The general nature of the observations and the tentative inferences drawn from available data can provide only working bases for further investigations. Several years' data and long-range observations are necessary before positive conclusions could be arrived at, and the recommendations and suggestions given here, if adopted, would not appreciably upset the present system of fishing industry.

In the course of the next few years when the Hirakud and other Mahanadi Valley projects are completed the volume of water flowing into the Lake through the Daya and the other branches of the Mahanadi will be definitely less and consequently the hydrological conditions and the fisheries may undergo some changes. The cumulative effect of reduction in the volume of flood water reaching the Lake may well be a loss in respect of the

fisheries. A detailed analysis of the present physico-chemical and biological conditions inclusive of the fish fauna as presented in this account may prove to be a useful record for comparison at some later date.

The work was planned and initiated by the senior author in the summer of 1947, and from 1948 onwards the investigations were carried out jointly. The junior author has been mainly responsible for the field collection of material and for the compilation of export figures of fish as made available by the Orissa State Department of Fisheries and by the Railway authorities from the records of parcel way bills maintained at the Stations on the Chilka Lake section of the Eastern Railway. He has also been responsible for the following sections of this account: (i) fishing grounds and fish exporting centres; (ii) collection of export statistics; (iii) fishing communities; (iv) fishing gear and methods; and (v) fish trade, and for the preparation of the tables, graphs, bar diagrams and glossary.

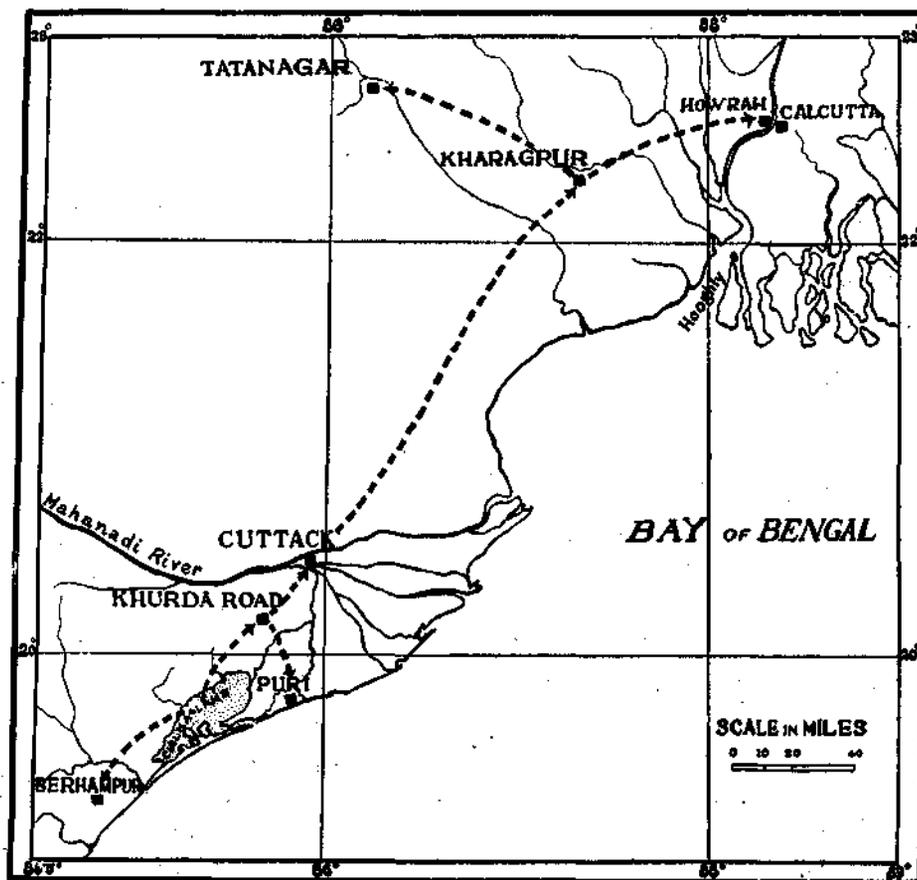


FIG. 1. Map showing the directional movement of fresh fish supplies from the Chilka.

II. TOPOGRAPHICAL AND HYDROLOGICAL FEATURES OF THE LAKE¹

Chilka Lake is a lagoon on the east coast of India in the districts of Puri and Ganjam in Orissa State, between latitudes $19^{\circ} 28'$ and $19^{\circ} 54'$ N. and longitudes $85^{\circ} 67'$ and $85^{\circ} 35'$ E. (Figs. 1 and 2). It is roughly pear-shaped with greatest length of 40 miles along north-south and greatest width of 12.5 miles along east-west covering an area of about 350 square miles in the dry season and about 450 square miles during the flood. The Lake is made up of two parts: (1) an outer channel 14 miles long which opens into the Bay of Bengal and has its bottom composed mainly of sand and (2) the main area with soft mud bottom which is the real lagoon and occupies the greater part of the Lake system. The latter is exceedingly shallow and its average depth in the dry season rarely exceeds 8 feet in the southern sector and 4 feet over a large stretch in the northern sector. In flood season depths increase by 5 to 6 feet varying from year to year depending upon the intensity of the floods. Along the north-east shore, when the water level goes down after the monsoons, the depth at and near the margin could be measured

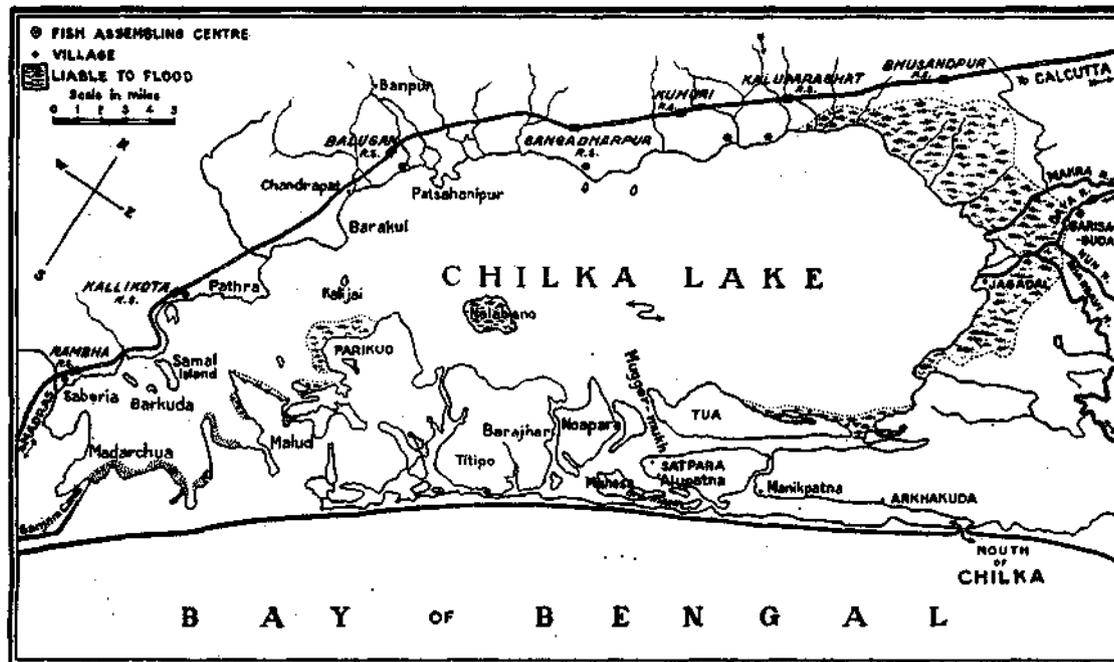


FIG. 2. Map of Chilka Lake showing the fish assembling centres and the important fishing grounds.

¹ For detailed information see *Mem. Indian Mus.*, 5 (1), 1915.

in inches rather than in feet and gradually a wide stretch of 2 to 4 miles all along it becomes exposed.

Of the hydrological features which influence the physical environment and consequently the fauna, the most important is salinity which changes from time to time and also from zone to zone depending upon rain, drought, temperature, evaporation, winds, tides, etc., and exercises a continual selective influence on life in the Lake. The fish fauna which is predominantly marine in composition gets continuously replenished from the sea through the channel which serves as a highway for the to and fro movements of the fish. During February-April, there is continuous ingress of sea water on account of the fall in the volume of flood waters of the rainy season immediately preceding, resulting in the abrupt rise in salinity at Mugger Mukh (the point where the channel enters the main area). The southern end of the Lake is highly saline, the highest salinity being recorded in the southern extremity of the Rambha Bay. From this point to Nalbano Island in the north-east the salinity goes on decreasing, there being gradual increase again north of Nalbano towards Mugger Mukh. In May and June, the hottest months of the year, ingress of the sea water is considerable both on account of the low level of water in the Lake and high rate of evaporation in the vast shallow area and the waters of the Lake south-west of Samal Island become highly saline. By about August, the monsoon floods begin and in September the salinity conditions are absolutely different. The flood waters of the branches of the Mahanadi enter the Lake at its north-east end and push out saline water from the main area replacing it completely with fresh or almost fresh water in due course of time. Direction of winds plays an important part and is responsible for local changes in the salinity.

The hydrological conditions, specially the salinity, are likely to undergo a great change in the next few years as with the completion of the Hirakud and Mahanadi projects the flow of water in the Kathjuri and consequently into the Lake will be reduced and will in turn cause rise in the salinity beyond the present levels leading to changes in the animal and plant life in the Lake. It is doubtful if the prevailing wide range of salinity would continue as before accommodating such a rich and variety of fish life in different seasons and different parts of the Lake. Fish life in the Lake seems to thrive on the annual flushing of the Lake by the flood waters which push out the stagnant water of the previous monsoon season and replace it completely, preventing the shallow area from becoming a marshy and swampy lagoon where fish cannot live and grow.

III. FISH AND FISHERIES

(i) Fish-Fauna of the Lake²

The situation of the Lake *vis-a-vis* the sea on one side and the great river system on the other results in a regular movement of euryhaline and freshwater fishes from the one into the other and *vice versa*. As many of the fishes are either seasonal migrants or stray visitors from the neighbouring waters no comprehensive list of them is given here. Only 112 species of 118 species given in the 'Chilka Lake Survey' are to be considered, as 6 of them are known to be synonyms of recorded species. Koumans (1941) has added one Gobiid thus bringing the number to 113. In the revised list presented here, there are 25 new records, thus raising the total number of species of fish known from the Lake to 138.

Classified List of Fishes

Class Elasmobranchii

Subclass Selachii

Order Lamniformes

Suborder Scyliorhinoidei

Family Carcharhinidæ

1. *Carcharhinus gangeticus* (Müller & Henle)
2. *Carcharhinus melanopterus* (Quoy & Gaimard)
3. *Physoden mulleri* (Müller & Henle)

Order Rajiformes

Family Pristidæ

4. *Pristis pectinatus* Latham

Family Trygonidæ

5. *Dasyatis (Amphotistius) imbricata* (Schneider)—*Trygon imbricata* (Schneider)
6. *Dasyatis (Himantura) uarnak* (Forskål)—*Trygon uarnak* (Forskål) and *Trygon pareh* (Bleeker)
7. *Dasyatis (Pastinachus) sephen* (Forskål)—*Hypolophus sephen* (Forskål)

² All the new records from the Lake are marked by an asterisk*. Wherever there has been a change in the name, the old names as given in the Fauna of the Chilka Lake are given after a hyphen. The Classification followed up to the families is that of Leo S. Berg ["Classification of fishes, both recent and fossil," *Trav., Inst. Zool. Acad. Sci. U.R. SS.*, 5 (2), 1940]. The genera and species are arranged alphabetically.

Family Myliobatidæ

8. *Aetobatis narinari* (Euphasin)—*Aetobatis flagellum* (Schneider) and
Aetobatis guttata (Block & Schneider)
9. *Aetomylæus nichofii* (Schneider)

Class Teleostomi

Subclass Actinopterygii

Order Clupeiformes

Suborder Clupeoidei

Superfamily Elopoidæ

Family Elopidae

10. *Elops saurus* Linnæus—*Elops indicus* Swainson

Family Megalopidae

11. *Megalops cyprinoides* (Broussonet)

Superfamily Clupeoidæ

Family Clupeidae

Subfamily Clupeini

- 12.* *Gadusia chapra* (Hamilton)
13. *Hilsa ilisha* (Hamilton)—*Clupeoides ilisha* (Hamilton)
14. *Kowala coval* (Cuvier)—*Clupeoides ille* (Cuvier & Valenciennes)

Subfamily Dorosomatini

15. *Anadontostoma chacunda* (Hamilton)—*Dorosoma indicus* (Russel)
16. *Nematalosa nasus* (Bloch)—*Dorosoma nasus* (Bloch)

Family Engraulidæ

17. *Anchoviella commersonii* (Lacépède)—*Stolephorus commersonii* (Lacépède)
18. *Anchoviella indica* (van Hasselt)—*Stolephorus indicus* (van Hasselt)
19. *Anchoviella tri* (Bleeker)—*Stolephorus tri* (Bleeker)
20. *Thrissocles annandalei* (Chaudhuri)—*Engraulis annandalei* Chaudhuri
- 21.* *Thrissocles hamiltonii* (Gray)
22. *Thrissocles kempfi* (Chaudhuri)—*Engraulis kempfi* Chaudhuri.
23. *Thrissocles mystax* (Schneider)—*Engraulis mystax* (Schneider)
24. *Thrissocles purava* (Hamilton)—*Engraulis purava* (Hamilton)
25. *Thrissocles rambhæ* (Chaudhuri)—*Engraulis rambhæ* Chaudhuri

Suborder Chanoidei

Family Chanidæ

26. *Chanos chanos* (Forskål)

Suborder Notopteroidei

Family Notopteridæ

- 27.* *Notopterus notopterus* (Pallas)

Order Cypriniformes

Division: Cyprini

Suborder Cyprinoidei

Family Cyprinidæ

- 28.* *Catla catla* (Hamilton)
 29.* *Chela cachius* Hamilton
 30.* *Chela labuca* Hamilton
 31. *Crossocheilus latus* (Hamilton)—*Cirrhina latia* (Hamilton)
 22.* *Labeo rohita* (Hamilton)
 33.* *Osteobrama vigorsii* (Sykes)
 34.* *Oxygaster bacaila* (Hamilton)
 35.* *Puntius sarana* (Hamilton)
 36. *Puntius sophore* Hamilton—*Barbus (Puntius) sophore* (Hamilton)
 37. *Puntius ticto* Hamilton—*Barbus (Puntius) ticto* (Hamilton)
 38. *Puntius vittatus* Day—*Barbus (Puntius) vittatus* (Day)
 39.* *Rasbora daniconius* (Hamilton)

Division: Siluri

Suborder Siluroidei

Superfamily Siluroidæ

Family Tachysuridæ

40. *Osteogeneiosus militaris* (Linnæus)
 41. *Tachysurus arius* (Hamilton)—*Arius arius* (Hamilton)
 42. *Tachysurus celatus* (Valenciennes)—*Arius celatus* (Cuvier & Valenciennes)
 43. *Tachysurus falcarius* (Richardson)—*Arius falcarius* (Richardson)
 44. *Tachysurus satparamus* (Chaudhuri)—*Arius satparamus* Chaudhuri

Family Plotosidæ

45. *Plotosus canius* Hamilton

Family Siluridæ

46. *Ompok bimaculatus* (Bloch)—*Callichrous bimaculatus* (Bloch)
 47. *Wallago attu* (Bloch & Schneider)

Family Bagridæ

48. *Mystus cavasius* (Hamilton)—*Macrones cavasius* (Hamilton)
 49. *Mystus gulio* (Hamilton)—*Macrones gulio* (Hamilton)
 50. *Mystus vittatus* (Bloch)—*Macrones vittatus* (Bloch)

*Family Schilbeidæ*51.* *Eutropiichthys vacha* (Hamilton)52. *Pangasius pangasius* (Hamilton)*Order Anguilliformes**Suborder Anguilloidei**Family Anguillidæ*53.* *Anguilla australis* Richardson54.* *Anguilla bengalensis* Gray*Family Murænidæ*55. *Rhabdura macrura* (Bleeker)*Family Murænesocidæ*56. *Murænesox cinereus* (Forskål)*Family Ophichthyidæ*57. *Pisodonophis chilkensis* Chaudhuri—*Ophichthus chilkensis* Chaudhuri58. *Pisodonophis hijala* (Hamilton)—*Ophichthus boro* (Hamilton) and
Ophichthus hijala (Hamilton)*Order Beloniformes**Suborder Scomberesocoidei**Family Belonidæ*59. *Tylosurus strongylurus* (van Hasselt)—*Belone strongylura* (van Hasselt)*Suborder Exocætoidei**Family Hemirhamphidæ*60. *Hemirhamphus gaimardi* (Valenciennes)—*Hemirhamphus limbatus*
(Cuvier & Valenciennes)*Order Syngnathiformes**Suborder Syngnathoidei**Family Syngnathidæ*61. *Hippocampus brachyrhynchus* Duncker62. *Ichthyocampus carce* (Hamilton)*Order Cyprinodontiformes**Suborder Cyprinodontoidei**Superfamily Cyprinodontoidæ**Family Cyprinodontidæ*63. *Aplocheilus panchax* (Hamilton)—*Panchax panchax* (Hamilton)64. *Oryzias melastigma* (McClelland)—*Aplocheilus melastigma* (McClelland)

Order Mugiliformes

Suborder Sphyrænoidei

Family Sphyrænidæ

65. *Sphyræna raghava* Chaudhuri

Suborder Mugiloidei

Family Mugilidæ

66. *Liza corsula* (Hamilton)
 67. *Liza macrolepis* (A. Smith)—*Liza borneensis* (Bleeker) and *Liza troschelli* (Bleeker)
 68. *Mugil cephalus* Linnæus
 69. *Mugil cunnesius* Valenciennes
 70. *Mugil jerdonii* Day
 71. *Mugil speigleri* Bleeker
 72. *Mugil subviridis* Valenciennes
 73. *Mugil tade* Forskål—*Mugil gymnocephalus* Swainson
 74. *Valamugil ceruleomaculatus* (Lacépède)—*Mugil ceruleomaculatus* Lacépède

Order Polynemiformes

Family Polynemidæ

75. *Eleutheronema tetradactylum* (Shaw)
 76.* *Polydactylus indicus* (Shaw)

Order Ophiocephaliformes

Family Ophicephalidæ

77. *Ophicephalus punctatus* Bloch
 78.* *Ophicephalus striatus* Bloch

Order Perciformes

Suborder Percoidei

Family Centropomidæ

79. *Ambassis ambassis* (Lacépède)—*Chanda ambassis* (Lacépède)
 80. *Lates calcarifer* (Bloch)

Family Serranidæ

- 81.* *Epinephelus tauvina* (Forskål)

Family Theraponidæ

82. *Therapon jarbua* (Forskål)
 83. *Therapon puta* Cuvier

Family Apogonidæ

- 84.
- Apogon gymnocephalus*
- (Lacépède)—
- Priopis gymnocephalus*
- (Lacépède)

Family Sillaginidæ

- 85.
- Sillago sihama*
- (Forskål)

Family Carangidæ

- 86.*
- Caranx*
- (
- Carangoides*
-)
- preustus*
- (Bennet)

- 87.
- Caranx*
- (
- Caranx*
-)
- carangus*
- (Bloch)

- 88.*
- Caranx*
- (
- Caranx*
-)
- sansum*
- (Forskål)

- 89.†
- Chorinemus tala*
- Cuvier

Family Lutianidæ

- 90.
- Lutjanus johnii*
- (Bloch)

Family Lobotidæ

- 91.
- Coius quadrifasciatus*
- (Sevastianof)

Family Leiognathidæ

- 92.
- Gazza minuta*
- (Bloch)

- 93.
- Leiognathus equulus*
- (Forskål)—
- Equula edentula*
- (Bloch) and
-
- Leiognathus equulus*
- (Forskål)

- 94.
- Leiognathus blochii*
- (Cuvier)

Family Gerridæ

- 95.
- Gerres oyena*
- (Forskål)

- 96.
- Gerres punctatus*
- Cuvier

- 97.
- Gerres setifer*
- (Hamilton)

Family Sciænidæ

- 98.
- Pseudosciæna coitor*
- (Hamilton)—
- Sciæna coitor*
- (Hamilton)

- 99.
- Sciæna russelli*
- (Cuvier)—
- Umbrina indica*
- (Kuhl & van Hasselt)

Family Psettidæ (Monodactylidæ)

- 100.
- Monodactylus argenteus*
- (Linnæus)

Family Cichlidæ

- 101.*
- Etroplus suratensis*
- (Bloch)

*Suborder Blennioidei**Family Blenniidæ*

- 102.
- Petroscirtes bhattacharyæ*
- Chaudhuri

*Suborder Siganoidei**Family Siganidæ*

- 103.*
- Teuthis vermiculata*
- (Kuhl & van Hasselt)

Suborder Anabantoidei

Family Anabantidæ

- 104.*
- Anabas testudineus*
- (Bloch)

Suborder Gobioidei

Superfamily Eleotrioidæ

Family Eleotridæ

105. *Butis butis* (Hamilton)
 106. *Eleotris fusca* (Bloch & Schneider)—*Eleotris cavifrons* Blyth and
Eleotris fusca (Bloch & Schneider)
 107. *Eleotris* sp.

Superfamily Gobioidæ

Family Gobiidæ

108. *Acentrogobius cyanomos* (Bleeker)—*Ctenogobius dentifer* Hora
 109. *Acentrogobius globiceps* (Hora)—*Ctenogobius globiceps* Hora
 110. *Bathygobius fuscus* (Ruppel)—*Gobius albopunctatus* (Valenciennes)
 111. *Brachygobius munus* (Hamilton)—*Ctenogobius alcocki* (Annandale)
 112. *Glossogobius biocellatus* (Valenciennes)
 113. *Glossogobius giuris* (Hamilton)
 114. *Glossogobius mas* Hora
 115. *Gobiopterus chuno* (Hamilton)—*Micropocryptes fragilis* Hora
 116. *Oligolepis acutipennis* (Valenciennes)—*Ctenogobius acutipennis* (Cuvier
 & Valenciennes)
 117. *Oligolepis cylindriceps* (Hora)—*Ctenogobius cylindriceps* Hora
 118.³ *Oxyurichthys microlepis* (Bleeker)
 119. *Oxyurichthys tentacularis* (Valenciennes)
 120. *Paragobiopsis ostreicola* (Chaudhuri)—*Gobius ostreicola* Chaudhuri
 121. *Parapocryptes rictuosus* (Valenciennes)—*Apocryptes rictuosus* (Cuvier
 & Valenciennes)
 122. *Pseudapocryptes lanceolatus* (Bloch & Schneider)—*Apocryptes lanceo-*
latus (Bloch and Schneider)
 123. *Stigmatogobius javanicus* (Bleeker)—*Ctenogobius chilkinsis* (Jenkins)
 124. *Stigmatogobius minima* (Hora)—*Ctenogobius minima* Hora

Family Periophthalmidæ

- 125.
- Periophthalmus kalreuteri*
- (Pallas)

* Not included in the "Fauna of the Chilka Lake," but recorded from Chilka Survey collection by Koumans (1941).

Family Tænioididæ

126. *Tænioides chilkenis* Chaudhuri
 127.* *Trypauchen vagina* (Bloch & Schneider)

*Suborder Cottoidei**Superfamily Platycephaloidæ**Family Platycephalidæ*

128. *Platycephalus indicus* (Linnæus)—*Platycephalus insidiator* (Forskål).

*Order Pleuronectiformes**Suborder Pleuronectoidei**Superfamily Pleuronectoidæ**Family Bothidæ*

129. *Pseudorhombus arsius* (Hamilton)

*Superfamily Soleoidæ**Family Soleidæ*

130. *Brachirus orientalis* (Bloch & Schneider)—*Synaptura orientalis* (Bloch & Schneider)

Family Cynoglossidæ

131. *Cynoglossus brevis* Günther

*Order Mastacembeliformes**Family Mastacembelidæ*

- 132.* *Macrogathus aculeatus* (Bloch)
 133. *Mastacembelus armatus* (Lacépède)

*Order Tetodontiformes**Suborder Balistoidei**Family Triacanthidæ*

134. *Triacanthus brevirostris* (Temminck & Schlegel)

*Suborder Tetrodontoidei**Family Tetodontidæ*

135. *Chelonodon patoca* (Hamilton)—*Tetrodon patoca* Hamilton
 136. *Torquigener oblongus* (Bloch)—*Tetrodon oblongus* (Bloch)
 137. *Tetrodon fluviatilis* Hamilton
 138. *Tetrodon reticularis* (Bloch & Schneider)

Details of New Records

Name	Locality	Date	Remarks
<i>Gadusia chapra</i> (Hamilton)	Jagadala	17-9-49 and 18-9-49	Juvenile specimens probably brought down by the river (Daya).
<i>Thrissocles hamiltonii</i> (Gray)	Balugaon	Several occasions	Appears to be not uncommon in the Lake.
<i>Notopterus notopterus</i> (Pallas)	Kaluparaghat inundated area	26-10-48	Probably brought in by the flood.
<i>Catla catla</i> (Hamilton)	Jagadala	17-9-49 and 18-9-49	Brought by the floods of the Daya.
<i>Chela cachius</i> Hamilton	Balugaon and Jagadala	27-10-48 18-9-48	Brought in during floods.
<i>Chela laubuca</i> Hamilton	Balugaon	27-10-48	Do.
<i>Labeo rohita</i> (Hamilton)	Kaluparaghat market	26-10-48	Adult fishes speared during nuptial play in the inundated parts of the Lake near the mouth of the Daya.
<i>Osteobrama vigorsii</i> (Sykes)	Jagadala	18-10-48	Brought in during floods.
<i>Oxygaster bacaila</i> (Hamilton)	Balugaon	26-6-48 and several times subsequently during the monsoon months	Brought into the inundated parts of the Lake.
<i>Puntius sarana</i> (Hamilton)	Balugaon	26-10-48 and May, 1951	Found usually in inundated areas. Capable of living in slightly saline waters.
<i>Rasbora daniconius</i> (Hamilton)	Kaluparaghat, inundated parts	27-10-48	Do.

Name	Locality	Date	Remarks
<i>Eutropiichthys vacha</i> (Hamilton)	Jagadala	17-9-48 and 18-9-48	Forms a minor fishery in the northern section of the Lake.
<i>Anguilla australis</i> (Richardson)	Kaluparaghat inundated area	24-8-48	Single specimen.
<i>Anguilla bengalensis</i> Gray	Kaluparaghat inundated area	24-8-48	Two specimens.
<i>Polydactylus indicus</i> Shaw	Balugaon fish assembling centre	24-8-48 and 25-8-48	Caught in the channel near Satpara.
<i>Ophicephalus striatus</i> Bloch	Kaluparaghat, inundated area	August 1948	Brought into the Lake during floods.
<i>Epinephelus tauvina</i> (Forskål)	Satpara Arhakuda	21-1-49 23-1-49	Young specimens entering Lake from the sea.
<i>Caranx (Carangoides) preustus</i> (Bennet)	Balugaon Fish Assembling Centre	16-3-52	Stray visitor.
<i>Caranx (Caranx) sansum</i> (Forskål)	Balugaon	24-4-51	In fish catches at assembling places.
<i>Chorinemus tala</i> Cuvier	Balugaon Fish Assembling Centre	25-1-49	Marketed from the channel area.
<i>Etroplus suratensis</i> (Bloch)	Balugaon	Several occasions	Common in the central sector of the Lake, constituting a minor fishery.
<i>Teuthis vermiculata</i> (Kuhl & van Hasselt)	Balugaon Fish Assembling Centre	24-4-48	Single specimen, probably occasional visitor.
<i>Anabas testudineus</i> (Bloch)	Balugaon	26-8-48	Brought into the Lake during floods.
<i>Trypauchen vagina</i> (Bloch)	Balugaon	24-8-48	Single specimen probably rare in the Lake.
<i>Macrognaathus aculeatus</i> (Bloch)	Kaluparaghat, inundated area	24-8-48	Single specimen.

The new records were made in the course of other routine work and it is difficult to say whether they are fresh incursions since the Chilka Survey or escaped the attention of previous workers. A majority of the new records are fresh-water species which are common in the rainy season, specially in the inundated parts and evidently these are brought by the flooded rivers and streams flowing into the Lake. Fry and fingerlings of *Cirrhina mrigala* (Hamilton) and *Cirrhina reba* (Hamilton) are common in the Daya but have not been collected so far from the Lake. It seems likely that more intensive collections from the channel area in the summer months will add to the record of marine species.

Among the additional records *Etroplus suratensis* (Bloch) and *Eutropiichthys vacha* (Hamilton) deserve special mention as they constitute a regular fishery of minor importance in the Lake, and the export records of the Orissa Fisheries Department indicate that during the year 1948 over 50 maunds of the former and 230 maunds of the latter were exported in fresh condition.

(ii) *General Observations on Breeding and Juvenile Stocks of Fishes*

As the Lake showed considerable evidence of its proving a vast rearing ground for a large number of fishes, it was considered desirable to collect, as far as possible, information about the breeding of Chilka fishes and of those definitely known to be migratory. Larval and juvenile fishes taken in plankton collections made for the study of fish eggs and larvæ, were regularly examined with a view to record seasonal fluctuations in juvenile stocks of fishes. Examination of adult fishes in commercial catches provided the necessary data as regards their sex and maturity. More intensive investigations made in the case of Hilsa have been published separately (Jones and Sujansingani, 1951). The available information about the fishes found in the Lake is given in this section.

There is very little information on the breeding of the Chilka fishes. Bhattacharya (1916) has described embryonic stages of *Paragobiopsis ostreicola* (Chaudhuri) and larval stages of *Petroscirtes bhattacharyæ* (Chaudhuri) and *Hemirhamphus gaimardi* Valenciennes with the respective dates and centres of collection. In addition to the above, Chaudhuri (1916 a, 1916 b, 1917 and 1923) makes casual mention of several other fishes with special reference to the embryos of *Dasyatis (Amphotistius) imbricata* (Schneider) and *D. (Pastinachus) sephen* (Forskal) "brood males" of *Ichthyocampus carce* (Hamilton) and specimens of *Oryzias melastigma* (McClelland) with clusters of eggs. Devasundaram (1951) states that mullets come into the Lake for growth and return to the sea for breeding. Recently we have referred to the spawning grounds and spawning seasons of the Chilka Hilsa. The above information is all that is available on the subject. The

information recently collected in the course of the study of the fishes in the Lake is given below.

Elasmobranchs

Among the sharks and rays of the Chilka only two rays, viz., *Dasyatis (Amphistinius) imbricata* (Schneider) and *Dasyatis (Pastinachus) sephen* (Forskål) are definitely known to breed in the Lake. Chaudhuri gives measurements of four embryonic stages of the former, two collected from Patsahanipur (March 1914), and Barkul (September 1914) and two from the channel near Satpara (21-3-1914). Evidently *D. imbricata* has an extended breeding season. From a large number of young specimens of the species found in catches after the rains it appears that the main breeding season is during the monsoons. Small-sized specimens of the ray are abundant in the shallow parts of the Lake near Balugaon where it is caught in drag nets. On 8-12-48 a specimen, with its disc measuring 21.5 inches across gave birth to a young one while being handled.

D. sephen also appears to have an extended breeding season as young ones of this are found except during winter. Chaudhuri has recorded two embryonic stages, one from Patsahanipur and other from Barakul collected in March and September 1914 respectively.

Clupeoids

Chaudhuri (1916) remarks that *Nematalosa nasus* (Bloch), *Thrissocles kempi* (Chaudhuri), *T. purava* (Hamilton), *T. rambha* (Chaudhuri) and *Anchoviella indica* (van Hasselt) probably breed in the Lake whereas *Anchoviella commersonii* (Lacépède), *Kowala coval* (Cuvier) and *Hilsa ilisha* (Hamilton) do not. Recent observations however indicate as under:

Nematalosa nasus (Bloch).—This fish is a permanent inhabitant of the Lake and breeds there. Its eggs, and the larval and juvenile stages have been collected from various parts of the Lake. The fish is seen in oozing condition in the summer and rainy months and its larvæ have a superficial resemblance to those of *Hilsa*.

Hilsa ilisha (Hamilton).—The fish has been found to ascend the Daya and other deltaic branches of the Mahanadi for breeding and its eggs and larval stages have been collected from the lower reaches of the former (Jones and Sujansingani, *op. cit.*; and Jones and Menon, 1951).

Anchoviella indica (van Hasselt).—The fish is a permanent inhabitant of the Lake, but according to Chaudhuri (1916) it breeds during the later half of winter. The characteristic elongated pelagic eggs of this species have however been collected from February to June, and the peak breeding season appears to be at the height of summer and the beginning of the rains.

Thrissocles spp.—Eggs of *Thrissocles* have been collected from the central sector of the Lake in May and June and the most common species met with is *Thrissocles purava*. It is possible that the large number of young ones occurring

in the rainy season belong to this species. There is at present no evidence that other species breed there, although Chaudhuri (1916) suggests a possibility.

Silurids

Several of the catfishes, especially the salt-water species, breed in the Lake. The young of some of the fresh-water species found during the monsoons in the flooded parts of the Lake are evidently brought down by rivers and streams that flow into it.

Osteogeneiosus militaris (Linnæus).—Contrary to the opinion of Chaudhuri (1916) this fish has been found to be a permanent inhabitant of the Lake and also to breed there. The male of the species is well known for its buccal incubation of eggs, revealing in one case 75 eggs in the mouth. Males carrying eggs and yolked larvæ have been collected in the months of May and June, but the breeding season is probably more extended. Usually egg-bearing fishes are sluggish in their movements and congregate in shoals.

Tachysurus spp.—*Tachysurus calatus* and *T. falcarius* have been found to breed in the Lake during the rainy season and have habits similar to those of *O. militaris*. The brood fishes appear to be more abundant in the northern sector.

Plotosus canius Hamilton.—The fish breeds in the Lake and its post larvæ have been collected during the rainy season (July-August) from the flooded parts of the Lake where water is almost fresh. Chaudhuri (1916) also refers to the collection of young specimens (27 mm. to 42 mm. long) from some parts of the Lake in 1913 and 1914. The fish is known to breed in the sea also.

Mystus spp.—No confirmation of Chaudhuri's (1916) statement that *Mystus gulio* and *Mystus vittatus* probably breed in the Lake is available.

Carps

The only information given by Chaudhuri (1916) is that *Barbus ticto* is a permanent inhabitant of the main area of the Lake and breeds there.

Major carps are known to breed in the inundated parts of the Lake and we have seen specimens of Rohu in oozing condition speared in shallow areas during the course of their nuptial play and brought to Kaluparaghat market. Possibly some of the small carp minnows also breed in this part of the Lake.

Pipe fishes and sea horses

Males carrying eggs have been found (Jones and Menon, 1954) during the summer and rainy months thus confirming the earlier observations made by Chaudhuri (1916) in respect of *Ichthyocampus carce* and *Hippocampus brachyrhynchus* which breed in the Lake.

Top-Minnows

Both the cyprinodonts, viz., *Aplocheilus panchax* and *Oryzias melastigma* are permanent inhabitants of the Lake and breed there (Chaudhuri, 1916).

These fishes probably breed all round the year but their peak season extends from close of winter to end of summer. *O. melastigma* appears to be more prolific as seen in some places where the water teems with young ones during the early summer months. Females, with clusters of eggs attached to their vent, are also very common.

Mulletts

Chaudhuri (1917) presumes that the only mullet to breed in the Lake is *Mugil cunnesius* from the fact that young ones of the fish occur in large numbers in the Lake. Regarding *Liza corsula* he (Chaudhuri) states that the fish breeds in rivers, the young ones being carried down into the Lake. Based on investigations conducted by him, Devasundaram (1951) is of the opinion that adult mullets of the Lake go to the sea for breeding during winter months.

Liza corsula (Hamilton).—*L. corsula* breeds during the rainy season in the inundated parts of the northern section of the Lake and in the rivers like the Daya and Bhargavi flowing into it. Fertilized eggs were collected on 16-9-49 from the mouth of the Daya River near the village of Jagadal and on 17-9-49 from some of the flooded parts of the Lake in the neighbourhood and from three miles up the river near the village of Garisaguda. An almost spent specimen caught from the Lake on 17-9-49 was stripped and a few dozens of eggs were artificially fertilized and the early development was observed. On the next day eggs of *L. corsula* were collected from the Lake off the mouth of the Makra. Plankton collections made from the Bhargavi at Jankeidpur and the Daya near Khurda Road on 20-9-49 and 21-9-49 respectively contained eggs of this fish.

An unfertilized egg is spherical and is about 0.8 to 0.9 mm. in diameter with an oil globule about 0.6 mm. in diameter. After fertilization the zona radiata swells up by about 0.1 mm. showing a very narrow vitelline space. Eggs and hatchlings are all pelagic. The incubation period is about 18 hours. Fertilization appears to take place invariably during night time, probably during the first half of the night as evident from the embryonic stages collected. All the eggs collected at any particular time from different places show more or less the same stage of development.

Almost all the eggs are evidently shed in one spawning act and those that happen to remain unejected at the hind end of the ovaries degenerate into an agglutinated mass which comes out when a slight pressure is applied. Spent specimens have been found gorged with fine bottom scum indicating voracious feeding soon after spawning. It appears that the same fish breeds more than once in a year.

Threadfins

The presence of very young specimens of *Eleutheronema tetradactylum* led Chaudhuri (1917) to believe that it breeds in the Lake near mouths of rivers

before rains. However, it could now be said with a fair degree of certainty that the fish does not breed in the Lake, from the fact that no adult specimens having eggs beyond the 3rd-4th stage of development has been seen in the Lake. The juvenile and young stages seen in the Lake are immigrants which begin to come up from the sea in large numbers at the close of winter.

Leather Jackets

Triacanthus brevirostris, the only leather jacket occurring in the Lake, is a permanent inhabitant and breeds there. Its breeding season is during the rainy months when post-larval stages and oozing females with transparent eggs are found in abundance.

Beloniformes

The two beloniform fishes found in the Lake are the half beak *Hemirhamphus gaimardi* and the gar-fish *Tylosurus strongylurus*. According to Chaudhuri (1917) *H. gaimardi* breeds in the Lake at least twice in the year. Larval stages collected by the Chilka Survey have been described by Bhattacharya (1916) but the first four stages are actually some gobiid larvæ.

Recent observations indicate that the half beak is a permanent inhabitant of the Lake and from the presence of larval stages it is inferred that breeding season is extended over a greater part of the year. The peak breeding season, however, appears to be during the early summer months. Eggs, which have filaments on their surface, are generally laid in algal growth, measure about 1.3 mm. in diameter and hatch out in a week. The larvæ generally keep near the surface.

Chaudhuri's (1917) observations on *T. strongylurus* find no confirmation in our investigations which place this fish amongst regular visitors affording a regular fishery, and could, perhaps, be called a permanent inhabitant. It breeds in the Lake and congregates among thick algal growth for spawning and to anchor their eggs to algæ by means of filaments rising from the zona radiata. The peak breeding season is during the rains though larvæ have been collected during the summer months also (Jones and Menon, 1954). The larvæ generally keep near the surface and are highly predaceous in habit.

Globe fishes

We are unable to confirm Chaudhuri's (1917) observation that *Chelonodon patoca* breeds in the neighbourhood of the outer channel in February and March. Though young specimens have been obtained in our collections made from the channel area it is possible that these could have been brought up by the tide from the sea.

Percoids

The information on the breeding habits of fishes of this important group is meagre. Chaudhuri's inferences were presumably based on the presence of young specimens and cannot be taken as conclusive.

Coius quadrifasciatus (Sevastianof).—Specimens measuring 40 mm. and over have been collected from Balugaon area but it is not possible to say with certainty that these were the progeny of the stock breeding in the Lake. According to Chaudhuri (1923), however, the fish is a permanent inhabitant of the main area where it breeds at the end of the rainy season. He also refers to the collection of young specimens measuring from 21 to 37 mm. from Barakul and Nalabano in the month of September.

Therapon puta Cuvier.—The fish is found in the Lake throughout the year but it is doubtful if it breeds there as stated by Chaudhuri (1923), since the possibility of its breeding in the sea and of the young ones coming into the Lake through the channel cannot be ruled out.

Apogon gymnocephalus (Lacepède).—What has been stated for *Therapon puta* applies here also for the same reasons (Chaudhuri, 1923).

Bekti.—The prime estuarine perch, *Lates calcarifer*, comes into the Lake as young fish and constitutes a rich fishery. The fish goes back to the sea for breeding. No gravid specimens have ever been taken and the maximum size of ova observed was in the 4th stage. Young stages, 3 to 4 inches long, are caught in the channel area and in the central zone. It would appear that the fish breeds in the sea, the young and the juveniles entering the Lake to feed. As the migration of the young ones is spread over a long period it is inferred that breeding takes place during summer months and is fairly extended.

Sillago sihama (Forskål).—According to Chaudhuri (1923) this fish is a permanent inhabitant of the Lake and goes out to the sea or the mouth of the Lake for breeding which takes place by about February. The breeding season however appears to be extended since juvenile specimens are available from close of winter till rainy season.

Leiognathus equulus (Forskål).—The possibility of the fish breeding in the sea and young ones coming into the Lake cannot be ruled out. Chaudhuri's (1923) observations that the fish breeds in the Lake during the rainy season remains unconfirmed.

Gerres spp.—*Gerres setifer* and other species have been seen in catches in large numbers during the rainy season specially in the central and southern sectors, though according to Chaudhuri (1923) *G. setifer* is a dry weather visitor and does not breed in the Lake. A number of specimens brought to the fish assembling centres in the southern sector in August 1948, i.e., during the rains, were found in ripe condition with flowing milt and ova almost in a fertilizable condition, but it is not possible to say that the species breeds in the Lake.

Petroscirtes bhattacharyæ (Chaudhuri).—This blenny is a permanent inhabitant of the Lake, breeds there and its post-larvæ have been collected on several occasions. It appears to breed both in summer and in winter, larval stages of this fish collected during the Chilka Survey have been described by Bhattacharya (1916).

Pearl-spot.—The only cichlid occurring in the Lake is the pearl-spot, *Etroplus suratensis*, which has not been recorded in the Chilka Survey collection. The fish is a permanent inhabitant of the Lake, breeds there and its young ones have been collected from the central sector.

Sciænids.—The Sciænids found in the Lake are *Pseudosciæna coitor* and *Sciæna russelli* which do not breed there. Young ones of these, however, migrate from the sea after the winter months.

Gobiids.—The only gobiid which is recorded to breed in the Lake is *Paragobiopsis ostreicola* (Chaudhuri) the eggs of which, showing various stages of embryonic development collected from inside a dead shell, have been described by Bhattacharya (1916).

The gobiid fauna of the Lake is fairly rich and most of the gobiids appear to breed in the Lake. Yolked larvæ of *Paragobiopsis ostreicola* were collected in the month of April 1950 from Satpara (Jones and Menon, 1954). Larval stages of various species have been obtained in large numbers in plankton collections specially during the summer and early part of the monsoons. Though their identity could not be established, a very large number of tiny ones amongst these appeared to be those of *Glossogobius giuris*. In September 1949, *Gobiopterus chuno* was found breeding close to the mouth of the river Daya near the village of Jagadala and eggs were found laid on filaments of *Spyrogyra*. Egg laying probably takes place in the evening hours, as evident from the condition of the embryos.

Fish seed resources

As stated elsewhere large quantities of the fry of major carps drift down into the Lake during the floods, some of which get distributed in the inundated parts in the northern sector at the close of the monsoons. The young of several marine fishes come in for food and growth. It is reported that the adults of the major carps also enter the Lake with flood waters and spawn in the inundated areas. When the floods subside, the fry get stranded in numerous isolated pools and puddles and are caught for immediate use by local people as the water does not take long to dry up. In large isolated pieces of water, however, the trapped fry and fingerlings grow for a few months and attain a size of about 6 to 10 inches. The latter, when found in excess of the local demand, are marketed at Kaluparaghat.

At present there are several practical difficulties in the full utilisation of the fish-seed. The number and extent of fresh-water tanks into which

the salvaged fry and fingerlings could be reared is very limited. Even the few available tanks are not systematically stocked as piscicultural practices are unknown to the local people. Inaccessibility of these areas and lack of suitable transport would make the seed supply difficult even if it were possible to create demand from other centres. Further, it would require intensive propaganda and large-scale demonstration to induce people, generally conservative and complacent, to take to a new vocation, more particularly as they are not short of fish.

The comparatively abundant brackish-water fish seed is composed mostly of young mullets, of which *Mugil cephalus* is the most important as among the Chilka mullets it attains the largest size and gives a greater yield than all other varieties of mullets put together. Mulletts can tolerate wide ranges in salinity and their adaptation to life in fresh-water is therefore within the range of practical pisciculture. As all sizes of fish are caught and marketed throughout the year, a large-scale destruction of young mullets of various species takes place, but this may be prevented to some extent if it is demonstrated that the mullet fry and fingerlings can be acclimatised in fresh-water ponds near the coast, in which growth will be fairly rapid. As mullets are not harmful to other types of fish, it should even be possible to stock some of the inland tanks and reservoirs as a supplement or alternative to the carp seed, especially when and where the latter is scarce.

Apart from young mullets there are no other suitable non-carnivorous fish fry available in sufficient quantities for pisciculture. The pearl-spot, *Etroplus suratensis*, the young of which have never been seen in the Lake in large numbers affords a very minor fishery. The milk fish *Chanos chanos*, is only an occasional visitor to the Lake.

Among the carnivorous fishes, the young of the so-called Indian Salmon, *Eleutheronema tetradactylum* occur in appreciable quantities whereas those of *Lates calcarifer*, *Megalops cyprinoides* and *Elops saurus* are found only in comparatively small numbers. As all the above types are predatory in their food habits, they cannot be recommended to be reared along with carps and mullets.

(iii) Fishing Grounds and Fish Exporting Centres

The Lake is not entirely 'Khasmahal', i.e., it does not belong to the Government alone but it is divided into about a thousand fishing areas of varying extents belonging to various owners including the Government which owns 24. There are only about a dozen principal owners—of whom the Rajas of Parikud and Kallikota are the more prominent. The fishing grounds

are mainly all along the border of the Lake and change hands very often on account of frequent partitions. For the purpose of exploitation, these are given away on lease by auction for a period not exceeding one year at a time. Barring these, an extensive area in the main body of the Lake is open for fishing to all fishermen on payment of a nominal tax. The shallowness of the Lake makes fishing operations very convenient and there is hardly any portion of it which is not fished. The whole Lake where intensive fishing by various methods goes on practically day and night, thus forms a vast fishing ground "full of fish" though, not of the "coarse-uneatable kind" as stated by Maltby (1918) in the *Ganjam District Manual*.

The fish is exported by rail which is the only channel of export. There is no possibility of export of fish north or south of the Lake. Ganjam and Puri are surplus in sea fish, though the latter still imports some Chilka fish by rail to cater to acquired tastes as the only possible land-route from Arkhakuda is impracticable. There is thus no road transport worth the name anywhere in the entire Chilka area, and no consuming centres in the neighbourhood where this perishable commodity could be disposed off at competitive rates. Under the circumstances all the fish from the fishing grounds are carried to the assembling centres which lie along the western shores of the Lake for export by rail.

Fore-shore fishing is generally carried out during the morning hours so that the catches are delivered for export or local sales on the same day, whereas fishing in the off-shore grounds is done in the late hours of the night (or sometimes even during the day). Country boats laden with iced fish leave before daybreak when the wind is generally favourable and reach the assembling centres near the rail-heads in the afternoon after about 6 to 10 hours journey depending on the distance and the direction of the wind.

There are six fresh-fish assembling and exporting centres (Fig. 2) at the rail-heads of Rambha, Kallikota, Balugaon, Gangadharpur, Kuhuri⁴ and Kaluparaghat spread over a distance of about 33 miles, and of these Balugaon and Kaluparaghat are the most important as they handle the major portion of the catches, throughout the year. Transport of fish from assembling points to the railway stations at all these centres is done by means of bullock carts only. Further details are given in the table below:

⁴ This centre came into existence in June 1948.

Name of exporting centre	Distance from the Lake	Distance of fish godowns from the railway station	Fishing grounds forming source of supply	Main exports
Rambha	Less than one mile. Good motorable road.	All at about a furlong's distance, excepting one in the village about three miles away.	Rambha, Saberla, Gajpatinagar and Madhur- chua.	Prawns, mullets, Mud shad, and small-sized Threadfins. Mulletts mainly caught from Janos.
Kallikota	About a mile. Road good.	Road not good. About a furlong.	Parikud, Malud and local fishing grounds.	Prawns, mullets, Mud shad and small-sized Bektli. Crabs caught in large numbers and exported if in excess of local demand.
Balugaon	About a mile. Road good.	All, excepting the godown of the Balugaon Fishermen's Co-operative Society—oldest in the Chilka area, along the shore of the Lake.	Local catches consist mainly of prawns, crabs and Patua (Engraulids). Main supplies received from Parikud and Gurwahi. Occasional supplies from Satpara and Arkhakuda.	Prawns, Mulletts, Catfishes, Threadfins, Hilsa and Bektli. Crabs exported only after meeting local demand.
Gangadhar- pur	About two miles. Road bad specially during rains.	Along the shore of the Lake.	Fishing within 3-10 miles of the shore. Main supplies from Parikud, Nalbano Bhubania and Barapania.	Mulletts, Catfishes, Hilsa, Prawns and Bektli.

Kuhuri	About 2½ miles. Road Near the Lake. bad specially during rains.	Fishing within 3-10 miles of the shore.	Mulletts, Catfishes, Hilsa, Sciænids, Patua (Engraulids), Bekti and Prawns.
Kalupara-ghat	About 1½ miles. Road Along the shore of the Lake.	Local catches of large quantities of prawns. Main supplies from Tua, Satpara, Karimpur, Borokud and Bhaganjee. Occasionally from Arkhakuda.	Mulletts, Catfishes, Threadfins, Sciænids, Hilsa, Patua (Engraulids), Bekti and Prawns.

(iv) *Fishing Gear and Methods*⁵

The gear used in commercial fishing in the Lake consists of nets and traps, the former for catching fish and the latter for prawns and crabs only. Cover baskets, spears, scoop nets, etc., are mainly used for catching fish in small numbers. The fishing boats are plank built flat bottomed ones known as "Naha" though for small-scale fishing operations close to the shore dugouts are also used.

Nets (Jalo).—There are a few types of nets common all over the Lake, the dimensions and mesh-size of which vary from place to place. Thus a *Bekti-jalo* or a *Noli-jalo* owned by a fisherman will rarely be of the same dimensions as that of another. Owing to the shallowness of the Lake and the consequent crowding of fish in depths ranging from 3 feet to 10 feet there does not seem to be any necessity for varying the type of nets. Thus both drag nets (Plate VI, Fig. 2) and gilling nets are used for catching large as well as small fish as the occasion warrants. For catching very small fish, a particular type of drag net known as *Patua-jalo* is used which, apart from *Patua* (Engraulidæ) catches not only other small fish but occasionally larger fish like Hilsa. Handy drag nets operated by only two people are employed to catch various types of fish, including prawns and crabs. For catching Bekti, Hilsa and large mullets, gilling and encircling nets are used (Jones and Sujansingani, 1951). Cast nets (*Khepla-jalo* or *Chauri-jalo*) are sometimes operated in very shallow areas by whirling them round the head like a lasso (Maltby, 1918).

In view of the scarcity and high cost of cotton yarn nets are made of sunn-hemp yarn by fishermen in their spare time. After the nets have been in use for 4 or 5 days they seem to need repair and treatment with preservative owing to the adverse effect of brackish-water on the texture of the fibre (Plate VII, Fig. 4). The preservative used is a decoction of the bark of *Sahajo* or *Korero* trees made in boiling water. The main features of the nets, prices, and other particulars are:—

A. Gilling nets

1. *Menjia-jalo.*—Length about 500 feet, depth about 2 feet, mesh $\frac{3}{4}$ inch from knot to knot. Floats conical 3.5 inches long and $\frac{1}{4}$ inch wide at base. Approximate price Rs. 25. Five such pieces are usually lashed together, and such a unit is operated by five people.

2. *Noli-jalo.*—Length about 240 feet, depth 3 to 3.5 feet, mesh 2.25 to 2.75 inches from knot to knot. Floats conical 4.5 inches long and 0.25 inch wide at base. Approximate price about Rs. 20. Five such pieces are lashed together in operation. The same type of net having rectangular floats measuring 8 inches \times 3 inches \times $\frac{1}{4}$ inch is known as "*Khainga-jalo*".

⁵ Some of these have been briefly mentioned in the *Fish Marketing Reports* (Govt., 1941 & 1946) and by Mitra (1946). A few have been described by us in fair detail separately (Jones and Sujansingani (1952 a, 1952 b) and some by Devasundaram (1952) and Job and Pantulu (1953).

B. Drag nets

1. *Bekti or Mori-jalo*.—Length about 30 feet, depth 10 to 15 feet, mesh from knot to knot from 1.75 to 3.0 inches. Diameter of the yarn about 1/12 inch. Floats rectangular, 8 inches \times 2.75 inches \times 0.25 inch. Net provided with bottom rope. Approximate price Rs. 50. About 40 pieces are lashed together to make an operational net for catching Bekti and other large-sized fish, hence the wide variation in the size of the mesh.

2. *Sahala-jalo*.—Length about 200 feet, depth about 7 feet, mesh $\frac{3}{4}$ inch from knot to knot. Floats rectangular 8 inches \times 2.75 inches \times 0.25 inch. Net provided with a bottom rope. Approximate price Rs. 35. About 50 pieces lashed together for operation by 15–20 people to catch all types of small fish except *Patua*.

3. *Khadi-jalo*.—Length 35 to 40 feet, depth about 10 feet. Net operated by two people is made of 20 count cotton yarn with mesh 5/16 inch from knot to knot. Mouth of the net kept stretched by a series of bamboo strips 36 to 40 inches long set 2 feet apart. Approximate price about Rs. 120.

4. *Mani-jalo*.—This is a light surface drag net (Plate VII, Fig. 3), consisting of 20 bags, each measuring 10 inches \times 8 inches \times 15 inches. Four such nets with 80 bags constitute an operational unit for dragging by two people near the surface of water. This type of net is used for catching garfishes and half beaks by the Koibartas of Chandrapat village (*vide* Jones and Sujansingani, 1952 *b*).

Traps

Bamboo traps are used for catching prawns, crabs and small fish. Traps used for prawns are known as *Daudi* and *Cheengri-Baaza* (Plate VII, Fig. 1). An essential accessory to these traps is *Thatta* (Plate VIII, Fig. 1) which is a bamboo screen measuring 40 feet \times 4 feet and serves as a pathway or guide for prawns to move in the direction of traps.

Daudi.—It is roughly prism-shaped, slightly longer at the base than at the top and is made of bamboo strips of about $\frac{1}{4}$ inch width. Usually strips of 34 bamboo poles each of 3.5 feet length are required to make one *daudi* which measures about 60 inches \times 12.5 inches \times 39 inches (Plate VII, Fig. 1).

Cheengri-Baaza.—It is made up of three separate parts, namely *patta* or strap about 88 inches \times 22 inches long and two rectangular pieces about 32 inches \times 8 inches each. The latter in contact with *patta* serve as top and bottom and form a rectangular trap 32 inches \times 20 inches \times 8 inches.

Konkra-kharia.—This cage trap for catching crabs measures 18 inches \times 12 inches \times 10 inches and is described in detail elsewhere (Jones and Sujansingani, 1952 *a*).

Openings of *Daudi* and *Cheengri-Baaza* are secured by *Chevaux de frise* of bamboo splints as in the case of *Konkra-kharia*.

Jhauri-Baaza.—This trap, about 22 inches \times 12 inches \times 5 inches, has the same shape as *Konkra-kharia* and is operated in winter period January-February for catching very small fish which can enter the interspaces between the strips.

All except *Jhauri-baaza* are used by fastening them to vertically planted bamboo poles to indicate their position in water. They are generally set in the Lake in the evening and removed in the morning when the catch is taken out and traps thoroughly dried before resetting in the evening.

Jano fishing.—Barricades of bamboo screens provided with openings known as *Jans* are employed for fishing in low-lying areas about a mile long and a few hundred yards wide. During rains, the *Jans* are filled as high as flood water would permit and then the openings are blocked thus trapping fish within the enclosure. Fishing takes place from end of October-February when the water level on account of recession falls catching almost all the fish, large and small. Intensive fishing by trapping (Devasundaram, 1952) is done from the very beginning of the season but a decline in the catches is noticed during January-February. This fishing results in the wholesale destruction of immature fish which have no chance to escape. Most of the *Jans* lie in the southern half of the Lake but a few are found near Tua also.

(v) Collection of Export Statistics

Classified statistics of different varieties of fresh fish tendered for sale at all the six assembling and exporting centres of the Chilka Lake are compiled by the Orissa Fisheries Department from the daily reports submitted by the authorised dealers, viz., co-operative societies, and merchants who hold permits for export of fresh fish outside the State. The daily reports are supposed to contain a classified statement showing weight (in maunds, seers and chataks) of each of the varieties of fish tendered for sale at fish godowns of the assembling centres, and do not include the fish disposed of between fishing grounds and the assembling centres, or the fish taken by fishermen for their own consumption. Almost all the fish caught in the Lake, except those caught in Arkhakuda, must come to these centres for disposals. Owing to the long distance from the rail-head (about 30 miles) the fish that has to come from Arkhakuda by country boats becomes stale as generally ice is not readily available. The surplus at Arkhakuda is therefore generally converted into dry fish and exported to Bhusandpur for disposal except in winter when no need for ice is felt, and the fish are transported by roads for three miles up to Jodupore and then 12 miles by boat to Kaluparaghat.

The elaborate classification adopted in the daily returns is due to the availability of a large number of economic varieties of fishes in the Lake which are classified as correctly as possible. Practically all the sorting of fish is done in boats on their inward journey from the fishing grounds to the assembling centres, excepting when the catches are unusually large. In the latter case an effort is made to separate as far as possible various species resembling each other but when time

is short the fishes belonging to the same family or group are put together. Thus *Pseudosciana coitor* and *Sciana russelli* (locally known as *Pendi* and *Golara*) are recorded separately or together according to the time available. In sorting of species according to their size, e.g., *Sahal*, *Sahalia* and *Baisali* (large, medium and small-sized) *Eleutheronema tetradactylum* there is bound to be some sort of overlapping depending on the time factor and the judgment of the different sorters concerned. In the case of small-sized clupeoids like *Thrissocles*, *Anchoviella*, etc., which are classified as Patua sorting is not possible. So far as mullets are concerned, the 9 species occurring in the Lake are classified under 5 groups as explained on page 289. Thus the actual classification, though somewhat different from that provided in the daily returns, gives a correct idea of the total output of different groups or families though not of the individual species, and it is mainly for this reason that the seasonal fluctuations and other aspects of the fisheries have been described in this account mostly according to groups of fishes and not according to individual species.

Next to classification comes the recording of the weight of the fish which to some extent, is dependent on available time as large quantities of fish are to be weighed as quick as possible to keep pace with the arrival of boats, and the fish is to be iced and packed immediately not only to prevent further spoilage but also to transport it in time to railway stations for export on the same day. Although the weights of fish recorded are rough and ready, the percentage error from the actual weight, especially in the case of economic varieties which are weighed more carefully, is very small considering that, under the existing circumstances where speed in packing for export is very desirable, rough and ready methods of weighing are almost unavoidable.

In view of the above, the records of the daily returns furnish valuable data regarding the relative abundance or otherwise of the various species of fish in different parts of the Lake and in different seasons. Further, as the fish from various fishing grounds are generally marketed through the same exporting centres some light would be thrown on the distribution of the fish in the various regions of the Lake. The data thus obtained by the Orissa Fisheries Department through the goodwill and co-operation of the authorised dealers but without employing any official machinery for the purpose are of great scientific value.

As the exports are entirely controlled by the State Government, it is to be expected that the records of daily returns maintained by the authorised dealers are reliable. As a check on the returns thus submitted by the dealers, records of consignments of fish exported by rail from the Lake sector kept by the Railway authorities were obtained and arranged in chronological order. To ensure accuracy, data were collected, as far as possible, from the primary records, i.e., the parcel way-bills of which there were at least 1,000 to 1,500 at Balugaon and Kaluparaghat alone every month. If way-bills for a given period were not available the export figures for that period were collected from the Guard's Signature Book, which is the next best source of information.

The data thus compiled from the railway records showed fair agreement with the statistics collected by the State Department of Fisheries in respect of the actual exports for the period January 1948–August 1949. As for the later period, *viz.*, September 1949–December 1950, the statistics indicate that the daily returns were more or less sample exports of different varieties. Further the data collected from the railway records have been used to estimate the exports under different varieties on the basis of statements compiled by the Orissa Fisheries Department.

As all dry fish are exported by rail only, figures of export have been collected from railway records maintained at the dry fish exporting centres in the Chilka area. Further any quantity exported from one centre to another within the Chilka area has been accounted for in one centre only and not in both and any dry fish received from outside the Chilka area has not been taken into consideration at all.

The railway records do not furnish any clue as to the varieties of fish exported but enquiries made of those engaged in the dry fish trade, give some indication of the varieties of fish generally salted and dried and their relative proportions in the exports from various centres.

(vi) Analysis of Fish Catches

An attempt is made here to analyse the fish catches as estimated from the statistics compiled by the Orissa Fisheries Department and from the available records of consignments of fish at the railway stations on the Lake; Also an attempt has been made to correlate the production capacity of the Lake with the general environmental conditions, prevailing in three major sectors each with its peculiar hydrological condition and trend of export figures during the years 1948–50. Apart from the statistical data, information collected at important centres of fish assembly and export during visits from an examination of fish catches and from personal contacts with fishermen has also been taken into consideration in drawing this report. In the difficult task of survey of a Lake of 400 square miles, producing about a hundred thousand maunds per year, the compilation of production figures undertaken by the Orissa Fisheries Department is a remarkable contribution. The discussion of the biology of the different groups of fishes and its correlation with the relative productivity of different sectors that follows should be regarded as more or less general to provide a background for future study.

For estimating fish production in the different regions of the Lake, it has been divided into three zones or sectors, *viz.*, the southern, the central and the northern according to the salinity prevailing in each of the zones (*vide supra*). As the waters of the three zones mix freely in all seasons, this division is arbitrary, and a considerable amount of overlapping where the zones meet is inevitable.

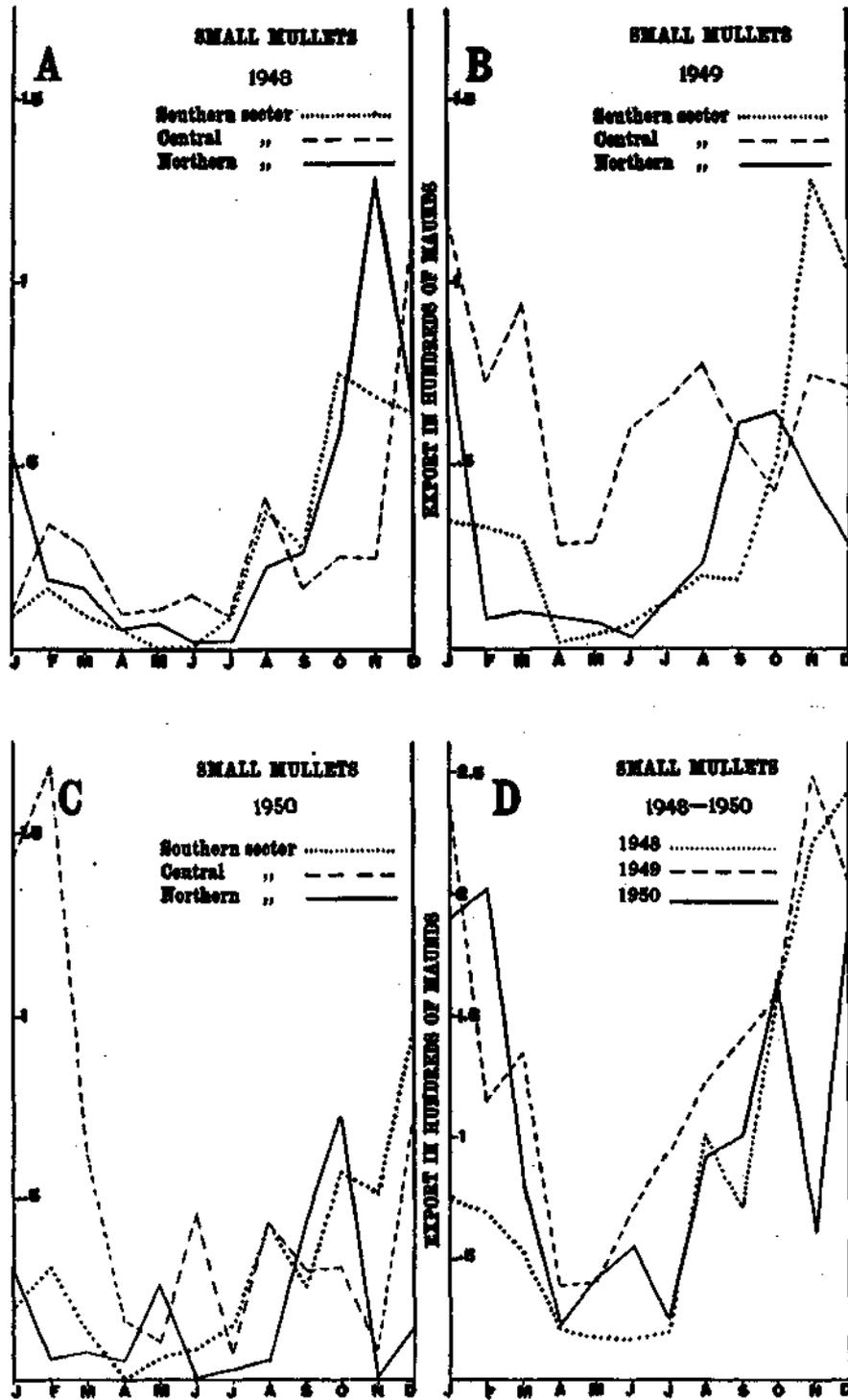
The southern zone which includes the fish exporting centres of Rambha and Kallikota covers an area of about 50 square miles of the Lake and is a *cul-de-sac* so far as circulation of fresh-waters during the rains is concerned. This zone remains therefore brackish throughout the year, its flushing even during the highest floods being partial for want of any direct outlet. The Ganjam canal which once connected the southern section of the Lake with the Rishikulya estuary is practically defunct now, with little or no flow of water.

The central zone covers an area of about 150 square miles and includes the fish exporting centres of Balugaon and Gangadharpur. The physico-chemical conditions in the main area of this zone are intermediate between those prevailing in the northern and southern zones. The flood waters which enter from the north, though inadequate to replace the brackish-water completely, cause an admixture and thereby bring about a considerable flushing of this area reducing its salinity appreciably. The entire zone is fertilized to a large extent by (1) the silt brought by the flood waters; (2) the droppings of millions of birds visiting it during the winter; and (3) the large resident population of cormorants, herons and other birds.

The northern zone comprises the major portion of the main area of the Lake and also the channel. It covers an area of about 200 square miles and includes the fish exporting centres of Kuhuri and Kaluparaghat. The whole of this zone, with the exception of a small expanse of water near the mouth of the channel, becomes fresh or almost fresh when the monsoon flood waters push out the brackish-water of the previous season replacing it completely but becomes brackish once again on account of the ingress of sea water when the floods subside. Thus this zone is flushed more or less completely every year depending upon the intensity of floods. The flood waters also bring in silt and detritus which settle down in this region contributing to its fertility. The Daya which is mainly responsible for the floods dries up completely after winter, leaving a tongue-like estuary about 15 miles long as far as Kanaus.

Thus, apart from the salinity which varies from zone to zone and season to season, the fertility of the Lake under natural conditions, which contributes in no small measure to the productivity of the Lake in its three zones, also varies. As a result, there is a marked difference in the fish fauna dominant in the three zones and also in the fisheries constituted by them, as indicated by the statistics of catches.

The total production of fish in the Lake has been calculated by taking into account the (1) estimated exports of different varieties of fresh fish; (2) dry fish in terms of fresh fish; and (3) fish consumed locally (*i.e.*, in the Lake proper, in and around the assembling centres and the quantity taken by fishermen for their own use) which is not recorded in daily returns. The first two items have already been dealt with. The last item has been worked



GRAPH 1. Export of fresh Small Mullet.

out on the basis of observations and enquiries as no records for local consumption are maintained. Considering the production figures in the Lake, local consumption of fish is insignificant as the very thinly populated villages are scattered far and wide. Further, as these villages are inhabited by poor people, most of the fish consumed locally are of an inferior type such as *Patua* (Engraulids), and small catfishes, perches, mullets and shrimps which, when exported, would not yield any high margin of profit over the local rates. The fishermen are satisfied with small quantities of cheap fish for their consumption while they export all prime fish in the expectation of earning good profit. Though no records are available it is obvious that the locally consumed fish consists of a number of cheap varieties. Accordingly, estimates of production of prime fish are far more correct than of the cheaper kinds.

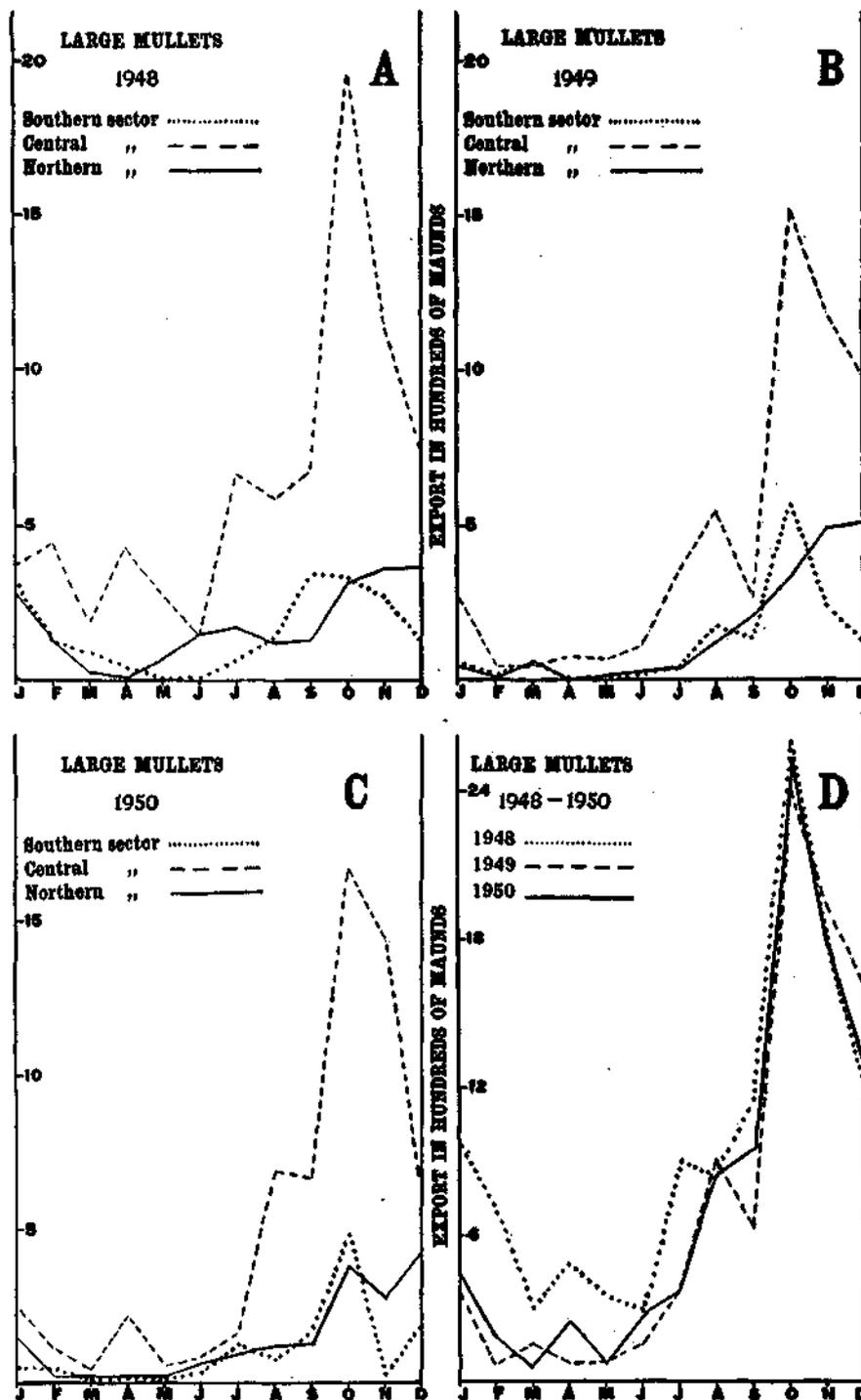
Valuation of the fresh fish produced in the Lake has been on the basis of the civil supplies⁶ rates (p. 326). For the sales within the State, the supplier or fisherman is paid at the same rates, while for export to Calcutta he is paid according to the Howrah wholesale market rates, which vary from day to day. Making allowance for transport and other charges incurred on the exports, it would be reasonable to expect that net realization per unit weight would be at least as much as the rates fixed for civil supplies.

Mulletts

Of Chaudhuri's (1917) record of 10 species of mullets from the Lake, only 9 valid species remain (*vide supra* revised list) in view of the fact that *Liza troschelli* and *L. borneensis* are synonyms of *L. macrolepis*. As the Chilka mullets are being studied in detail at the Chilka Biological Station, only the Statistics of exports are interpreted (Graph 13 B) in this paper.

Ecologically the Chilka Lake mullets fall into two main groups, *viz.*, (1) the fresh-water species consisting of *Liza corsula* and (2) the salt-water species consisting of the rest of the species, of which *M. cephalus* is the most important. *L. corsula* is confined to the less saline parts of the Lake, especially in the northern sector and the region adjoining the mouths of the Daya and its branches where it breeds. The salt-water species however migrate into the Lake from the sea through the channel for food and growth. The absence of *Mugil parsia* (= ? *M. dussumieri*) in the Lake, although it is very common in the Gangetic delta and in the coastal waters of Bengal and Orissa, is noteworthy and difficult to explain.

⁶ The quantity of fish allocated to the State for civilian population was termed as "Civil Supplies" to differentiate it from supplies requisitioned for the Military during the Second World War, but the use of the above term still continues.



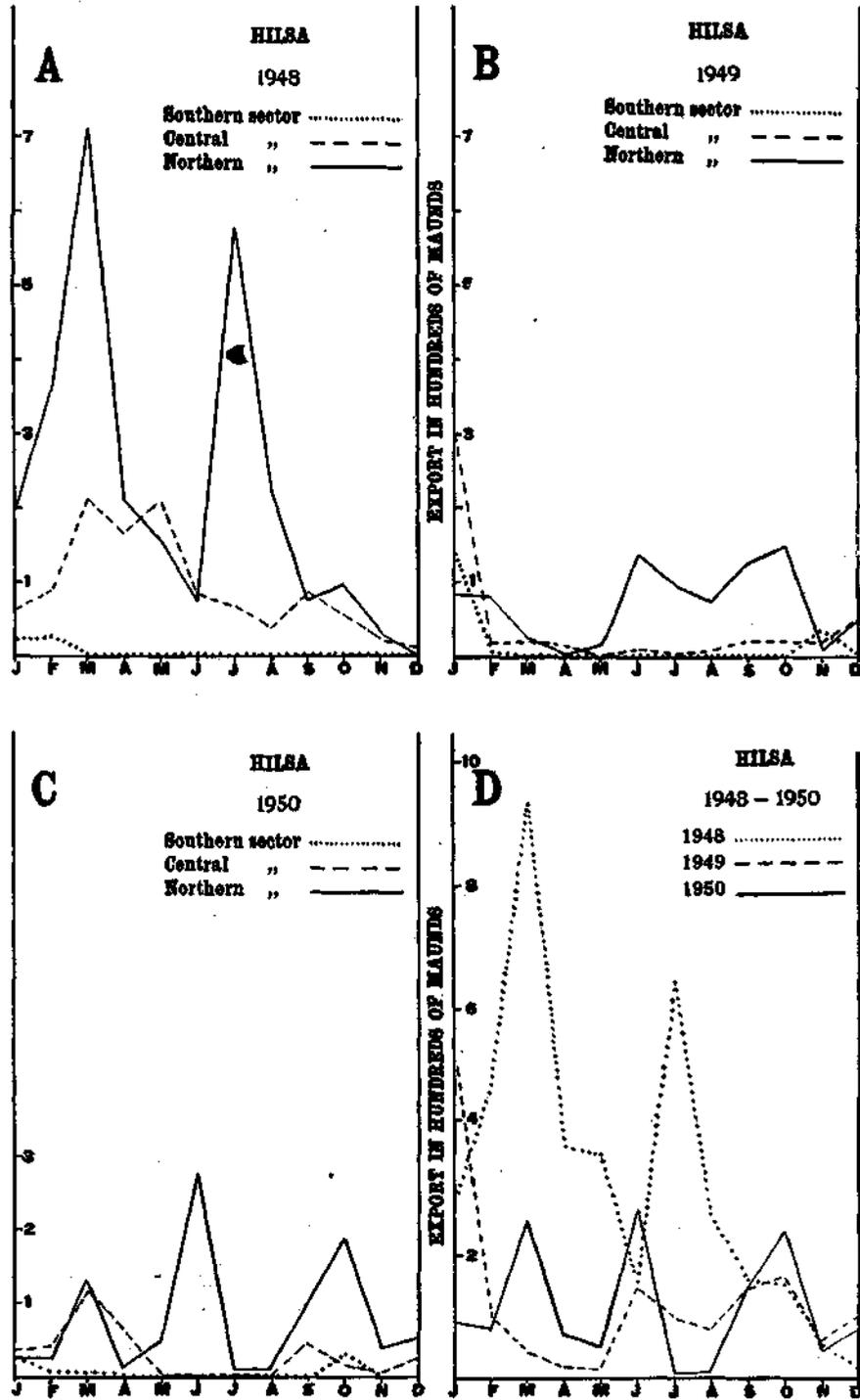
GRAPH 2. Export of fresh Large Mullet.

In the export returns, the mullets are recorded under five categories on the basis of classification followed in the fish godowns. *L. corsula* is classified as *Kekeranda* irrespective of its size. Young ones of all other species upto about 8 inches are classified as *Menjia* and adults, except those of *L. macrolepis*, as *Khainga* and *Kabala*. Strictly speaking *Khainga* and *Kabala* are two local terms for *M. cephalus*, used by the Oriyas and the Bengali merchants respectively. Oriya term for *L. macrolepis* is *Dangla* and the adults are classified under that name. Occasionally when adults of any of these varieties, e.g., *Dangla* and *Khainga* or *Kabala* appear in catches in stray numbers they may not be weighed and recorded separately but included in the predominant variety.

Liza corsula (Hamilton).—This fish is generally caught by means of *Menjia-jal* and *Khainga-jal*. Estimated exports of the fresh fish for the years 1948, 1949 and 1950 are 344, 656 and 301 maunds respectively (Table I). The statistics of exports indicate that large catches are generally obtained during the rainy months, the highest record of January 1948 being exceptional. In the inundated parts of the Daya region the fish is abundant in the monsoons, but as these areas are very far off from fish assembling and exporting centres and are not themselves self-sufficient in the cheap varieties of fish, such as minor clupeids and small prawns, etc., a good quantity of this mullet is consumed locally and thus remains unaccounted for.

Small mullets (Menjia).—These are generally caught by means of *Menjia-jal* and *Sahalo-jal*. Export figures for the three years 1948-50 indicate a fairly uniform trend during different seasons in all the three zones (Graph 1). Large numbers are obtained during the winter season with a peak period from November-January. After February there is a fall and catches are very low from April-July. With the advent of the monsoons there is a general rise in production up to October when the flood season is over.

Stocks of *Menjia* in the Lake get replenished from the sea as, apart from *L. corsula*, no other mullet appears to breed in the Lake. Young mullets start on their lakeward journey through the channel during the later part of winter and this invasion continues till the rains, by which time they get distributed all over the main area. Being probably too small to be fished when they enter the Lake they do not constitute any sizeable exports when caught during early part of the year. Gradually their size increases and so also their number and with increase in fishing intensity on account of *Jano* fishing from the end of October heavy catches are obtained towards the end of the year.



GRAPH 3. Export of fresh Hilsa or the Indian Shad (*Hilsa ilisha*)

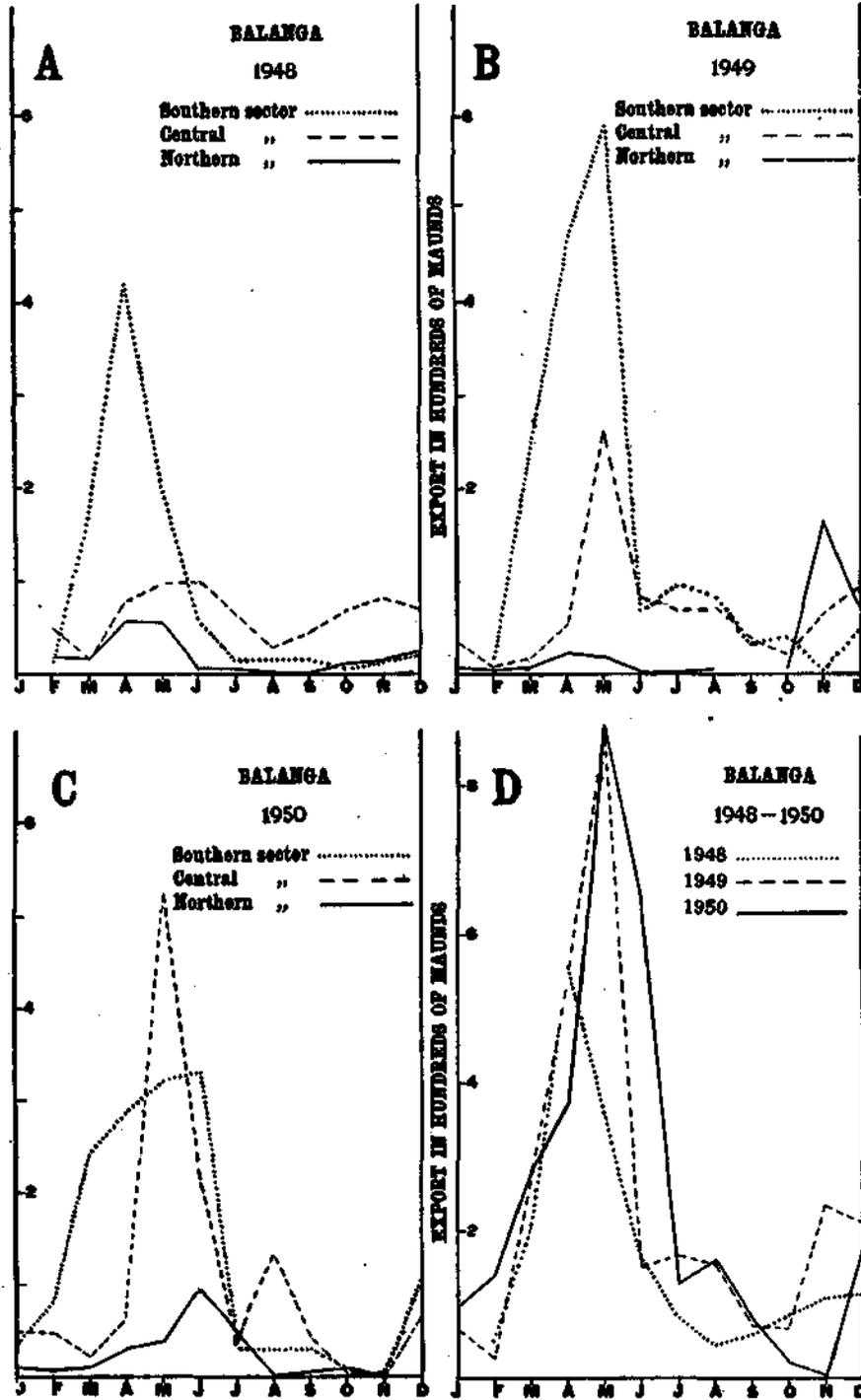
More *Menjia* is caught from the central and southern zones than from the less saline northern zone. Further, the rich algal growth of these regions also seems to provide suitable food for their growth. These require to be confirmed by further investigations.

Large Mullet (*Kabala* or *Khainga* and *Dangla*).—These are caught by means of *Khainga-jal*, also known as *Noli-jal*. Major portion of the catches consists of *M. cephalus* locally known as *Kabala* or *Khainga* which is the most important and economic variety amongst the Chilka mullets and is easily distinguished and classified by sorters. The catches of *Dangla* (*L. macrolepis* = *L. troschelli* and *L. borneensis*) being very low, record of its exports as a separate variety seems to have been maintained only when found convenient, as detailed export figures for 1949 and 1950 indicate. Further, appearing in catches generally as stray individuals, *Dangla* is mixed with *Kabala* and weighed and exported as such.

The central zone yields the highest catches, while the southern zone produces nearly as much as the northern though it is only one-fourth of the area of the latter (Graph 2). Catches are very low from March-June in all the sectors, but register a steep rise from July onwards. Highest catches are obtained in October and November, and these seem to be due to the exploitation of *Jano* or vast enclosed fishing areas. Though *Jano* fishing season continues till February, the catches progressively decline during January and February due to intensive fishing in the earlier period. Most of the *Jano* fishing areas are in the central and southern zones and contribute in no small measure to the greater output of these regions. It is not clear if the decline observed in the catches of large mullets is due to the more intensive fishing of the young ones in 1949 (which contributed to the 50 per cent. higher exports) than in each of the years 1948 and 1950.

Clupeoids

The Clupeoids as a whole form one of the most important groups of fishes in the Lake. Though the fresh fish export figures of mullets and catfishes exceed those of the clupeoids, it is estimated from general observations that the total quantity of the clupeoids caught exceeds that of any other group of fishes, excepting prawns. This is due to the fact that a good portion of catches of small fish, both fresh and dried, is locally consumed in the Lake region and its environs. Estimated exports for the three years 1948-50 are 8,607, 11,469 and 9,920 maunds respectively, and consist mainly of *Hilsa ilisha* (Hamilton), *Nematalosa nasus* (Bloch), *Thrissocles* spp., and *Anchoviella* spp., which predominate in the catches. Great



GRAPH 4. Export of fresh Balanga (*Nematolosa nasus*)

fluctuations in their yield are noticeable from season to season and year to year (Graph 13 C).

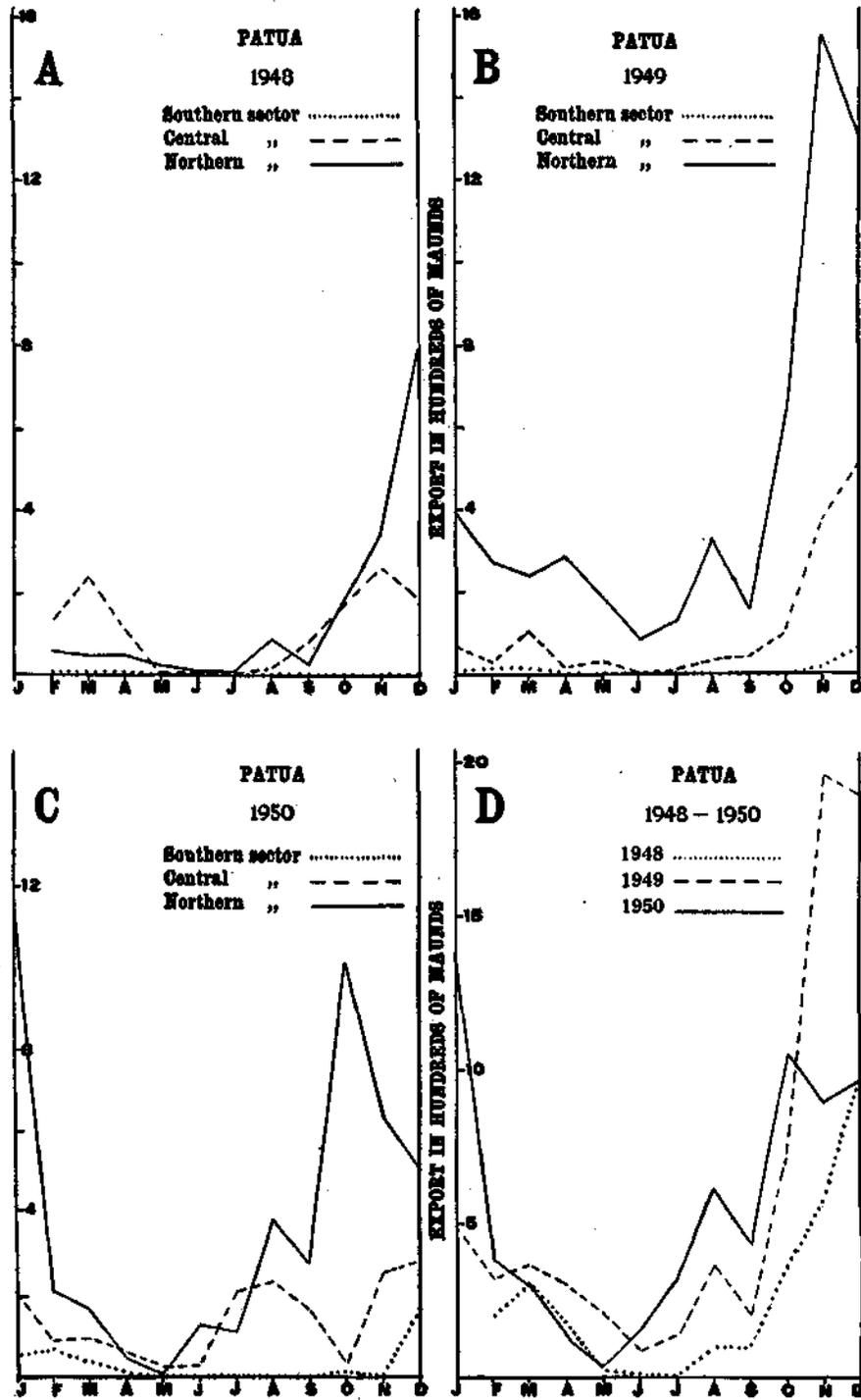
Hilsa.—As the fishery of the Indian Shad has already been described by us (Jones and Sujansingani, 1951) no detailed account is presented here. The statistics of landings dealt with in the paper cited pertain to the years 1948 and 1949. In 1950 1,376 maunds of fresh *Hilsa* were exported showing a progressive decline in the catches. The exact causes for this decline have not been traced, but there is an indication that the movements of the fish are influenced by the volume of water flowing through the Daya and other deltaic branches of the Mahanadi River into the Lake. It would also appear from published accounts dealing with the fish that temperature and currents play an important role in determining its migratory movements.

Hilsa is fished in the Lake throughout the year. The available statistics indicate that there are great fluctuations in the catches from month to month, with two peak periods corresponding to the two main waves of migration, one at the close of the winter and the other at the commencement of the monsoons (Graph 3). The catches are more abundant in the northern sector of the Lake which is less saline owing to the freshes during the monsoons.

“*Balanga*”.—Among the clupeoid fishes, the mud shad, *Nematalosa nasus* (Bloch), ranks next to *Hilsa* in importance. It is caught by gilling as well as drag nets such as *Menjia-jal* and *Sahala-jal* respectively and its exports during the years 1948, 1949 and 1950 were 1,842, 2,858 and 2,993 maunds respectively. The catches are high from April to June and tend to rise again in the period intervening between the flood season and winter, but are lowest both when the Lake is flooded and winter is fully established. A good deal of the small-sized fish in fresh condition is sold along with *Patua* for local consumption, but when there is a surplus it is dried. The southern sector gives the highest yield while the northern sector, in spite of its vast area, produces the least (Graph 4).

Distribution of the fish in the Lake shows its preference for relatively higher salinities and greater depth which prevail in the southern sector.

“*Patua*”.—All the Engraulids are included under this group and so also the small-sized minor clupeoids not classified under any other category. These are generally caught in *Patua-jalo*, *Khepla-jalo* and *Chouri-jalo* and at times in *Khadi-jalo* also. The most important fishes constituting the *Patua* fishery are *Thrissocles* spp., *Anchoviella* spp. and *Kowala coval*, locally known as *Khonda-Patua* and *Kona-Patua*, *Chawli-Patua*, and *Ranji-Patua* respectively. *Ranji-Patua* occurs in the catches practically throughout the year, *Kona-* and *Khonda-Patua* during the winter season and *Chawli-*



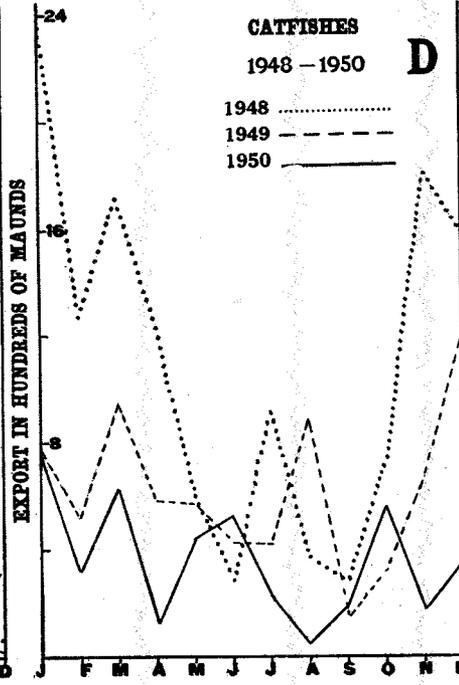
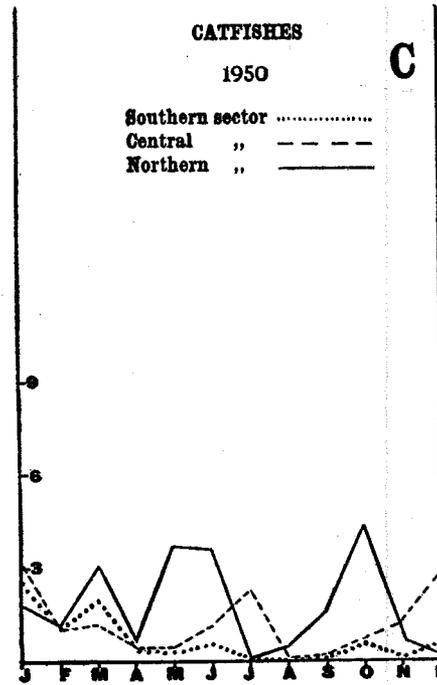
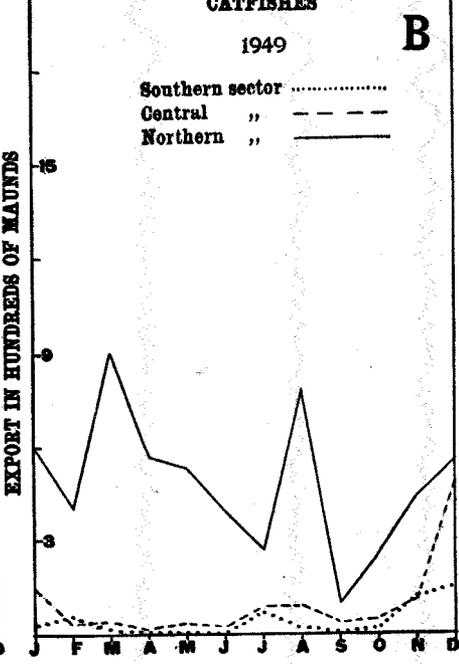
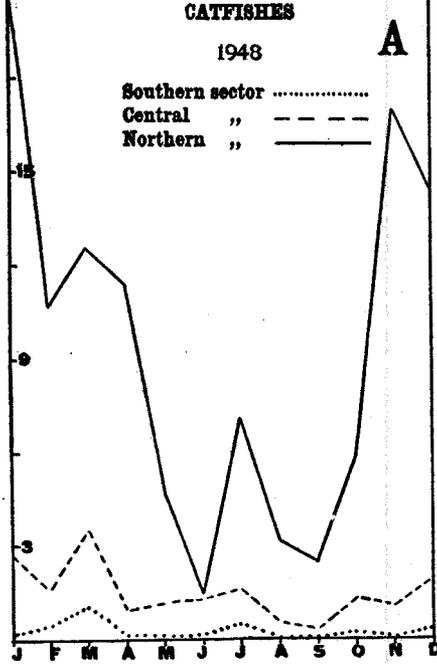
GRAPH 5. Export of fresh Patua (*Engraulids*)

Patua during the rains only, when it forms the major portion of the catches. The northern and central sectors yield the highest catches during October-March while the southern sector yields very little (Graph 5). Statistics indicate that exports during the years 1948, 1949 and 1950 were 2,866, 7,080 and 6,662 maunds respectively. The export figures do not represent the total production of *Patua* in the Lake as a good deal of it is consumed locally on account of its low price. For local sales the fish are deliberately smeared with liberal quantities of sand (Plate VII, Fig. 2) by retailers to increase its weight and thus to compensate to some extent the dehydration that might eventually take place. When catches are usually heavy large quantities of *Patua* are sun-dried to avoid glut in the local as well as in the Calcutta markets. The sun-dried stuff is also found to have a good deal of sand on it.

Catfishes

The Catfishes as a group rank third in the exports of fish which in the years 1948, 1949 and 1950 were 13,228, 7,448 and 4,345 maunds respectively. The cause of the big drop in exports in two successive years is not clear. The more important species of catfish generally caught in large numbers in winter and again in May-July by nets (*Jalo*) like *Khainga-jalo*, *Sahala-jalo* and *Menjia-jalo* are *Osteogeneiosus militaris*, *Tachysurus* spp., and *Mystus* spp., locally known as *Sunga*, *Singda* or *Gondia* and *Kontia* respectively. The highest catches are from the shallow silt-laden relatively fresh-water northern zone and the lowest from the more saline and deeper southern (Graph 6) zone, thus indicating that these catfishes prefer, as a rule, less saline and shallower waters of the Lake.

Catches of *Tachysurus* spp. are generally high during the summer months from May-August and then again in winter, whereas *Osteogeneiosus* and *Mystus* spp. are caught in large numbers towards the later part of the winter and in early summer months. *Plotosus canius* or *Kaunda* is common during the rainy season, i.e., from July-September and appears to breed in the Lake. *Bacha* (*Eutropiichthys vacha*) which is brought into the north zone of the Lake with the flood waters in the Daya and other branches of the Mahanadi, is also recorded in the exports from June-September, with a peak in July, the major part of it being netted in the northern zone. All but an insignificant portion of the small catch of *Jalanga* (*Pangasius pangasius*) is taken in the central zone and figures in the exports from February-July, with a peak period from April-May.



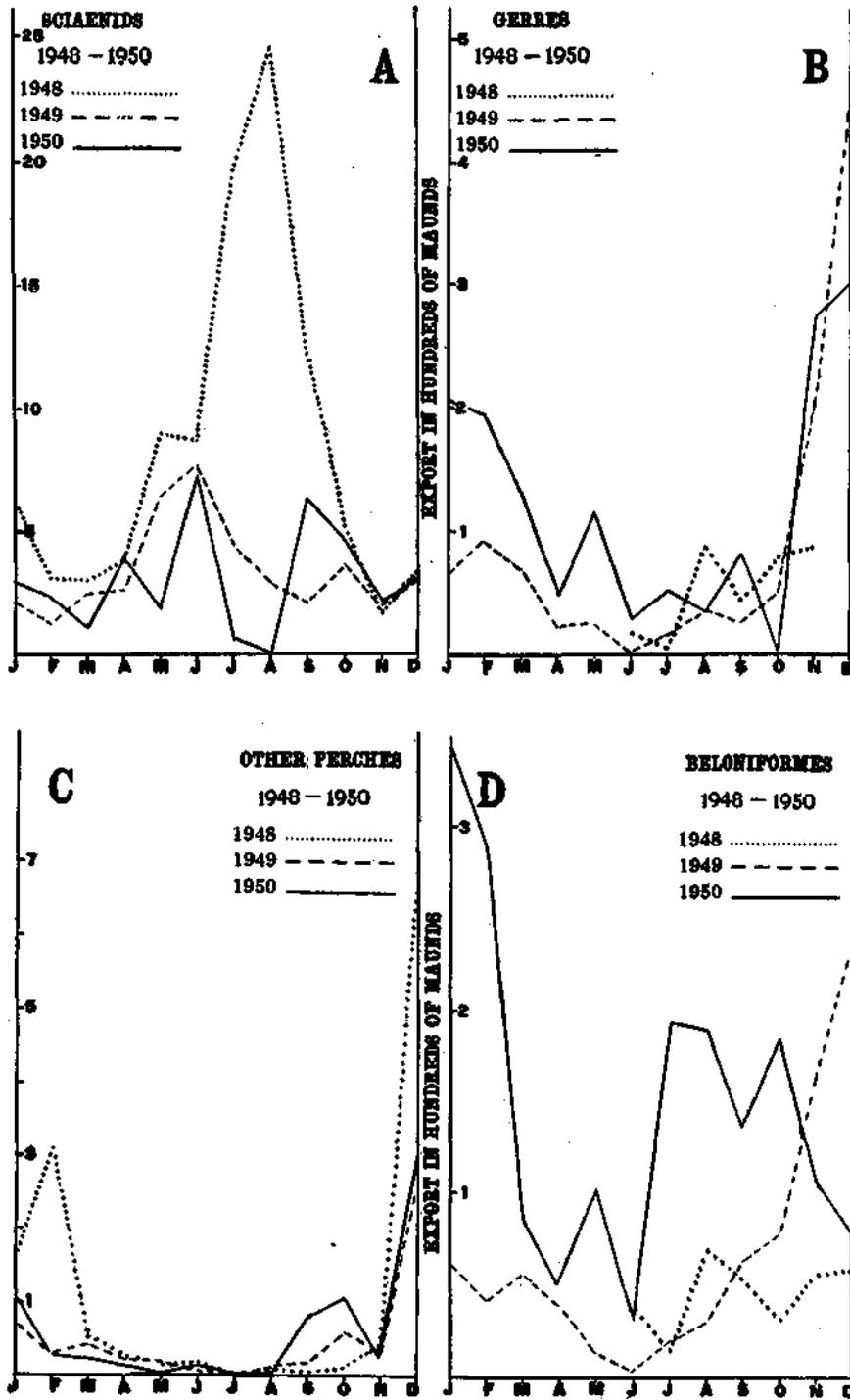
Sciænids

Sciænids rank fourth in the order of fish exports, which during 1948, 1949 and 1950 were 10,189, 4,082 and 3,699 maunds respectively. In this case also the cause for the marked and sudden decline in 1949 and 1950 is not known. The peak season for the fishery which is confined to the northern zone extends from March-April to August-September (Graph 7 A), and the catches consist of *Pseudosciæna coitor* and *Sciæna russelli*. The larger *Pseudosciæna coitor* locally known as *Boroga* are caught by *Khainga-jalo* and *Bekti-jalo*. Their young, locally known as *Pendi* and *Golara*, caught by *Sahala-jalo* are taken in the northern zone from June-September.

Perches

All the perciform fishes except the Sciænids which have been dealt with above are listed here and rank fifth in the exports during 1948-50. Of these the most valued amongst food fishes and dominant in the catches is *Bekti* [*Lates calcarifer* (Bloch)]. Next in importance to *Bekti* are the species of *Gerres* which occur in very large numbers and have therefore been classified and analysed separately. The rest of the fishes, constituting minor fisheries, are grouped under "Other perches". The chance inclusion of some perches in export returns of miscellaneous might be possible. With the exception of *Gerres* spp. which shows a tendency to increase, a general decline in perciform fishes, including Sciænids is noticeable (Graph 13 D).

Bekti.—It is generally caught by a special net called the *Bekti-jalo*. Among the fishes of the Lake, *Bekti* fetches a very high price (almost as high as that obtained by *Bagda* which generally fetches the highest price) and almost the entire catch is exported fresh to Calcutta. The exports during the years 1948, 1949 and 1950 were 6,595, 5,130 and 3,706 maunds respectively. Occasionally, in the summer months when ice supplies fail and fish cannot be exported as it often happens in the channel area, they are salted and cured. The summer and winter catches which are high contain a majority of large fish whereas the monsoon catches which are very low consist of a majority of small fish. The bulk of the catches comes from the northern and the central zones of the Lake, but calculated on the basis of area, the southern zone also gives a fairly good yield (Graph 8). The largest specimen seen by us weighed about 45 lb., although still larger specimens are reported to be occasionally caught. But as the flesh of the large-sized fish is coarse, there is more demand for medium-sized ones.



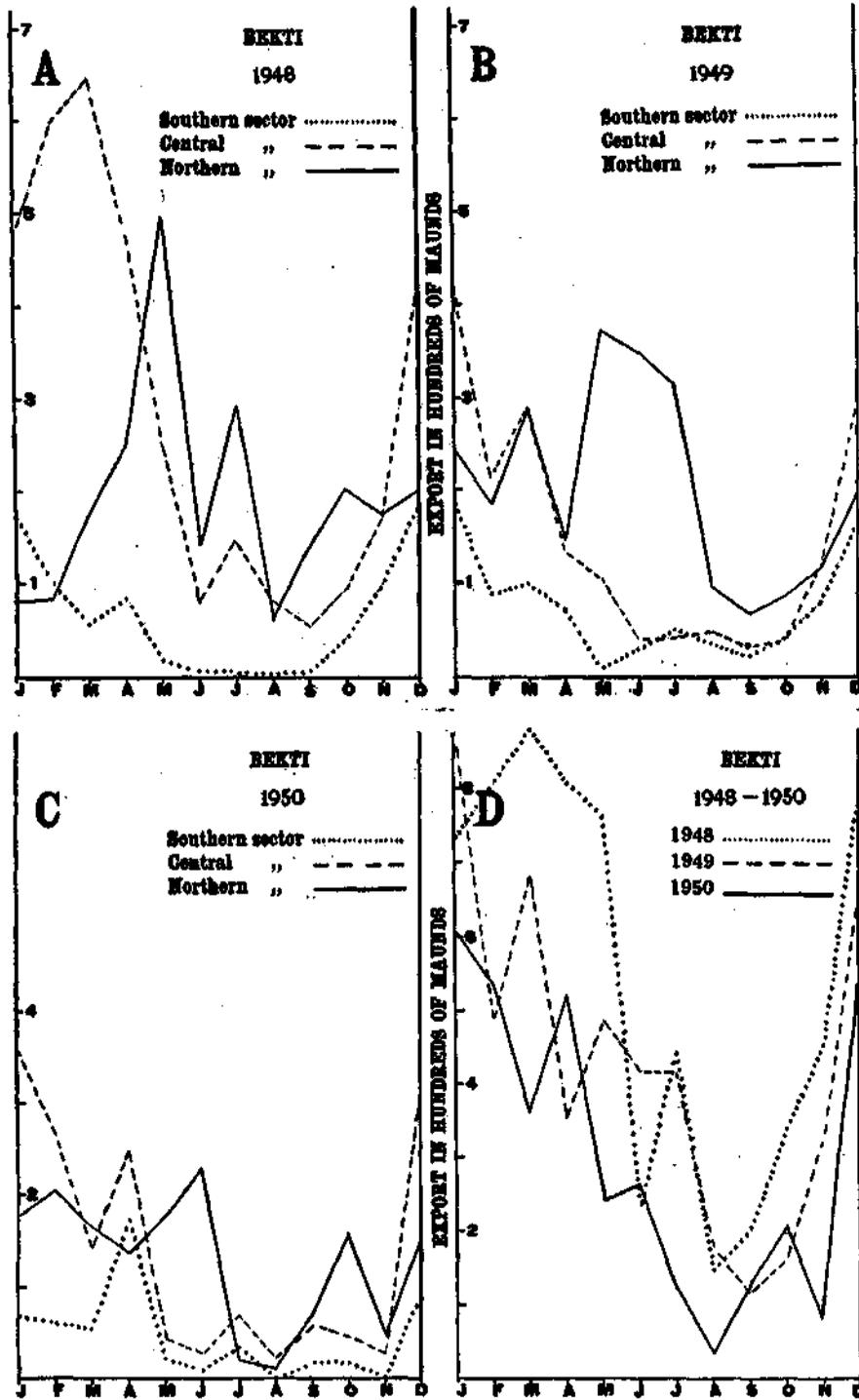
GRAPH 7. a. Export of fresh Sciænids, b. *Gerres* spp., c. Other Perches, and d. Beloniformes.

Gerres spp.—The exports from 1948-50 were 325, 1,067 and 1,490 maunds respectively. The low figure for 1948 was partly due to the fact that no separate data were available for this fish for nearly half the year. The highly saline southern zone yields the maximum catches and the least saline northern zone the lowest. The catches are highest during the winter months (Graph 7 B).

“Other perches”.—All Perciform fishes except those dealt with above are recorded under this group. Prominent amongst those, constituting the main catches, are the pearl-spot, *Etroplus suratensis*, *Coilus quadrifasciatus*, *Ambassis* spp., *Therapon* spp., *Leiognathus equulus* and *Caranx* spp., locally known as *Kundal*, *Khuranti*, *Chandee*, *Ghaun Chandee* and *Konti* respectively. Owing to their small size they are generally caught in *Patua-jalo*, *Sahala-jalo* and *Khepla-jalo*. There has been a decline in the catches as is indicated by exports which during the years 1948, 1949 and 1950 were 1,379, 589 and 707 maunds respectively. The decline in export figures is inexplicable. The catches, are high in the central zone during the winter months and low during the rest of the year (Graph 7 C). When the catches are too small to be weighed and recorded separately, they are mixed with miscellaneous fishes and recorded as such. The low price of these minor perches offers a good inducement for some quantity to be consumed locally.

Threadfins

The threadfins rank sixth in respect of exports, the common species being the so-called Indian Salmon, *Eleutheronema tetradactylum*. The other species of threadfin in the Lake, *Polydactylus indicus*, is extremely rare. Export figures indicate a progressive increase in the catches during the years 1948, 1949 and 1950 [3,111, 3,587 and 6,574 maunds respectively]. Best catches are obtained in the winter months but in 1950 high catches were obtained in the monsoon months also, i.e., from July — September. The great bulk of them are caught in the northern and the central zones, the lowest output being in the southern zone (Graph 8). In the daily export returns the threadfins are classified under three size groups, viz., *Sahal*, *Sahalia* and *Baisali* which denote large, medium (upto 9 inches) and small-sized fish (upto 6 inches) respectively. The large-sized fish which are available in abundance in winter only are caught by *Khainga-jal*. The medium and small-sized fish which are commonly caught in *Sahala-jal* in winter period decline in numbers in the summer months only to reappear in large numbers in July and August after which they are rare.



GRAPH 8. Export of fresh Bekti (*Lates calcarifer*)

Beloniformes

The garfishes and half-beaks are recorded together in the daily export returns, the important species being *Tylosurus strongylurus* and *Hemirhamphus gaimardi* locally known as *Gania* and *Sarbara* or *Ek-Danti-Gania* (i.e., *Gania* with one tooth or jaw) respectively. An increase in catches is indicated by the exports which in the years 1948, 1949 and 1950 were 325, 815 and 1,801 maunds respectively. Separate exports records were maintained from June 1948 and till then these fishes were being included among "miscellaneous" and as such figures for 1948 indicate exports during seven months from June-December. The catches are heaviest in the monsoons and all the three zones yield almost equal quantities (Graph 7 D).

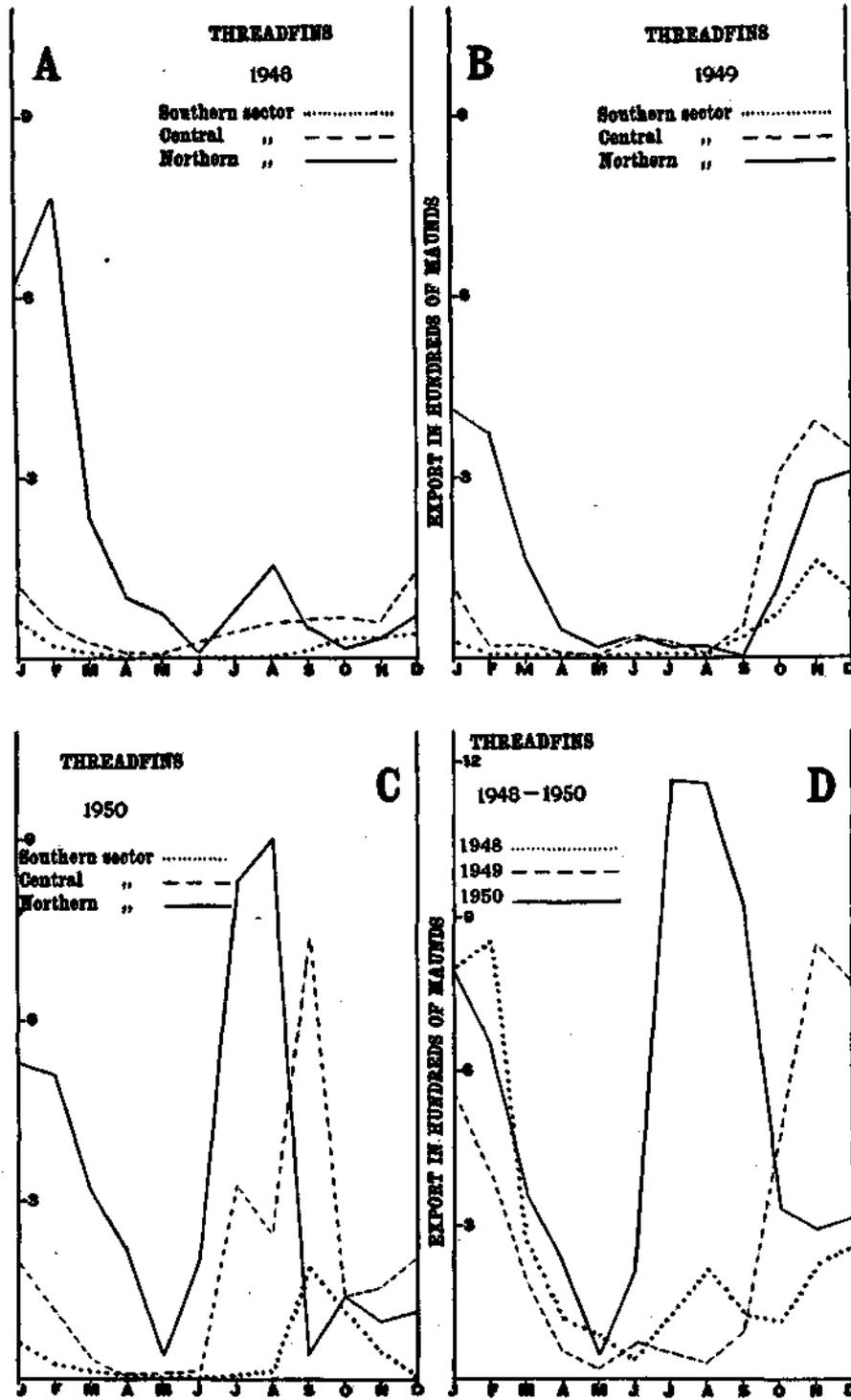
The garfishes appear to constitute the major item under this group and are more abundant after the commencement of the South-West monsoon. The half-beaks though found all over the lake constitute only a small portion of the catches.

A special kind of net known as *Mani-jal* (Plate VII, Fig. 3) described in detail elsewhere (Jones and Sujansingani, 1952) is employed to catch these fish in certain areas.

Miscellaneous fishes

A large quantity of fresh fish, about 10 to 15 per cent. of the total exports, is classified as miscellaneous. This group covers all the unclassified species⁷ and is generally made up of very small-sized fish, fish received in very small quantities irrespective of its size, and such fish as are not regularly caught from the Lake. Detailed observations have shown that in addition to the small quantities of some economic species which are occasionally included in this group, the bulk of the miscellaneous lot is invariably made up of a large number of unimportant species numbering about 75 and that this group is very flexible as the number of species constituting it varies considerably from time to time depending upon the availability of the fish and the time available for sorting. Though from a scientific point of view it would be desirable to classify and record these fishes under appropriate heads, considering the time involved in sorting this mixture and the low price fetched by it, it would not be worthwhile specially as the catches would have to be kept for a day for the sorting. Some of the comparatively important fishes included in this group are described separately.

⁷ i.e., except those coming under mullets, clupeoids, perches, catfishes, scianids, threadfins and Beloniformes.



GRAPH 9. Export of fresh Threadfins (Polynemids).

Exports of miscellaneous fish during 1948, 1949 and 1950 are estimated to be 14,511, 12,461 and 12,660 maunds respectively, and, as may be expected, these were the highest from the northern zone and the lowest from the southern (Graph 10).

Sharks.—*Carcharhinus gangeticus* and *O. melanopterus*, locally known as *Mundah-mugur* and *Ichha-mugur* respectively, occur in the channel area near the mouth of the Lake, the first one being most common. They are reported to vary in size from 2 feet to 10 feet but individuals measuring more than 7 feet have rarely been seen. The 5-6 feet size which is very common in catches weighs about 2 maunds.

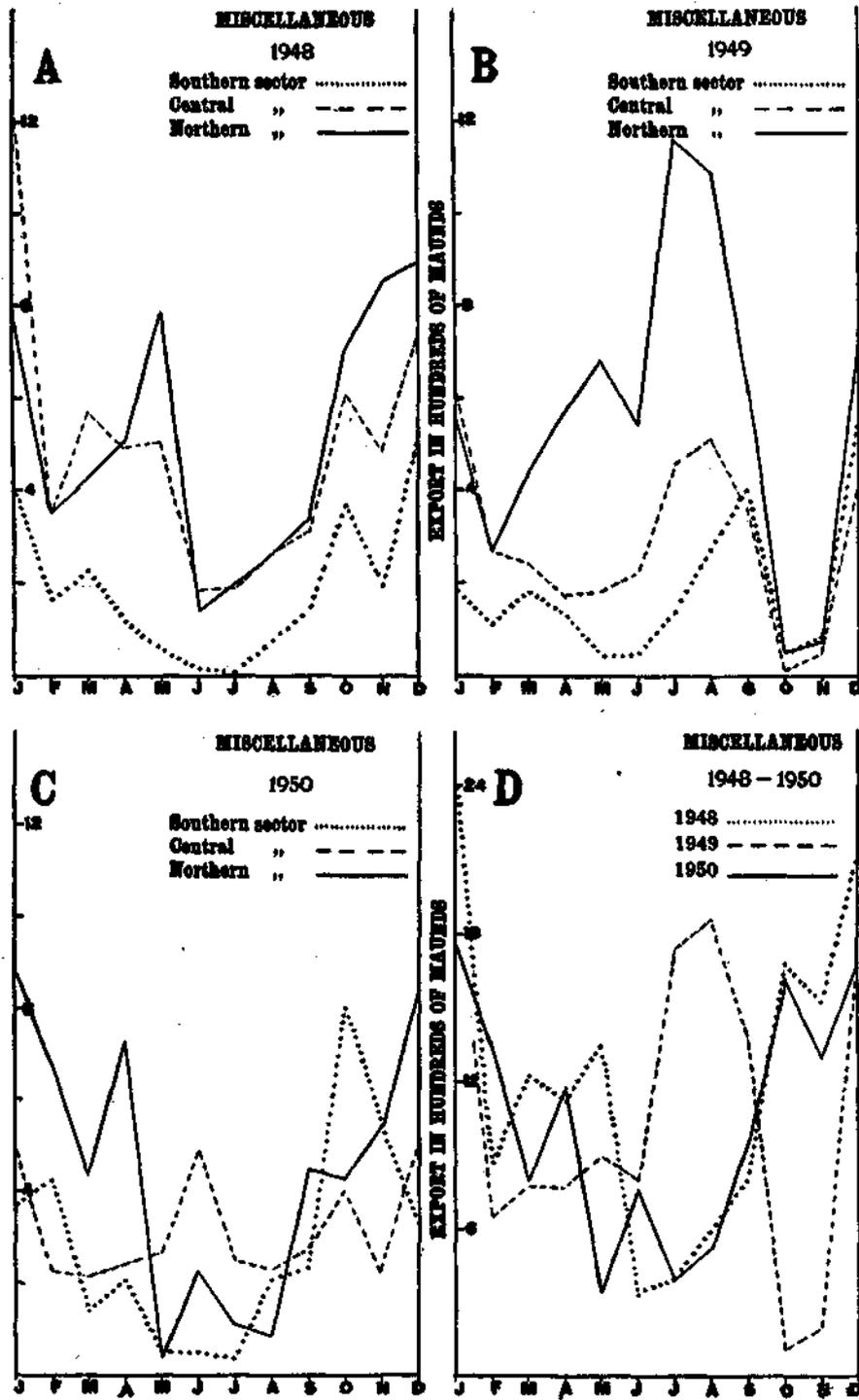
No special fishing is done for catching sharks but any accidentally caught in the nets, which are often damaged, are brought to the assembling centres for export. Though they are caught practically throughout the year, their main season extends from October-January.

In the Chilka area shark flesh is not fancied except by the lower class of people, and there is therefore no local demand for sharks. Before the shark liver oil industry was started in the State, the fish were exported to Tatanagar where, on account of its low price, there was a demand by the working class. With the establishment of the liver oil industry, the price of the sharks has more than doubled. The surplus when exported to Tatanagar fetches about Rs. 15 per maund.

In the export records there is no mention about this fish as it is included in the miscellaneous lot but random observations indicate that the annual catches are approximately 250 maunds.

Rays.—The rays classified as *Sankush* [*Dasyatis (Himantura) uarnak*] and *Chilli* (*Aetobatis narinari*) by the Oriyas and *Shankar* by Bengali merchants appear in export records from December 1949, there being no mention about them at all from January 1948-November 1949 probably because they were being exported in small quantities and recorded under miscellaneous category. As far as random observations indicate the exports continued to be low even after December 1949 though they were classified and recorded separately in export returns. Enquiries reveal that though rays are available in all parts of the Lake they used to be thrown back to the Lake when caught, owing to the lack of local demand and of little profit when exported.

Large-scale export of rays started by about November 1950 by force of circumstances when catches from the Lake during November and December 1950 fell considerably below those of the corresponding periods



GRAPH 10. Export of fresh Miscellaneous fishes.

of the years 1948 and 1949. The fishermen had thus no other alternative but to augment the supplies by this inferior variety, and since then the export of rays continued, regularly.

The main fishing season extends from January-April, these fishes being reported to be rare or practically absent in the Lake during the rainy season. Practically all the fish caught are exported to Calcutta where they are sold at Re. 0-3-0 to 0-8-0 per seer depending upon their condition. Most of it is consumed by labourers working in the mill areas. No regular export records of rays are maintained as it is generally included in the miscellaneous lot but random observations show that about 1,500 maunds are exported in the main season.

Leather jackets.—*Triacanthus brevirostris* Temminck and Schelegel, locally known as *Sukura*, occurs all over the Lake practically throughout the year. It is caught in large quantities in the central and southern sectors especially in their western half but its output from the northern zone is not much. Its main fishing season extends from July to October with highest catches during the early part of the monsoons.

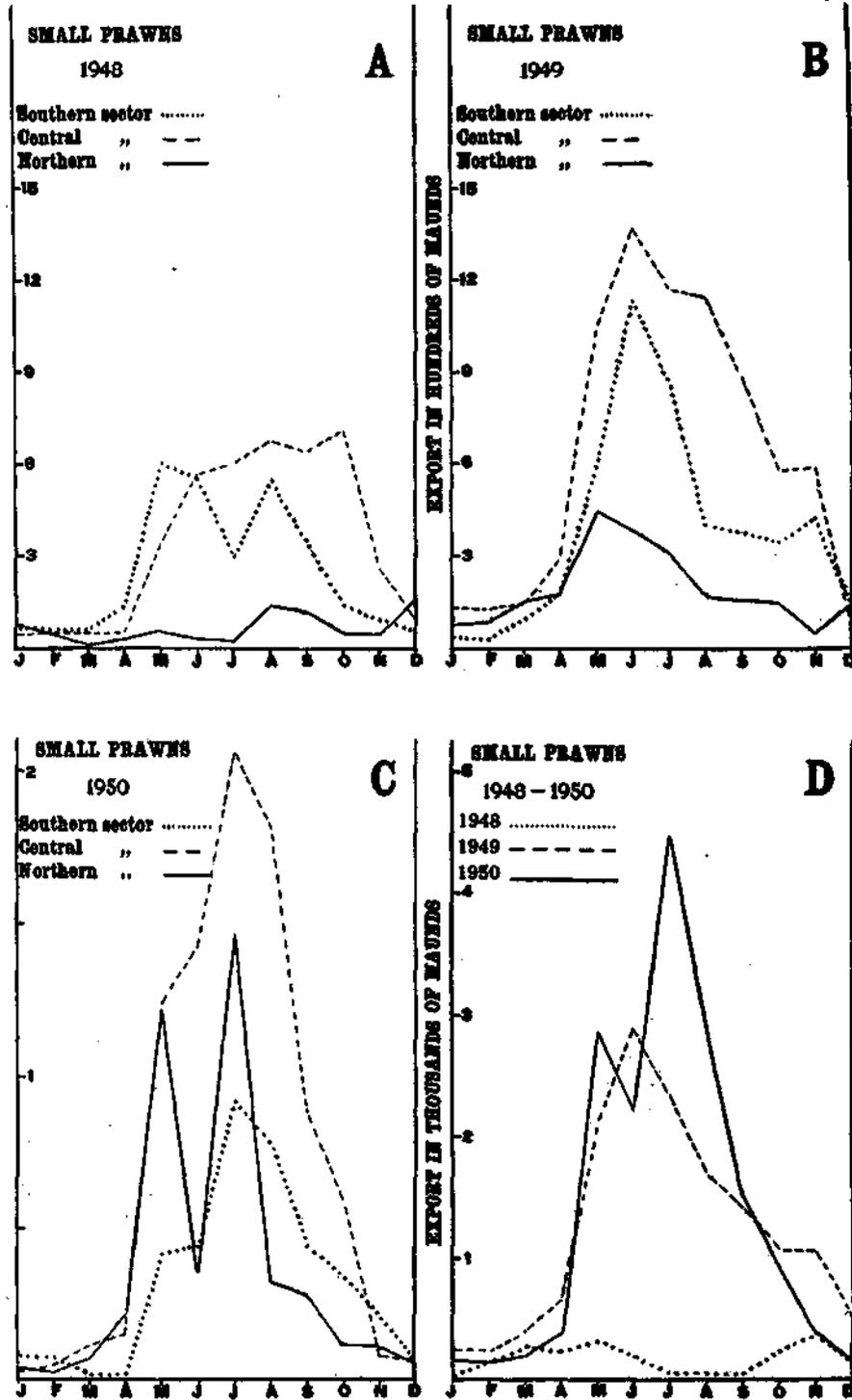
Being one of the most inferior varieties, there is little demand for it from outside markets, and even locally it is eaten only by the poorest class of people who can afford only a very low priced fish. During the main fishing season when it is in surplus, it is generally exported to Tatanagar where it fetches a nominal price. Export records are not regularly maintained as the fish is generally included in the miscellaneous lot but from random observations it is found that fairly large quantities are exported in the main season.

Prawns

The prawns constitute one of the most important groups amongst the fishes (*sensu lato*) of the Lake both on account of their bulk and value. Among the most important from the economic point of view are the Penæid prawns consisting of *Penæus indicus* Milne-Edwards, *P. carinatus* Dana, *Metapenæus monoceros* (Fabricius), *M. affinis* (Milne-Edwards) and *M. dobsoni* (Miers). The Palæmonids, which also occur in the Lake, are relatively less important and consist mainly of *Palæmon rudis* Hellen and *P. malcolmsoni* Milne-Edwards. In addition to the above, a variety of small prawns and shrimps are also caught.⁶

The stocks of Panæids which constitute the major portion of the catches are regularly replenished from the sea. The young ones come into the Lake

⁶ For a complete list of prawns and shrimps refer Kemp, S. (1915), "Fauna of the Chilka Lake," *Mem. Indian Mus.*, 5 (3).



GRAPH 11. Export of fresh Small Prawns.

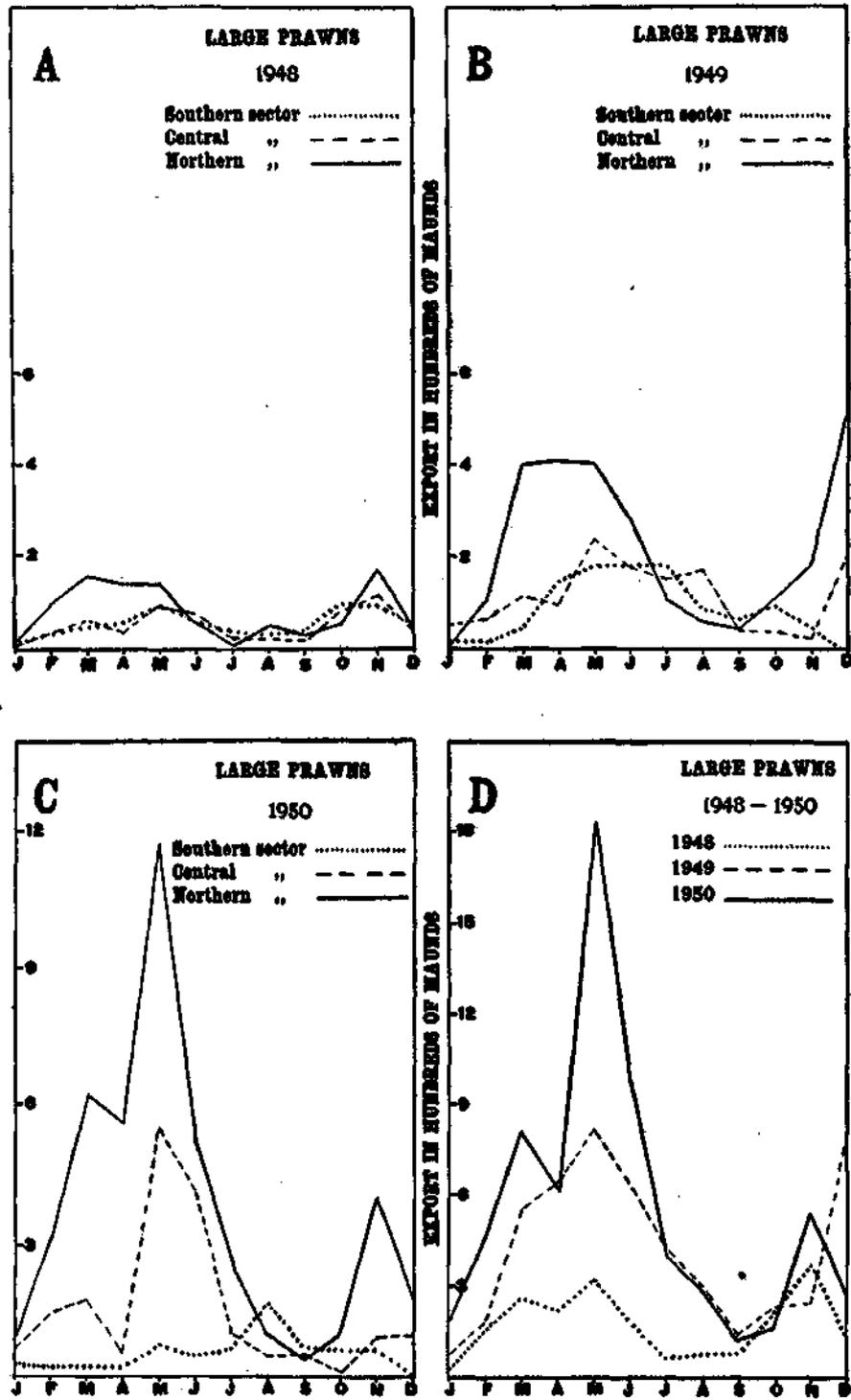
for food and growth and subsequently return to the sea for maturity and breeding (Kemp, 1915). The *Palæmon* spp., on the other hand, are seasonal migrants from the adjoining fresh-water areas and come into the Lake during the rains when salinity goes down. A study of the distribution of the prawns, as reflected in the catches, indicates that the young prawns have a preference for the comparatively deeper and more saline central and southern zones whereas the larger prawns are more uniformly distributed all over the Lake, except in the inundated parts of the northern zone where prawns as well as fish are rather scarce.

The well-organised prawn fishing is systematically done by the Kondras of Rambha, Kallikota and Balugaon villages, the Tiors of Banpur and the Ghodeies of Gangadharpur and Kaluparaghat.

Fishing is done by means of traps only. The Kondras use traps known as *Daūdi* (Plate VII, Fig. 1) whereas Ghodeies use *Cheengri-Baaza*. An essential accessory to these traps is *Thatta* (Plate VIII, Fig. 1), a bamboo screen, which serves as a pathway and guides the prawns in the direction of traps. No nets are ever used for catching prawns and small quantities occasionally caught in these are mere accidental catches. In addition to these, small quantities are sometimes obtained from *Jano* fishing areas in the months of November and December. Prawns occur in the Lake throughout the year but the main fishing season in the southern and central zones extends from April-August and in the northern zone from December-April.

In export returns, the small prawns are classified as *Kantal* and *Cheengri* and the large ones as *Kalipoi*, *Kallakhera* and *Bagda*. As separate export records of different species of the large and small prawns are not regularly maintained, only the total exports under the size-categories small and large are discussed here. Total exports of prawns in fresh condition during the years 1948, 1949 and 1950 are estimated to be 9,971, 19,514 and 23,267 maunds respectively. Though the export figures for 1950 exceed those for 1949, actual observations indicate that catches during 1949 were equal if not higher and this view is also confirmed by those engaged in the fish trade. Unusually high catches of small prawns during 1949 caused severe glut in the local as well as consuming markets and brought down their price with the result that all the catches were not being tendered for sale at assembling centres, and large quantities were dried all over the Lake. It is also presumed that the quantity used for local consumption would have been relatively more in 1949, on account of the unusually low price prevailing then.

The export trend, regionally as well as seasonally, is the same for all the three years (Graph 13 A). There has, however, been a great increase in the catches in the years 1949 and 1950 as compared to those in 1948. Low rainfall in these years has probably resulted in less flooding (Graph 14 D) and flushing and consequent maintenance of salinity at a higher level than in 1948. However, long range observations are necessary to confirm this inference.



GRAPH 12. Export of fresh Large Prawns.

Small prawns.—Exports in the fresh condition during the years 1948, 1949 and 1950 are estimated to be 7,845, 14,457 and 16,512 maunds respectively. The southern and the central zones form the main fishing grounds for these prawns, the output from the much vaster northern zone being insignificant. Catches mainly consist of *Kantal* or medium size prawns. Although the main fishing season extends from May-August, good catches may be obtained in some years during September and October also (Graph 11). Being relatively cheap, a good deal of *Cheengri* is locally consumed and during the peak period some quantity is dried to prevent glut and to provide a cheap substitute in the off-season specially for consuming centres in the interior where it is in great demand.

Large prawns.—They are found in all the three zones (Graph 12) though their occurrence in the northern zone in much larger numbers than the small prawns is inexplicable except as due to a normal seaward migration from the southern and central sectors through the northern zone which is connected to the sea by the channel. The commercial catches are much higher from March-June (Graph 12 D) when salinity is the highest and the water level the lowest than during the rains from July-October when with the flooding of the Lake with freshets from rivers the salinity goes down considerably. There is a subsidiary peak of occurrence by about November-December when the floods subside, but thereafter, *i.e.*, in January and February, there is a decline in the catches all over the Lake.

As large prawns fetch a better price in outside markets than locally almost all the catches of *Bagda* are exported in the fresh condition thus giving a fairly correct estimate of prawn production in the Lake. The export estimates for the years 1948, 1949 and 1950 are 2,126, 5,058 and 6,755 maunds respectively showing a progressive increase.

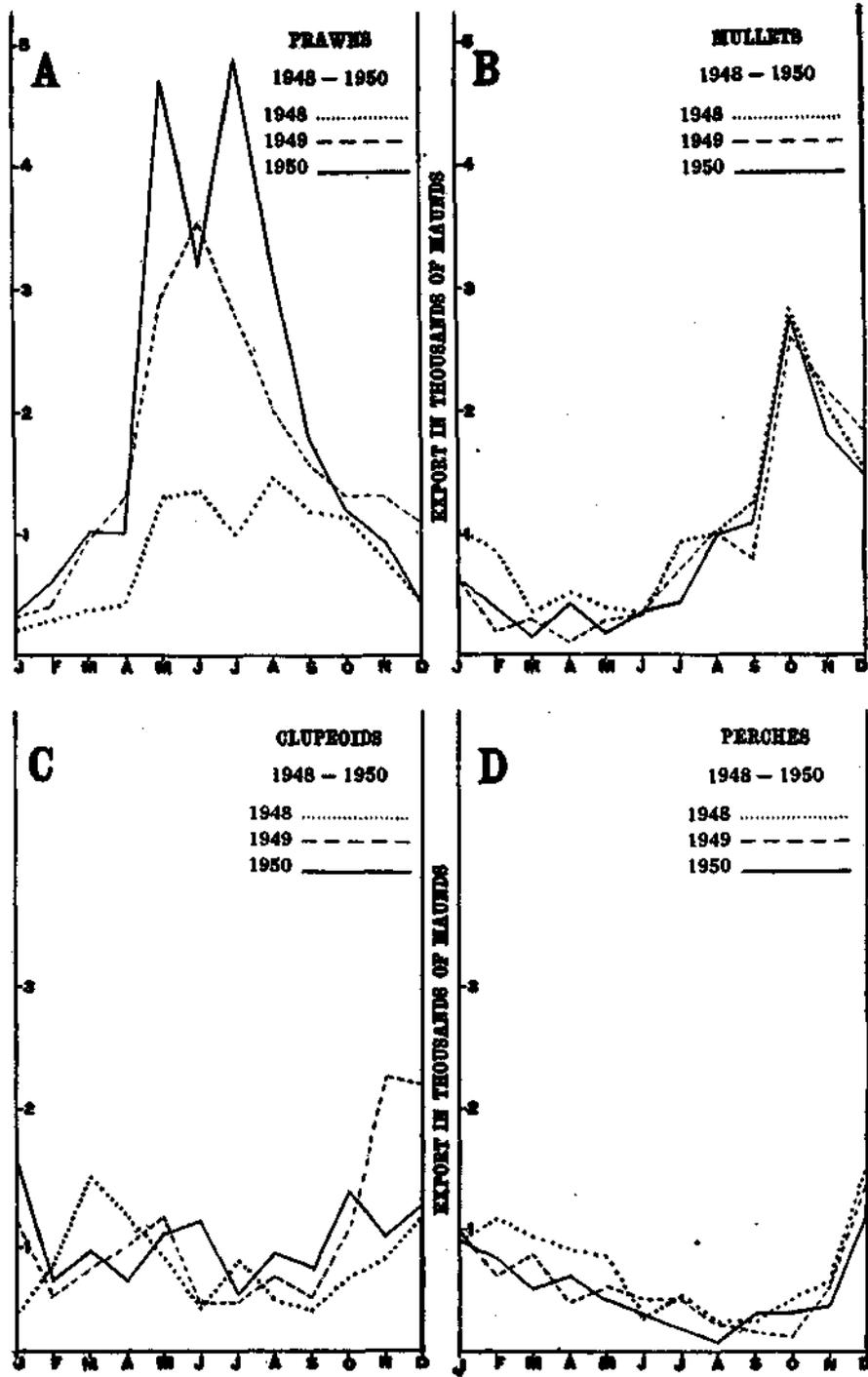
Unclassified items

Crabs.—Crabs constitute a minor fishery in the Lake estimated to produce about 500 maunds per annum of which less than half is exported, the rest being consumed locally or sold at railway stations on the Chilka Lake.

Export figures for crabs though not recorded by exporters are available in the railway way-bills wherein crabs are recorded separately from the other fish.

The best known species occurring in the Lake is *Scylla serrata* (Forskål) the fishery of which has already been dealt with (Jones and Sujansingani, 1952 a) along with that of *Neptunus pelagicus* (Linnaeus). *Scylla serrata*, mostly caught by means of *Nolt-jalo*, has its peak fishing season spread over the four months from August-November. Its main fishing grounds are Malud, Parikud, Kallikota and Rambha.

Oysters and other molluscs.—A small oyster bed consisting of *Ostrea virginiana* occurs at Manikpatna in the channel area where *Meretrix* spp. are also found in abundance. Large quantities of shells, especially of the latter, are collected and taken to Kaluparaghat for the manufacture of lime.



GRAPH 13. A. Total export of fresh Prawns. B. Total export of fresh Mulletts. C. Total export of fresh Clupeoids. D. Total export of fresh Perches.

Weeds.—Agar-producing weeds (*Gracillaria* sp.) occur in the central and southern zones of the Lake in some quantities. Preliminary experiments conducted by the Orissa Fisheries Department in the extraction of agar agar from these weeds appear to have given encouraging results. There has, however, been no commercial exploitation of the weeds.

IV. FISHING COMMUNITIES AND FISH TRADE

(i) Fishing Communities

The fishing communities comprise the Oriyas and the Telugus. By caste the Oriya fishermen are Keots, Koibartas, Behra-koibartas, Tiors, Ghodeies and Kondras or Maliks. According to the age-old customs and traditional practices the Koibartas, who are considered to belong to the higher strata of the fishing community, catch fish by operating nets only, never resorting to the use of the "less dignified" traps which are meant solely for the lower classes of the community, namely the Tiors, Ghodeies and Kondras. The lower class fishermen have, therefore, a virtual monopoly in the catch of prawns and crabs. Fishing in the extensive *Janos* (enclosed fisheries) though remunerative, is considered to be an inferior job and has fallen to the lot of Kondras.

The fishermen take pride in fishing in the grounds in which their forefathers fished for generations. Groups of fishermen fish in the Lake for 4 or 5 days at a stretch carrying their nets, traps and cooking kit in their fishing boats. During their stay out, catches of fish are arranged to be sent every day to the assembling and exporting centres through the agency of the merchants or middlemen. During the rest of the week when no fishing is done they mend their nets and traps, apply preservative to the nets, if necessary, settle accounts with the middlemen who find a market for their catches. On the night of the seventh day they again fish in the Lake completing the cycle of work and rest.

Those who do not fish on these boats but act as commission agents or middlemen and supply fish to merchants are known as "*Khotias*", the actual catchers being called "*Bahanias*".

Fishermen residing all along the western border of the Lake, between Bhusandhpur and the district of Ganjam, have to pay a nominal tax to the State Government amounting to one rupee per year irrespective of the nature of the gear used. As the tax is collected per "*Chulhi*" or hearth it is known as *Chulhi* tax. Thus in the case of a joint family having one hearth, only Rupee one is to be paid per year.

The Oriya fishermen as observed by O'Mally (1908) are found in all the fishing centres of the Lake, but a small minority of the Telugus (Plate VI, Fig. 1) belonging to the Nulia and Balji castes is confined to Arkhakuda, Manikpatna, Khirsahi (near Satpara) and Sahandi (near Parikud). Within the last 300 years the Telugus

have adapted themselves so well to the local conditions and customs that at present the social life of the two communities is hardly distinguishable.

The illiterate fishermen or '*Machha Jeevhe*' as they are locally called (according to Maltby, 1918) are a quiet sort of people with very little ambition or drive and appear to be content with their lot. This lack of ambition appears to be due not only to their illiteracy and ignorance, but also to the rich soil which provides them with an alternative source of food. Their poverty restricts their choice of fish as food to *Patua* (Engraulids), small catfishes, shrimps, leather jackets and such other cheap varieties the export of which does not fetch a price much above the local rates. Their luxury articles, such as beedi, tobacco, 'Pan', betel-nut and occasionally a little of opium are not beyond their means. Their scanty clothing is probably a result of the trying climate but primarily due to their poverty. Their standard of living has not risen although the production level of the Lake has more than doubled itself due to the steady rise in prices of fish during and after the war. This is to be attributed to the continued exploitation of the fishermen by the middlemen who ensure that they are always indebted to them. As long as the present zamindari system of the Lake, which compels the sale of fish through the middlemen lasts, the present economic condition of the community is bound to continue. Attempts made by the State Government to free the indebted fishermen through the agency of the co-operative societies have not fully succeeded. According to Mitra (1946) "the situation has degenerated into a truck system that has imprisoned the fishermen in a complicated network of indebtedness, obligations and economic exploitation". However, as a result of the controls exercised the fisherman now earns 25 per cent. to 30 per cent. more than in the pre-war years.

As between economic exploitation and the social disabilities, which the lower strata of the community have to undergo, the latter constitute a more compelling factor obliging them to remain idle for about 4 months in a year during which they somehow eke out a livelihood. Thus the Tiors of Banpur earn their livelihood by catching prawns and crabs from May-July. Similarly the Kondras of Balugaon and Rambha exploit *Janos* from November-February and catch prawns from May-July. Ghodeies of Gangadharpur and Jaganathpur (Kaluparaghat) depend solely on prawns practically throughout the year though the main season lasts only 3-4 months. Keots and Koibartas have a social status which permits them to operate nets throughout the year.

The elders of the fishing community seem to think that regular attendance at school of their children would deprive them of the assistance they could render their parents in the fishing operations. Further they apprehend that the type of education their children receive may wean them away altogether from the traditional fishing profession. The social contacts of the members of the fishing community are confined to the season of religious festivals, marriage ceremonies, etc., when fishing is suspended, and typical rural programmes of amusement and community feeding are arranged for all.

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The fishermen worship the goddess Kali, also known as *Gangadevi* (*Ganga* = water, *Devi* = goddess) at their annual festival in the island temple of Kalijai near Balugaon built by the Rajas of Banpur about 300 years ago on *Makar Sankranti* day in the month of *Magh*, i.e., by about January. Before starting fishing operations the fishermen perform some religious ceremony as otherwise they believe no fish will ever enter their nets and on the bow of their fishing boats they paint some mysterious figures for invoking the favour of the goddess Kali whom they worship. The fishermen also worship *Trinathmela* (Holy Trinity) and suspend fishing on *ekadasti* (eleventh day following full moon and new moon). *Dol-Purnima* or *Holi* also, one of the more important festivals, is celebrated with much hilarity and throwing of coloured water and powder.

The Oriya fishermen remain content with the exploitation of Chilka waters only while their more adventurous Telugu brethren go out to the sea as well for fishing whenever weather permits it.

(ii) Fish Trade

Merchants and Co-operative Societies

The fresh fish trade of the Lake has developed in the course of the last 25 to 30 years, as a result mainly of the enterprise of merchants from Bengal, who have ensured a regular flow of supplies to consuming centres by leasing fisheries from their respective owners and sub-leasing them to fishermen at higher rates on condition that the entire catches are handed over to them. Large quantities of fish are also obtained through "Khotia" fishermen who act as middlemen and procure fish on a commission basis, and by granting interest-free loans to fishermen against catches in unrestricted areas. Although marketing of fish is no longer the monopoly of the Bengali merchants, owing to the increase in the number of co-operative societies, the traditional modes of exploitation of the fishermen continue in a lesser degree.

The Balugaon Fishermen's Co-operative Society was the first of its kind to come into existence in the Chilka area in the year 1923. Strictly speaking, it was not a fishermen's society as its membership was not restricted to fishermen or to those engaged in fish trade nor was its managing committee composed of representatives of fishermen. It was at first a general purposes society buying and selling merchandise on a co-operative basis but later engaged itself in monopoly fish trade supplying large quantities of fish with great profit to the Defence Forces in the Second World War under the Military Requisitioning Scheme in force during 1944 to 1946. The twenty-four Government-owned fishing areas of the Lake were exploited solely by the Society for a number of years, but since September 1951 the number

was reduced to 6, the remaining 18 having been allotted to societies of actual fishermen. At present the Society is dealing not only in fish but also in cloth and yarn.

High prices and heavy demands for fish during the World War II gave a fillip to the fish trade, which profited non-fishing middlemen and fish merchants and not fishermen who toiled. In 1944 the Orissa Fisheries Department brought about a change for the better by administrative measures designed to have the fish marketed through co-operative societies formed by the fishermen themselves and the exports regulated. Heavy profits earned by some fishermen due to direct dealings with exporters since their colonisation at Gajpatinagar after the cyclone of 1942 gave an incentive to other fishermen with the result that between 1945 and 1950 more societies were registered bringing up the total to 21. There has been of late a healthy move on the part of the Chilka and Harichandi Fishermen's Co-operative Societies to pool their resources.

The societies were started with the following primary objectives which permitted them, however, to carry on trade in any commodity other than fish:

- (1) Leasing or purchase of water-courses, e.g., rivers, tanks, etc., for fishing;
- (2) Direct or subsidised purchase of fishing implements;
- (3) Sale of fish to the members and the general public;
- (4) Regulation of supplies of fish to consuming centres in and outside the State to maintain price levels and prevent waste;
- (5) Fair remuneration for the fishermen's toil and the checking of exploitation by the middleman;
- (6) Dissemination of knowledge of the latest methods of better pisciculture; and
- (7) Grant of loans to members for construction of residential buildings, education of children, purchase of seeds, etc.

Each society has an 'operational area' in which its activities are confined but with the increase in the number of societies there has been unavoidable overlapping of the operational areas occasionally resulting in mutual recrimination.

The minimum share capital varies widely, but the face value of a share is fixed at the uniform rate of one rupee per share. Any one over 18 years of age who carries on fishing as his profession or is otherwise connected with the fishing

industry can become a member by the purchase of a minimum of one share with an entrance fee of annas two per share. The number of shares which could be purchased by an individual member is limited, the number varying with each society. Membership ceases *ipso facto* in the event of death or if a member is disqualified by the Panchayat unless he appoints a successor. No member can sell or transfer his shares without the permission of the Panchayat or of the general body of the society concerned. For the day to day work of every society the concerned Panchayat elects a Managing Committee which ordinarily consists of a president, a secretary, and five to seven ordinary members, and functions for a year. The Balugaon Fishermen's Co-operative Society has in addition a Vice-President. As the managing committees have no officials they are truly representative of their members, and are free from official influence or pressure over their deliberations. The members of the committee draw travelling allowances for attending meetings and are entitled to a bonus if audited accounts for the year show any profit. This bonus differs with different societies and depends on the net profits declared by the Registrar of Co-operative Societies. Apart from the payment of this bonus, the profits of a society are distributed more or less as under.

- (1) About 35 per cent. as reserve fund;
- (2) 6½ per cent. as deposit in the name of each member which bears an interest of 0-0-1 per rupee per month;
- (3) 7½ per cent. as common-good fund, to be utilised for the relief of the poor, education, etc.;
- (4) 20 per cent. as rebate to the fishermen, proportionate to the value of the fish supplied to the society; (60 per cent. of the total amount to be paid as rebate is set apart for the actual catchers);
- (5) 10 per cent. as honorarium to the secretary;
- (6) 5 per cent. as bad debt fund; and
- (7) the balance as dividend to the shareholders.

The net profit as declared by the Registrar is distributed more or less on the above lines but the actual percentage differs with different societies.

For ameliorating the condition of their needy members, the societies grant loans in cash or kind at the rate of Rs. 5 per share held or Rs. 200 whichever is less.

Loans are generally granted for the following purposes:—

- (1) For the purchase of yarn, nets and other fishing gear (boats) which shall form a security to the society;
- (2) For the purchase of fish, or for curing, beach-drying and salting of fish;
- (3) For repair of boats, and fishing gear;
- (4) For purchase of food-grains or other necessities of life.

A co-operative society may also grant a loan to another co-operative society but previous approval of the Registrar is necessary for this purpose.

Preservation

Crushed ice is used for preservation of fish in transport from the fishing grounds to the assembling centres and in export by rail to consuming centres. In summer, for every maund of fish to be exported, one maund of ice is used as against 25 seers (about $\frac{3}{4}$ ds of the weight of the fish) in winter. In transport of fish in winter from the fishing grounds no ice is used but in summer blocks of ice packed in paddy husk in gunny bags are taken to the fishing grounds to pack the fish catches of the following day. Ice is made available by the exporters (societies and merchants) to their respective fish suppliers at the rate of half a block or 50 lb. per maund of catch, but as it is not possible to forecast the size of the catches with fair accuracy, the quantity taken is usually found short of the actual requirements, more particularly in the hot months when a good portion of the ice block melts away long before the fishing grounds 20 or more miles away are reached. Thus the summer catches of fish are invariably packed in insufficient quantities of ice resulting in the deterioration of the fish before it reaches the assembling centres.

Ice plants on the Chilka Lake^a

Sl. No.	Name of Ice Factory	Established in	Situated at	Manufacturing Capacity	
				in tons	in blocks of 100 lb. each
1	Bhima Ice Factory	1928	Kalupara-ghat	10	200
2	Chilka Lake Ice Factory	1948	Balugaon	5	100
3	Orissa Industrial Corporation Limited	1950	Balugaon	10	200
4	Rambha Industries	1951	Rambha	5	100

During the period 1948-50, the average daily export of fresh fish was 217 maunds, the minimum and maximum being 11 and 600 maunds respectively. The average daily requirement of ice (on the basis of $1\frac{1}{2}$ blocks for every maund of fish) was about 325 blocks, and it will be seen that during the period of high exports

^a No details are available about the ice factory, which was established at Balugaon about 25 years back and closed down after about 3 years working, the ruins of which still exist.

which varied from year to year, each of the three factories had to work more than one shift a day to meet the entire demand. Further, the monthly export figures for the Lake during the busiest season indicate that for about 5 months, more than one shift has to be worked by all the factories to meet the export requirements. For other three months one daily shift would seem to be enough whereas during the remaining four months production of one shift in a day is likely to meet the requirement of about three days.

At Balugaon and Kaluparaghat ice is sold at the rate of Rs. 2-8-0 per block *ex-factory*, but in out-stations it is supplied at Rs. 2-2-0 to Rs. 2-4-0 depending upon the distance over which the ice has to be transported with attendant loss in weight due to melting. The price of ice at Rambha is Rs. 2-14-0 per block. The State Government levies a sales-tax of three pice per rupee on the ice sold on the Lake.

Transport

Fish is transported from the fishing grounds to the assembling centres in flat bottomed country craft locally known as *Naha* (43' × 5.5' × 2.5') which are of the same type as the fishing boats. Merchants or middlemen loan their boats to fishermen many of whom do not own any.

As most of the main fishing grounds are in the eastern half, more than 10 to 20 miles away the boats take 6 to 12 hours to deliver catches at the assembly centres under unfavourable conditions of wind. The fishermen have to punt for hours when the wind fails, and do not reach their destination in time to export their catches the same evening which are thus left over for export the following day resulting in lower rates (5 to 15 per cent. less) being offered for them.

The number of boats engaged in the transport of fish is roughly 300, few of which ordinarily deliver more than 2 to 3 maunds of fish at the rail-heads, although their capacity is upto 20 maunds. This is inevitable in the present set-up of the industry with its innumerable middlemen who have so far not thought of organising common mobile assembling centres in the Lake, near the fishing grounds. The average daily export of fish from the Lake is about 217 maunds. The boats ply roughly four times a week, each trip from the fishing grounds to the assembling centres and back taking about 24 hours. The average quantity of fish transported per boat per trip is therefore about 1.27 maunds, which is roughly 1/16th of its normal cargo-carrying capacity. If the carrier fleet is reduced to about ¼th its present strength by co-operative assembling system, the normal transport needs of the industry will be met.

Weights and measures

Fish is sold by weight in crude balances of which two types specially suited for quick weighment are used on the Lake in the assembling and exporting centres.

The limited space available in boats necessitates the use of a compact Danish Steel yard type balance consisting of a beam with a pan suspended at one end and

a heavy metal knob fixed at the other. The beam is held in hand by means of a sliding loop and has grooves along its lower edge indicating weights in ascending order from the knob end. After putting fish in the pan, the position of the loop is adjusted till the beam becomes horizontal and the groove in which the loop rests gives the weight of the fish.

The other balance in use on the Lake assembling and exporting centres is cord pivot type balance and consists of two cane baskets of similar size tied to a wooden or bamboo beam by means of a coir rope. The beam has no pointer and does not rest on any stand. The balance is operated by firmly holding in hand a small piece of rope, drawn through a hole in the centre of the beam. The unequal weight of the two arms of the balance is adjusted by stones or other weights until the beam is horizontal.

The exporters do not favour the use of accurate balances mainly because of the time involved in weighing.

Marketing of Fish

The fisheries of the Lake are in the hands of the lessèe merchants who offer to buy up all the fish caught by the fishermen at a price fixed by the former. The keen competition among the merchants to take the lease of fisheries makes it difficult for the co-operative societies to save the fishermen from the dictation of the lessees.

A large number of middlemen purchase fish at very low prices direct from fishermen who own no transport to carry their catches to the assembling and exporting centres. These middlemen supply fish to the merchants as well as to the co-operative societies.

Apart from the low rates paid for the fish, it is said that the middlemen try to cheat the fishermen with a unit of weight known as *Beesa* or *Viss* (two seers) which may be *Nau kuria* (nine scores or 180 Tolas) or *Dasa kuria* (ten scores or 200 Tolas) as against the standard *Beesa* of 160 Tolas. In other words for every $2\frac{1}{4}$ to $2\frac{1}{2}$ seers of fish sold, the fisherman gets only the price of two seers of fish.

Fresh fish trade

The fresh fish trade of the Lake has developed after the outbreak of the World War I when great demand for fish was found in the Calcutta market. With the establishment in 1928 of the ice factory at Kaluparaghat a regular flow of exports to Calcutta and other centres (Fig. 1) has been maintained (Fig. 4). The annual exports of fish of about 50,000 maunds before the World War II rose by about 60 per cent. on account of the high prices prevailing during the war and the post-war periods. The trade in dry fish, which was considerable during the pre-war period, fell correspondingly as also the trade in fish roe which is now non-existent.

About 60 per cent. of the exports goes to the Calcutta market which absorbs most of the Chilka fish. The exports during the years 1948, 1949 and 1950 were 81,217, 77,094 and 79,759 maunds respectively.

The entire export of fresh fish from the Chilka area is controlled by the Director of Industries, Orissa. There is no restriction on the movement of fish within the State. Export outside the State is allowed on permits issued by the Director of Industries subject to an export duty¹⁰ of eight annas per basket containing not more than one maund of fish and weighing not more than two maunds in the aggregate when packed in ice. The local co-operative societies get export permits as a matter of course. Permits are also issued for certain fixed quantities of fish to merchants (19 in number) who have been in the Chilka fish trade continuously since 1944. Further, temporary permits are issued by the Assistant Registrar, Co-operative Societies, when the quantities of fish are in excess of the export and local quota, to prevent glut in the local markets and to avoid loss to the fish trade. Temporary permits are freely given to the societies with a view to make more fish available to them for marketing and thus help the actual fishermen who receive a share of the societies' profits only if they dispose off their fish through them.

For export, fish is packed only in cheap standardised bamboo baskets (Plate VI, Fig. 3) priced about six annas having the dimensions 20.5" × 13" × 14.5" and provided with a rectangular lid. When packing, the bottom is lined with the broad dry leaves of *Bauhinia* sp. over which is spread a layer of crushed ice and the fish placed on it in rows. Usually three layers of fish alternated by four layers of ice are packed in a basket. The top layer of ice in the basket is also covered by the leaves before the lid is secured to the basket by four pieces of coir rope, one along each side. Two more pieces, tied above the middle of the narrower sides of the basket in the form of loops, serve as handles.

The fish going outside the State averaging about 150 maunds per day is mainly exported to Calcutta, the largest consuming centre of the Chilka fish. Small quantities are also exported to Kharagpur and Tatanagar. Disposal of the fish is done through 'Adatdars' or the stall-holders in the Howrah wholesale market under the personal supervision of an Adat Officer of the Orissa Fisheries Department.¹¹ The Adatdars are appointed by the co-operative societies and the merchants, i.e., the exporters, with the approval of the Assistant Registrar of Co-operative Societies, and are required to deposit an advance of Rs. 1,000 per head with the latter. The fish is transported to Khurda Road junction in a 40-ton van by the Fish Shuttle¹² which collects fish parcels from the railway stations on the Lake between 4 P.M.

¹⁰ Export duty increased to Re. 1/- since September 1951.

¹¹ Services of Adat Officer have been discontinued from 1949.

¹² Since 6th November 1951 the Fish Shuttle has been replaced by a regular Passenger train.

and 6 P.M. At Khurda Road the fish van is attached to the Puri Express the same evening so that the consignment is ready for auction at the Howrah market next morning. The contents of each basket of fish are displayed on the floor and auctioned separately. If a basket contains more than one variety of fish, each is auctioned separately and the sale proceeds recorded. 'Chalans' showing details of sales and sale proceeds are generally sent on the day of the auction to the exporters, the net amounts being remitted on the following day, after deducting the following charges:—

- (1) Cartage from the Howrah Station to the Howrah wholesale market at Re. 0-5-0 per basket.
- (2) Commission at Re. 0-0-9 per rupee on sale proceeds.
- (3) *Brithi* (Collection for Puja) one anna for a day's transactions per exporter.
- (4) *Dan* (charity), *Chalan Jama* (Hundi charges), *Hisabana* (Maintenance of accounts) at Re. 0-1-0 for a day's transactions per exporter.

All the above charges work out roughly at Re. 0-1-0 per rupee or at 6½ per cent. of the sale proceeds.

If the net amount realised per maund of any fish exceeds Rs. 40, the exporter makes a deduction of Rs. 16 per maund on account of various charges detailed below and pays the balance to the supplier of the fish, *i.e.*, the middlemen or the fishermen as the case may be.

- (1) Payment of license fee of Rs. 200 per year for the fish godown to the District Board if the average daily export of fish is not less than 10 maunds.
- (2) Sales-tax to the State Government at Re. 0-0-6 per rupee.
- (3) Railway freight from the place of export to the consuming market, about Rs. 3-11-0 per maund.
- (4) Cost of packing material, *i.e.*, one bamboo basket, dry leaves and a few pieces of coir rope, about Re. 0-8-0.
- (5) Cost of ice, about Rs. 3-12-0 (cost of 1½ blocks of 100 lb. each is recovered for each basket of one maund of fish).
- (6) Export fee of Re. 1 per basket payable to the Orissa Fisheries Department.
- (7) Rs. 3-0-0 per maund to make up the difference between the rate obtained outside the State and the civil supplies rate within the State, as the supplier of the fish is to be paid at the rates realized in Howrah market for all the fish tendered by him for sale, irrespective of the compulsory allocation for the Orissa State.

- (8) Cartage from the fish assembling centre to the nearest railway station.
- (9) Rs. 2-0-0 per basket to the exporter (Society or merchant) for meeting the running expenses, e.g., salary of clerk, wages of labourers for packing, etc.

On the other hand if the net realization per maund is Rs. 40 or less it is shared equally by the exporter and the supplier of the fish.

In order to ensure that merchants do not employ unfair means to secure fish in competition with the societies and that the interests of the suppliers also do not suffer, a uniform procedure for making payments for supplies of fish has been laid down by which the merchants¹³ have also to pay as per rates shown in the 'Chalans' of the Adatdars of the Howrah market.

The suppliers of fish, if they so desire, can have upto 75 per cent. of the value of their supplies according to the civil supplies rates (*vide infra*) at the time of delivery and the balance, if any, on the receipt of 'Chalans' from Howrah market.

A society must accept the entire catch tendered for disposal by any of its members but supplies from non-members may also be accepted. Conversely the supplier is not obliged to dispose off his catch only through the society of which he is a member, though in practice he does so with a view to share the profits of the society. Even if he sells through some other society he gets a share from the profits meant for the actual catchers as detailed (*vide supra*), but he is definitely at a loss if he sells through a merchant, who has a firm hold on the fishermen by the interest-free loans, etc., which he has furnished them with whenever needed. The societies need for their growth and stability increased supplies of fish which they can ensure only by leasing larger areas of fishing grounds in competition with the merchants. The State Government have therefore fixed separate export quota for the merchants and the societies giving preference to the latter which, under this safeguard, have steadily developed and may in due course oust the merchant if the State policy so demands it.

Sale within Orissa State

There is no appreciable local demand for fresh fish in the Lake area where the choice for the poorer classes of consumers is restricted to the cheaper varieties of fish [Plate VIII, Fig. 2]. The high prices offered for the prime fish outside the State tend to stimulate export to the maximum possible extent. This tendency which is a legacy of the latter phase of the war period has been sought to be counteracted by the State Regulation that for every 100 maunds exported outside the State, the exporters should reserve for sale within the State

¹³ These merchants are exporters and may not necessarily be the lease-holders of the fishing areas of the Lake.

30 maunds of fish at the following civil supplies rates fixed by the Chilka Fishermen's Union.¹⁴

Types of Fish	1947	Rates	
	to April 1948	Up to 15-3-51	After 15-3-51
	Rs. A. P.	Rs. A. P.	Rs. A. P.
<i>Bekti and Bagda</i>	40 0 0	65 0 0	60 0 0
<i>Khainga, Kabala, Sahal, Hilsa and Seba Khainga</i>	28 0 0	32 0 0	35 0 0
<i>Menjia, Khuranti, Boroga and Keckeranda</i> ..	23 0 0	28 0 0	30 0 0
<i>Gania, Jagili, Kantal Cheengri and large Balanga</i>	22 8 0	22 8 0	22 8 0
<i>Small Cheengri</i>	15 0 0	15 0 0	17 8 0
<i>Patua, Sunga and Kontia</i>	15 0 0	15 0 0	12 8 0

The State Regulations also require that the reservation of civil supplies should consist of prime fishes (*Hilsa, Khainga, Kabala and Sahal*) and the cheaper varieties of fish (*Menjia, Khuranti and Cheengri*) according to their availability, but this proviso is evaded whenever possible, the bulk being made up of small catfishes, *Balanga, Menjia, Patua and Cheengri*, the margin of profit of which over the civil supplies rates, when exported, is very little. The price of prime fish (*Bekti and Bagda*) fixed at Rs. 65 per maund is much beyond the means of the middle class consumers.

Inspectors of the Fisheries Department frequently check records of catches tendered for sale in the fish godowns to ensure that the stipulated quantities of fish are supplied to about 50 centres in the State. The fresh fish despatched to the State centres by evening trains reach their destination at night where they are sold the next morning. The sale at controlled rates is effected only through authorised dealers who are permitted to charge Rs. 4-8-0 per maund towards cost of ice, transport and incidental charges from the exporting centres and Rs. 5 per maund as transport, handling and marketing charges at the consuming centres over and above the civil supplies rates.

As the average daily export from the Lake is 217 maunds the quota for the 50 State centres is hardly 60 maunds. As the demand for fresh fish is always far in excess of the supply, those who must have fish due to scarcity of vegetables or other reasons have no alternative to consuming dry fish, which is neither clean nor pleasing in appearance. The very fact, that large quantities of dry fish are

¹⁴ This Union, though it has been functioning for a number of years, has not been registered so far.

imported (Plate VIII, Fig. 2) by the consuming centres around the Chilka area from distant places in Bombay and Madras States, shows that the supplies of locally produced fresh fish apart from being inadequate are beyond the means of the local people. The export of fish from the Lake gives no indication as to whether there is an actual marketable surplus.

Dry fish trade

Before the two World Wars there was a brisk trade in the Chilka Lake centres in dry fish and fish roe which slackened with export of fresh fish to Calcutta during World War I, and dwindled down to insignificance during the World War II on account of the high price fetched by fresh fish. Nearly all the prime fish are at present exported fresh though some times owing to lack of ice and transport or to persistent bad weather, they are dried or salted and dried. The small or un-economic varieties of fish such as shrimps, catfishes, Engraulids and small Clupeids for which there is not much demand outside the State are sun-dried more particularly when they are caught in abundance.

The main fish-drying centres are Alupatna, Arkhakuda, Barhampur, Gorowahi, Mahosa, Malud, Parikuda and Satpara whence the dried fish is taken to the wholesale market at Bhusandpur, the only important assembling centre in the Chilka Lake area from which it is distributed all over the State and the adjoining areas of Madras State.

Actual exports from Bhusandpur alone, during the years 1948, 1949 and 1950 were 6,385, 5,313 and 4,436 maunds respectively but excluding the dry fish imported from outside the Chilka area and that re-exported from the Chilka centres, the net exports were 4,480, 4,542 and 1,503 maunds respectively. Further the exports as a whole have gone down and the fall has been progressive as well as considerable (Table II), indicating that more fish is being exported in the fresh condition.

Salting of fish

The belly of the fish is longitudinally slit in two places and salt is liberally applied on to the flesh and rubbed in before the fish is dried. In fatty fish like *Hilsa* and large-sized fish, a quantity of salt equal in weight to that of the fish is said to be used for proper preservation, but medium-sized fish require salt half their weight. The former lose about 50 per cent. of their weight on salting and the latter about 60 per cent. Shrimps and other small fish which are sun-dried without salting lose about 2/3rds of their weight. The loss in weight due to drying, which the fishermen are reluctant to bear, is made good to some extent by mixing up sand with salt in the case of the large-size fish or turning the shrimps and small fish in the wet condition over sand.

It will be seen from the foregoing account that the salted product prepared so carelessly and unhygienically is neither pleasing nor palatable, and even so it fetches a good price in the retail market in the Chilka Lake area. The sale prices

of fish are as follows: *Hilsa*, large *Sciaenids* and *Sahal* about Rs. 2 per seer, mullets about Rs. 1-8-0 per seer, small clupeids and catfishes about Rs. 1-4-0 per seer, and small prawns and shrimps about Re. 1 a seer.

The dry fish exports from the Chilka Lake area, except those from Bhusandpur which include large quantities of dry fish imported from Bombay and Madras States, consist of the fish caught in the Lake. Thus on the basis of local enquiries and reference to railway records more than 95 per cent. of the cured *Hilsa* exported from Bhusandpur appears to have its origin in Bombay State.

V. DISCUSSION AND SUGGESTIONS

In this paper an attempt has been made to list the fish fauna of the Lake, describe its important fisheries, and to give an account of the fishing industry of the Lake. On the basis of the available data the biology of the fishes and their distribution in the different zones have been interpreted and the production capacity of the Lake as a whole in terms of yield per acre estimated.¹⁵

It is evident from the available records that exports of fresh fish have been maintained, except for slight fluctuations, at a steady level from 1930 to 1939 with a tendency on the whole to rise (Fig. 3). The decline for the years from 1940 to 1942 must have been due to the adverse economic conditions prevailing at the beginning of the War. The general unfavourable conditions brought about by the entry of Japan into the War, the August disturbances and the great Bengal Famine during the year would have been responsible for the sharp fall in 1942.

Export of fresh fish in relation to the total production from the Lake is fairly high and amounts to 26.10, 24.78 and 25.62 lb. per acre of water spread during the years 1948, 1949 and 1950 respectively. If the fishes consumed locally and those converted into dry fish are taken into account, the yield per acre rises to 34.48, 31.58 and 29.80 lb. in the three years respectively. The Lake is an uncultivated piece of water, more than a fourth of its area being too shallow to sustain any good fishery of economic importance, and yet the production is not unsatisfactory. The yield per acre of different groups of fish appears to fluctuate as indicated in table given below, and it will be noted that the average yield is not equal to $\frac{1}{3}$ rd of the total yield from the three zones which are of unequal size.

The division of the Lake into three zones based on the differences in the ecological conditions throws some light on the distribution of fishes in the

¹⁵ As statistics of persons actually employed in the fishing operations were not available at the time of the preparation of this account estimation of *per capita* income and catch per unit of effort was not possible. It is presumed that the total fishing effort remained practically the same during all the three years.

Lake and their seasonal abundance in successive years. Thus the southern zone which is the smallest of the three is deeper and more saline than the other two, and is relatively rich in species. As the range of variation in the

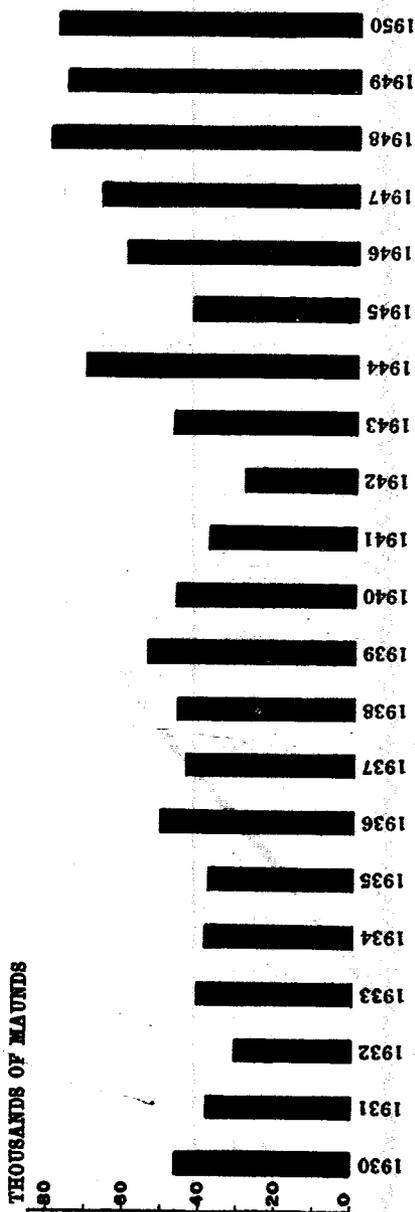


Fig. 3. Fresh fish exports from 1930-50.

Tabulated Statement of Yield of Fish in Terms of lb. per Acre of Water Spread

	Based on Fresh Exports								Based on total production	
	Southern Sector		Central Sector		Northern Sector		Average		Yield	Rank
	Yield	Rank	Yield	Rank	Yield	Rank	Yield	Rank		
1948										
Mullets	5.61	3	6.81	1	1.83	5	4.17	3	4.81	4
Clupeoids	2.67	5	2.55	5	2.95	4	2.77	6	4.05	6
Catfishes	0.84	6	1.50	6	7.17	1	4.25	2	5.40	2
Sciænids	0.31	8	0.77	7	5.89	2	3.27	4	4.16	5
Perches	3.19	4	3.84	4	1.66	6	2.67	7	3.12	7
Threadfins	0.54	7	0.58	8	1.43	7	1.00	8	1.57	8
Beloniformes	0.18	9	0.15	9	0.05	9	0.10	9	0.11	9
Miscellaneous	5.98	2	5.09	2	4.01	3	4.67	1	5.94	1
Prawns	9.21	1	4.02	3	1.09	8	3.20	5	5.32	3
TOTAL	28.53		25.31		26.08		26.10		34.48	
1949										
Mullets	4.83	4	5.30	2	1.84	6	3.52	4	3.91	4
Clupeoids	5.25	3	2.29	4	4.35	2	3.69	3	4.91	3
Catfishes	1.22	6	0.99	7	3.74	3	2.39	5	3.15	5
Sciænids	0.11	9	0.33	8	2.35	5	1.31	7	1.91	7
Perches	4.31	5	2.13	5	1.69	7	2.18	6	2.41	6
Threadfins	1.13	7	1.15	6	1.16	8	1.15	8	1.40	8
Beloniformes	0.52	8	0.20	9	0.24	9	0.26	9	0.27	9
Miscellaneous	5.67	2	2.99	3	4.35	1	4.01	2	5.04	2
Prawns	14.64	1	7.62	1	3.16	4	6.27	1	8.58	1
TOTAL	37.68		23.00		22.28		24.78		31.58	
1950										
Mullets	4.06	4	5.74	2	1.42	6	3.37	4	3.64	4
Clupeoids	5.03	3	2.79	4	3.74	2	3.54	3	4.27	3
Catfishes	2.10	6	1.23	7	1.35	7	1.39	7	1.73	7
Sciænids	0.08	9	0.20	9	2.20	5	1.19	8	1.45	8
Perches	3.90	5	2.35	5	1.06	8	1.89	6	2.02	6
Threadfins	1.19	8	1.86	6	2.53	4	2.11	5	2.30	5
Beloniformes	1.26	7	0.62	8	0.38	9	0.58	9	0.64	9
Miscellaneous	8.76	2	3.26	3	3.50	3	4.07	2	4.74	2
Prawns	11.31	1	8.79	1	5.53	1	7.48	1	9.01	1
TOTAL	37.69		26.84		21.71		25.62		29.80	

yield is very wide in the various parts of the Lake, it may be of interest to trace the causes of such fluctuation over a much longer period than has been possible in the present survey.

The rank occupied by the different groups of fishes in productivity appears to fluctuate too except in the case of mullets which occupy the same fourth rank throughout the period of investigation. As far as mere bulk in production is concerned prawns, the fish classed as "miscellaneous," the clupeoids, and the mullets occupy the top rank throughout the period. The yield in prawns has been most spectacular, having doubled itself in the last two years, the clupeoids have risen from the sixth rank to the third, the perches and threadfins have shown increases while the "miscellaneous" fishes have shown a downward trend which probably indicates that they are being more rationally sorted. On the other hand, two important groups, viz., catfishes and sciaenids, have registered a decline, the former sliding down from the second to the seventh rank and the latter from the fifth to the eighth. The Beloniform fishes though registering a progressive increase in production, rank last owing to the relatively low total yield.

The total production from the Lake during the three years has been estimated at 1,07,270.86, 98,253.25 and 92,713.36 maunds valued at Rs. 26,00,698, Rs. 25,26,290 and Rs. 24,60,067 respectively as indicated in the table given below: (Also Fig. 4).

	1948		1949		1950	
	Production in Maunds	Value in Rupees	Production in Maunds	Value in Rupees	Production in Maunds	Value in Rupees
Mullets ..	14,952.25	4,49,997	12,171.63	3,74,137	11,312.38	3,52,047
Clupeoids ..	12,604.35	2,63,175	15,272.50	2,73,940	13,302.42	2,38,369
Catfishes ..	16,805.04	2,79,777	9,786.47	1,65,862	5,397.31	88,746
Sciaenids ..	12,945.29	3,36,114	5,948.62	1,62,624	4,496.51	1,22,602
Perches ..	9,709.66	4,27,004	7,487.78	3,91,321	6,298.80	3,03,715
Threadfins ..	4,894.29	1,32,421	4,365.96	1,32,405	7,164.91	2,13,823
Beloniformes ..	341.59	6,750	856.02	16,916	1,980.97	30,164
Miscellaneous	18,468.93	3,30,497	15,676.68	2,80,077	14,737.90	2,60,273
Prawns ..	16,549.46	3,74,963	26,687.59	7,29,008	28,022.16	8,50,328
TOTAL ..	1,07,270.86	26,00,698	98,253.25	25,26,290	92,713.36	24,60,067

In spite of the progressive decline in yield fresh fish exports have risen forming 75.71, 78.46 and 86.02 per cent. of the total production respectively in each of the three years (Tables III-V). Local consumption including civil supplies amounts to 5.07, 5.87 and 6.55 per cent. respectively of the total production. The production of dried fish, on the other hand, has progressively declined constituting only 19.21, 15.67 and 7.42 per cent. of the total production in the three years.

There has been a downward trend in the yield of fishes (*sensu stricto*) while there has been big increase in the catches of prawns (Graphs 14 A & B). As most of the stocks are replenished from the sea, and the fishing effort has been more or less the same, the decline may be attributable to causes other than intensive fishing assuming that the replenishable stock has remained constant. The salinity, which on account of less of flooding in 1949 and 1950, may have been higher than in 1948, is probably responsible for the big rise in the yield of Penæid prawns which form the bulk of the catches. This is also corroborated by the fact that the production in the usually relatively less saline northern zone was higher in the last two years presumably on account of the prevailing higher salinity. At the same time there has been a corresponding steep fall in the total yield of fishes (*sensu stricto*) probably as a result of the deficient rainfall and the consequent reduced flooding and the low fertility of the waters in the zone. Until the causes of the fluctuations in production levels are thoroughly investigated it will not be possible to suggest ways and means for the development of the Chilka Lake fisheries. Till then, however, it is advisable to conserve the existing stocks of fish, and the following measures based on available information are for tentative adoption.

Abolition of zamindari rights

The fishing industry can develop only if the actual producer, the fisherman gets an adequate return for his toil. So long as the prevailing zamindari system of the Lake lasts, by which fishing rights in the various fishing grounds rest in the owner, the primary producer will have little incentive to toil. The zamindari system should therefore be abolished passing on the ownership of the Lake to the State (Khasmahal), and the primary producer allowed to exploit the resources with a sense of security that the fish he has toiled to catch is all his own. What has been possible in the case of agricultural land should be possible in regard to fishing waters.

Literacy and mass education

There are very few primary schools in the Chilka area and even those that exist are never fully utilised as in the view of the villagers the kind of

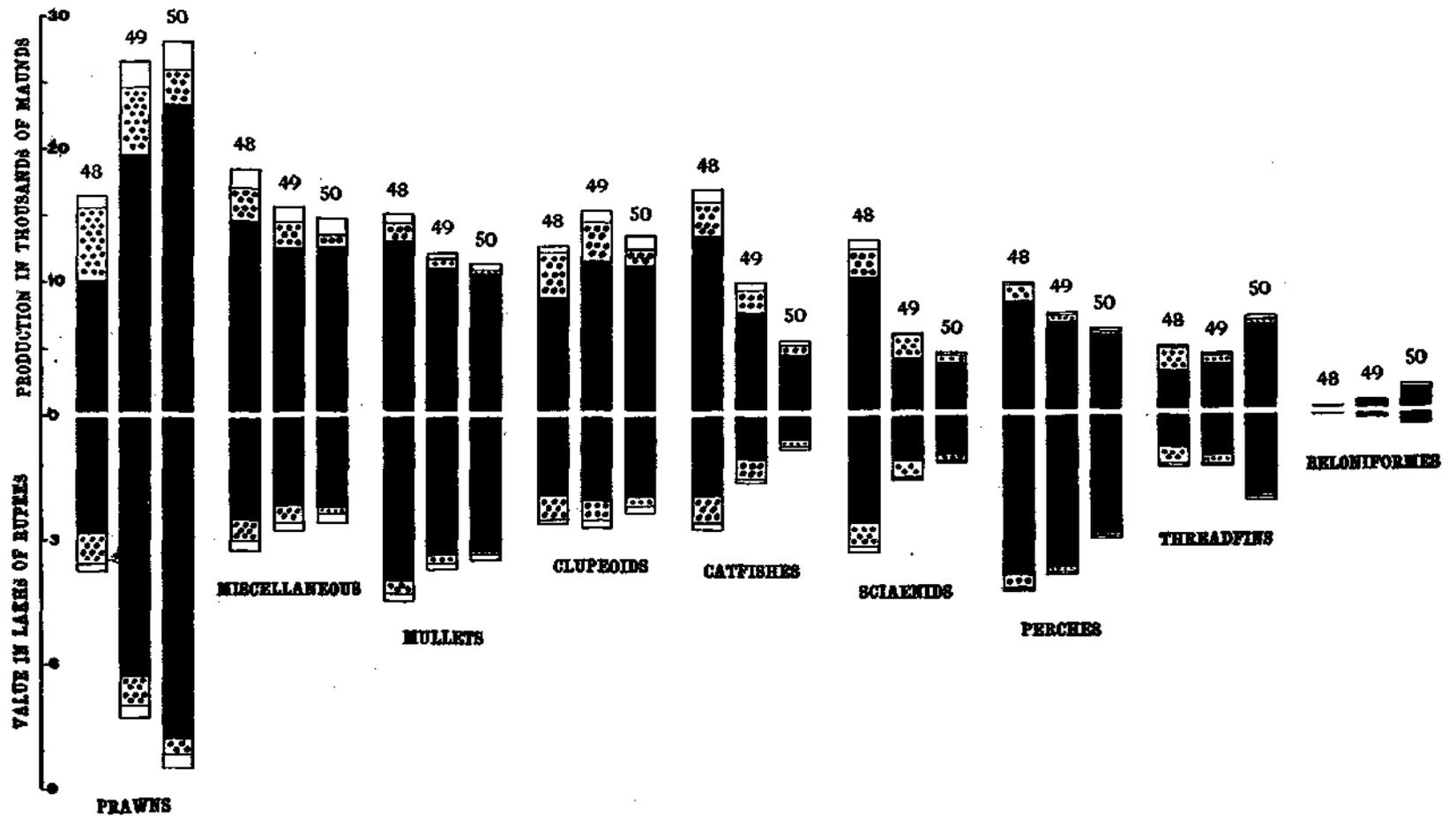


FIG. 4. The estimated total production of fish from the Lake and its estimated value. Shaded portion indicates fresh fish exports. Dotted portion indicates dry in terms of fresh fish. Blank space indicates estimated local consumption of fresh fish.

education that is imparted will divert their children from their traditional profession. Adult education and intelligent propaganda may help in changing this view, but it may be necessary to reorient the system of education so as to afford the fishermen opportunities to better their professional efficiency and physical stamina.

Modifications in the system of Jano Fishing

The *Jano* fishing from October-February takes a heavy toll of all types and sizes of fish. By restricting the period of fishing, by raising bunds instead of enclosing the fishing ground by bamboo structures, and by prescribing a minimum size limit for fishes of economic importance during the *Jano* season the destruction of young fish can be greatly minimised.

Size limit of fish for exports

Owing to the size of the Lake it would be difficult to enforce effective measures against use of certain types of nets or minimum size of mesh designed to destroy immature fish. It is, however, desirable that a minimum size to suit export for certain important groups of fishes like the mullets caught from *Janos* during certain seasons to check indiscriminate fishing be enforced, as this will not cause any appreciable hardship to the producer and may ensure a uniform supply of good sized fish all through the year.

Prospects of culture in embanked areas

Although fish stocks are derived mainly from the sea, there is scope for augmenting the output of fish by cultural methods in the shallower areas of the main body of the Lake. Some of the low-lying inundated parts of the Lake could be converted by raising bunds into fish ponds for growing mullets and prawns the young of which are always in plentiful supply. The fry of *Mugil cephalus* is available in large numbers and grows to a large size even in confined waters.

The fry of major carps washed in by the Daya, Bhargavi and other streams during the monsoon into the inundated areas of the north-eastern portion of the Lake grow only to a moderate size in the absence of proper cultural methods, which if employed, would stimulate yield. The possibilities of converting some of the deeper pools into regular ponds and of stocking them with suitable types of fry after bunding them need to be explored as the output from embanked waters will not only augment the existing fish production but also compensate the fishermen for any initial loss

which they incur as a result of the enforcement of conservation measures suggested.

Improvement in transport

Transport cost of fish from fishing grounds to assembling centres can be cut down considerably if the transport system is re-organised on a co-operative basis. The use of insulated boxes in transport boats, could minimise expenditure on ice for preserving fish.

The use of power craft wherever possible between auxiliary assembling centres and rail-heads will ensure quick transport of fish and their preservation.

Ice Depot and fish purchasing agency at Satpara

Satpara, which is situated conveniently at the junction of the main area of the Lake and the channel and has good fishing grounds in the vicinity, can serve as a base for collection and transport of fish to the assembling centres and also for supply of ice.

At present ice is carried in fishing boats from the assembling centres on the western shore of the Lake to the main fishing grounds in the eastern half of the Lake some of which are more than 20 miles away. When the ice thus carried melts during transport some fish cannot be preserved and are therefore dried as often happens at Arkhakuda near the mouth of the Lake. If in addition to a cold storage chamber a steady supply of ice could be made available at Satpara much of the fish that now gets spoiled or is converted into dry fish can be saved for export in an excellent state of preservation. Satpara can serve also as an assembling centre for co-operative societies and the authorised exporters under Government supervision. Packed fish transported in power boats to rail-heads for direct export will save as many as 4 to 8 hours in transport by country craft as at present. A co-operative consumer's store at this base will help the fishermen as well as the inhabitants of these remote areas.

Improvements in communication

Bhusandpur (Fig. 2) at the northern extremity of the Lake, is a very inconvenient exporting centre in the absence of a road link between it and the railway station separated by a distance of about three miles. Fish are therefore transported by boat to Kaluparaghat by a circuitous route. The unfavourable winds which prevail there also contribute to the considerable delay in the transport of fish and fresh fish traffic at this centre is, therefore, irregular, and fish have often to be dried. A road link as suggested will enable the fish to be transported direct from the Daya region to

Bhusandpur, which is within easy reach. Roads between the assembling centres at Kuhuri and Gangadharpur and their nearest rail-heads of the same name also require to be improved so that fish transport may be quickened.

Marketing systems

The export of fish through the agency of co-operative societies and permit-holding merchants should be extended. As a safeguard against the monopoly right of lease-holders higher export quotas may be allowed to societies, so that more fish is automatically diverted for disposal through them enabling fair prices to be obtained for their produce and profits to be distributed to the members. This will also contribute to the growth and stability of the societies and help them acquire the fishing rights of more grounds from the middlemen.

Use of standard weights and measures

The use of standard balances and weights which will cut down loss to the primary producer should be encouraged by enforcing the Weights and Measures Act which had been partially relaxed in the Chilka Lake area since the Military Requisitioning Scheme ended in 1946.

Handling of fish

Handling of the fish in all stages from the time of capture to packing should be made as hygienic as possible. The fish godowns at the assembling and the exporting centres, where large quantities of fish are handled, should be washed and disinfected every day under the supervision of the officers of the Orissa Fisheries Department. This will be greatly facilitated if the floor of the godowns is properly cemented. Similar sanitary measures have also to be enforced while the fish are being transported in boats, but the need for these will cease if packing is undertaken at the assembling centres nearer the fishing grounds.

Railway Facilities

(1) The loading of fish consignments into trains at wayside stations is rendered difficult for want of raised platforms. This can be minimised if wooden platforms or steps are provided at these stations.

(2) More racks in fish vans are essential to prevent damage by pressure due to overload of packages.

(3) Insulated vans may be introduced for the transport of fish so that the spoilage of fish in transit may be minimised and better prices assured.

(4) Care in handling fish baskets at destination is essential to ensure a good price.

(5) The weighments of fish baskets at the Horwah wholesale market show a loss in weight during transit which cannot be accounted for as due to expected causes such as dehydration, etc. The real cause needs investigation.

Disposal of fish at Calcutta

Disposal of fish at Calcutta, which is the main consuming centre of the Chilka fish, is through Adatdars of the Howrah Wholesale Market some of whom are the principal merchants in the Chilka area and belong to the "ring" (Mitra, 1946). To prevent malpractices in Adats an officer of the Orissa Fisheries Department was deputed to Calcutta for supervising auction of fish, but as there was no improvement in the situation during his stay of over one year, he was called back. The only alternative, therefore, for disposing of the fish at fair price seems to be that Chilka exporters should have their own stalls at Calcutta with the co-operation of the West Bengal Fisheries Directorate, in convenient centres managed by their own representatives or by the representatives of the Chilka Fishermen's Union.

The fish consignments are received too late for the morning sales as a result of which they are again packed in ice and kept for the evening or the next day. Especially in the summer months this causes additional spoilage.

Collection of statistical and biological data

It is well known that collection of statistical data is absolutely essential for the planning of any industry or measuring its progress. The Chilka Lake is the largest piece of brackish water in India with an annual yield of about a lakh of maunds of fish valued at about Rs. 25 lakhs. It is, therefore, a national asset which requires careful conservation so as to serve as a steady and permanent source of income. The submission of regular correct returns of fish tendered for sale at the assembling centres should be encouraged and these returns may be scrutinized by officers of the Orissa Fisheries Department stationed at these centres with verifications obtained from export figures available in railway records. Submission of a daily statement showing prices obtained for different varieties of fish in Calcutta market may also prove useful. Apart from the above commercial data, scientific data regarding size groups and conditions of maturity of different species in catches should be collected by random sampling and regular observations made regarding breeding seasons of fishes occurring in the Lake and migratory movements of economic species.

VI. ACKNOWLEDGEMENTS

It gives us great pleasure to place on record our thanks to the Government of Orissa in general and in special to Mr. G. N. Mitra, Deputy Director of Fisheries, Orissa, whose magnanimous co-operation and interest have been primarily responsible for the completion of this work. We are grateful to Dr. H. Srinivasa Rao, Chief Research Officer, Central Inland Fisheries Research Station, for critically going through the manuscript of the paper and for improving it. We are indebted to Dr. T. J. Job, the former Chief Research Officer, for the interest shown in the course of the work. Our thanks are due to Mr. Peter Devasundaram, Senior Research Assistant, Chilka Biological Station, for the valuable local assistance rendered during our visits and for placing at our disposal the fresh fish export figures compiled by the Orissa Fisheries Department. We are also thankful to Mr. B. Ratha, Assistant Registrar, Co-operative Societies, and Mr. S. K. Bhuyan, Inspector of Fisheries, Balugaon, for their kind co-operation during our visits to the Chilka area. We acknowledge with thanks the help rendered by Mr. A. K. Banerjee, Research Assistant (Engineering) of this Research Station, in inking most of the graphs reproduced in this paper.

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VIII. TABLES

TABLE I. Showing export in maunds of fresh *Liza corsula* from the Chilka

	1948	1949	1950
January .. ..	..	14.75	2.59
February	90.53	5.39	5.43
March	2.57	8.68	1.60
April	11.55	20.20	..
May	19.90	156.30	59.72
June	9.40	96.01	117.68
July	7.58	241.92	30.12
August	48.61	45.47	4.84
September	27.61	24.33	15.84
October	67.59	25.95	54.47
November	27.79	4.30	5.92
December	30.44	12.44	2.96
TOTAL ..	343.57	655.74	301.17

TABLE II. Showing Export in Maunds of Dry Fish From the Chilka*

Centre	1948	1949	1950
Rambha ..	101·57	59·85	35·45
Kallikota ..	238·52	120·90	73·62
Balugaon ..	86·20	260·12	95·65
Gangadharpur ..	117·15	200·75	104·62
Kuhuri ..	412·12	14·18	2·35
Kaluparaghat ..	2,496·57	599·00	743·90
Bhusandpur ..	4,480·07	4,541·57	1,502·92
TOTAL ..	7,932·20	5,796·37	2,558·51

* Re-exports of dry fish, received from Bombay and Madras States, are excluded.

TABLE III. Showing Estimated Total Production in Maunds from the Chilka during the Year 1948

	Export of fresh fish	Dry in terms of fresh fish	Local consumption	Total production
Mulletts ..	12,975·31	1,328·18	648·76	14,952·25
Clupeoids ..	8,607·36	3,487·28	609·71	12,604·35
Catfishes ..	13,227·59	2,585·40	992·05	16,805·04
Sciænids ..	10,189·17	2,246·67	509·45	12,945·29
Perches ..	8,299·03	1,232·23	178·40	97,09·66
Threadfins ..	3,110·88	1,627·87	155·54	4,894·29
Beloniformes ..	325·32	..	16·27	341·59
Miscellaneous ..	14,511·24	2,506·57	1,451·12	18,468·93
Prawns ..	9,971·20	5,597·64	980·62	16,549·46
TOTAL ..	81,217·10	20,611·84	5,441·92	1,07,270·86

TABLE IV *Showing Estimated Total Production in Maunds from the Chilka during the Year 1949*

	Export of fresh fish	Dry in terms of fresh fish	Local consumption	Total production
Mullets ..	10,929·50	695·66	546·47	12,171·63
Clupeoids ..	11,469·31	2,794·06	1,009·13	15,272·50
Catfishes ..	7,448·44	1,779·40	558·63	9,786·47
Sciænids ..	4,081·84	1,662·69	204·09	5,948·62
Perches ..	6,786·97	529·85	170·96	7,487·78
Threadfins ..	3,586·88	599·74	179·34	4,365·96
Beloniformes ..	815·26	..	40·76	856·02
Miscellaneous ..	12,461·32	1,969·23	1,246·13	15,676·68
Prawns ..	19,514·48	5,366·04	1,807·07	26,687·59
TOTAL ..	77,094·00	15,396·67	5,762·58	98,253·25

TABLE V *Showing Estimated Total Production in Maunds from the Chilka during the Year 1950*

	Export of fresh fish	Dry in terms of fresh fish	Local consumption	Total production
Mullets ..	10,477·59	310·92	523·87	11,312·38
Clupeoids ..	11,031·95	1,291·17	979·30	13,302·42
Catfishes ..	4,344·78	726·67	235·86	5,397·31
Sciænids ..	3,698·79	612·79	184·93	4,496·51
Perches ..	5,903·73	175·34	219·73	6,298·80
Threadfins ..	6,574·07	262·14	328·70	7,164·91
Beloniformes ..	1,800·89	..	180·08	1,980·97
Miscellaneous ..	12,660·42	811·44	1,266·04	14,737·90
Prawns ..	23,266·78	2,691·36	2,064·02	28,022·16
TOTAL ..	79,759·00	6,881·83	6,072·53	92,713·36

IX. GLOSSARY OF ORIYA NAMES OF THE FISHES OF THE CHILKA LAKE

ASWA	<i>Cynoglossus brevis</i> Günther
BACHA	<i>Eutropilichthys vacha</i> (Hamilton)
BAISALI	<i>Eleutheronema tetradactylum</i> (Shaw) upto about 6 inches in length (see SAHAL AND SAHALIA also)
BAKUR	<i>Catla catla</i> (Hamilton)
BALANGA	<i>Nematalosa nasus</i> (Bloch)
BALIGIRDIA	<i>Glossogobius giuris</i> (Hamilton)
BANOKUASA	<i>Chela cachius</i> Hamilton
BEKTA OF BEKTI	<i>Lates calcarifer</i> (Bloch)
BENGFULA	<i>Chelonodon patoca</i> (Hamilton)
BHUSA-SAHAL	<i>Polydactylus indicus</i> (Shaw)
BOLA	<i>Pseudosciana coitor</i> (Hamilton) (for small-sized Sciaenids upto about 6 inches. Generally used by Bengali merchants of Chilka area); see also BOROGA and PENDI
BOMBI	<i>Mastacembelus armatus</i> (Lacépède)
BORGUDI	<i>Aplocheilus panchax</i> (Hamilton) see also DHALANGA
BOROGA	<i>Pseudosciana coitor</i> (Hamilton) (Large sized), see also BOLA and PENDI
CHANDEE	<i>Ambassis ambassis</i> (Lacépède), <i>Apogon gymnocephalus</i> (Lacépède) and <i>Leiognathus equulus</i> (Forskål)
CHARA	<i>Mugil speigleri</i> (Bleeker)
CHILI	<i>Aetobatis narinari</i> (Euphasin)
DANGLA	<i>Liza macrolepis</i> (A. Smith) (Large sized), see also MENJIA
DANTI	<i>Muræsox cinereus</i> (Forskål)
DENWA	<i>Pisodonophis hijala</i> (Hamilton)
DHALANGA	<i>Aplocheilus panchax</i> (Hamilton), see also BORGUDI
DUDH-PATHA	<i>Brachirus orientalis</i> (Bloch & Schneider)
EK-DANTI-GANIA	<i>Hemirhamphus gaimardi</i> (Valenciennes), see also SARBARA
GAGAR	<i>Tachysurus</i> spp.
GANIA	<i>Tylosurus strongylurus</i> (van Hasselt)
GAUN	<i>Therapon jarbua</i> (Forskål)
GAYAL	<i>Sphyræna</i> sp.
GODISA	<i>Ophicephalus punctatus</i> Bloch
GOLORA	<i>Sciana russelli</i> (Cuvier)
GONDIA	<i>Tachysurus arius</i> (Hamilton), see also SINGDA
ILISH	<i>Hilsa ilisha</i> (Hamilton)
JAGILI	<i>Gerres</i> sp.

JALANGA	..	<i>Pangasius pangasius</i> (Hamilton)
JALARI ..	..	<i>Oxygaster bacaila</i> (Hamilton)
JHURRANG	..	<i>Sillago sihama</i> (Forskål)
KABLA ..	..	<i>Mugil cephalus</i> Linnæus, see also KHAINGA
KALI-GOUDINI	..	<i>Cirrhina latia</i> (Hamilton)
KAUNDA	..	<i>Plotosus canius</i> Hamilton
KEKERANDA	..	<i>Liza corsula</i> (Hamilton)
KHAINGA	..	<i>Mugil cephalus</i> Linnæus, see also KABLA
KHURANTI	..	<i>Coius quadrifasciatus</i> (Sevastianof)
KOKARBA	..	<i>Lutjanus johnii</i> (Bloch)
KONTI ..	..	<i>Caranx (Caranx) carangus</i> (Bloch)
KONTIA ..	..	<i>Mystus cavasius</i> (Hamilton)
KOU ..	..	<i>Anabas testudineus</i> (Bloch)
KOWA ..	..	<i>Gadusia chapra</i> (Hamilton)
KUII-KERANDI	..	<i>Puntius ticto</i> Hamilton
KUNDAL	..	<i>Etroplus suratensis</i> (Bloch)
MAGUR ..	..	Shark
	MUNDAH-MAGUR ..	<i>Carcharhinus gangeticus</i> (Müller & Henle)
	KHONDA-MAGUR ..	<i>Pristis pectinatus</i> Latham
MENJIA ..	..	<i>Liza macrolepis</i> (A. Smith) (Small sized) and small mullets in general (excepting the CORSULA) measuring upto about 8 inches in length
MUSSAYAHRI	..	<i>Rita hastata</i> (Valenciennes)
NAHAM ..	..	<i>Megalops cyprinoides</i> (Broussonet), see also PANNIKOWA
NAUM ..	..	<i>Elops saurus</i> Linnæus
PANIA-AUNDA	..	<i>Trypauchen vagina</i> (Bloch & Schneider)
PANNIKOWA	..	<i>Megalops cyprinoides</i> (Broussonet), see also NAHAM
PATUA ..	..	Engraulids and occasionally small clupeids
	CHWALI-PATUA ..	<i>Anchoviella</i> spp.
	KOHNDA-PATUA ..	<i>Thrissocles</i> spp.
	KONA-PATUA ..	<i>Thrissocles</i> spp.
	RANJI-PATUA ..	<i>Kowala coval</i> (Cuvier)
PAREI ..	..	<i>Caranx (Caranx) sansum</i> (Forskål)
POBDA ..	..	<i>Ompok bimaculatus</i> (Bloch)
POTPOTIA	..	<i>Pseudorhombus arsius</i> (Hamilton)
ROHI ..	..	<i>Labeo rohita</i> (Hamilton)
SAHAL ..	..	<i>Eleutheronema tetradactylum</i> (Shaw) (Large size), see also BAISALI and SAHALIA

SAHALIA	..	<i>Eleutheronema tetradactylum</i> (Shaw) (between 6 inches and 9 inches in length), see also BAISALI and SAHAL
SAMADHO	..	<i>Teuthis vermiculata</i> (Kuhl & van Hasselt)
SANKUSH	..	<i>Dasyatis (Himantura) uarnak</i> (Forskål), see also SHANKAR
SARBARA	..	<i>Hemirhamphus gaimardi</i> (Valenciennes), see also EK-DANTI GANIA
SERANA ..	..	<i>Puntius sarana</i> (Hamilton)
SEULA ..	..	<i>Ophicephalus striatus</i> (Bloch)
SEBA KHAINGA	..	<i>Chanos chanos</i> (Forskål)
SHANKAR	..	<i>Dasyatis (Himantura) uarnak</i> (Forskål), see also SANKUSH
SUKURA ..	..	<i>Triacanthus brevirostris</i> (Temminck & Schlegel)
SUNGA ..	..	<i>Osteogeneiosus militaris</i> (Linnæus)
TADIKIRI	..	<i>Therapon puta</i> Cuvier
TAKARA ..	..	<i>Platycephalus indicus</i> (Linnæus)
TIRAN ..	..	<i>Caranx (Carangoides) preustus</i> (Bennet)
TODI ..	..	<i>Macrogathus aculeatus</i> (Bloch)

EXPLANATION OF PLATES

PLATE VI

- FIG. 1. A group of the sturdy Nulia fishermen of Arkhakuda setting out for fishing. Their village is seen in the background.
- FIG. 2. A view of an ordinary drag net in operation in a shallow area of the Lake.
- FIG. 3. Bamboo baskets for fresh fish export stacked near a fish godown.

PLATE VII

- FIG. 1. *Daudi* and *Thatta* set in the Lake for catching prawns.
- FIG. 2. Local retail dealers busy mixing Patua with sand before starting for their respective markets.
- FIG. 3. *Mani-jal* for catching Beloniform fishes hung up for drying.
- FIG. 4. Nets of various types, treated with preservative hung up for drying.

PLATE VIII

- FIG. 1. *Thatta* brought from Banpur stacked within a temporary enclosure of *thatta*.
- FIG. 2. Dry fish packed in palm leaves and gunny bags from Madras and Bombay States lying on the platform of Bhusandpur railway station for re-export.

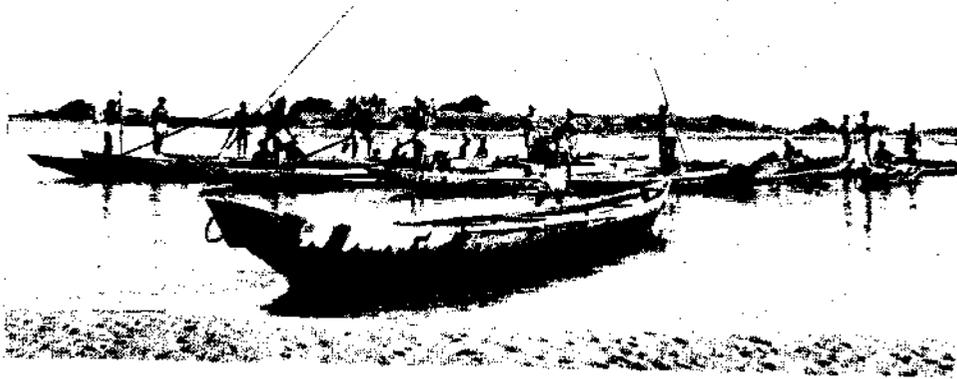


FIG. 1

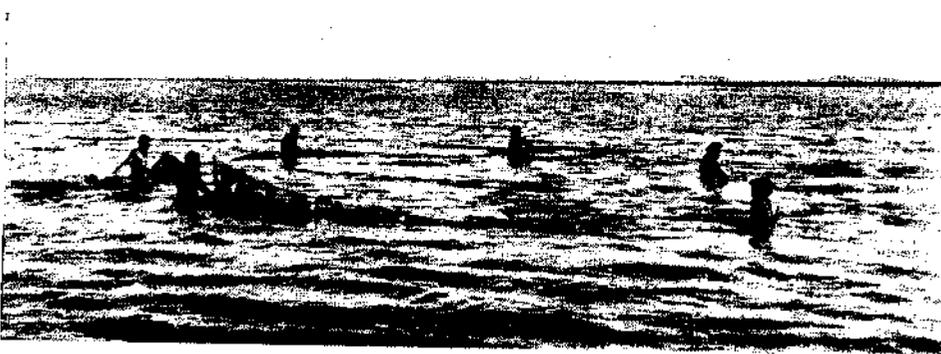


FIG. 2



FIG. 3

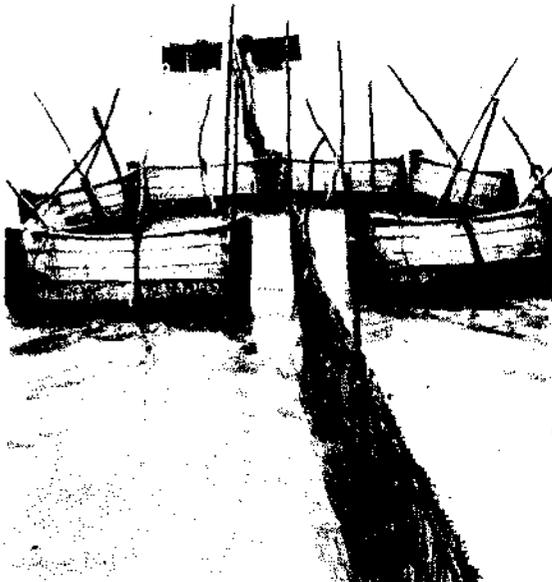


FIG. 1



FIG. 2



FIG. 3



FIG. 4



FIG. 1



FIG. 2