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# A Contribution to the Limnology of Colombo Lake

By

A. S. MENDIS

(*Fisheries Research Station, Colombo 3, Ceylon*)

## INTRODUCTION

The earliest recorded biological work in the Colombo Lake is by F. von Daday (1898). He described several species of animals from the lake, many of them being new to science. Later workers were Gurney (1906 and 1916), Apstein (1907), Lemmermann (1907), Crow (1923), Bär (1924) and Holsinger (1955).

In 1949 the Department of Fisheries converted a small portion of the lake, which formed a rectangular shaped bay, into an experimental pond (Wekande Pond—See Fig. 1). This pond was declared a fish sanctuary and stocked with *Osphronemus goramy*, Lacepede, *Etroplus suratensis* (Bloch) *Ctenopharyngodon idellus* (Valenciennes) and *Trichogaster pectoralis* (Regan) between 1949 and 1951. A net dragged in the pond in 1951 brought up only one adult *Osphronemus goramy*, but more specimens of this species were observed in the rocky portion of the pond where the net could not operate. In 1952 this pond ceased to be used for experimental purposes and two hundred *Tilapia mossambica* (Peters) fingerlings were introduced into the main lake.

In 1953 and 1954 the author made a preliminary qualitative limnological investigation of the lake and observed that there were enormous quantities of plankton and benthic fauna which were not being fully utilised by the fish. He recommended further stocking of the lake with *Tilapia mossambica* (Peters) a fish with omnivorous habits, and *Cyprinus carpio* Linnaeus a bottom feeder (unpublished report). Accordingly 2,250 fingerlings of *Tilapia mossambica* and 500 fingerlings of *Cyprinus carpio* were stocked in 1953. No further work was done on this lake till 1957.

Between 1957 and 1963 the author investigated the plankton, the benthic fauna and the fish fauna in the lake. The results of the investigation are reported in this paper.

## BACKGROUND INFORMATION

### Geography and Morphometry

The lake, popularly referred to as the "Beira Lake", is situated in the city of Colombo in the "Wet Zone" of Ceylon which receives an average rainfall of over 150 inches per year. The lake now covers an area of approximately 160 acres. Other morphometric data are given in Table I. The lake was larger in area several years ago but much of it has been reclaimed for building purposes. Even today small areas are being reclaimed for such purposes. A Port Commission dredger has been in use during the past few years.

TABLE I

MORPHOMETRIC DATA OF THE LAKE

| | |
|---|---|
| Area of lake .. .. | 64·8 hectares (160 acres) |
| Volume of water in the Lake .. .. | 1,872 × $10^3$ cu. m. |
| Maximum depth .. .. | 8·5 m. |
| Mean depth .. .. | 2·8 m. |
| Shore line .. .. .. | 11,315 m. |
| Shore development .. .. | 2·1 |

The lake is divided into two main parts, East Lake and South West Lake, connected by a broad canal termed West Lake (Fig. I). The lake has three outlets. A westward extension of West Lake termed the Galle Face Lake terminates at the Galle Face Spill. This is a 150 feet solid, level concrete spill across which the over-flow of the entire lake discharges into the open sea, southward of the harbour. East lake connects with Colombo harbour through a canal provided with lock gates which are opened only to allow the passage of boats and barges. East lake also connects with the Kelani River about 4 miles away, through the St. Sebastian Canal which is provided with lock gates.

The sides of the lake are built up in cement, sloping steeply except in the South-West Lake where the slope is now gradual due to heavy silting.

Several surface drains open into the lake. A large number of engineering and other commercial firms have their workshops bordering the lake and there is the possibility that their unwanted discharges find their way into the lake. The lake is rain-fed and it is possible that springs are present in its bed. It receives small quantities of water from the Kelani River by way of the lock gates in St. Sebastian Canal. There is also the ingress of negligible quantities of sea water when the lock gates near the harbour are operated to allow the passage of boats.

### Certain Other Characteristics

The lake has a characteristic green soapy appearance at most times of the year due to the presence of large quantities of phytoplankton (usually blue-green algae). Sufficient quantities of Copepods, Cladocerans and Rotifers are gathered daily from the lake in about twenty minutes by a tow net and used to feed several thousand fry in the fish nurseries at the Fisheries Research Station in Colombo.

Lake flies (Chironomid) in proportions to create a public nuisance were a feature around the lake prior to 1956. Correlated with this was the presence of their larvae in large numbers in the lake. These larvae were collected by aquaria owners to be used as fish feed. Such collections of larvae are no longer possible due to their absence in large numbers. The fly nuisance has also disappeared.

A feature of the lake is that, occasionally, unexplained and alarming mass mortality of fish occurs. Usually only big fish are affected but there has been no measure of the mortality rate in any size group of any species present. These mortalities have nearly always been observed to take place after very heavy overnight showers.

## PLANKTON

A Wisconsin type net with a mouth diameter of 30 cms. made of No. 20 bolting silk was used to collect plankton. A Juday plankton bucket attached to the end of the straining cone of the net received the plankton. From the bucket the plankton was transferred into bottles and 5% formalin was added as preservative.

Six total vertical hauls of plankton were obtained by hauling the net at approximateley 1 metre per second. These plankton hauls were made at depths ranging from 5.5 m. to 8.5 m. All plankton samples were taken in duplicate. One set was used in the quantitative determination of the dry weight of plankton while the other set was used in the qualitative examination for plankton forms.

Table II gives the analysis of the total vertical haul samples of plankton. Ricker (1932 and 1938) and Rawson (1953) have warned about variations in net efficiency. Rawson indicated that the net efficiencies vary from 25% to 55% and clogging of the net during hauling was considered the major factor affecting net efficiency. The nets used in Colombo Lake were fequently changed for new ones and were washed and dried each time they were used. However since Colombo Lake has large quantities of blue green algae which easily clog nets, the assumption is made that the efficiency of the nets used in Colombo Lake was only 25%. On this basis the average standing crop of dry plankton and organic matter in Colombo Lake are—

249·6 Kg./ha. (222·9 lbs./acre) and 197·4 Kg./ha. (175·8 lbs./acre) respectively.

TABLE II

ANALYSIS OF SAMPLES OF PLANKTON COLLECTED BY VERTICAL HAULS OF THE NET

| *Depth at which sample was taken* | *Dry Wt. plankton in g.* | *% Ash* | *Wt. of organic matter in g.* |
|---|---|---|---|
| 6·0 m. | 1·075 | 20 | 0·860 |
| 6·5 m. | 1·191 | 27 | 0·869 |
| 8·5 m. | 1·137 | 29 | 0·807 |
| 5·5 m. | 0·922 | 19 | 0·747 |
| 6·0 m. | 0·770 | 6 | 0·724 |
| 5·0 m. | 0·894 | 20 | 0·716 |
| | Av. 0·998 | | Av. 0·787 |
| | =249·6 Kg./ha* or 222·9 lbs./acre* | | =197·4 Kg./ha* or 175·8 lbs./acre* |

*Calculated on the assumption that the net was 25% efficient.

Qualitative examination of the plankton samples showed the presence of the following forms :-

Phytoplankton.

*Microcystis* sp. *Chroococcus* sp. *Pediastrum* sp. *Oscillatoria* sp. *Lyngbya* sp. *Scenedesmius* sp. *Coelosphaerium* sp. *Diatoma* sp. *Cyclotella* sp.

Zooplankton.

*Cyclops* sp. *Diaptomus* sp. *Euglena* sp. *Moinodaphnia* sp. *Macrothrix* sp. *Daphnia* sp. *Bosmina* sp. *Brachionus* sp.

## BOTTOM FAUNA

A six-inch Ekman dredge was used to bring up bottom sediment from an area 36 sq. ins. During the course of the study 138 dredge samples were taken. These samples were taken at random in different areas to cover different depths. The samples brought up by the dredge were washed through a shallow cone-shaped bag made of bolting silk having 32 meshes to the inch. Each washed sample was transferred to a large white enamel tray. The fauna was picked out from the tray and preserved in 70% alchohol. The dry weight of the fauna was obtained by placing it on filter paper for a minute or so to absorb any alcohol or other liquid adhering to the fauna and then weighing it. A six-foot handle net with hoop frame and a coarse sack cloth bag was also used to obtain mud from the shallow areas of the lake for qualitative examinations.

Analysis of the bottom fauna from the dredge samples is given in Table III. The samples have been distributed into four depth zones. The richest zone as far as number of organisms per unit area is concerned is 0–1·0 m. with 2,011 organisms per square metre. The next highest is the 2·1–3·0 m. zone with 1,468 organisms per sq. m. The high figure of 2,011 organisms per sq. m. in the 0–1·0 m. zone is due to the large number of *Cyclestheria* present in that zone.

## TABLE III

ANALYSIS OF BOTTOM FAUNA FROM DREDGE SAMPLES

| | *No. of Dredgings* | *Chironomid larvae* | *Amphipods* | *Gastropods* | *Oligochaetes* | *Dragonfly larvae* | *Cyclestheria* | *Nematodes* | *Leeches* | *No. of Organisms per sq. m.* | *Wet Wt. of Organism in Kg. per hectare** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0–1·0 m. | 31 | 562 | 10 | 18 | 53 | — | 802 | 2 | — | 2,011 | 14·51 |
| 1·1–2·0 m. | 79 | 1,189 | 241 | 276 | 104 | 3 | 138 | 2 | 1 | 1,063 | 27·21 |
| 2·1–3·0 m. | 17 | 315 | 226 | 19 | 20 | — | — | — | — | 1,468 | 36·38 |
| 3·1–8·5 m. | 11 | 68 | — | 7 | — | — | — | — | — | 293 | 1·84 |
| All Depths | 138 | 2,134 | 477 | 320 | 177 | 3 | 940 | 4 | 1 | 1,266 | 24·37 |

* Mollusc shell weight deducted.

The number of organisms per unit area is not a very suitable basis for comparison of the various zones. The dry weight of the dredge samples in kilograms per hectare increases from 14·51 in the 0–1·0 m. zone, through 27·21 in the 1·1–2·0 m. zone to 36·38 in the 2·1–3·0 m. zone. Below 3·1 m. the quantity of botom organisms drops to 1·84 kilograms per hectare. The average weight of bottom organisms for the entire lake is 24·37 kilograms per hectare.

Chironomid larvae and gastropods are present in all depth zones while oligochaetes were collected from dredgings taken up to 3·0 m. All other types of fauna were collected from dredgings taken at depths less than 2·1 m. Amphipods were collected only near the canal leading to the harbour. These amphipods have been indentified as *Grandidierella megnae*. This species has been reported from the brackish water Chilka lake in India. *Grandidierella* is probably present near the canal leading to the harbour on account of the ingress of small quantities of sea water into the lake at this spot making the water slightly saline there. *Cyclestheria* was the prédominent faunal type in the shallow (0–1·0 m.) zone.

Besides the fauna coming up in the Ekman dredge other bottom fauna collected included several species of leeches, ostracods, shrimps (*Caridina* spp.) and many adult Coleoptera and Hemiptera.

### FISH

The dominant species present in the lake in 1954 was *Glossogobius giuris* (Valenciennes) while large numbers of *Megalops cyprinoides* (Broussonet) and *Mugil* spp. were also present. *Puntius amphibius* (Valenciennes), *Elops machnata* (Forskal), *Ophicephalus striatus* Bloch, *Etroplus suratensis* (Bloch) and *Esomus danrica thermoicos* (Valenciennes) were the other species observed. Occassionally *Lates calcarifer* (Bloch), *Caranx* spp. and *Leiognathus* spp. were seen in the catches of the fishermen. The gear employed by them in capturing the fish were cast nets and rod and line.

In 1957 Colombo Lake was teeming with *Tilapia mossambica*, and a large number of fishermen (both adults and children) were engaged in capturing this species. The majority of the fishermen were using rod and line with earthworms as bait, while a few were using gill and cast nets to capture the fish. Fig. 2 shows a group fishing for *Tilapia* with rod and line and Fig. 3 the catch of two fishermen in approximately two hours fishing. Fishing was so heavy in 1957 that on certain days over 2,000 lbs. of *Tilapia* were removed from the lake. The average for the year was in the region of 1,000 lbs. per day which works out to about 2,000 lbs. of *Tilapia* per acre per year.

In 1963 a smaller number are fishing in the lake but it is estimated that the average catch per day has not appreciably decreased. In addition to the large quantity of adult fish taken by the commercial fishermen thousands of fry and fingerlings of *Tilapia* are removed by the Department of Fisheries for stocking of other water bodies in Ceylon.

The fishing pressure on the lake varies from day to day and season to season. Between May and October each year when there is a scarcity of marine fish along the western coast, the lake is heavily fished and the catches fetch a good price, *Tilapia* being sold for about 50 cts. per lb. in the market. When there is a glut of marine fish in the market, the fishing pressure on the lake is not heavy and the price of *Tilapia* falls to about 25 cts. per lb. Daily supplies of fish from the lake are railed to a few outstation towns like Maggona, Ratnapura and Balangoda.

Occasionally in addition to *Tilapia* (which now contitutes the dominant species) and those species mentioned above adult carp (*Cyprinus carpio*) have been reported in the catches. Some of these carp have weighed as much as ten pounds each and were sexually mature.

The entire catch of *Tilapia* from a single haul (2–3 hours) of a commercial fisherman's net was weighed and measured on 5 different occasions in 1957 and on 2 occasions in 1963. Table V gives an analysis of the lengths and weights of the fish examined in 1957 and 1963. The table indicates that both the average weight and the average length of the fish in 1963 have increased from the 1957 figures.

TABLE V

ANALYSIS OF LENGTHS AND WEIGHTS OF TILAPIA TAKEN FROM THE NETS OF A COMMERCIAL FISHERMAN

| Year | *Average weight per fish in g.* | | | Average total length per fish in cms. | | |
|---|---|---|---|---|---|---|
| | Females | Males | Entire Catch | Females | Males | Entire Catch |
| 1957* | 127 | 140 | 129 | 18·2 | 18·8 | 18·3 |
| 1963* | 149 | 174 | 155 | 20·1 | 22·1 | 20·5 |

* 226 fish were examined on five occasions in 1957 and 123 fish were examined on two occasions in 1963.

## DISCUSSION

The large quantities of algae present at all times of the year and the readiness with which large quantities of zooplankton can be collected from the lake are indications that the lake is extremely rich in both phyto-and zooplankton. The high figure of 249·6 Kg./ha. for the standing crop of plankton confirms the richness of the lake. In spite of the large fish populations in the lake, much of the plankton is not being utilized. Stocking of the lake with a plankton feeder, e.g., *Chanos chanos*, in large quantities is recommended.

The figure of 24·37 Kg./ha. for the standing crop of bottom fauna in the lake is low compared to some eutrophic lakes elsewhere in the world. This comparatively low figure is due to the small quantity (1·84 Kg./ha.) of bottom fauna at depths below 3·1 m. thereby reducing the average for the entire lake (24·37 Kg./ha.). A possible explanation for the paucity of fauna in the deeper zone may be found in the constant use of the Port Commission dredger during the past few years in East Lake wherein lies the deeper section of the lake.

Although no quantitative bottom fauna sampling was carried out prior to 1957, the absence of the fly (chironomid) nuisance and the inavailability of the larvae in large numbers in recent years is an indication that the quantity of chironomid larvae in the lake has dropped. Since these chironomid larvae contribute a considerable proportion to the total quantity of bottom fauna in the lake, it could be assumed that the standing crop of bottom fauna in the lake prior to 1957 was more than the present 24·37 Kg./ha. Indications are that the bottom fauna is being utilized to capacity by the fish fauna.

The introduction of exotic species of fish between 1951 and 1953 has altered the composition of fish in the lake. The effects of these introductions became very noticeable in 1957 when the lake was being fished heavily for *Tilapia mossambica* (Peters). *Glossogobius giuris* (Valenciennes) has now been replaced by *Tilapia* as the dominant species in the lake.

Contrary to popular notions the continued presence in the lake of the species of fish that were present prior to the introduction of *Tilapia* is an indication that *Tilapia* has not wiped out a single indigenous species from the lake. On the other hand *Tilapia* is almost solely responsible for the very high fish productive capacity of 2,000 lbs. per acre per year.

The increase in size of *Tilapia* and the negligible decrease in the quantity of this species being captured from the lake between 1957 and 1963 indicates that there is no depletion of stock. On the other hand the mass mortalities and the large scale removal of fry have helped to prevent overcrowding and stunting of fish.

With additional stocking of *Chanos chanos* (Forskal) the lake can be exploited further and produce more than the present 2,000 lbs. of fish per acre per year.

## SUMMARY

1. This paper records the results of investigations of plankton, benthic fauna and fish fauna carried out between 1957 and 1963.

2. The standing crop of net plankton in the lake was found to be 249·6 Kg./ha. This plankton is not being fully utilized by the fish fauna in the lake. Stocking the lake with a plankton feeder like *Chanos chanos* (Forskal) is recommended.

3. The figure of 24·37 Kg./ha. obtained for the standing crop of bottom fauna in the lake was comparatively low. This indicates that the bottom fauna is being fully utilized by the fish.

4. The introduction and establishment of *Tilapia mossambica* (Peters) had not wiped out a single indigenous species of fish from the lake.

5. The lake produces about 2,000 lbs. of fish per acre per year. This can be increased by the introduction of a plankton feeder (*Chanos chanos*), and by further exploitation of existing stock.

## REFERENCES

Apstein, C. 1907 : Das Plankton in Colombo See auf Ceylon. Zool. Jb. (Abt. Syst.) 25, 201–224.

Balasuriya, D. R. L, 1963 : Administration Report of the Director of Fisheries for 1961–62.

Bär, G., 1924 : Uber cladoceran von der Insel Ceylon (Fauna et Anatomia Ceylonica 14.) *Jena Z. Naturw.* 60, 83–126.

Brady, G. S., 1886 : Notes on entomostraca collected by Mr. Haly in Ceylon. *J. Linn. Soc. (Zool.)* 19, 293.

Crow, W. B., 1923 : Freshwater Plankton algae from Ceylon. *J. Rot.* 61, 111.

Daday, E. Von, 1898 : Microskopische Susswasserthiere aus Ceylon. *Termeszetr. Fuz.* 21, 1–123.

de Fonfeka, D. T. E. A., 1957–1963 : The Administration Reports of the Director of Fisheries for each of the years 1956–1961.

de Zylva, E. R. A., 1952 : Administration Report of the Acting Director of Fisheries for the years 1940–1950 (Pt. II, 1948–1950).

——— 1952 and 1953 : Administration Reports of the Acting Director of Fisheries for the years 1951 and 1952.

Fritsch, F. E., 1907 : A general consideration of the sub-aerial and freshwater algal flora of Ceylon, *Proc. Roy. Soc., B.* 79–197.

Gurney, R., 1906 : On two new entomostraca from Ceylon. *Spolia Zeylan.* 4, 126–134.

——— 1916 : On some fresh-water entomostraca from Ceylon. *Proc. Zool. Soc. Lond.*, 333–343.

Holsinger, E. C. T., 1955 (*a*) : The plankton algae of three Ceylon Lakes, *Hydrobiologia* 7, 8–24.

——— 1955 (*b*) : The distribution and periodicity of the phytoplankton of three Ceylon lakes. *Hydrobiologia* 7, 25–35.

Lemmermann, E., 1907 : Protophyten-Plancton von Ceylon. *Zool. Jahr.* 25, 263.

Rawson, D. S., 1953 : The standing crop of net plankton in lakes. *J. Fish. Res. Bd. Can. 10* (5), 224–237.

Ricker, W. E., 1932 : On adequate Quantitative Sampling of the Pelagic Net Plankton, *J. Fish. Res. Bd. Can. 4*, 19–32.

——— 1938 : The utility of nets in fresh-water plankton investigations. *Trans. Am. Fish. Soc.* 62, 292–303.

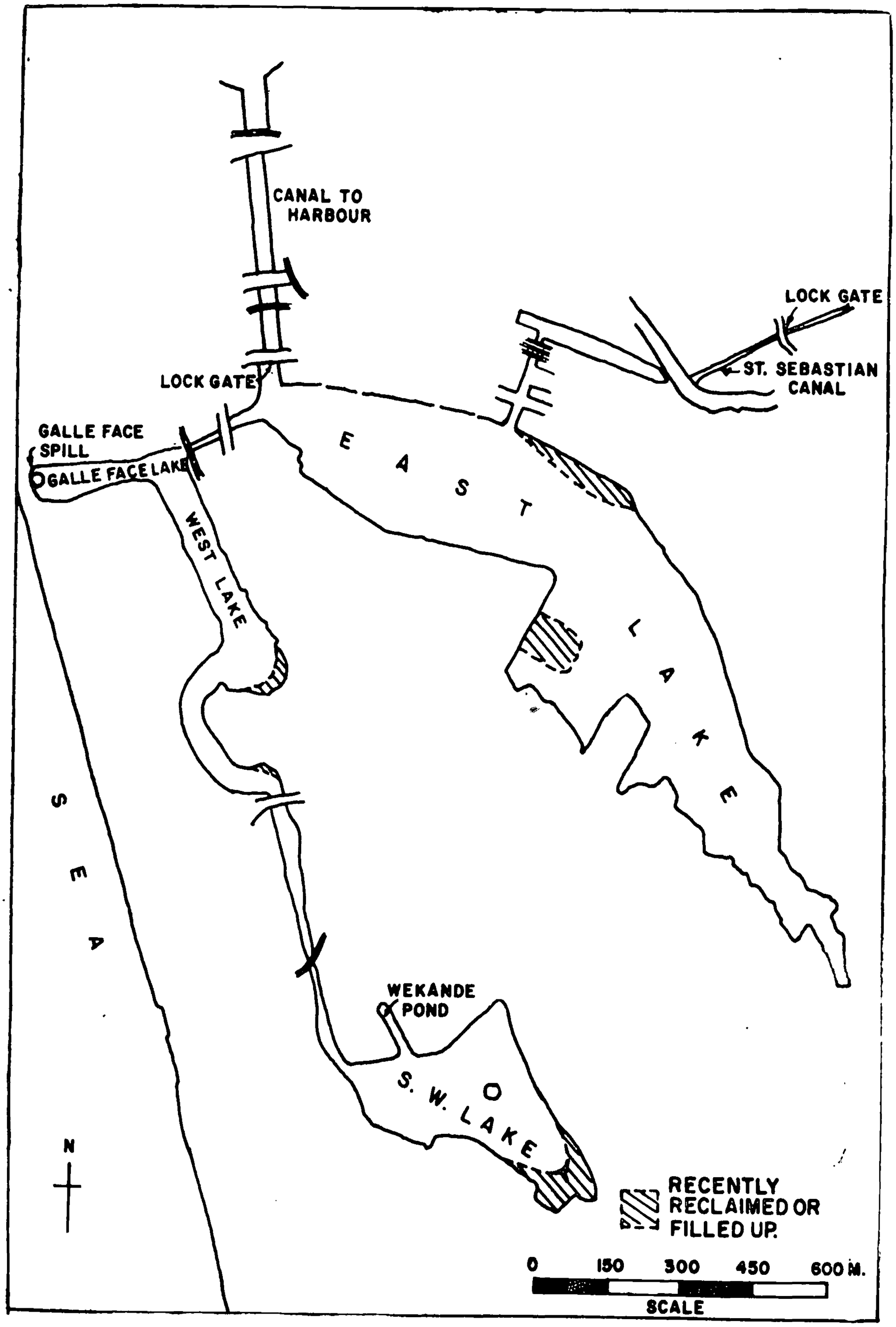


Fig 1. Outline Map of Colombo Lake.

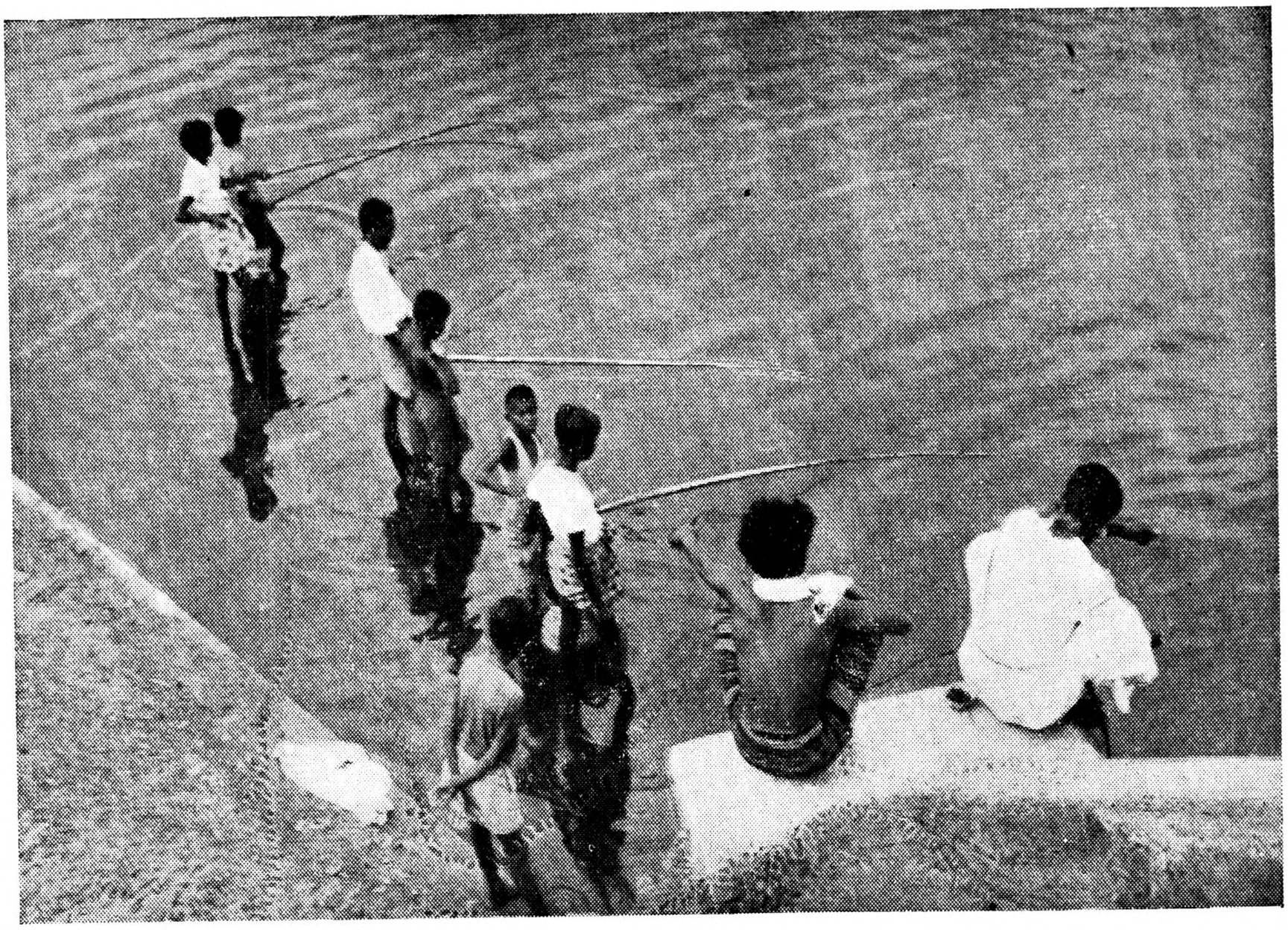

Fig. 2. A group of men and boys fishing for *Tilapia* in Colombo Lake. This was a familiar scene all round the lake in 1957.

Fig. 3. The fish caught by two fishermen in approximately two hours fishing. The average length of the fish was 17 cms. The total weight of catch was 12 Kg.