REPORT
ON THE FISH AND FISHERIES OF LAKE NYASA

BY

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ZOOLOGICAL LABORATORY AND GIRTON COLLEGE,
CAMBRIDGE

H. J. H. BORLEY
DISTRICT COMMISSIONER, NYASALAND

AND

ETHELWYNN TREWAVAS, D.Sc.
BRITISH MUSEUM (NATURAL HISTORY)

Price 12/6

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CONTENTS.

LIST OF ILLUSTRATIONS.

PREFACE.

THIS paper is the report of a Fishery Survey that was carried out on Lake Nyasa during 1939 in conjunction with the Nyasaland Nutrition Survey. The international situation prevented the continuation of the field work, so that the report must necessarily be incomplete in certain respects.

The report is a description of the work carried out by the three members of the Fishery Survey working together, and the recommendations are a joint opinion.

DR. RICARDO (Mrs. Bertram) is responsible for the general arrangement and writing of the report.

MR. BORLEY, however, wrote the sections in Part II on the Description of the Lake, the Description of the Fisheries, the Descriptions of Experiments with Gill Nets, and Fish Curing in the Experimental Section and the corresponding Appendices, and he shared the work of sorting out the native records. He gave up much of his leave in the autumn of 1939 to do this work.

DR. TREWAVAS wrote the preliminary description of the fauna, many of the notes on the *Tilapia* and other Cichlid species in the Section on Fish in Part II, supplied information on the systematics, and made out the lists and glossary of the Cichlidae in the Appendix.

Much of the information for the section on Fish in Native Economy was supplied by DR. PLATT and MISS BARKER of the Nutrition Survey.

The members of the Survey wish to take this opportunity of thanking the people, both in Africa and England, who helped and advised them. First, they would like to thank all the members of the Administration of Nyasaland who helped the Survey and, in particular, Mr. Ellis, Assistant Chief Secretary; Mr. Barker, District Commissioner at Fort Johnston; Messrs. Allan, Whitechurch, Parker, and Rangeley, District Commissioners and Assistant District Commissioners at Kota Kota; and Dr. Black of the Agricultural Department. They are also grateful to all the members of the Nutrition Survey; to Mr. Hughes, Master of the S.S. *Malonda*; Mr. Cazes; Mr. Tylor; Messrs. Yiannakis; and many members of the Universities Mission to Central Africa. The Survey would also like to acknowledge the courtesy of the Portuguese Government in allowing work among the fishermen on their shores.

Grateful thanks are also due to the Director and Trustees of the British Museum; Mr. Norman of the British Museum; Mr. Graham of the Fisheries Laboratory at Lowestoft; Dr. Worthington, Director of the Freshwater Biological Association; Dr. Reay, Director of the Torry Research Station at Aberdeen; Dr. Kemp, Director of the Marine Biological Laboratory at Plymouth; Mr. S. E. Chandler of the Imperial Institute; and the many other people at home and abroad who helped, both in person and by letter.

PART I.
Introduction.

IN 1938 a Nutrition Survey was started in Nyasaland under the leadership of Dr. B. S. Platt to investigate the state of nutrition of the native population of the Protectorate.* In addition to general survey work it was hoped to find methods of improving the health and standard of living of the natives. During this work it soon became clear that fish played an important part in native economy, and that no survey of Nyasaland would be complete—or full development of the natural resources possible—without a thorough investigation of Lake Nyasa itself. It should be noted that the lake occupies about a third of the whole country. In January, 1939, therefore, a Fishery Survey was started to study the lake and to work in connection with the main Nutrition Survey.

It has been found that many of the Nyasaland natives depend to a large extent on fish for their supply of protective food substances (proteins, minerals, especially calcium, and certain vitamins). With rare exceptions, however, fresh fish is not available to natives living more than about three miles away from the lake shore, though a crudely cured product is eagerly bought whenever possible by people living away from the lake. This dried fish is not only a welcome, but on nutritional grounds a desirable addition to the diet of these natives who otherwise rely on vegetable sources (legumes, green leafy vegetables, and some roots) for the protective principles in their diet. The importance of these protective foods will be appreciated when it is known that at least threequarters of the food consumed—measured in terms of its fuel value—is derived from a single staple, usually maize or kassava. An increase in the supply of fish would, therefore, greatly improve the diet of the natives living far from the lake.

Aims of the Survey.

(1) To make a survey of the existing fisheries on Lake Nyasa and to find the part played by fish in native economy.

(2) To attempt to make an estimate of the total fishery resources of the lake, and of the extent to which they are being utilised.

(3) To study how the resources should best be exploited so that the main stock of fish may not be damaged, and to see whether more fish and better fish products can be made available to the natives.

Data Required.

In order to carry out a survey of this kind, it was necessary to collect data on the following subjects:—

(1) The abundance of fish in the lake.
(2) The rate at which fish are produced in the lake. This will depend on the rate of breeding and the rate of growth of the various kinds of fish.
(3) The rate at which fish are being removed from the lake by fisheries and natural enemies.

* See Platt—Report of the Nutrition Survey.

(4) The biology of the different species of fish, including their movements, breeding habits, feeding habits, and interdependence.
(5) The efficiency of the present methods used for the capture, curing, and marketing of the fish.
(6) The food value and commercial value of local fish products.
(7) The possibilities of increasing the supply of fish by improvements in the existing fisheries and by stocking other waters.

Methods of Collecting Data.

The three main methods of collecting data were :—

(1) direct observation by the members of the Survey. This included—
  (*a*) the study of methods used in both the native and European fisheries,
  (*b*) the examination of the size and composition of the hauls of fish caught in these fisheries,
  (*c*) observations on the locality, size, gonad development, and stomach contents of all fish caught ;
(2) the employment of native recorders. The recorders were trained clerks who kept continuous records of the fishing at particular places on the lake shore ;
(3) experimental methods. Experimental work was planned to determine the rate of growth of fish and their movements in the lake ; to try out different methods of fishing ; to try different methods for curing fish and the production of various fish products ; to discover suitable fish for introducing into impounded waters.

Survey, general.

The personnel of the Survey consisted of : Dr. E. Trewavas of the British Museum (Natural History) ; Mr. H. J. H. Borley, seconded from the Nyasaland Administration ; and Dr. C. K. Ricardo* of the Zoological Laboratory and Girton College, Cambridge. Dr. G. A. C. Herklots of Hong Kong University kept the Fishery Survey in touch with the Nutrition Survey.

The Survey was financed by the Colonial Development Fund, except for Dr. Trewavas, who received a grant from the British Museum.

The original plans were for the Survey party to work for six months in Nyasaland. In England information about fishing seasons was scarce, but it appeared that the main breeding season of the fish was during the rains (December to April), and in spite of very short notice the party left England at the end of December to see as much as possible of the breeding season. It soon became clear that by the middle of January large parts of both the fishing and breeding seasons were already over. Luckily, it was then found possible to extend the Survey to cover the whole year.

After six months in the field, spent mainly in making general surveys of the fisheries round the lake† and the habits of the different fish, Dr. Trewavas had to return to the British Museum, and Dr. Herklots to China. Dr. Ricardo also came back to England in June for three months to work out the results of the first part of the expedition and to consult with authorities at home on methods of improving fish curing and other fishery problems. She had plans to return to Nyasaland early in September to continue the Survey till January, and to study the fishery during the most important fishing and breeding seasons. Meanwhile, Mr. Borley remained in Nyasaland carrying on the field

* Now Mrs. Ricardo Bertram.
† See Appendix I for details of itinerary and work.

work and starting experimental work on fish curing. In August he too returned to England in order to discuss the work. The outbreak of war then made it impracticable for Dr. Ricardo to go back to Nyasaland in September, and the remaining part of the Survey had to be postponed.

The effects of this curtailment are* :—

(1) the first parts of the main fishing and breeding seasons have not been studied, so that there are certain gaps in the information both on the fisheries and on the habits of the fish ;
(2) the experimental work has not yet been carried as far as had been planned ;
(3) it is not possible to make quite as many suggestions for immediate development as had been hoped.

However, the Nutrition Unit recently formed to continue work in Nyasaland on nutrition problems, includes one of the members of the Fishery Survey. It should, therefore, be possible for him to complete the Survey, fill in many of the gaps in the present information, and carry out further observational and experimental work which will lead to a fuller understanding of the fish stocks of the lake and the ways in which they may best be exploited.

Summary of Recommendations.

(1) As a result of the Survey it is believed that the fisheries of Lake Nyasa could be enlarged without damage to the stock of fish. Further evidence over a longer period is desirable to confirm this conclusion.

(2) Since there is a need for more fish in the diet of the natives—particularly of those living in the hills—the fisheries should be encouraged to produce more fish and better fish products.

(3) It is vitally important that any extension or enlargement of the fisheries should be carried out under the control of some officer fully competent to judge the effect of the extension.

(4) The question whether most of the enlargement should be carried out in the European fisheries or in the native fisheries is outside the scope of this report. An increase in the European fisheries, so that the catch is three times as large as at present, as well as enlargement of the native fisheries should be possible without damaging the stock of fish.

(5) If there is to be any extension of European fisheries, the following points are essential :—
  (*a*) The number of fishing licences granted should be limited.
  (*b*) The licensee should keep statistics of his fishery and thus co-operate with the officer in control of fisheries in finding out about the size of the stock and the amount of fishing it can support.
  (*c*) The sites for the new fisheries should be chosen so that they do not interfere with any established native fishing beach.
  (*d*) The licensee should submit to mesh regulations if they are found to be necessary in the future. At present no new seine nets or gill nets for use in the lake should have a mesh of less than $3\frac{1}{2}$ inches and 5 inches respectively.

(6) The native fisheries are of great importance to the native population of the Protectorate, and they should be encouraged as much as possible.

(7) In order to encourage and help the native fisheries, it is important to :—
  (*a*) build up and organise the fish trade, which will include turning the desire for fish into a conscious demand for fish among the natives in the hills, and improvements in the methods of transport and marketing ;

* This report was completed in April, 1940, and does not include any record of work since done by Mr. Borley in Nyasaland (E.T., June, 1942).

(*b*) improve the material and gear used in the fisheries ;

(*c*) improve the methods of curing ;

(*d*) introduce methods of control where the stock is being damaged by the fishery.

(8) It is very desirable that careful statistics of fisheries should be kept wherever possible, so that information may be collected on the following points :—

(*a*) The amount of fishing and the effectiveness of the various methods.

(*b*) The size of the catches and their seasonal variation.

(*c*) The size of the fish and the proportion of immature and breeding fish in the catches.

From these data it should be possible to determine the optimum rate of fishing and to see whether the stock is being overfished.

(9) The experimental work started should certainly be continued and enlarged. This should include the following subjects :—

(*a*) Fish marking to show the movements of the fish in the lake and the proportion of the stock being removed by the fishery.

(*b*) Gill nets should be used to catch fish other than the present main commercial species, to reduce the number of predators and to discover the optimum size of mesh.

(*c*) Methods of improving fishing gear should be studied, particularly preservatives for nets and ropes, methods of twisting for making stronger twines and ropes, and methods of constructing cheaper and better boats.

(*d*) Experiments on methods of curing should be continued—particularly smoking and salting —and investigations should be made into the possibilities of producing other fish products.

(*e*) Studies should be made of the purchasing power of the native in the hills and the best methods of building up a fish trade.

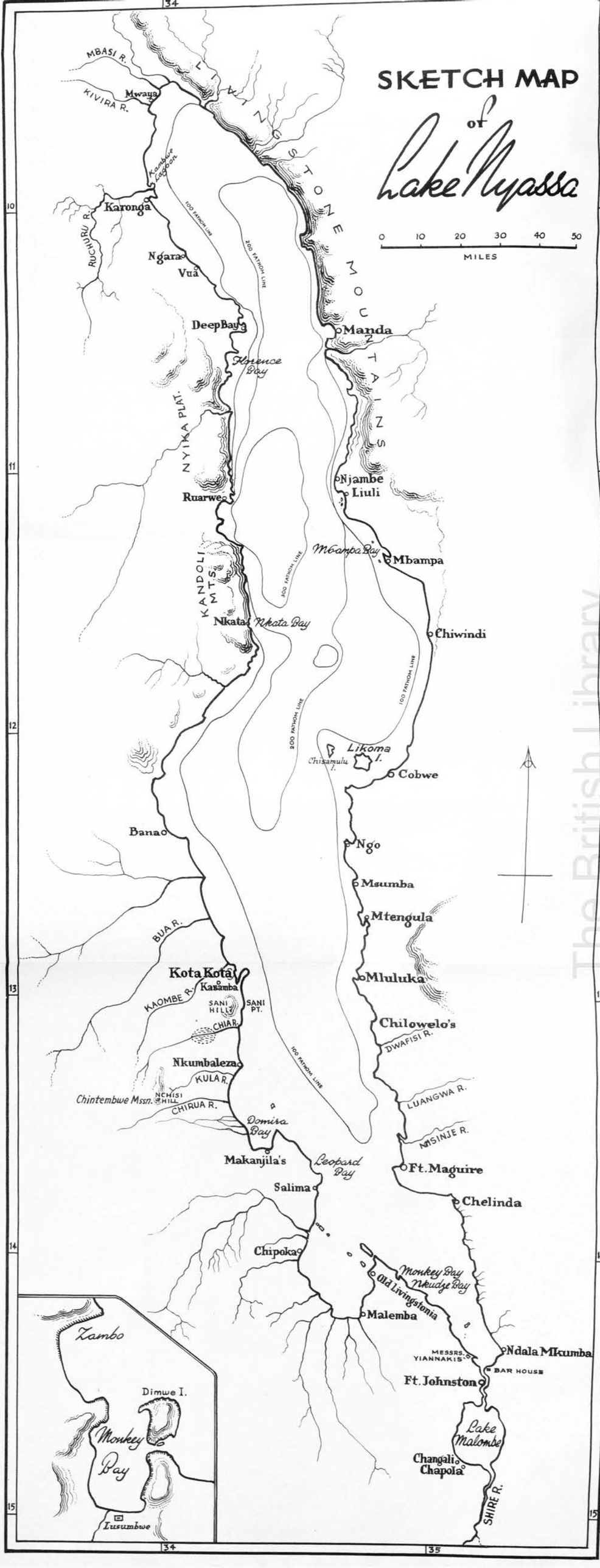
(*f*) The stocking of impounded waters should continue, to increase the supply of fish in the hills.

(10) It is also extremely important that biological observations should be continued. These should include :—

(*a*) studies on the breeding, rate of growth, and habits of many of the fish—particularly of *Tilapia*, *Labeo*, *Barbus*, *Haplochromis*, *Clarias*, *Barilius*, and *Engraulicypris* ;

(*b*) observations on the food of fish-eating birds and crocodiles to see to what extent they are feeding on the commercial species.

(11) Control of the level of the lake would facilitate any increase in the fisheries and all development of the lake.


SKETCH MAP
of
Lake Nyassa
0 10 20 30 40 50
MILES
MBASI R.
KIVIRA R.
Mwaya
Karonga
Karonga Lagoon
RUCHURU R.
100 FATHOM LINE
200 FATHOM LINE
Ngara
Vua
Deep Bay
Florence Bay
NYIKA PLAT.
Ruarwe
KANDOLI MTS.
Nkata
Nkata Bay
Manda
STONE MOCTAIZS
Njambe
Liuli
Mbampa Bay
Mbampa
Chiwindi
Likoma I.
Chisamulu I.
Cobwe
Bana
Ngo
Msumba
Mtengula
Mluluka
Chilowelo's
DWAFISI R.
LUANGWA R.
MSINJE R.
Ft. Maguire
Chelinda
Salima
Leopard Bay
Makanjila's
Domira Bay
Chipoka
Monkey Bay
Nkudye Bay
Old Livingstonia
Malemba
MESSRS. YIANNAKIS
Ndala Mkumba
BAR HOUSE
Ft. Johnston
Lake Malombe
Changali
Chapola
SHIRE R.
BUA R.
Kota Kota
Kasamba
KAOMBE R.
SANI HILL
SANI PT.
CHIA R.
Nkumbaleza
KULA R.
Chintembwe Mssn.
NCHISI HILL
CHIRUA R.
100 FATHOM LINE
200 FATHOM LINE
100 FATHOM LINE
200 FATHOM LINE
Zambo
Dimwe I.
Monkey Bay
Iusumbwe
10
11
12
13
14
15
34
35

PART II.

A. Description of the Lake.

TOPOGRAPHY.

General.

Lake Nyasa, the third largest of the African lakes, lies near the southern end of the Rift Valley, and stretches from 9° 29′ S. to 14° 25′ S. in a direction slightly east of south. (See map, fig. 1.*) It is 350 miles long, and about 50 miles wide at its widest part. At 14° S. it splits into two arms, one of which continues in the main direction of the lake, while the other runs off at a slight angle to the south-west. Both arms are about twelve miles wide. The Rift continues southwards, and along it runs the Shire River, which is the only outlet of the lake. The area of the lake is some 11,000 square miles, and its surface has been variously estimated at 1,500 to 1,665 feet above sea level. The ground on either side consists of high plateaux. Althouth there is a fairly wide plain between the scarps and the lake in its southern half, in the northern region the scarps of the plateaux come close to the shore on both sides. Thus, on the western side the land rises steeply to the Vipya and Nyika plateaux (4,500 feet and 7,000 feet respectively), and on the eastern side to the Kinga (or Livingstone) Mountains (8,000 feet) and the hills south of them as far as lat. 13° S.

The lake was first surveyed in detail by Commander, then Lieutenant, Rhoades (1902). His charts show that the contour of the bottom conforms, broadly speaking, to the trough-like nature of the Rift Valley, the areas of deeper water running longitudinally down the central part of the lake. There is a fairly close agreement between the angle of slope of the land above and below water, so that the areas of greatest depth occur in the northern portion of the lake where the scarps rise sheer from the lake shore. Nearly the whole of the southern part of the lake, fringed as it is by plains, is comparatively shallow, being under 100 fathoms in depth. The deepest sounding recorded by Rhoades was 386 fathoms, at 11° 10″ S.

Description of shore-line.

The lake shore may be divided into six areas for descriptive purposes.

(*a*) THE SOUTH-WEST ARM AND THE WEST SIDE NORTHWARDS TO NKATA BAY.

This stretch of shore-line is for the most part gently curving and of gradual slope, and consists of sandy beaches or mud flats running out under water for a considerable distance. Immediately behind the beaches lie tracts of low scrub " bush " country, very little higher than the lake itself and often flooded and marshy in the rainy season. It is mostly fairly thickly wooded with small trees 10 to 20 feet high, which give way to reeds and coarse grass where the wide marshy river valleys wind down to the lake. Much of the shore-line and all the river mouths are obstructed by dense growths of reed (*Phragmites communis*), especially where the conformation gives protection from the southerly winter

* This sketch map was drawn by Mr. A. Fraser-Brunner, and is based on Admiralty map 3134 (1935), scale 4 miles to the inch ; on the map of scale $\frac{1}{1,000,000}$ compiled in the Geographical Section, General Staff (1906), revised and reprinted at the War Office in 1923 ; and on the map G.S., G.S. 3026, Ordnance Survey 1916, scale $\frac{1}{3000000}$ sheets F3 and 4, G4.

gales. These reeds are present in all parts of the lake, wherever there is shelter and a gradually sloping shore. They appear sometimes in isolated groups standing in the water and sometimes as a long hedge-like growth 5 to 20 feet in width, which completely prevents access to the shore and covers the beach. Sometimes the larger bays in this area, notably Domira Bay and Kota Kota Bight, become choked with " sudd," which consists of clumps of reeds washed out of the river mouths during the rains. These float for a time as small islands in the lake, and may be driven into such protected places by the wind, remaining there until some shift of the weather drives them out into the lake again. There are, however, considerable stretches of open, smooth beach, of which the most notable are those at Chipoka, Salima, Mkumbaleza, and Kota Kota. Small beaches are found intermittently all the way up the west side as far north as Nkata Bay. North of the Dwambazi River, spurs of the Vipya range begin to run directly into the lake, and the beaches are much split up by rocky outcrops and headlands. Important rivers of this section of the lake shore are the Lintippe, Chirua, Bua, Dwangwa, Dwambazi, and Luweya, and there are many smaller streams.

(*b*) The west side from Nkata Bay northwards to Florence Bay.

Here the scarps of the Vipya and Nyika plateaux come close to the lake, and the coast line is characterised by rocky headlands, small narrow inlets, and underwater reefs. Many of the inlets have small beaches at the back, but the only considerable ones are those at Usisya Bay, Deep Bay, and Florence Bay, and even these do not compare in size with the beaches at the southern end of the lake.

(*c*) The north-west corner of the lake.

Here the scarp of the Nyika runs some distance from the shore-line, and there is a comparatively wide plain, through which run the Rukuru and Songwe Rivers. In this area stretches of sandy beach with intermittent reed clumps are again to be met with.

(*d*) The north-east corner and east side as far south as Mbampa Bay.

In this stretch the Kinga Mountains and their adjoining hills lie close to the lake, and the shore-line is similar to that between Nkata Bay and Florence Bay, but much steeper. Only in the shelter of Mbampa Bay itself, and on the edge of the plains about the mouth of the Ruhuhu River are there considerable beaches.

(*e*) The central portion of the east side as far south as Fort Maguire.

Much of this shore is rocky and without beaches, but there is a good stretch of open beach near the mouth of the Kobwe River. Likoma and Chisamulo Islands are themselves steep and rocky, and there are few beaches except at the heads of the small inlets. South of Malo Point the stretches of beach become larger and more frequent, in correlation with the decreasing height of the land immediately fringing the lake, though underwater reefs and rocks are still present.

(*f*) The south-east arm.

From Fort Maguire southwards to the bar of the Shire River, the lake is fringed by low-lying land, and there is a great stretch of beach running all round the northern horn of the bight below Fort Maguire. A reef of rocks runs parallel to this beach a mile or two off shore. There are beaches in the southern portion of the arm, but they tend to be obstructed by reeds. In the neighbourhood of Monkey Bay, on the north-east corner of the peninsula which divides the south-west from the south-east arm, the hills again come down to the lake shore with consequent absence of beaches, except at the heads of the bights.

HYDROGRAPHY.

Some hydrographical observations were made, and the results (Appendix II) are summarised below :—

Clearness of the water.

(1) The water varied considerably in clearness. In the middle of the lake it was extremely clear, and Secchi's disc was visible to a depth of 14 metres.

Temperature.

(2) (*a*) The temperature of the surface water varied between 21·4° C. and 28·1°C., and the average for 67 readings was 24·9° C. During March and April, the readings were all over 26° C., but after the beginning of May the values dropped to well below 25° C.

(*b*) Temperature Gradient.

There is a difference in temperature of 3° to 4° between the surface water and the deep water. The figures suggest that the temperature does not decrease regularly with increase of depth, but that there is a thermocline.

Hydrogen ion concentration.

(3) The pH of the surface water varied between 8·2 and 8·6, and the average of 15 readings was 8·4. The value for pH decreased slightly in the deep water, and the figure for a sample from 165 fathoms was just under 8·0.

Alkalinity and phosphate.

(4) The average value for the alkalinity is ·0025 N, and this is about the same as the alkalinity of Lake Naivasha and Lake George (Beadle, 1932, p. 205). The phosphate content varies considerably both in the different parts of the lake and at different depths. The values ranged from 0·02 to 0·15 parts per million.

Oxygen content.

(5) The average value for the oxygen content of the surface water is 5·15 ml/litre. The amount of oxygen diminished with an increase of depth and at 165 fathoms (302 metres) there was practically none present.

Currents.

(6) The only current observed—other than those obviously attributable to wind action or the outflow of rivers—was an extremely strong set southwards in the channel between Likoma Island and the mainland. This was sufficiently strong to hold the lake steamer *Malonda* at right angles to a force four wind from the south when she was at anchor.

Further and more detailed work on the hydrography of the lake is being carried out by Mr. R. S. A. Beauchamp. Since he proposed to concentrate on the hydrography it was considered unnecessary for the members of the Fishery Survey to make further observations.

CLIMATE.

Rainfall.

The climate of Nyasaland is similar to that of the rest of central East Africa. The rainfall is confined to the period from November to April. On Lake Nyasa the rains are usually heaviest in the period from December to February, and continue slightly later in the northern part of the lake than in the southern portion. The average annual rainfall in the southern part of the lake, as recorded at Fort Johnston, is about 28 inches, while the more northern stations of Kota Kota, Chinteche, and

Karonga show 50 inches, 70 inches, and 40 inches respectively (see Nyasaland Handbook). Rain falls mainly in storms of considerable violence, alternating with fine periods.

Temperature.

The months of April, May, June, and July are cold. During August and September the temperature gradually rises and reaches a maximum in November and December, just before the rainy season starts, though there is local variation in the time of greatest heat. January, February, and March show a gradual decline in temperature. Figures from official records summarised for the five years before 1933 show mean minimum temperatures of 64°, 64°, and 65° Fahrenheit for Karonga, Kota Kota, and Fort Johnston respectively, while mean maxima are given as 88°, 97°, and 85° Fahrenheit for the same stations. Absolute maxima are given as 99°, 106°, and 105° Fahrenheit. Figures for the maximum and minimum thermometer readings taken by the Survey are given in Appendix II.

Winds.

From August to December the winds are mostly light and easterly or north-easterly, though strong from the east at times. The prevailing wind is from the north during January and February, and is often strong. The rest of the year, from March to August, is the main windy season. During these months, although local north or easterly winds may occur, the prevailing wind is south-east or south, often remaining at about 35 m.p.h. for several days on end, and reaching a considerably greater force in squalls. A very strong wind from the south, after it has blown for three or four days, is usually succeeded by a quiet period, but the wind soon begins again and gradually works up to a climax. This continual pressure from the south sets up a heavy swell which seldom dies away during the calm periods. While the wind is blowing strongly a big, short sea is set up—particularly in the narrower parts of the lake. These south winds often prevent fishing and interfere considerably with shipping on the lake, especially at the northern end.

Morning and evening breezes to and from the lake are also to be found—particularly on the eastern side—which is somewhat sheltered from the south-easterly gales.

A table of wind directions, as observed by the Survey, is to be found in Appendix II.

VARIATIONS IN WATER LEVEL.

Lake Nyasa, like the other large African lakes, is subject to variations in surface level. These are of two types :—

(*a*) An annual variation of level due to the differences in precipitation, inflow, and evaporation during the wet and dry seasons. This is of the order of four feet, but varies slightly.

(*b*) A variation in mean annual level over a long period of years. This variation appears to be due to differences in precipitation and evaporation which are possibly connected with a cyclic variation in solar activity. (Dixey, 1924 ; Gillman, 1933.)

Thus, the mean annual level, which stood at about 65 inches above datum in 1896, rose to 70 inches in 1898, and sank to 35 inches in 1902. Thereafter it rose gradually to 50 inches in 1906, but sank again to 15 inches between 1906 and 1915. The level rose till 1917, dropped in 1920, and then rose through the succeeding years, stood at 60 inches in 1924, and continued to rise till it reached 94 inches above datum in 1931. Up to 1924 the mean annual level in some of the other African lakes rose and fell in a similar way, but after this date Lake Nyasa began to differ from the others. In most cases the levels began to fall after 1924, but in Lake Nyasa it continued to rise and reached the highest figure ever yet recorded. Since 1931 it has fallen slightly.

The abnormal rise after 1924 appears to have been caused by the reduction in outflow through the Shire River, which probably became silted up after 1914–15 when the level of the lake was low.

Effect of variation of water level.

The effect of this rise of water level on the agricultural and fishing populations of the lake shore is enormous. Large areas of once profitable rice fields have been flooded to a depth of several feet, and rendered useless. At many places the rising water has covered reefs and washed away sandspits, so that the shelter they once afforded has disappeared. Though many important beaches remain, many others have had their fishing value impaired or destroyed. It has already been stated that the greater part of the land immediately fringing the southern shores of the lake is low-lying, and covered with scrub bush containing many small trees. The rise of the water above its normal level therefore means that much of the shore-line now runs through an area of dead trees and stumps, which make the working of a seine net almost impossible, so that many communities have had to abandon this, the most favoured, method of fishing.

The effect of the rise on the fish is much more difficult to estimate. It is beneficial to the stock in that it reduces the number of nets worked, but it may be that the washing away of sandspits and covering of reefs has spoiled some of the feeding and breeding grounds. Again the effect on the rivers, which are the spawning grounds of many of the lake species, is not to be overlooked. The rise of the lake has greatly reduced the rate of flow of the last few miles of some of the rivers, and the tendency to form marshy and semi-stagnant deltas, unsuitable for the breeding grounds of fish, has thus been increased.

Unless active steps are taken the lake will continue to undergo these fluctuations indefinitely with the same ill effects on fishing, agriculture, and drainage. Control of the lake level—by keeping the outlet of the lake free from obstructions, would help not only the fishermen and inhabitants near the shores but would also have far reaching effects on the country. The fishermen would have the advantage that they could then clear large areas of beach for fishing without the fear that the beach would be either completely dry or too deeply submerged in later years. They would be able to build small jetties to give sheltered anchorages so that they could use larger boats and not always have to haul all boats out of the water after use as at present. Both they and the cultivators near the shore would benefit by the increased lake transport that would become possible as soon as larger boats could be used and permanent landing stages built.

Stabilisation of the lake level would also benefit the country as a whole by controlling the rate of flow of some of the rivers. This, in turn, would reduce soil erosion—for the erosion is always rapid when a river is constantly changing its speed. Soil conservation is intimately connected with the problems of water conservation and re-afforestation, and it may be pointed out here that the fisheries would gain from re-afforestation, in that timber for boats and fibres and preservatives for nets and ropes could all be grown within reach of the fishermen.

B. Description of the Fish.

THE FISH FAUNA.

The first fish were collected from Lake Nyasa by Sir John Kirk when he was accompanying Livingstone on his travels. No more collections were made for about 30 years when Sir H. H. Johnston sent many specimens to the British Museum in 1893. Both Professor J. E. S. Moore, accompanied by Commander Rhoades, and Dr. Cunnington made collections in the lake on their way up to Lake Tanganyika between 1895 and 1905. There is also a collection of fish from Lake Nyasa in the Berlin Museum, made about this time. In 1920 a large collection was sent to the British Museum by Mr. Rodney Wood, and another in 1925 by Dr. Cuthbert Christy. These collections were studied by

Regan (1921), Trewavas (1931 and 1935), and Worthington (1933), with the result that the large total of 223 species has been recorded from the lake. The fish collected by the Fishery Survey also included some new species, one of which is the important *Tilapia lidole*, described below.

This great wealth of species is a remarkable character of the fish fauna of Lake Nyasa, which is considerably richer even than that of Lake Tanganyika. No less remarkable is the fact that 194 of the species are endemic ; that is they are found only in the lake and not in any other region. The single Percoid family, Cichlidae, is mainly responsible for these high numbers, and it provides 178 species, of which only four are found elsewhere.

Geographical distribution.

The high proportion of endemic fish suggests that the lake has been isolated, so far as fish are concerned, from the neighbouring drainage systems for a long time, though the family Cichlidae is believed to evolve faster than most other African families. The 29 non-endemic fish show that Lake Nyasa has faunal relations with the Zambezi system and the eastward flowing rivers of Tanganyika Territory, Portuguese East Africa, and Zululand (see Appendix V). Nineteen of these species occur in the Zambezi system showing that the lake was probably at one time in direct communication with that system, although it is now separated by the Murchison Rapids on the Shire River. Worthington in 1933 drew attention to the large common element in the faunas of Lake Nyasa and the Bangweulu Region. This does not mean, however, that the connection between the two regions has necessarily been direct. The similarities are probably due to both regions having been in communication with the Zambezi system. Seventeen out of the nineteen species common to Lake Nyasa and the Bangweulu Region are also found in the Zambezi Basin.

Nyasa has nine species in common with Lake Tanganyika. Their distribution shows that they might all have entered the two lakes independently, three from the Congo Basin (by way of the Luapula-Zambezi watershed), three from East African rivers, and three from either the Congo or East Africa. There is no evidence, therefore, to show that a direct connection ever existed between these two great lakes. *They have only one Cichlid species in common*, but each has its own large and varied endemic Cichlid fauna.

In passing it is interesting to note that two groups of fishes that passed their zenith in distant geological epochs, and which are represented in Africa to-day by the lung-fish *Protopterus* and the reed-fish *Polypterus*, have never been recorded from Nyasa, although *Protopterus* has been found in the Zambezi.

Ecology.

Although many collections had been made in Lake Nyasa, the ecology of the fish had never been studied. As a result of the Survey the habits of the commoner species are now described in some detail and a general picture has been built up of the life of the fish in the lake.

The non-Cichlid part of the fauna includes one zooplankton* feeder, the sardine-like *Engraulicypris* (Usipa) ; two mud-feeding species of *Labeo* ; a few species that feed on insect larvae and snails ; the actively fish-preying *Barilius* species (Sanjika and Mpasa) and *Barbus rhoadesii* ; and the lurking predators *Bagrus* (Kampango), *Clarias*, and *Mastacembelus*.

The 178 species of Cichlidae include almost every kind of feeding habit except parasitism. Four species of *Tilapia* feed on phytoplankton† and perhaps on mud-dwelling algae also, others feed on plant debris ; many species of *Haplochromis*, including the Utaka group, feed on zooplankton* ; the

* Small floating animal life, here mainly Crustacea.
† Microscopic floating plant life.

species of *Lethrinops* and several others pick up bottom-dwelling insect larvae ; the several genera known as Chindongo or Rock-fish scrape a living from the algal slime covering the rocks ; a few species are equipped with heavy grinding teeth and feed on water-snails ; a few are scavengers ; and a large number prey on the young of other fishes and on the adults of small species like Usipa and Utaka. The chief predator genus is *Rhamphochromis* (Mcheni or Sangwe) with eight species, all active, open-water fish, slender and silvery. *Serranochromis* (Sungwa or Chiuwa), also found in the Zambezi and the Bangweulu Region, is another active predator. Many species of *Haplochromis*, although growing to no great size, take a steady toll of young fish. Finally, there are the half-hearted predators *Docimodus* and *Corematodus* which bite or rasp pieces from the fins of other fishes.

It should be remembered that so far knowledge of the fish in Lake Nyasa is entirely confined to those caught within 20 fathoms of the surface. Below this top layer, any fish in the great depths of the lake remain unknown.

LIST OF IMPORTANT SPECIES WITH KEY AND SKETCHES FOR THEIR IDENTIFICATION.

A list is given below of the commoner fish in the lake, arranged as far as possible, in the order of their economic importance. The most usual native names are added to the list. For further names recorded for the different species see Appendices III and IV.

List of the more important fish.

	Scientific name.	*Commonest native names.*	*Family.*	*Page.*
1.	*Tilapia squamipinnis*	Chambo, Kayawa, Ching'anga, Ngwalu, Kasawala	Cichlidae	25
2.	*Tilapia shirana*	Katukusi, Nkututu	Cichlidae	37
3.	*Labeo mesops*	Nchira	Cyprinidae	41
4.	*Haplochromis* spp.	Utaka	Cichlidae	43
5.	*Bagrus meridionalis*	Kampango	*Bagridae	45
6.	*Clarias* spp.	Mlamba, Sapuwa, Nkomo, Kwazula, Sawasawa, Bombe ..	*Clariidae	47
7.	*Barilius microlepis*	Mpasa	Cyprinidae	50
8.	*Barilius microcephalus*	Sanjika	Cyprinidae	51
	Barbus eurystomus	Kadyakola, Kuyu	Cyprinidae	52
	Tilapia lidole	Lidole, Lolo	Cichlidae	34
9.	*Engraulicypris sardella*	Usipa	Cyprinidae	53
10.	*Serranochromis thumbergi* ..	Sungwa, Chiuwa	Cichlidae	55
	Rhamphochromis spp.	Mcheni, Sangwe, Kekena ..	Cichlidae	56
	Tilapia melanopleura	Katukusi, Ningwichali ..	Cichlidae	39
	Barbus rhoadesii	Tamba	Cyprinidae ..	53
	Barbus johnstonii	Ngumbo	Cyprinidae ..	54
	Mormyrus longirostris	Mbelewele, Panda	Mormyridae ..	57
11.	*Synodontis zambesensis*	Kolokolo, Njekayeka	*Mochochidae ..	59
	Labeo cylindricus	Ningwi	Cyprinidae	43
	Mormyrops deliciosus	Nyanda, Ngondi	Mormyridae ..	58

* Families marked thus are Catfishes and all used to be known as Siluridae.

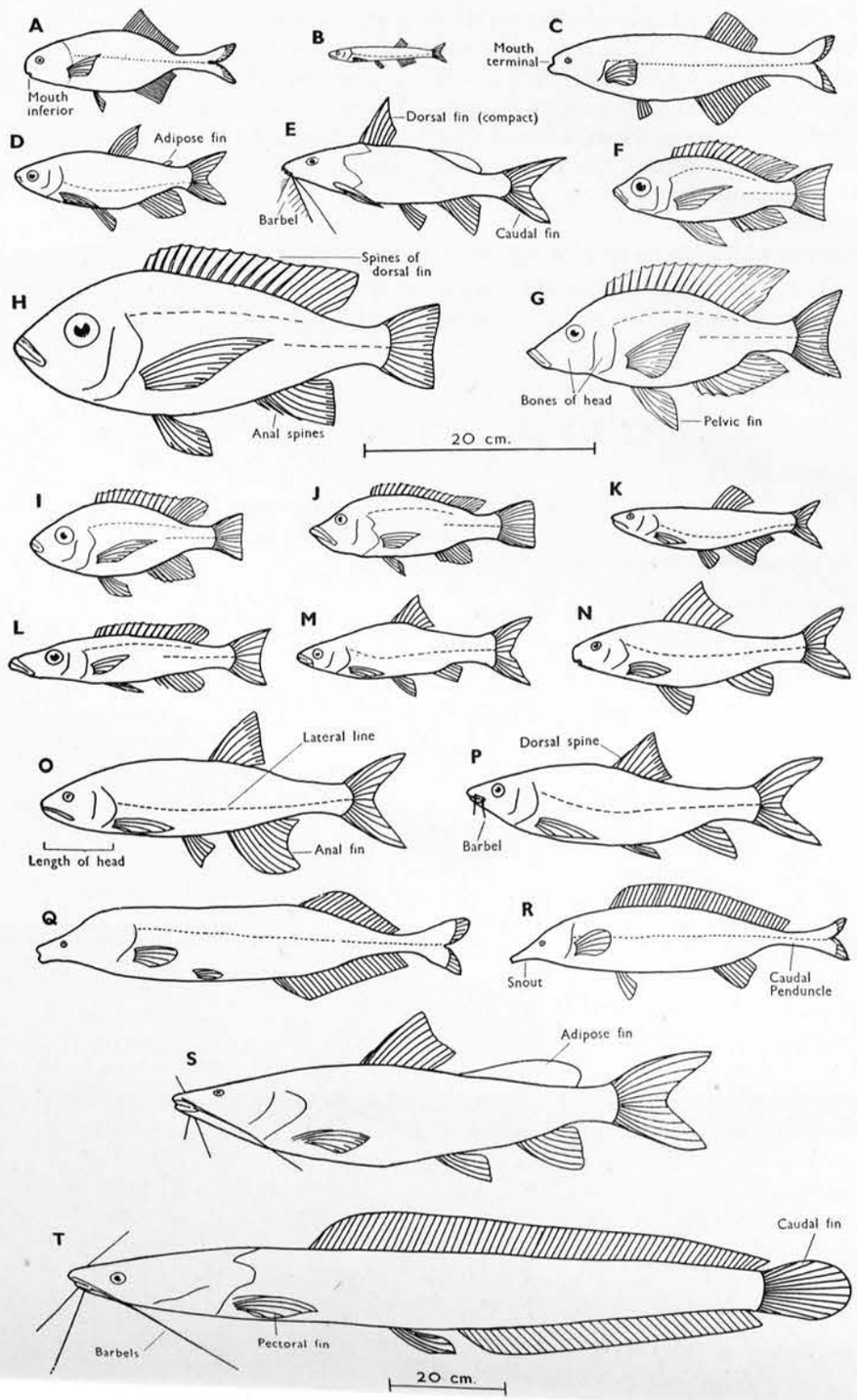


Fig. 2. Outline drawings of the more important fish.

These sketches are intended to give an idea of the general appearance of the fish and to illustrate the meaning of the terms used in the key. They are not detailed drawings and the number of fin rays, etc., is arbitrary.

A. *Marcusenius*
B. *Engraulicypris*
C. *Gnathonemus*
D. *Alestes*
E. *Synodontis*
F. *Haplochromis* sp. " Utaka "
G. *Lethrinops praeorbitalis*
H. *Tilapia*
I. *Tilapia*
J. *Serranochromis*
K. *Barilius microcephalus*
L. *Rhamphochromis*
M. *Barbus rhoadesii*
N. *Labeo*
O. *Barilius microlepis*
P. *Barbus eurystomus*
Q. *Mormyrops*
R. *Mormyrus*
S. *Bagrus*
T. *Clarias*

N.B.—The drawings from A to H are all to one scale and the remainder from I to T are drawn to half this scale.

Key for the identification of the fish.

A simple key has been drawn up for the identification of the more important kinds of fish, and it is designed for use by people with no special knowledge of systematics.* The key is built up in the following way. Certain important characters are picked out and described, and the fish are then divided into groups depending on whether or not they possess these characters. These groups are then sub-divided on the presence or absence of other characters and gradually, by elimination, it is possible to find a description which fits one fish alone. Outline sketches are given in Fig. 2 to help in the identification and to illustrate the meaning of the terms used in the key.

The method of using the key is best explained by an example, e.g. *Barilius microlepis* or Mpasa. As the fish has scales go direct to No. 2 of the key, and then examine the dorsal fin to see whether or not it extends all along the back and is mostly spiny. Actually the fin is short and compact with only three fine spines, so one eliminates No. 3 and turns direct to No. 8. The scales are distinct and the bones of the head and gill cover are visible through a thin skin, and therefore one goes on to No. 9. The mouth is protractile and toothless, and there is no small fatty fin, so one proceeds to No. 10, and further, as there are more than 10 branched rays, to No. 11. Now, since the dorsal fin originates in front of the anal fin and the fish is over four inches in length, it must be a *Barilius*, and one goes on to No. 12 to determine the precise species. Here it becomes clear that as there are over 80 scales along the lateral line, the fish must be *B. microlepis*. If, however, at the beginning, the fish had been seen to have no scales, one would skip all the lower numbers and turn direct to No. 15, and proceed from there by a similar series of eliminations.

Key for the identification of the more important species.†

1.	Scales present	—	..	2
	No scales on body	—	..	15
2.	Dorsal fin long and extending all along back, the greater part of it with spines	CICHLIDAE‡ ..	..	3
	Dorsal fin short and compact, with never more than three spines	—	..	8
3.	Head broad, width between eyes more than 1/3 length of head ; body deep ; total length up to 15 inches (39 cm.)	*Tilapia* (p. 23) ..	..	4
	Head narrow, width between eyes usually less than 1/3 length of head ; body deep or elongate	—	..	7

* Full descriptions of the fish can be found in Boulenger (1909–16), Worthington (1933), or Trewavas (1931, 1935 and 1941).

† This key is only of use for identifying fish from Lake Nyasa and will not work for fish from any other region.

‡ It is extremely difficult to make satisfactory separations for this family of fish in a key.

4.	Three anal spines	—	5
	Four anal spines ; colour green, often yellow underneath	*T. shirana* (p. 37)	
5.	Tail fin scaled only at its root ; three or four horizontal rows of scales on cheek below eye ; colour dark green or grey, often pink underneath	*T. melanopleura* (p. 39)	—
	Tail fin coated with minute scales ; rarely more than two horizontal rows of scales on the cheek below eye ; colour grey with vertical black bars	—	6
6.	Back usually highest behind origin of dorsal fin ; length of lower jaw 2·7 to 3·1 times in length of head ; colour grey to silver grey or pale blue	*T. squamipinnis* (p. 25)	
	Back usually highest in front of dorsal fin ; length of lower jaw 2·4 to 2·75 times in length of head ; colour dark, often brownish-grey above, or wholly dark	*T. lidole* (p. 34)	
7.	Colour green or brownish ; mouth large with strong jaws, the upper extending to below eye or nearly ; body rather deep	*Serranochromis* (p. 55)	
	Colour silver or grey ; mouth with strong jaws not extending nearly to below eye, upper jaw beak-like ; body slender	*Rhamphochromis* (p. 56)	
	Not as *Serranchromis* or *Rhamphochromis*	Other Cichlidae (pp. 60 and 43)	
8.	Scales rather large ; bones of head visible through thin skin	—	9
	Scales small and thin ; bones of head and gill cover hidden under thick skin	MORMYRIDAE (pp. 57, 58)	
9.	Mouth non-protractile ; teeth large ; small adipose dorsal fin present	*Alestes imberi* (p. 59)	
	Mouth protractile ; no teeth ; no adipose dorsal fin	CYPRINIDAE	10
10.	Anal fin with 10 or more branched rays	—	11
	Anal fin with less than 10 branched rays	—	13
11.	Dorsal fin originating above anal fin ; fish small, slender, never longer than four inches (10 cm.)	*Engraulicypris* (p. 53)	
	Dorsal fin originating in front of anal fin ; fish more than four inches in length, often much more	*Barilius*	12
12.	Over 80 scales along lateral line	*B. microlepis* (p. 50)	
	45 to 55 scales along the lateral line	*B. microcephalus* (p. 51)	
13.	Mouth inferior, with large lips forming sucker ; barbels minute, often hidden	*Labeo* (pp. 41–43)	
	Mouth with small lips ; one or two pairs of barbels evident on upper lip	*Barbus*	14
14.	Mouth terminal ; anterior barbel minute, posterior barbel short ; dorsal spine strong	*B. rhoadesii* (p. 53)	
	Mouth inferior ; anterior and posterior barbels of equal length ; dorsal spine strong	*B. eurystomus* (p. 52)	
	Mouth inferior ; posterior barbel longer than anterior ; dorsal spine flexible	*B. johnstoni* (p. 54)	
15.	Rayed dorsal and anal fins very long ; all barbels simple ; teeth small	*Clarias* (p. 47)	
	Rayed dorsal and anal fins short ; adipose dorsal fin present ; all barbels simple ; teeth small	*Bagrus* (p. 45)	
	Rayed dorsal and anal fins short ; adipose dorsal fin present ; mandibular barbels branched ; patch of long curved teeth on lower jaw	*Synodontis* (p. 59)	

DESCRIPTIONS OF THE MORE IMPORTANT SPECIES.

In the following pages the more important fish are described. The information for each species is arranged as shown below :—

SCIENTIFIC NAME.

NATIVE NAMES.

DESCRIPTION.—Brief notes on the shape, distinguishing characters, and colour of the fish.

ECONOMIC IMPORTANCE.—Brief notes on why it is important.

DISTRIBUTION.—Notes on the geographical and seasonal distribution of the fish within the lake.

METHODS OF CAPTURE.—Notes on how the fish examined by the Survey were caught.

SIZE.—Notes on the length, weight, and condition factor of the fish.

BREEDING NOTES.—Notes on sizes and numbers of sexes, age of maturity, breeding season, and habits connected with breeding.

FEEDING HABITS.—Notes on the food of the fish, as shown by examination of stomach contents.

OTHER NOTES.

Appendix VI shows how the data were collected and contains the details, for each species, of the specimens examined, both by the Survey and by the native recorders.

Tilapia.

The genus *Tilapia*, which is represented throughout tropical Africa by important food fishes, has six species in Nyasa. Four of them are endemic, and their abundance puts them in the first rank of economic importance. The six species are :—

T. shirana Boulenger.
T. melanopleura A. Dumèril.
T. sparrmani A. Smith.
T. squamipinnis (Gunther).
T. lidole Trewavas.
T. karongae Trewavas.

T. shirana is immediately distinguishable by the fact that it has four spines in the front of the anal fin, instead of three, as in all the other species.

T. melanopleura and *T. sparrmani* differ from the rest in having only eight to 12 gill rakers instead of 17 to 21 on the lower part of the first gill arch. (See fig. 3.) *T. melanopleura* grows to a larger size than *T. sparrmani* and has a greater number of scales along the body (29–32 instead of 27–29 in a longitudinal series from the gill cover to the tail fin). In life young *T. melanopleura* may be distinguished by the presence of a pink flush on the belly. *T. sparrmani* was not seen in the main lake.

The three remaining species are very closely related to each other, and are difficult to distinguish in the field. The tail fin of each is densely coated with minute scales, a character which accounts for the name *T. squamipinnis*, under which they were all formerly included. When the Survey reached the lake it was found that among the fishes identified as *T. squamipinnis*, the natives distinguished—in addition to a number of growth stages and reproductive phases of Chambo—specimens which they insisted were not Chambo, and which they called Lolo or Lidole. The conclusion was reached later that these were specifically distinct. On the return of the Survey to England the British Museum material was studied carefully and was found to contain examples of both species and also of a third, which has been named *T. karongae*. All the specimens (except one without details) of *T. karongae* were collected

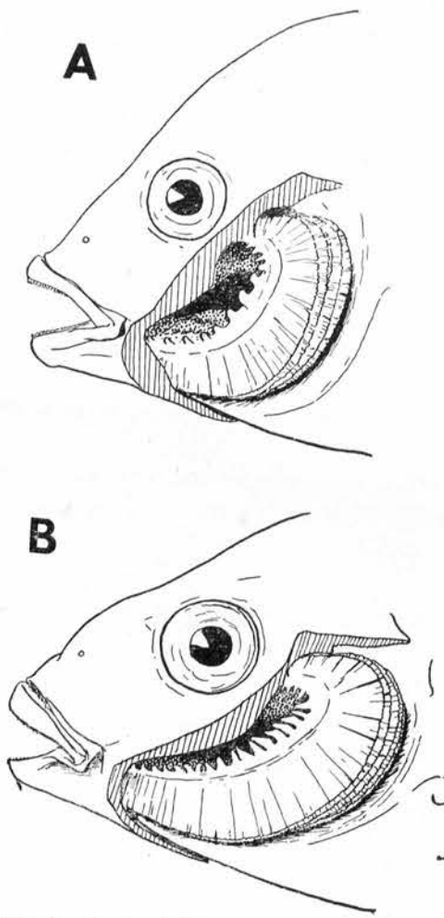


Fig. 3. Heads of *Tilapia* spp. with the gill cover cut away to expose the gills and gill rakers of the anterior arch.

A. *T. melanopleura*, specimen with 8 gill rakers on the lower part of the arch and 4 on the upper.
B. *T. squamipinnis*, specimen with 18 gill rakers on the lower part of the arch and 4 on the upper.

(The length of each fish is 23·5 cm.)

by Christy at the north end of the lake, where the Survey saw few *Tilapia*, and in the months of August to October, of which the Survey has no experience. It is, therefore, believed that the present records (with one possible exception to be noted below) include only *T. squamipinnis* and *T. lidole*.

FIGS 4 AND 5.

DISTINGUISHING CHARACTERS.

Since these fish are the most important in the lake, and the most difficult to separate, some detailed notes are given to help in their identification.

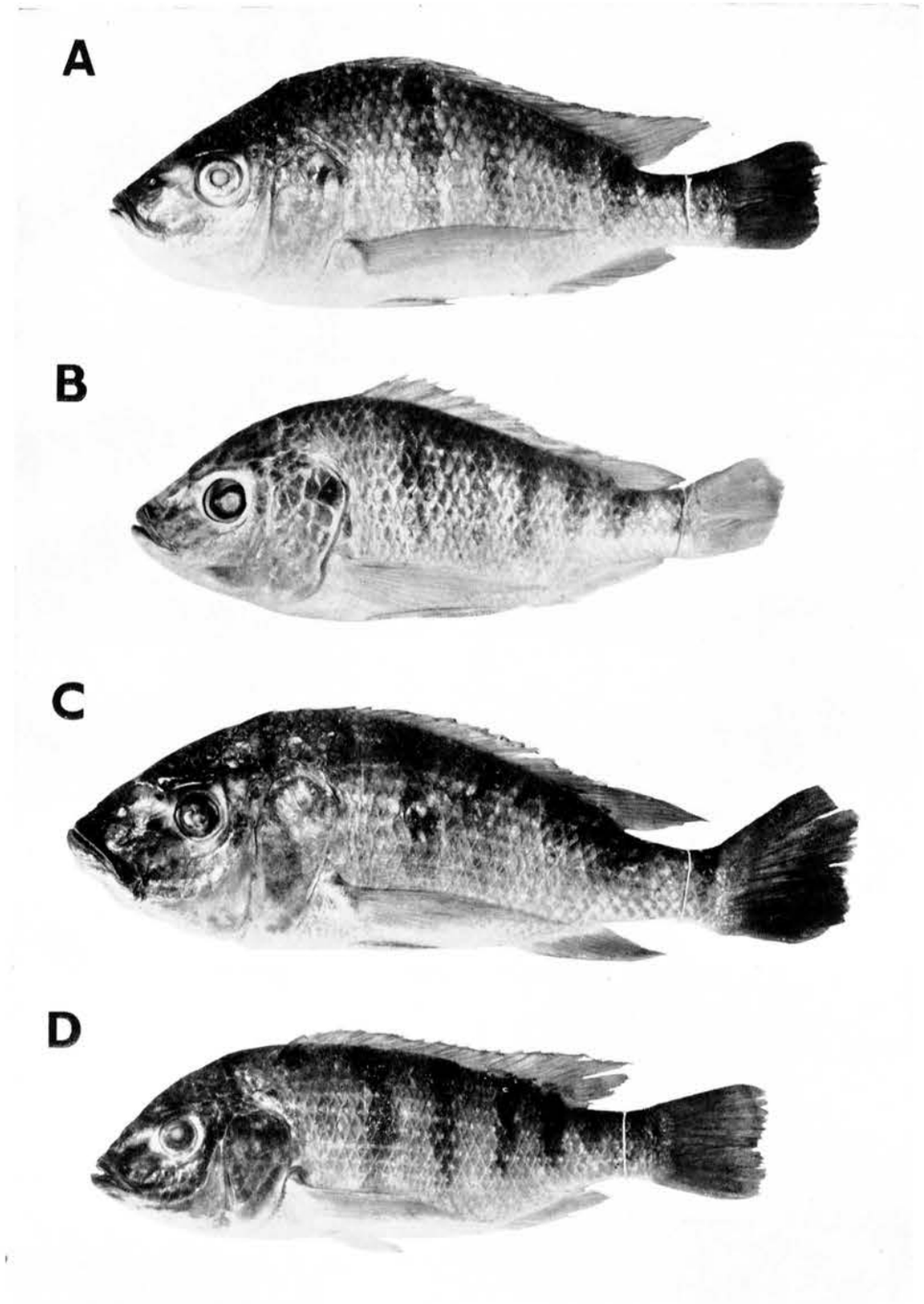


Fig. 4. *Tilapia squamipinnis* and *Tilapia lidole*.

A. *T. squamipinnis* of 33 cm. from Shire River. (Female "spent".)
B. *T. squamipinnis* of 28 cm. from Fort Johnston Bar. (Specimen collected by Christy, probably a male "starting"; head pale but not full breeding coloration.)
C. *T. lidole* of 34 cm. from Shire River. (Female "spent".)
D. *T. lidole* of 29 cm. from Messrs. Yiannakis' beach. (Female "spent".)

(Photographs reproduced by permission of the Trustees of the British Museum.)

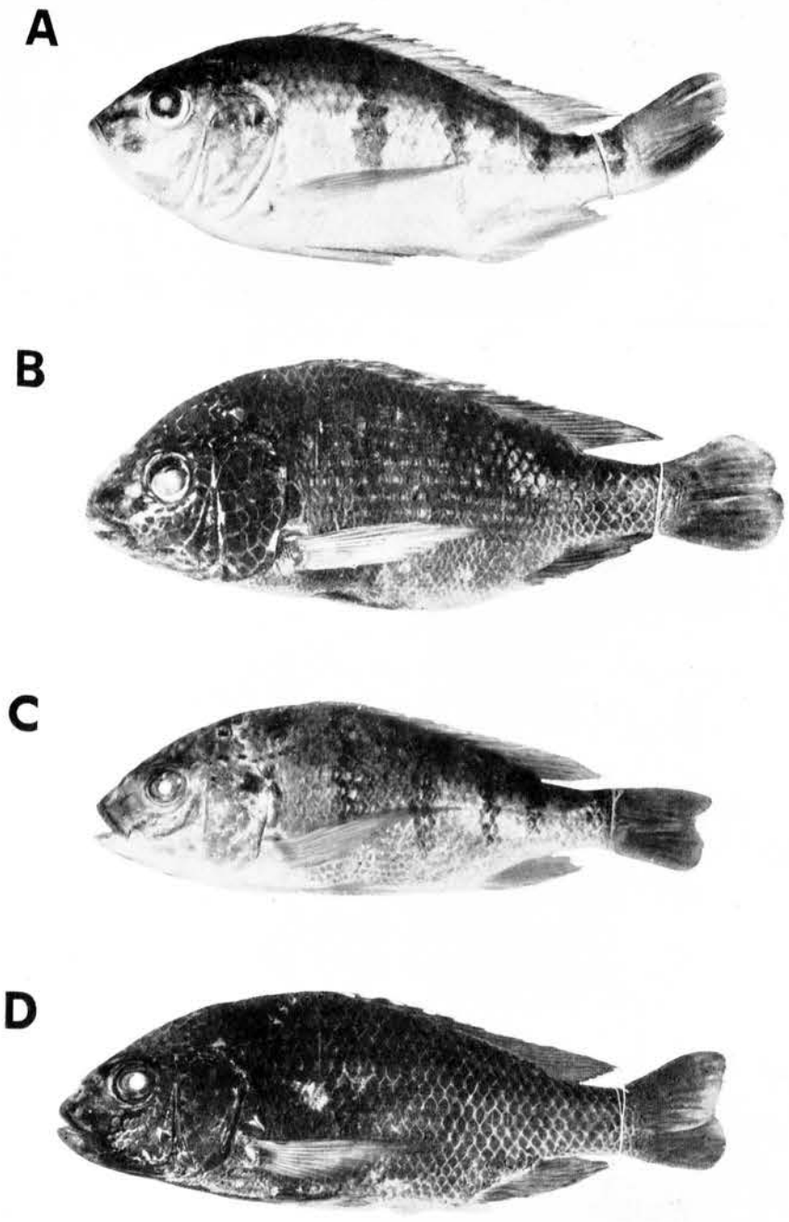


Fig. 5. *Tilapia squamipinnis* and *Tilapia karongae*.

A. *T. squamipinnis*, Zeya, of 27 cm. from Messrs. Yiannakis' beach. (Female "spent".)
B. *T. squamipinnis* of 30 cm. from Karonga. (Collected by Christy.)
C. *T. karongae* of 26 cm. from Deep Bay. (Collected by Christy.)
D. *T. karongae* of 29 cm. from Karonga. (Collected by Christy.)

(Photographs reproduced by permission of the Trustees of the British Museum.)

T. squamipinnis is known in all stages, from fry sheltering in the maternal mouth, to a size of 41 cm. *T. lidole* is known between 28 and 40 cm., but was not distinguished from *T. squamipinnis* below 28 cm. *T. karongae* is not known to exceed 29·5 cm. The proportions of fishes vary with age and size. Direct morphological comparison of all three species is, therefore, based on the few available individuals of 29 or 29·5 cm., and *T. squamipinnis* and *T. lidole* can be compared only between 29 and 39 cm.

THE PHARYNGEAL DENTITION.

The most reliable structural character distinguishing the three species is found in the toothed pharyngeal bones (fig 6) which lie between the lower ends of the hindmost pair of gill arches. The toothed triangular or heart-shaped part of the bone is largest in *T. karongae*, smallest in *T. lidole*. The teeth are very small, and form a dense felting, more dense behind than in front (at the apex of the triangle). The anterior teeth are pale, the posterior have brown tips, and form the dark areas in the photograph.

PROPORTIONS.

The depth is measured as the greatest depth from back to belly, excluding fins, and varies considerably within each species, but on the whole is greatest in *T. squamipinnis* and least in *T. karongae*. For purposes of identification the length of the body is taken from the tip of the snout to the base of the caudal fin.

The natives said they could distinguish *T. lidole* by its having a bigger head and smaller tail than *T. squamipinnis*. In specimens of 28 or 29 cm. this could not be confirmed, but was nearly always so in larger individuals. *T. karongae* has a markedly smaller head than either of the other two species. The length of the head is taken from the tip of the snout to the hind border of the gill cover.

The three species also differ in the size of the mouth.

The main distinguishing characters of the three species are summarised in the table below :—

Species	*T. squamipinnis*	*T. lidole*	*T. squamipinnis* and *lidole*	*T. karongae*
Size of fish examined	29—34 cm.	29—34 cm.	17—29½ cm.	17—29½ cm.
Greatest height of back	behind first dorsal spine	at back of head	—	—
*Length of body / Depth of body	2·3—2·6	2·5—2·8	2·3—2·8	2·4—2·9
Length of body / Length of head	2·8—3·1	2·6—3·0	2·6—3·1	3·0—3·2
Length of head / Length of lower jaw	2·7—3·1	2·4—2·7	2·7—3·2	3·0—3·3
Sides of toothed area of lower pharyngeal bone	slightly concave	concave	concave	straight
Fry carried in mouth of mother till they reach length of	15 mm.	40 mm.	—	—

* This means that the body is between 2·3 and 2·6 times as long as deep.

Tilapia squamipinnis. (Appendix VI, Tables A, 1–13.)

NATIVE NAMES.

Chambo ; (females and non-breeding males) Chambo, Kayawa, Sanga, Igege ; (breeding males) Chinganga, Ngwalu, Nchesichesi ; (young) Kasawala, Katungulu, Kababa, Kambuzi.

DESCRIPTION.

Tilapia squamipinnis is an ovate fish with a long spiny dorsal fin, a broad, blunt head, and a small terminal mouth set with bands of small teeth. This description covers all the *Tilapia* spp., but the distinguishing characters are given on p. 25 and in the key, p. 22. In colour the non-breeding individuals, the young and the breeding females are pale to dark grey on the back, passing through silver-grey or silver on the sides to silver-white on the belly, marked with five to nine broad black bars extending from the back towards the ventral surface. These bands are particularly well-marked in the young, but may be indistinct in adults and entirely absent in breeding males. (For colour of breeding males see p. 28.)

ECONOMIC IMPORTANCE.

T. squamipinnis is economically the most important fish in the lake. It is extremely abundant ; it lives close to the shore during a large part of the year ; it is easy to catch ; it is a suitable size and shape for curing, and it is particularly good to eat. It forms the major part of the catches of the fisheries in the lake—particularly at the southern end.

This fish and *T. shirana* together probably include quite threequarters of the total weight of fish taken from the lake, at least in its southern half.

DISTRIBUTION.

1. *Geographical.*

A study of the fisheries shows that this species is particularly abundant at the southern end of the lake where the water is shallow and there are extensive sandy beaches and patches of weed. It continues to be abundant northwards along both shores of the lake as far as Bana on the west and Mbampa Bay on the east. Further north the water is deeper and the shores are more rocky, so that although *T. squamipinnis* appears in large numbers wherever there is shallow water with a sandy or muddy bottom, it seems to be scarcer in this region, and is no longer always the predominant species. But it is much easier to catch fish in shallow than in deep water, so that *Tilapia* may be equally abundant in the open water though practically never caught there. In most lakes a fine flax gill net is the best method for sampling open water faunas and *Tilapia* is generally caught in large numbers in these nets (See reports on Lake Victoria, Lake Rukwa, etc., Graham, 1929 ; Ricardo, 1939.) In Lake Nyasa exactly similar nets were used, but *Tilapia squamipinnis* were rarely caught in them, even when the nets were set in shallow water where the fish were known to be abundant. The fact that no *Tilapia* were caught in gill nets set in deeper water therefore does not mean that these fish were not present. All that can be said is that neither the Survey nor the native fishermen have any real evidence as to whether or not *Tilapia* abound in the open water. In other lakes closely related species of *Tilapia* are usually found in shallow water, and by analogy *T. squamipinnis* might be expected to be an inshore form. The stomach contents of the Nyasa fish (see p. 33) support this suggestion. All the stomachs examined (except a few that were empty) contained fine organic material and debris, and this material is more abundant and easier to collect near the shore than far out in the lake. Occasionally, large shoals of *Tilapia* were seen swimming some distance out from the shore, feeding on the clouds of algae that appear periodically in the surface waters. Although the fish can only feed intensively in the surface layers when the algae are concentrated—and the algae can only remain concentrated while the weather is extremely calm—it is possible that fish living permanently in the open water could find enough food in the ordinary plankton.

From indirect evidence then, it seems probable that this fish lives mainly in inshore waters, but that it may make considerable migrations both to other parts of the shore and to the middle of the lake. A number of fish were marked in an attempt to study possible migrations, but so far not enough marks

have been returned to show significant results. Both Europeans and natives told us about migrations they had seen, but the reports were vague and contradictory, so that it was impossible to get any idea of whether or not large movements of fish had ever been observed, whether the reputed movements were erratic and occasional, or whether they were regular and in any particular direction.

2. *Seasonal.*

There was unanimity that at certain times of year the fish become scarce on the fishing beaches, though the scarce period was not everywhere at the same time of year. In the Fort Johnston region, Salima, and Kota Kota—where the beaches are exposed to the south-east—the fish are scarce from April to September which is the period of strong south-east winds. From September to April, in the calm weather, *Tilapia* is abundant near these beaches. At Marembo, the *Tilapia* are said to be abundant in June in spite of the strong winds and this may be due to the fact that the bay here faces north and is sheltered from the south-east. In March there were no *Tilapia* to be seen at Marembo, whereas they were abundant in the Fort Johnston region at that time, but by June they had appeared in considerable numbers. In many other places *Tilapia* were said to be scarce at various times of year, but the dates given were vague and it was only possible to confirm the statements at a few places.

Native records show that at all recording stations, except the Shire River, larger numbers of fish are taken in the first months of the year, and again from August to October, than in the intervening months between April and August.

When the fish disappear from the beaches the native fishermen say that they move away to another part of the lake. It is clear that the fish do move out from the shore during these times, but there is no evidence as to how far they go. The fact that quite large hauls are sometimes taken in intervals between strong winds suggests that they do not move far, and this is supported by evidence from Monkey Bay during the windy season. In this region there are two beaches, one outside the bay and exposed to the south-east and one inside the bay which is usually sheltered. On calm days in May large catches were made on the exposed beach, while on windy days when this beach yielded nothing, fish were abundant near the sheltered beach (see inset map, p. 13). On the other hand, in the middle of May, the huge seine net used by Messrs. Yiannakis, which stretches well out into the lake, had caught practically no fish for a week even though the weather had been calm during that period. This suggests that sometimes there are extensive movements away from beaches to other parts, and that the reputed scarcity of *Tilapia* inshore during the mwera* season is not entirely due to the difficulty of fishing in rough water.

To summarise : *Tilapia squamipinnis* is not equally abundant throughout the year on any beach, with the possible exception of the beaches in the Shire River, but the period of maximum catches is not the same in all areas. Chambo were found to be scarce at every place visited by the Survey in March and April, and everywhere other seasons were said to be better. At Kota Kota and the Bar at Fort Johnston, the catches remained small through May, June, July, and probably August. On the other hand at Monkey Bay at the end of May and at Marembo at the end of June, large hauls were being taken. The facts suggest that the abundance of *T. squamipinnis* near the beaches may be influenced by two factors, the weather and the breeding season. The period of prevailing strong south-east winds coincides with the scarcity of the fish on beaches exposed to these winds, and yet includes a time when they are abundant on certain sheltered beaches. The great increase in the size of the catches at Kota Kota and the Bar in September coincides with the onset of the breeding season, and is probably due to a breeding migration.

* " mwera " = south-east wind.

The further evidence needed to determine the movements of this fish may be collected in two ways : continued native records will establish the time of its appearance and disappearance at different places ; and marking experiments will show whether the shoals desert one beach for another, or whether they retire periodically from a beach to the open water and return to the same locality again. Records of wind direction and force should also be kept for comparison with records of catches.

METHODS OF CAPTURE.

The figures in Table A.8 show how the fish examined by the members of the Survey were caught. Out of a total of 8,460 fish handled, the majority were taken in native seine nets, 662 in native traps, and 139 were caught with survey equipment, 101 in gill nets and 28 in a small seine net.

The various fishing methods used by the natives are described in the next section, and the numbers caught by the different methods during the different months of the year are set out in Appendix VIII.

SIZE.

During the work in the field 1,150 specimens were measured and 865 were weighed (see Table A.2). These, excluding Makumba (see p. 32) ranged in length from 6 to 37 cm., in weight from 40 to 850 gm., and condition factor from 0·9 to 2·7. The commonest sizes seen by the expedition were from 25 to 33 cm., with a maximum at about 27 to 28 cm. Native records (Table A.9) show a range of length from 8 to 39 cm. for 2,710 measured specimens. They also show that the size of fish most commonly caught was between 25 and 31 cm., with a distinct maximum at 30 cm. Table 3 gives the numbers of fish of each particular length that were examined. Since all types of fishing were included, these tables give an idea of the sizes of fish most commonly caught, but do not show the proportion of the various sizes in the population as a whole, because most fishing methods are to a certain extent selective. The fact that fish below 25 cm. are fewer in number than larger ones does not mean that small fish are less abundant (that would clearly be impossible), but that they are less often fished for. Since the larger specimens are all caught in large meshed seine nets or traps, neither of which are selective above a limiting size, and since the measured specimens were picked out at random, the tables should give a fair picture of the relative abundance of the larger sizes of fish. The figures suggest that above the length of about 30 to 31 cm. the number of fish markedly decreases with increases in size.

Table 3 also gives the average weight and average condition factor for each particular length. These figures have been worked out from all the weighed and measured specimens, and they can be used in the future for determining the approximate weight of any fish of known length where it is not convenient to weigh the fish itself. (See Appendix VI, p. 126.) The average weight and condition factor are probably a little low in value because they are based on figures mainly from outside the breeding season, and fish are at their heaviest just before they begin to breed.

Both Survey and native records show that the fish tend to be rather larger in the Fort Johnston region than at Kota Kota and the places further north.

BREEDING HABITS OF T. SQUAMIPINNIS.

Breeding colouration.

The colour of breeding females, non-breeding individuals, and young, is grey, marked with five to seven broad black vertical bars, and has already been described (p. 26). Breeding males (Ching'anga or Ngwalu) are pale silver-grey or blue-grey, with the stripes less well defined, and with the top of the head and anterior part of the back a brilliant turquoise blue. These blue heads make the fish very easy to see in the water, and on clear days they can be seen swimming a long way below the surface when the normal grey fish are invisible.

Breeding season.

Males in breeding dress were seen in large numbers from January to early April, but after this they disappeared and no more were seen during the rest of the survey. Native records (Table A.9.) also show that they were abundant in the early part of the year, that they disappeared in April, and that they began to appear again in September. It is probable, therefore, that they are abundant from September to the end of March, and that breeding takes place between these extremes. The presence of large numbers of females with recently " spent " ovaries,* many of them sheltering young fry, the rarity of females with ripe eggs, and the fact that the breeding colours of the males were losing their brilliance during February suggests that the breeding season is nearly at an end by early February, and that it may be at its height in December.

The evidence for this conclusion is summarised below and in Appendix VI. Table A.1. shows that at Kota Kota from January 22 to February 8 about 30 per cent of the fish caught in seines were breeding males. In the Fort Johnston region from February 11 to March 8 the proportion of breeding males had dropped to 10 per cent, and during the voyage round the lake on S.S. *Malonda* they disappeared altogether, the last one being seen at Deep Bay on April 11. From February to April the number of Ching'anga having the full turquoise colour became smaller and a dingy greenish tinge became more common. At Messrs. Yiannakis's station on February 22–23 most of the fish had the duller colouration.

The results of examination of the gonads are shown in Table A.5., and in those figures, males both in breeding dress and with normal colouration are included. In studying the gonads it must be remembered that it is much more difficult to determine accurately the stage of development in males than in females. Whereas in the females the sexual products are large and conspicuous eggs within a transparent bag, the male products are minute and invisible to the naked eye, and the gonad appears throughout as an opaque strip. The male gonad is extremely narrow when it is quiet and becomes enlarged, and often folded, when the fish is preparing to breed. It is possible, therefore, to distinguish a " quiet " testis from a ripening or ripe one by size alone, but it is extremely difficult to determine a " spent " testis. After a time the colour changes from a milky white to pinkish brown and the folds are lost, but this may not be for some time after the milt has been shed. Brownish testes are usually found in males with the duller colouration. In the table very few " spent " males are shown, but it is probable that some of the fish put down as " ripening " or " ripe " were in fact " spent," as the meaning of the brown tinge was not appreciated at first.

The figures in the table show that after early April, when the males in breeding dress had disappeared, no more males with enlarged gonads were seen till June and July. At Marembo and Fort Johnston at the end of June, about 20 per cent of the males had testes starting to enlarge, and at Kota Kota in June and July about 15 per cent were " ripening " and 15 per cent " starting." This suggests that the male gonads may start to develop some time before the appearance of the breeding colouration.

Among the females it is not possible to determine whether the fish is breeding from its external appearance, except that it may be carrying young fry. One female with fry in the mouth was seen at Likoma as late as April 26. The records of two ripe females at Florence Bay must be taken as doubtful for this species as the existence of *T. karongae* was not then suspected. Otherwise the last ripe females were seen at Salima on March 17.

The results of the gonad examination (in Table A.5.) show that between January and May, 75 per cent of the females examined in different regions had " spent " ovaries, whereas during June and July only 4 per cent of the females were " spent." It was not possible in the field to determine how

* See Appendix VI for descriptions of development of the gonads.

long previously the eggs had been shed, because " spent " gonads are similar in appearance whether the eggs have recently or long been shed. The large number of " spent " females recorded as late as May does not mean therefore that the breeding season continues on to this period. The rarity of females with " ripe " ovaries, even at the beginning of the Survey when males with enlarged gonads were abundant, shows that the main breeding season did not occur between the months of January and July. The proportion of the females that were " ripe " was only 12 per cent of the total number of the females caught, and most of the " ripe " fish specimens were taken between January and March. Only two were seen from March to June, but in June and July at Marembo the proportion of ripe females rose to about 30 per cent. In May and June individuals with gonads starting to develop made up from about 10 per cent to 40 per cent of the numbers of females in the catches during that period.

Native records (Table A.9.) give similar data on the breeding season of these fish. The distribution of the males in breeding dress has been mentioned above. At all four recording stations they disappear and reappear in the same months, suggesting that the breeding season occurs approximately at the same time in both Kota Kota and Fort Johnston regions. In the females the figures show a very high proportion of " spent " fish—particularly in the early months when a few individuals were still carrying fry in their mouths. A scarcity of females with ripe ovaries is also shown, even in the months from August to October, and this indicates that the breeding season had not really started by the end of October.

Survey and native records together suggest therefore that the breeding season is not in full swing until the end of October and is dying out early in February.

Breeding habits.

No data are yet available on the mating and egg-laying of these fish. From native reports, and by analogy with closely related species, it seems probable that the eggs are shed and fertilised in circular depressions in the sand or gravel. Depressions of this type were seen on several occasions when the water was clear, but they were said to be the nests of another species. The fertilised eggs, about 4 or 5 mm. in diameter, are taken into the mouth of the female and are kept there during development, and until the yolk sac has disappeared. The brood stays near the parent until the fry reach a length of about 15 mm., and during this time they may return to her mouth to rest and shelter. As in most African Cichlidae, it is the female that shelters the brood, and fish with young fry in their mouths were seen in the early part of the Survey.

While the brood is with her, the female comes close inshore and may seek the reed beds and shallows. Any inlet in the lake shore, the mouth of any stream, however small, appears to be a special attraction, and the reedy shores of the Shire River seem to be favourite nurseries. The fishermen take advantage of this habit to set traps in fences across small streams and inlets. The Survey records show that of 430 specimens trapped at Kota Kota between January 23 and February 8, the gonads of 109 were examined, and were all found to be ovaries from which the eggs had been shed. A few fish still had fry in their mouths, but most of the broods had escaped.

The males at this time are not found among the reeds and are rarely caught in traps, but they abound in the zone fished by the shore seine nets. Usually they are caught in mixed hauls with females, but occasionally hauls were taken in which they were greatly predominant. At Chipoka in February one seine haul was seen which contained about 250 fish, nearly all of which were breeding males.

In Lake Malombe the experience of a single day in early March showed that the fishing was mostly done with traps in the reeds, and among the 200 fish seen, only one was a male in breeding dress. Sixteen of the 199 others were sexed and were all females, 15 " spent," and one " ripe." It is not known whether males are abundant in any part of Lake Malombe, which is very shallow.

LIFE HISTORY.

Kambuzi.

When the fry become independent they live, often in swarms, in quiet, shallow water at the edge of the lake. They are usually seen among reeds, or in pools and lagoons partly cut off from the main lake. In the lagoon at the mouth of the River Kaombe at the end of January, the edge of the water was alive with young *Tilapia* from 15 to 20 mm. in length. At this time there were many *Alestes* swimming not far from the edge, and it was possibly to avoid these and other enemies that the fry were pressing into the shallows. Near the mouth of the Rukuru River in early April, a pool—probably only temporarily separated from the lake by about 10 feet of dry sandy beach—was full of young fish (15 to 20 mm.) of this species or of *T. karongae.* A cloth held between two boys and dipped in the water among or near the reeds (at Kota Kota in January, February, and June ; in the Shire River in February, March, and May) always included in its catch a number of Kambuzi (young *T. squamipinnis* 3 to 5 cm. or more long). At Messrs. Yiannakis's beach at the end of February, in dead calm weather, water at the edge of the lake was filled with thousands of young *Tilapia* from 2 to 5 cm. long, swimming with their mouths open at the surface. The day before, a very large catch had been made on that beach, and the work on the fish had left the water rich in organic matter, and possibly the young fish were feeding on this. At Nkudzi in the middle of May a swampy lagoon, probably connected with the lake during the rainy season, contained Kambuzi about 4 cm. long.

Kasawala or Kababa.

From 6 or 8 cm. to about 20 cm. young *T. squamipinnis* are called Kasawala in the Fort Johnston region and Monkey Bay, and Kababa at Kota Kota. At the latter place the names Kasawala or Katungulu are used for the next size, up to 24 cm., though the limit between the various stages is rather indefinite. These young fish are frequently caught in the finer meshed seine nets, and probably inhabit a zone not far from the shore where they feed like the adults. They do not seem to be fished for deliberately, unless a beach is temporarily deserted by more valuable fish. Native records show that very large catches of Kasawala were being made in the Shire River from April to July.

Size at maturity and sex ratio.

Two specimens of 17 and 18 cm. seen by the Survey were found to be females with spent ovaries, and a ripe female and a" ripe " male each of 19 cm. are recorded. One specimen of 18 cm. at Kota Kota was the smallest carrying fry in the mouth. The figures in Tables A.6., however, show that a more usual size at which the fish reach sexual maturity is between 20 and 25 cm. Native records also show a few breeding fish of 17 and 18 cm. among the Chambo, Kayawa, Ching'anga, and Ngwalu, but among the Kasawala one or two specimens of a only 11 and 12 cm. are said to have had gonads starting to enlarge.

During the studies of breeding in this species, 1,205 specimens were opened and among these 600 were females, 359 were males, and in the rest the sex was not determined with sureness. (See Table A.4.) There is, of course, no certainty that these figures represent comparable samples of the two sex populations. There is no difference in size between the two sexes ; they have the same ranges of length and weight, and specimens of equal length and similar stage of development have approximately the same average weight and condition factor. (See Tables 6.)

It may be observed that in the females the average weight at any length, and the average condition factor, are slightly higher for fish with " ripe " or " ripening " gonads than for those with " quiet " ones, and that the corresponding figures for " spent " females are lower. In the males a difference in average weight and condition factor between breeding and quiet fish is not observable.

INDIVIDUALS OF DOUBTFUL SIGNIFICANCE IN THE LIFE HISTORY.

Ngong'o or Makumba.

These are described by the natives as big, fat Chambo, and are highly prized as food. They appear to be large examples of *T. squamipinnis*, and they show the normal silver-grey colouration with dark cross bars. Few specimens were seen and only six were examined. Three of these came from Messrs. Yiannakis's seine in February, and three from native seines at Monkey Bay in May. The range of length was from 33 to 41 cm., and four specimens from 38 to 41 cm. weighed from 1,100 to 1,150 gm., and had condition factors varying between 1·7 and 2·1.

All six fish were opened and found to have minute, inactive gonads, and much fat among the viscera. They are perhaps old individuals which have not bred in the current, or recent season. Native fishermen say they are old male fish and that they are the leaders of the Chambo. If, after a period of poor catches, a few Ngong'o are taken in the nets, the fishermen are delighted ; for they then believe that the Chambo will come back shortly.

Zeya.

In the field, the Survey was satisfied that this name, met only at Messrs. Yiannakis's beach and at Lake Malombe, referred to young specimens of *T. squamipinnis* that were breeding or had bred. Of the 49 specimens in which the gonads were examined, 10 were " spent " females, six " ripe " females, four females with gonads " small " or " starting," two were recorded as males with " quiet " testes, and the remaining 27 were queried. They all appeared to have in common a small size (28 of the measured specimens were 25 to 26 cm. in length and only two were over 27 cm.), a pale, yellowish-silver ground colour, and a rather slender form. One specimen of 27 cm.—a spent female—is shown in fig 5, where it shows well the characteristic form. The lower pharyngeal bone is figured in the series on fig 6, and it can be seen that although, in the shape of the bone and of the toothed area, it agrees with *T. squamipinnis*, in its absolute size it does not fit well into its place in the series. Since so far it has been impossible to distinguish *T. lidole* below a length of 28 cm., the specific identity of Zeya remains in doubt. The general physiognomy, however, is in favour of its identification as *T. squamipinnis* rather than *T. lidole*, and this is supported by the opinion of native fishermen. But it is to be noted that at the localities in which it was seen, not all the *T. squamipinnis* of the Zeya size were called Zeya.

Langasime or Mlangasime, Vyambo.

The name Langasime was given to a few dark fish at Messrs. Yiannakis's beach in February. Three specimens were examined, and they ranged in length from 31 to 34 cm., in weight from 630 to 800 gm., and in condition factor from 2·0 to 2·1. The gonads of all three were too small for the sex to be determined with certainty, but they were apparently male. Christy records the same name for a similar fish caught at the Shire bar in June.

In Monkey Bay, in May, very similar fish were named Vyambo. They had rather more black pigment than ordinary Chambo, especially on the head and scattered irregularly over the body, giving a blotched or speckled effect. Three of these measured from 33 to 35 cm. and were males with testes of moderate size, probably " spent."

All these fish appeared to be identical with *T. squamipinnis* in structure, and it was first thought that they might be males suffering from a general pigmentary disturbance following the loss of the breeding colouration. Native records (Table A.10.) for the Shire River, where considerable numbers of Langasime were caught, show, however, that this name includes both males and females, and that practically all were breeding. The identification of these fish and their possible place in the life-history must remain in doubt therefore until further collections are made.

Black males (Chinkulu, Biliwili, Ng'ara, Lingula, Saka).

Ten black fishes with a broad white edge to the dorsal fin, all ripe males, and all having the proportions and pharyngeals characteristic of *T. squamipinnis*, were seen by the Survey. Another, collected by Christy, with its gonads removed, is preserved in the British Museum.

The details of these fish are given below :—

4 Biliwili	30 to 35 cm.	..	..	Kota Kota	.. .. January.
2 Chinkulu	27 to 30 cm.	..	..	Salima	.. .. .. March.
2 Ng'ara	29 to 30 cm.	..	..	Karonga	.. .. .. April.
2 Lingula	27 to 30 cm.	..	..	Manda	.. .. .. April.
1 —	30 cm. (Christy)	..	..	Karonga	.. .. October.

The range of weight for six specimens from 27 to 31 cm. long was from 390 to 560 gm., and of condition factor from 1·7 to 2·2. The lower pharyngeal of a 30 cm. Chinkulu is figured in fig. 6 in the *T. squamipinnis* series.

Seventeen dark males, 15 with ripe gonads and two with testes starting to develop, were taken at Marembo in June, where they were called Saka. These ranged in length from 27 to 34 cm., in weight from 390 to 840 gm., and in condition factor from 1·8 to 2·4.

These fish are possibly melanistic individuals of *T. squamipinnis*, but the fact that they are all males with large gonads suggests that they may represent a phase in the sexual cycle. Native records (Table A.11–13.) support this idea. Large numbers of Chinkulu and Biliwili are recorded from the Kota Kota region between July and October, and all specimens examined were breeding males. It is not known whether these two names are given to the same fish or whether the natives distinguish two different types. In most cases either one name or the other was recorded, but in three hauls the two names occur together. Considerable numbers of Saka are also recorded from the Fort Johnston stations during these months. Although the majority of the 44 specimens examined were breeding males, six were males with quiet gonads, and three were said to be females with ripening eggs.

It is difficult to see the place of these fish in the life history and what can be their relationship with the ordinary blue breeding males. The fact that they tend to start breeding rather earlier in the year than the blue Ching'anga suggests the possibility that some of the black males may belong to the species *Tilapia lidole*, which it is believed, may have a slightly earlier breeding season than *T. squamipinnis*. However, those examined by the Survey were not *T. lidole*, and it seems probable that further investigation will show that within the present species *T. squamipinnis* there is one form with pale blue males ripening from September onwards and a second form with black males ripening rather earlier.

FOOD.

The contents of 245 stomachs were examined in the field. Seventy of these were empty and the rest contained fine organic matter. In 54 there were fragments and debris of vascular plants in addition to the fine material, in nine there were considerable quantities of sand grains, and three contained small crustaceans from the zooplankton. Fine organic matter connotes minute particles of non-fibrous plant matter, almost certainly algal, usually too far digested to be identifiable. Occasionally there was material fresh enough to be identified as planktonic algae,* even under the relatively low magnifications used in the field.

Fifteen stomachs were preserved and examined in England. Three of these were empty ; in six all that was recognisable consisted of minute algae from the plankton ; one contained phytoplankton

* Mr. R. Ross of the British Museum (Natural History) very kindly identified algae from the stomachs of fish and provided valuable notes on their ecology.

with a sparse admixture of vascular plant fragments ; in one vascular fragments made up the main bulk ; and four contained a considerable quantity of fine sand among which were algae characteristic both of the plankton and of the surfaces of mud and stones.

The conclusion is that *T. squamipinnis* feeds mainly on phytoplankton and only incidentally on zooplankton, rotting fragments of higher plants, or on the algae that grow on submerged surfaces. This is deduced from the facts that when the lake had been calm for some time and the surface layers contained pure plankton, so, too, did the stomachs of both *T. squamipinnis* and *T. lidole*. Also, when vascular fragments and sand grains were prominent in at least some stomachs, the lake had been disturbed by winds and plankton, bottom-deposits and plant debris had been stirred together in shallow water. Sand grains may also, of course, be swallowed in the turbulent conditions under which seined fish are drawn ashore.

It is noteworthy that the stomachs of breeding fish were often empty or only half full, and that the large fish, with small gonads, known as Ngong'o or Makumba, had stomach and intestine filled with rich green plankton. Rough weather also seems to slow down the feeding, probably because the plankton is distributed through the water instead of being concentrated in the surface layers ; also the fish may then seek shelter near the bottom.

During a calm period in May the surface layer of the lake at and near Monkey Bay was clouded for miles with minute particles that gave it a brownish-green hue. A sample showed that this was due to the presence of immense numbers of a spiral Blue-green Algae, *Anabaena flos-aquae*, which was the main feature of the plankton. This alga undergoes from time to time a phase of rapid multiplication by budding. The *Tilapia* of three species were seen feeding on this concentrated food. The natives call it Kang'ona and say that it is abundant between May and September, during which time the Chambo grow fat.

Native opinions on the feeding of *T. squamipinnis* were that it feeds on Kang'ona when possible, or on the " dirt " in the water. There is no satisfactory evidence of bottom feeding on the part of any Nyasa *Tilapia*.

Social behaviour.

There is evidence that the catching of *T. squamipinnis* in large quantities is not dependent only on their congregation in suitable breeding and feeding grounds and in sheltered places, but that true shoaling occurs. This shoaling was observed on several occasions when the water was perfectly calm, as at Messrs. Yiannakis's beach in February, in the Shire River in early May, and in the Monkey Bay region in mid-May. The following field notes may be quoted : (E.T.)—" On the afternoon of May 15, as we moved slowly in a motor boat* from Nkudzi to Monkey Bay, the still surface of the lake, as far as we could see, was ruffled in little patches. As we drew near to a patch we could see the snouts of a number of fishes, 20 to 100 or more, projecting above the water. All the fishes of each company were swimming in one direction, and suddenly as at a signal, the whole company would submerge with a plop. In the days that followed many such little shoals were observed in Monkey Bay. A canoe gliding gently, could approach near enough to see the dark bars that showed them to be either *T. squamipinnis* or *T. lidole*, or both. At the same time similar small shoals, with the same habits, were formed near the beach by *Tilapia shirana*."

Tilapia lidole. (Appendix VI, Tables B., 1–6.)

Native names.

Lidole, Galamula, Lolo

* Kindly lent and handled by Mr. Sharpe.

Description

T. lidole may usually be distinguished from *T. squamipinnis* by its more massive head, with larger mouth, by the different shape of the dorsal outline, which usually rises to its greatest height at the back of the head and in front of the dorsal fin, and by a darker, brownish-grey colour, especially on the head. The lower pharyngeal bone is narrower and its toothed area is smaller than in *T. squamipinnis* of the same size. (For details see p. 25 and fig. 6.)

Economic importance.

This species is taken in small numbers in the seine nets with *T. squamipinnis*. The economic importance is not great. It seemed usually to be eaten as readily as *T. squamipinnis*, but at Messrs. Yiannakis's beach it was stated that a native always prefers a Chambo (*T. squamipinnis*) as food if it is available, and that when Chambo are plentiful, *T. lidole* is not sent to the market.

Distribution

T. lidole is taken in small numbers all round the lake probably throught the year. The Survey records cover January to July and the native records from February to October. In contrast with *T. squamipinnis* males are rare or absent in the seines from January to April, and even females are never found in the traps set in the reeds or across inlets. Most were seen in the southern part of the lake in February and June. Like *T. squamipinnis* it probably lives mainly in shallow water where there are sandy beaches and large areas of weed, but the zone it occupies, at least during the breeding season, and judging by trap records, seems to be a little farther from the shore than that normally occupied by *T. squamipinnis*. Perhaps a different idea of its abundance might result from regular fishing in a zone beyond that exploited by the shore-seines. The evidence of the two largest gill-net catches of *T. lidole* suggests that it may be especially abundant off river-mouths. No *T. lidole* were recorded from Lake Malombe, but the method of fishing, by traps, would be enough to explain this, and it is not known whether they occur in the open water of this small lake.

Methods of capture.

Table B.5. shows that the majority of the 277 *T. lidole* examined by the Survey were caught in seine nets by the natives, but that considerable numbers were taken in the Survey's gill-nets at Msinje and at Monkey Bay. It is worth noting that the 5 inch net was the more effective for this species, and that the 4 inch caught the greater number of *T. squamipinnis*.

Size.

The range of length for 202 measured specimens was from 22* to 40 cm., the range of weight for 160 weighed specimens was from 210 to 1,100 gm., and the condition factor varied from 1·5 to 2·8. Table B.3., giving the number of fish of various sizes seen by the Survey, shows that those from 32 to 38 cm. in length were the most numerous. It is noteworthy that this is considerably larger than the most commonly caught size of *T. squamipinnis*. Native records (Table B.6.) show a range of length from 23 to 40 cm., and the commonest size is from 31 to 36 cm.

Breeding habits.

There is evidence of mating and egg-laying taking place from January to July, but the large number of females carrying fry in the mouth found from January to March shows that many fish must have mated in November or December. Among the 178 fish examined (see Table B.4.) 132 were females, all with " spent " gonads.† The fry in the mouths of the females were all about 40 to 45 mm.

* Specimens below 28 cm. were not separated with certainty from *T. squamipinnis*.

† Excluding the ripe female recorded at Salima in March, the identification of which was not checked.

in length and much larger, therefore, than any found in *T. squamipinnis*. This fact may be correlated with the different zones occupied by the two species. Young *T. lidole* may not be able to rely on the safety of shallow pools and the shelter of weeds.

The males seen by the Survey were similar to the females in colour, and they give little information about the breeding. Of the 32 male gonads distinguished, only three were developing, two were probably " spent " and the rest were " quiet." Breeding males are said by the natives to be black and it may be that some of the black fish described above belong to this species. Two dark specimens with broad white marginal bands on the dorsal and anal fins, collected by Christy from the Shire Bar and Nkudzi in November are probably males approaching the breeding condition ; one of them has large, but not folded testes ; the gonads of the other had been removed.

The absence of fish with ripe gonads, even in the first months of the year, suggests that the breeding season of this species finishes rather earlier than that of *T. squamipinnis*. Native records (Table B.9.) show that only five males, all with large gonads, were seen and that among the females the majority were " spent." Females with ripe ovaries were very scarce, but there are indications that they may be increasing in number in September and October. The figures show that this fish is scarce in the nets between April and August.

Food.

Seventeen stomachs were examined during the Survey. Two from Chilowelo and Monkey Bay were empty, 12 from Fort Johnston contained fine organic matter, similar to that found in the stomachs of *T. squamipinnis*, and occasional pieces of higher plants. At Msinje, three contained the usual fine organic material, and in one of these there were small animals from the plankton in addition.

Four stomachs were preserved and examined in England. Two of these were from fish taken at Kota Kota in March when the lake was much disturbed, and they contained algae that were a mixture of planktonic and bottom-living forms. The other two were taken at Monkey Bay in the calm days in May when the planktonic algae formed a visible layer near the surface, and these contained only phytoplankton. Thus, the evidence indicates that *T. lidole* feeds in mid-water or near the surface and mainly planktonic algae. In the few instances where stomachs of this species and of *T. squamipinnis* were examined from specimens taken at the same place and about the same time, it is seen that variations in diet were parallel. The feeding habits of the two species are, therefore, believed to be identical. Probably, however, if *T. lidole* occupies a more offshore zone, it finds a lower percentage of coarse particles mixed with the plankton, and with this fact may be correlated the weaker pharyngeal dentition.

Other habits.

It is not known with certainty whether *T. lidole* was among the shoaling *Tilapia* observed at the surface in calm weather. The fact that on two occasions large catches of *T. lidole* were made in the 5 inch gill-net is evidence that they do move in shoals. The failure to catch quantities of *T. squamipinnis* in gill-nets points to a difference in habits between the two species, for the nets were not always set in a zone beyond the reach of shore seines. It may be that *T. lidole* continues to move about at dusk or after nightfall, or starts to move before dawn. It is even possible that it may sleep by day and feed at night, for a seine may take a sleeping fish, but a gill-net only an active one.

Towards the end of the time spent at Monkey Bay, a large catch of *T. lidole* was taken in nets set in about $2\frac{1}{2}$ fathoms, not far from shore in the current caused by the entry of the small river. The fisherman gave this current as the explanation of the catch, and it is worth noting that at Msinje, where the other large gill net catch was made, there was a river entering the lake. This suggested correlation should be checked experimentally.

Comparison between Tilapia species in Lake Victoria and in Lake Nyasa.

The results described in detail in the preceding pages show that there is a striking parallelism between Graham's discoveries in 1927–28 concerning the main food-fish of Lake Victoria and those of the Nyasa Fishery Survey concerning the Nyasa food-fish. There are only two species of *Tilapia* in Lake Victoria and the parellelism is between them on the one hand and *T. squamipinnis* and *T. lidole* on the other. *T. karongae* and *T. shirana* are left out of consideration for the purposes of this comparison. The parallel facts are :—

(i) In Lake Victoria *T. esculenta* (Ngege) and *T. variabilis* (Mbiru) are so closely related as previously to have been confused by systematists under one name. In Lake Nyasa this was true of *T. squamipinnis* (Chambo) and *T. lidole* (Lidole).

(ii) In Lake Victoria, although the feeding habits of the two species appeared to be identical, and neither species is found far from shore, one (Mbiru) occupies a zone nearer the shore than the other (Ngege). In Nyasa, Chambo occupies the inshore zone, and Lidole possibly a more remote, though overlapping zone.

(iii) The females of the inshore species in both lakes, especially those carrying fry, enter river mouths and inlets, and are caught in fence traps, in contrast to the offshore species.

(iv) The pharyngeal dentition of the offshore species is more reduced than that of the inshore species in both lakes.

Equally striking, in view of this parallelism, is the difference that in Lake Victoria the more important food-fish is the offshore species whereas in Lake Nyasa it is the inshore fish. In Lake Victoria the greater importance of Ngege seems to be due almost entirely to the method of fishing, and dates from the introduction of the European fine, flax gill-net. Seines, either for shore or open water work, are little developed by the natives of Lake Victoria, but both kinds were evidently in use on Lake Nyasa when Livingstone visited it. The possibility suggests itself, therefore, that the wider use of gill-nets in Lake Nyasa might make *T. lidole* available on a commercial scale. The establishment of a second fishery would relieve any strain on the *Tilapia squamipinnis* and lessen the danger of overfishing this species if the fisheries are to be further developed.

Tilapia shirana. (Appendix VI, Tables C., 1–6.)

Native names.

Katukusi, Fwilili, Nkututu, Makumba (large), Pelela.

Description.

T. shirana can be distinguished at once from all the other *Tilapia* spp. by the fact that it has four spines in the front of the anal fin instead of three. (See key, p. 21.) It is dark olive green in colour on the back and sides and yellow or whitish underneath, often with a dark horizontal band along the middle of the side.

Economic importance.

This species is probably the most important in the lake after *T. squamipinnis*. Both species are very abundant and easy to catch and cure. The *T. shirana* fishery is less important however because although the fish may be as abundant, they are slightly smaller in size and are said by the native to be less good to eat. Europeans consider them to have a rather muddy flavour.

Distribution.

T. shirana is abundant all round the lake, and is caught in particularly large numbers where the water is shallow and there are large expanses of reed. It is also common in Lake Malombe and in the shallow lagoons in the lake shore. During the main fishing season it is caught in seines on sandy

beaches and in traps among the reeds. During rough weather, when fishing on the main beaches is difficult, the native fishermen concentrate on fishing in the lagoons. At Kota Kota considerable numbers of *T. shirana* were being caught in scoop nets in Lake Chia in June when all other fishing on the lake shore had been stopped by the winds. Livingstone describes similar fishing in Lake Chia in September and October of 1861.

There is no evidence that these fish occur in the deep or open water, and the high proportion of plant fragments in the stomachs (p. 39), suggests that they stay in the inshore waters where weeds are plentiful. They appear to live among reeds to a greater extent than *T. squamipinnis*.

Native records show that these fish are caught in large numbers all through the months from February to October, and that they do not become scarce during the windy season.

METHODS OF CAPTURE.

During the Survey a total of 1,205 specimens were handled and Table 5 shows how they were caught. It is interesting to see that gill-nets are not effective, but that, as for *T. squamipinnis*, the 4 inch mesh caught the largest numbers.

SIZE. (Tables C.2, 3, 6.)

The range of length for 340 specimens measured by the Survey was from 7 to 36 cm., and native records show a range from 11 to 37 cm. The weight of 250 specimens varied from 80 to 760 gm., and the condition factor from 0·5 to 2·7. Table 3 shows that the commonest size of fish caught is from 21 to 30 cm. in length, and that above 30 cm. the number decreases with size. The average weight for each length and the condition factors are also given in this table. The figures show that although these fish grow as large as *T. squamipinnis* and that specimens of equal length have about the same weight and condition factor, the usual size caught in the fisheries is slightly smaller in the case of *T. shirana*.

BREEDING. (Tables C.4 and 6.)

Three hundred and forty fish were opened and sexed by the Survey, and among these, females were considerably more abundant than males. This preponderance may be more apparent than real because it is possible to determine the sex in the females at an earlier stage than in the males, and many of the specimens whose sex was not determinable may have developed into males. Native records show about equal numbers for the two sexes at each of the stations. The Survey records suggest that the males grow to a larger size than the females, the largest male being 35 cm. and the largest female 32 cm. Native records, however, do not show any appreciable difference between the sizes of the sexes. The size of maturity is from 20 to 25 cm. according to Survey figures, but native records have notes of a female of 15 and a male of 18 cm. that were breeding.

Results of the examination of the gonads show that the breeding season did not occur between January and July, and native records show that it had not started by the end of October (though a small proportion of the fish seem to be breeding all through the year—particularly in the Fort Johnston region). The high proportion of " spent " females, many of them still carrying fry, suggests that, as for the preceding two species of *Tilapia*, the breeding season was probably at its height in December. A few breeding females were seen in January and February by the Survey. Among the males about a third of the fish seen by the Survey had enlarged testes, but probably many of these were really " spent," and in all the native records the majority were said to have " big " gonads.

T. shirana seems to have breeding habits similar to *T. squamipinnis*, and the main breeding season probably occurs in November and December. The fish are said to have nests in the sand or mud in shallow water, and the females carry young fry in their mouths. Breeding males may become very

dark and nearly black in colour. Dark fish are often called Makumba or Pelela, but native records show that these names may cover dark individuals of both sexes.

Young fry seen in the mouth were smaller in this species than in *T. squamipinnis* and *T. lidole*, and were never found above a length of about 10 mm.

FOOD.

Fifty-two stomachs were examined from Fort Johnston, Kota Kota, Florence Bay, and Chilowelo. Eight stomachs were empty and the rest contained mainly fine organic matter, but in many of these there was a large proportion of fragments of higher plants. In one there were a few small Copepods among the vegetable matter, and in another which was otherwise empty, there were the remains of a fish fry. The fine organic material in the stomachs of all these fish was very similar to that found in the stomachs of *T. squamipinnis*, but on the whole *T. shirana* contains a higher proportion of vascular plants and plant fragments, suggesting that they feed to a greater extent on the weeds growing round the edge of the lake. This habit, according to natives, is often extended to the eating of young rice plants.

This fish then has a wide range of vegetarian feeding habits, feeding readily on plankton when this is abundant, but more often browsing on the submerged parts of higher plants, a habit for which it is well equipped dentally.

SHOALING.

Evidence that these fish do form shoals has been given above (p. 34), where small shoals were described swimming at the surface close to the shore in Monkey Bay in May.

Tilapia melanopleura. (Appendix VI, Tables D., 1–4.)

NATIVE NAMES.

Ningwichali, Katukusi, Nyankarua.

DESCRIPTION.

This fish can be distinguished from *T. squamipinnis* and *T. lidole* by its deeper body, the deeper scaly cheek below the eye, the fact that the soft rays of the dorsal and anal fin are produced into a point and by the colour, which is dark green on the back and usually pink underneath. The main characters are given on p. 23, and in the key.

ECONOMIC IMPORTANCE.

It is not sufficiently abundant to be of much economic importance, but it is taken in small numbers in the nets with the other *Tilapia* spp., and is treated in the same way.

DISTRIBUTION.

This species was seen in many places round the lake, but it seems to be scarce in the southern end. Only two specimens were seen in the Fort Johnston region and these were both called by the natives, Katukusi, which is the usual name for the very abundant species *T. shirana*. The absence of *T. melanopleura* in the native records at Fort Johnston may mean that no specimens were seen, or it may mean that they were included in the *T. shirana* figures. *T. melanopleura* occurs in the Kampambe Lagoon near Kota Kota.

METHODS OF CAPTURE.

Fifty-nine specimens were handled by the Survey and these were mostly caught in seine nets ; a few were taken in traps and it was surprising to find that one was caught by trolling in the Shire River. (See Table 3, p. 137.)

SIZE.

Survey records show a range of length from 3 to 35 cm., native records from 13 to 39 cm. (Tables 1 and 4.) The commonest size caught is from 26 to 31 cm., and the range of weight is from 200 to 850 gm. The condition factor varied from 1·7 to 2·4 with an average value of 2·2, which is considerably higher than the value for the condition factors of the other species of *Tilapia*, a result to be expected from the greater depth of body.

BREEDING.

There are no data about the breeding habits and very few fish were breeding during the Survey. No fish were ever seen carrying fry in their mouths, and it is believed that in the closely related species *T. zillii* the young are not sheltered in this way. The high proportion of " spent " and " quiet " females shows that the main breeding season was not between January and October. The native records show a large number of males all through this period with enlarged gonads, but it seems probable that many of these were really " spent."

FOOD.

Six stomachs were examined and they all contained chopped-up weed and a little fine organic matter. This suggests that these fish feed to a greater extent on the higher plants than the other species of *Tilapia*. The stronger dentition of jaws and pharynx is associated with this feeding habit. Observations on aquarium specimens of the species *T. zillii*, which has an identical dentition show that it too eats vascular plants.

Tilapia sparrmani.

NATIVE NAME.

Chimbente.

This *Tilapia* is widely distributed from Namaqualand and Natal to the Zambezi Basin, Katanga, and Bangweulu. It is now recorded from the Nyasa Basin for the first time. It was seen only in the Kampambe Lagoon, near Kota Kota, and not in the main lake.

DESCRIPTION.

The distinguishing characters are given on p. 23. In life, *T. sparrmani* may be distinguished from young *T. melanopleura* by its colour, which is a rich dark green with a red flush behind the gill-opening and no pink colour on the belly. The dorsal fin may have a crimson margin. It is not known to exceed a length of 20 cm.

ECONOMIC IMPORTANCE.

The present economic importance of this fish is almost negligible, but its suitability for introduction into impounded waters gives it a greater potential importance.

METHOD OF CAPTURE.

This fish was caught in traps set in fences at the edges of rice-fields, or in single traps among the reeds in the Kampambe Lagoon. The fence traps are unbaited, but those set elsewhere were baited with kassava. The traps used were of narrow enough mesh to catch fishes as small as 5 cm., and a considerable proportion of these were *T. sparrmani* and were used for food.

SIZE.

Twenty fish caught on a day in March ranged from 5 to 15 cm. in length and up to 100 gm. in weight. Eight caught one day in July ranged from 8 to 12 cm. and from 20 to 30 gm.

FOOD.

Specimens in the baited traps had their stomachs swollen with kassava. The stomachs of eight others were examined : one was empty ; the rest contained organic debris, among which fragments of vascular plants figured largely.

BREEDING.

The gonads of all the specimens examined were small. It is believed that this was because breeding occurs at another season rather than that all the fishes were below the size of sexual maturity. The gonads of seven (one in March, six in July) were large enough to be identified as male.

Labeo mesops. (Appendix VI, Tables E., 1–7.)

NATIVE NAMES.

Nchira, Ntuwa, (young) Kasomela.

DESCRIPTION.

This fish belongs to the barbel or carp family and has a long body, slightly narrower from side to to side than dorso-ventrally, large scales, and a toothless mouth with large sucker-like lips. Its distinguishing characters are shown in the key and outline sketches in fig. 2. It is olive green in colour on the back and sides, yellowish underneath, and the fins are grey.

ECONOMIC IMPORTANCE.

This species probably comes next to *Tilapia squamipinnis* and *shirana* in importance. It is abundant in the lake and is especially important commercially in the northern part where it may be caught in greater numbers than the *Tilapia* species. It is easily caught in seine nets on sandy beaches and is also taken in gill-nets in rather deeper water. It is easy to cure, but in most places it is not considered as good to eat as the *Tilapia*, and the flesh is full of small sharply-pointed bones.

DISTRIBUTION.

Labeo mesops is present all round the lake and seems to be abundant wherever there are beaches and relatively shallow water, particularly in the northern part of the lake. At Liuli one seine net haul contained about 200 *Labeo* and only four other fish. It is not common in the deep rocky parts of the lake. Large numbers were caught in gill-nets when these were set in shallow water, but only few when they were off rocky shores. Thus gill-nets were effective in Monkey Bay, Domira Bay, Kota Kota, Florence Bay, Ngara, Karonga, Deep Bay, Msinje, Fort Maguire, and Old Livingstonia, where the nets were set in shallow water, but at Nkata Bay, Ruarwe, Mbampa Bay, and Likoma, where they were set in deep water, only 13 fish were caught in 20 nets. It is worth noting that at Nkata Bay it was only the nets that were set on the bottom that caught *Labeo* whereas surface nets caught none.

This species does not appear to move away from the beaches during the windy season, and native records show that considerable numbers were being caught in gill-nets at Kota Kota in June and July when it was too rough for most other kinds of fishing. At certain seasons, however, large numbers of these fish do leave the lake and run up the rivers to spawn.

METHODS OF CAPTURE.

During the survey 830 specimens were handled by the Survey, and Table E.5. shows that most of these were caught in native seines, but that gill-nets—particularly the 3 inch mesh—were effective.

SIZE. (See Tables 2 and 3.)

The range of length for 411 specimens measured by the Survey was from 13 to 46 cm., whereas native records give a range from 11 to 48 cm. The range of weight for 352 specimens was from 50 to 1,100 gm., and the condition factor varied from 0·7 to 1·6. Table 3 shows that the fish most commonly

caught are from 29 to 38 cm. in length. The table also gives the average weight and condition factor for each length. Since this fish is elongated in shape, it has a lower value for its condition factor (average 1·1) than the *Tilapia* species (average 1·9) and fish of all lengths are considerably lighter than corresponding lengths of *Tilapia*.

BREEDING. (See Tables 3 and 6.)

The examination by the Survey of 381 fish suggested that females were both more abundant and larger in size than the males. Of the 381 fish opened, 155 were females, 84 were males, and in the rest the sex could not be determined with certainty. Native records show preponderance of females in the Kota Kota region and of males in the Fort Johnston region. The largest females seen by the Survey were 46 cm. in length and the largest males only 37 cm., while the smallest breeding specimens were 30 and 22 cm. respectively for the two sexes. Native figures do not show such a marked difference in size of the sexes—the range for females being from 16 to 48 cm., for males from 12 to 43 cm., and the smallest breeding fish were 23 cm. and 21 cm. respectively.

The large proportion of fish with ripe and spent ovaries in the early part of the Survey shows that the breeding season was in progress from January to April, and that it must have started well before January. The season, therefore, continued long after the season for *Tilapia* spp. was over, and it appeared to end rather abruptly early in April. The last breeding fish were seen at Mwaya and no more were seen during the remainder of the Survey. Native records show that, although there may be indications that the number of fish with developing gonads was beginning to increase, the main breeding season had not started by October.

In studying Table 3, it must be remembered that among the " quiet " fish, many young specimens are included which have not yet reached sexual maturity.

There are very few data on the breeding habits of *Labeo*. During the breeding season large numbers are said to run up many of the rivers to spawn. Unfortunately, the Survey was rather too late to see the fish going into the rivers, but large numbers were seen in the lagoon at the mouth of the Kaombe River in January. A few days before the arrival of the Survey there had been a remarkable sight in this river. The level of the water in the lagoon was very low that year, and it had become completely shut off from the lake by a sand bar. The *Labeo* were said to have arrived as usual, but were unable to enter the river. A few days later there was heavy rain which raised the water level in the lagoon ; a passage was broken through the sand bar and enormous numbers of the *Labeo* at once ran into the lagoon and started to go up the river. For some reason, however, they could not live in the water in the lagoon and river and they soon tried to return to the lake. The gap in the bar had, by then, been blocked by native fences and traps so that there was no escape, and for about two days these fish were swimming round and round the lagoon with their mouths above the surface of the water, gasping and dying slowly. The water was said to be a seething mass of fish and thousands were caught by the natives in traps or were scooped out of the water with baskets or by hand. The most probable explanation of this behaviour seems to be that while it was cut off from the lake the water in the lagoon became so stagnant and lacking in oxygen that the fish straight from the lake were unable to live in it.

There is no evidence yet as to what proportion of the fish go into the rivers, nor is there any information about the spawning grounds.

Labeo differs from *Tilapia* spp. in that there is no change of colour in the breeding male, the female has a very large number of small eggs, and there is no parental care after the eggs are shed.

FOOD.

Labeo has no differentiated stomach. The intestines of 88 fish were examined, eight at Fort Johnston and the rest during the journey round the lake. Among these, 53 were empty and a few

more were empty except for small quantities of slime. All the intestines of the larger fish examined during the early part of the Survey were empty, which suggests that the fish do not feed while they are breeding. Later in the year guts were found to contain sand grains and finely divided organic matter, including diatoms of species characteristic of the surface of the bottom mud of lakes. It is clear that *Labeo mesops* is a mud-feeder.

Labeo cylindricus. (Appendix VI, Tables F., 1–5.)

NATIVE NAMES.

Ningwi, Mbununu, Mbuwa, Limboti.

DESCRIPTION.

This species is closely related to *L. mesops*, but can be distinguished by the more cylindrical body, the more angular head, and the fact that it usually has warts on its snout. It is very dark green in colour and greyish underneath.

ECONOMIC IMPORTANCE.

It does not seem to be sufficiently abundant to be of much commercial value, but it is taken in small numbers with *L. mesops*, both in native seines and gill-nets.

DISTRIBUTION.

This fish occurs all round the lake, but is usually found near rocks. Unlike *L. mesops* the largest numbers were seen in the deep rocky part of the lake at Nkata Bay, Florence Bay, and Likoma, though it was also found in many shallow parts if there were rocks in the neighbourhood.

METHODS OF CAPTURE.

Eighty-one specimens of this fish were handled by the Survey and Table 4 shows that most of these were caught in gill nets, the 3 inch mesh being the most effective.

SIZE.

The range of length was from 20 to 39 cm., and the commonest sizes caught were from 29 to 33 c.m. The range of weight was from 100 to 590 gm., and the condition factor varied from 0·7 to 1·3. They are considerably smaller than *L. mesops*, but have about the same value for the condition factor. There is no marked difference in size between the two sexes, and the smallest breeding fish seen was 28 cm. among the females, and 30 cm. among the males.

BREEDING.

The examination of 75 gonads (Table 3) shows that females were caught in greater numbers than males. The fact that breeding and " spent " specimens were taken in considerable numbers from February to April suggests that the breeding season of this fish is similar to that of *L. mesops* and continues after the main breeding season for the *Tilapia* spp. is over.

FOOD.

Twenty-two guts were examined from various places round the lake, but the contents give very little information about the food or feeding habits. Fourteen were empty, four were empty except for a little white or orange slime, two contained slime and vegetable debris, and two had a few lumps of unrecognisable and much-digested material. In clear water these fish can often be seen swimming close to the rocks, scraping the surfaces with their mouths, and presumably feeding on the algae growing there.

Haplochromis spp. Utaka. (Appendix VI, Table G.)

Among the 102 species belonging to the genus *Haplochromis* there is a group of about six species of great economic importance known collectively to the natives as Utaka. It is convenient to consider

them together under this name, which is used all round the lake, either for the whole little group or, in some places, specifically for one or another of the species.

SCIENTIFIC NAMES with provisional native equivalents.

Haplochromis inornatus ..	Ukongola (Chilowelo).
H. eucinostomus	Utaka (Ruarwe).
H. prostoma	Nsese (Monkey Bay).
H. chrysonotus	Chyala (Likoma), Ling'ara ♂ and Chituwi ♀ (Manda), Chibwale ♂ and Njoronjo ♀ (Sani), Kapesa (Deep Bay).
H. cyaneus	Kapamola (Mluluka).
	Nguwa (Nkata Bay).
	? Chafinya (Likoma).
H. quadrimaculatus	Ngiri (Ruarwe).
	Mbarule (Nkata B. ; Mbampa B. ; Likoma).
	Ling'ara (♂, Mbaha).
	Msalule (Likoma).
	Utaka wa Ndiwili (Likoma).
	Mkazi wa Njelu or Kazinjelu (Likoma).
	Utaka Chigombati (Monkey Bay).
	Kafupa (Mluluka).

H. quadrimaculatus has been described as " a variable species," but it probably includes a group of closely related species that can be defined only after further work.

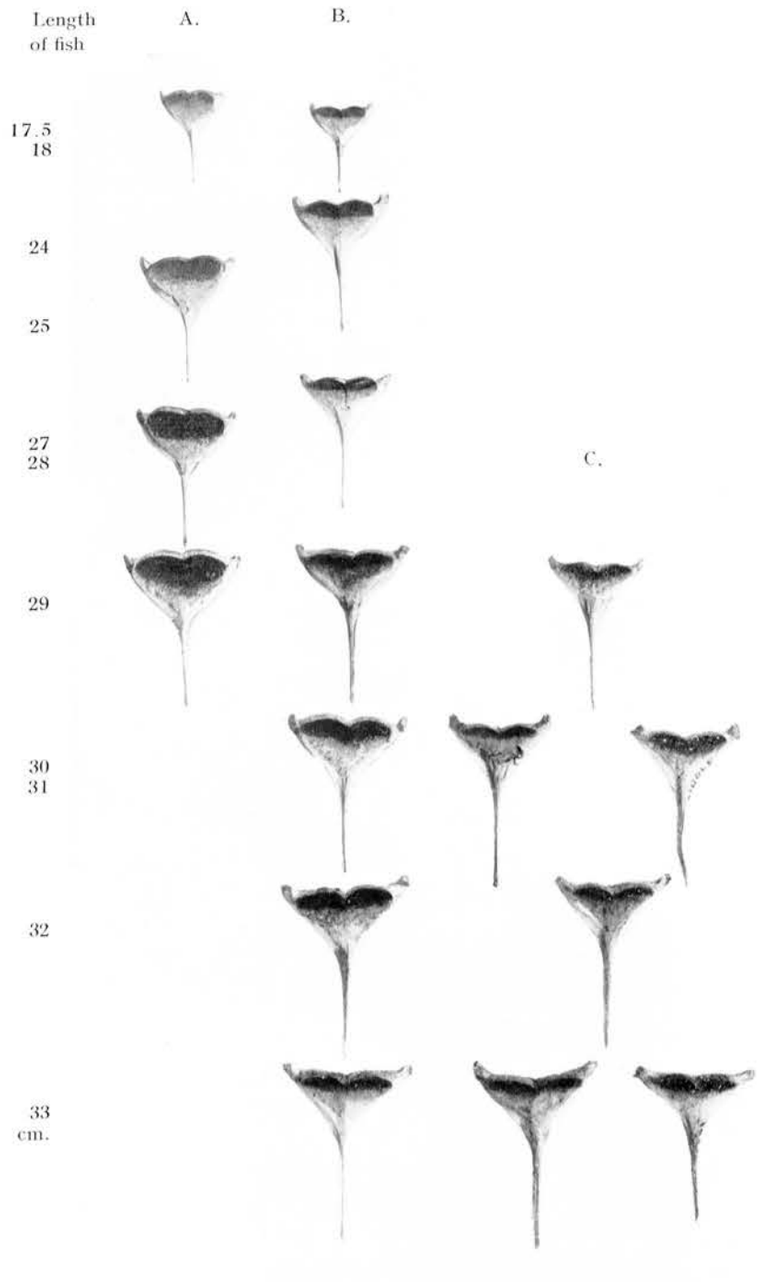
DESCRIPTION.

Utaka are small fishes, with only the larger species attaining a length of 20 cms. In all, the mouth is small and narrow, with small teeth, and the upper jaw is strongly protractile. This protractility differs only in degree from that of other species of *Haplochromis*, and among the Utaka it is most pronounced in *Haplochromis quadrimaculatus*, *H. cyaneus*, and *H. eucinostomus*. From the middle of the bone of the upper jaw a shaft extends backwards under the skin of the top of the snout, and in these three species it reaches to between the orbits. If the lower jaw is depressed the upper shoots forward so that the mouth is produced into a short tube. In colour the females are silvery, either with no markings (*H. inornatus*, *H. eucinostomus*, some *H. quadrimaculatus*) or with a dark spot on the gill cover, two spots on the side, and one at the base of the tail fin, or with some of these spots only (*H. chrysonotus*, typical *H. quadrimaculatus*) ; or with two black bands along the side (*H. prostoma*, some *H. cyaneus*). Vertical bars are also sometimes present. These colour patterns may be discernible in the males whose breeding colouration is described below ; and they are not confined to the Utaka group.

ECONOMIC IMPORTANCE.

In spite of their small size, the abundance of these fish gives them considerable importance in native economy. Near rocky shores where the bottom slopes away steeply, they are often the main commercial fish. At Likoma and Chisamula Islands the inhabitants rely largely on them as a means of barter with the people of the mainland to obtain flour. At many fishing beaches they are important during the times that *Tilapia* spp. are scarce.

Utaka are oily fishes and, as the natives eat them complete with bones, full use is made of their nutritive value.



T. karongae *T. squamipinnis* *T. lidole*

Fig. 6. Pharyngeal bones of *Tilapia* spp.

A. *T. karongae* of 17·5, 25, 28, and 29 cm.
B. *T. squamipinnis* of 18, 24, 27, 29, 30, 32, and 33 cm.
C. *T. lidole* of 29, 31, 31, 32, 33, and 33 cm.

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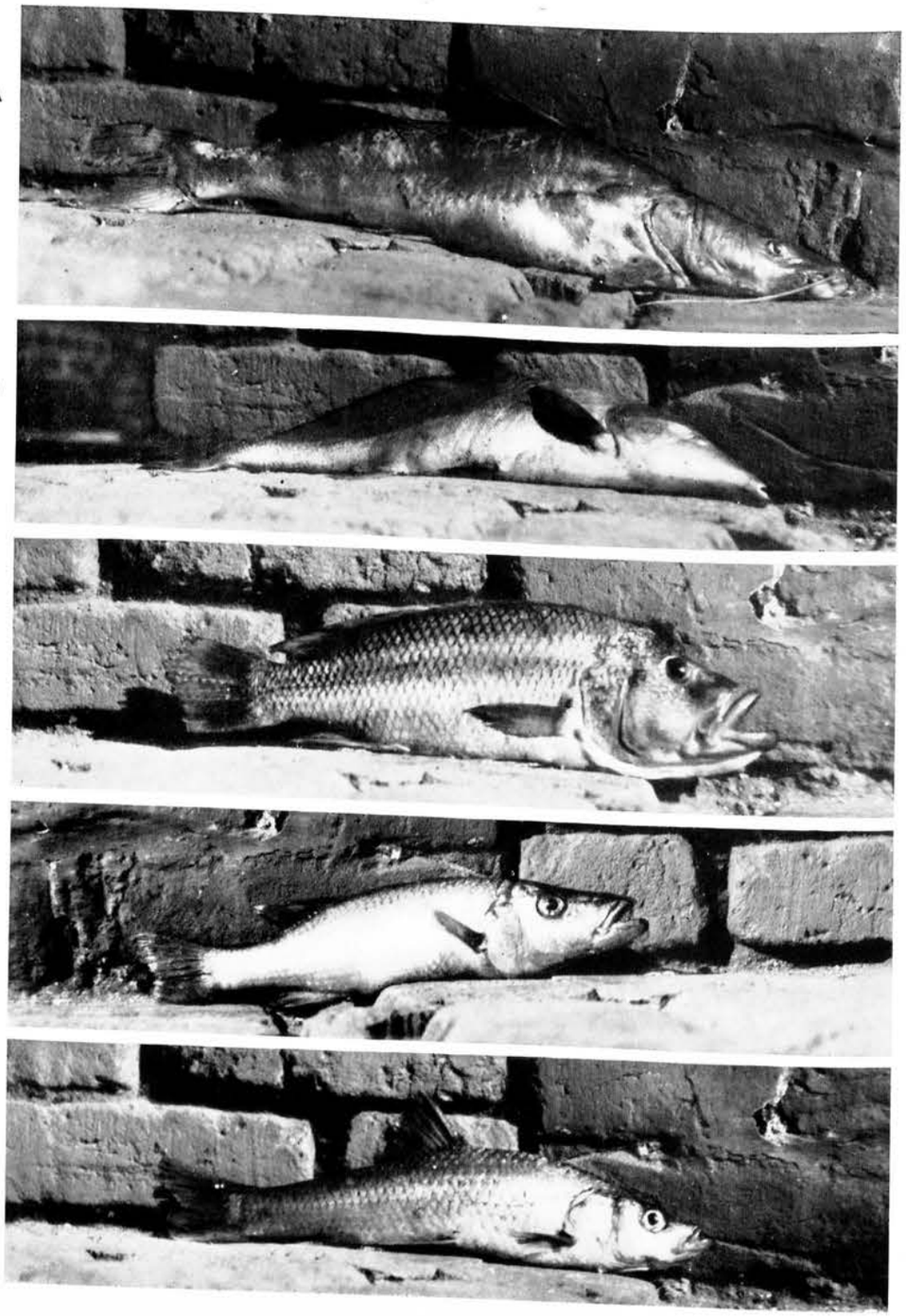


Fig. 7. Photographs of some of the fish. (*Photos. H.J.H.B.*)

A. *Bagrus meridionalis.*
B. *Mormyrus longirostris.*
C. *Serranochromis thumbergi.*
D. *Rhamphochromis* sp.
E. *Barbus rhoadesii.*

Distribution.

The distribution of Utaka probably extends over the whole lake. The abundance of the fish could be estimated only where fine-meshed seines were being used, that is at places where there was temporarily or permanently no *Tilapia* fishery. They were certainly abundant near rocky shores and also on some of the big sandy beaches. It was noticeable, however, that Utaka seines hauled on sandy beaches had very long ropes and enclosed an area of water far from shore. This suggests that these fish do not usually come very close inshore. The only species found fairly frequently in the short-roped Survey seine was *H. chrysonotus*, a small species of little economic importance. The largest species —*H. quadrimaculatus* (Mbarule)—was the main object of the open-water seine fisheries at Nkata Bay and Likoma Island where the fishing grounds were above submerged rocks or round rocky islets. Utaka fisheries were being vigorously pursued at Nkata Bay, Deep Bay, Mbaha, Likoma, Fort Maguire, and Old Livingstonia at the times of the Survey visits, where the fishing was usually done at sun-down, dawn, or during the night.

Breeding habits.

H. quadrimaculatus was found in large numbers with "ripe" or recently "spent" gonads in April and early May. *H. chrysonotus* was found in breeding condition at Sani in January, and a female carrying young in the mouth was found as late as May 15 (at Nkudzi). The limits of the breeding season for the various species are not yet known. The only information available on their breeding habits is: that the female carries the young in her mouth, that the fish are found in large numbers together during the breeding season, and that the breeding males are strikingly different in colour from the females. Males of *H. chrysonotus* in breeding condition have the top of the head and back golden yellow or whitish electric blue, and a large part of the dorsal fin bluish white; the rest of the body is deep blue and the fins are decorated with orange spots. This colouring is found also in *H. quadrimaculatus* and *H. cyaneus*, though *H. chrysonotus* is the only one with a golden back. The white dorsal fin is also known only in *H. chrysonotus* and is a livery probably taken on only at the height of the breeding condition. There is great variety of colouring within the group. Males in April and May, if they did not show the colouring described above, had deep blue bodies, much black on the fins, with sometimes large orange or white spots on the anals and yellow edges to the dorsals.

Food.

All the species of Utaka feed on the minute Crustacea of the plankton. Stomachs of breeding fishes were often empty. The fact that these fish are plankton feeders confirms the idea that they are offshore species and they may well be present in the surface waters all over the lake.

Native records show that these fish are not important in the catches of the recording stations in the Kota Kota region, but that sometimes considerable numbers are taken at the Bar at Fort Johnston.

Bagrus meridionalis. (Appendix VI, Tables H., 1–6.)

Native names.

Kampango, Mbuvu (large), Kansosole (small), Ntungumba.

Description.

This is a large, grey or bronze coloured catfish, with a scaleless body and with four pairs of long barbels round the mouth. There is a short, rayed dorsal fin with a large adipose fin behind it. The distinguishing characters and an outline sketch are given on p. 22 and in fig. 2. (See also fig. 7.)

ECONOMIC IMPORTANCE.

Bagrus is extremely important from the economic standpoint, both because it is caught in large numbers in fisheries and because it is a predator feeding on many other kinds of fish. It is caught in considerable numbers all round the lake on lines, in gill-nets, and in seine nets. It is valued by the natives for local consumption, but it does not seem to be traded to any great extent, probably because it is nearly cylindrical and therefore difficult to cure.

DISTRIBUTION.

Bagrus is present all round the lake and lives usually a little way out from the shore. It is often caught in shore seines, showing that it does come into shallow water, probably to feed on the fish near the beaches. Although considerable numbers were seen in most of the native fisheries, the natives do not fish for it very extensively, and the native records do not give a true picture of its abundance. Gill-nets set by the Survey, both in shallow and deep water in many different parts of the lake, show that it can be taken in very large numbers.

There is no evidence that the distribution of this fish varies with the seasons.

METHODS OF CAPTURE.

During the Survey 564 of these fish were handled, and most of these were caught in the Survey gill-nets, the 4-inch mesh being the most effective. (Table 5.)

SIZE.

The range of length, according to Survey records, is from 19 to 96 cm.; according to native records (Table 6) from 15 to 105 cm. The range of weight was from 50 to 9,500 gm., and the condition factor varied from 0·4 to 1·8. Table 3 shows that the sizes of fish most commonly caught are from 34 to 60 cm., and it also gives the average weight and average condition factor for each length. *Bagrus* is a long, thin fish and, therefore, has a rather low value for its condition factor.

BREEDING.

Four hundred and fifty-five specimens were opened for examination of the gonads. Among these 239 were females, 205 were males, and the rest doubtful. In the records both of the Survey and of the natives, females were slightly more numerous than males. There is no conclusive evidence of a sexual disparity in size for, although Survey records gave the maximum lengths of females and males as 96 and 71 cm. respectively, the corresponding figures in the native records are 91 and 99 cm. The smallest breeding fish were recorded by the native clerks and these were 28 cm. for the females and 30 cm. for the males.

Unfortunately, there are few data for the first months, but during March and April a large proportion of the fish (about half the females and nearly a quarter of the males) were breeding or had recently bred. After this time the number of breeding fish was lower though they never disappeared altogether. Compared with those of the Survey, native records show a higher proportion of breeding fish throughout and their figures suggest that after August the numbers of fish with developing gonads is beginning to increase. It seems probable that there is a long drawn out period, from about September to April, during which a large proportion of the fish breed, but that there is no short intensive season as is found among the *Tilapia* spp. Nothing is known about the breeding habits and there is no change in the colour or external appearance of the fish during the breeding season.

FOOD.

Bagrus is a predator, feeding almost exclusively on smaller fish, many of them belonging to important commercial species. Four hundred and twenty-eight stomachs from places all round the

lake were examined. Among these 285 were empty, 140 contained remains of fish, and three contained snails, mud, and remains of fine, green algae. In 30 of the stomachs there were recognisable fish, and these included three *Tilapia* (up to 18 cm. in length), 30 *Haplochromis* spp. (Utaka), eight Mbaba,* one *Rhamphochromis*, and one *Mastacembelus*. In 13 other stomachs there were altogether 19 small fish recognisable as Cichlids. The remaining 97 stomachs contained fish remains in various stages of digestion.

Bagrus, owing to its feeding habits and its abundance, clearly plays an important part in controlling the numbers of the smaller fish.

Clarias spp. (Appendix VI, Tables I., 1–6.)

NATIVE NAMES.

Many. (See Appendix IV.)

DESCRIPTION.

These are catfish with very long dorsal and anal fins extending far along the dorsal and ventral surfaces of the body. The external appearance can be gathered from the outline drawing in fig. 2 and from the key. The systematics of this group are extremely difficult, and the species are almost impossible to separate in the field. During the field work the fish were separated by their native names and data on the more abundant forms are arranged under these names in the Appendix. The species are, however, so closely related and mostly have such similar habits that here they are for the most part considered together. At a later date it is hoped to identify these fish in detail, and to decide how many species are represented. A great variety of names were given in different parts of the lake and it is clear that any one species has a large selection of native names.

ECONOMIC IMPORTANCE.

Like *Bagrus*, these fish are important both to man and to the lake because they are used in the fisheries and because they are predators feeding on smaller fish. They are probably rather less abundant than *Bagrus* and they are equally difficult to cure and to market.

DISTRIBUTION.

These fish are common all round the lake both in shallow and deep water. A few are taken in most of the hauls with large shore seine nets, many are caught both on hand-lines and long lines in water of varying depth, and large specimens can often be seen basking at the surface far out in the open lake.

METHODS OF CAPTURE.

Altogether 311 specimens were handled by the Survey, and Table 5 shows that most of these were caught in native seines, in Survey gill-nets, or on long lines.

SIZE. (Tables 2 and 6.)

The lengths of specimens examined by the Survey ranged from 25 to 116 cm., while those examined by the native recorders were from 17 to 108 cm. The weight varied from 100 gm. to 11,000 gm. The condition factor was usually between 0·5 and 0·9 and does not appear to increase appreciably with the growth of the fish. The range of length is large and the number of specimens rather small, so that to give average values for weight and condition factor on present knowledge would be unwise.

BREEDING.

Two hundred and twenty-seven fish were opened for gonad examination, and of these 112 were females, 100 were males, and the rest doubtful. Table 3 shows that for each kind females and males

* An inclusive term for many kinds of small fish.

were caught in about equal numbers, and native records confirm this. Both sets of records show that the two sexes are about equal in size.

The figures suggest that these fish, like *Bagrus*, also have a long and not very well marked breeding season, but more details will be given below for the different species separately.

FOOD.

Two hundred and fourteen stomachs were examined and these showed that *Clarias* are omnivorous feeders. Their main food seems to be fish, but they also eat weeds, snails, insects, plankton, crabs, and even rats when they can find them. Fuller details are given below.

DIFFERENT KINDS CONSIDERED SEPARATELY.

Mlamba (*Clarias mossambicus*). This fish can be distinguished from the other kinds by its long and granular head. It is the most abundant form and was seen all round the lake. In a few places it is not highly valued by the natives, but generally it is considered to be good to eat.

The range of size was from 30 to 79 cm. for Survey records and 17 to 108 cm. for native records. Specimens above 60 cm. are rather few in number and are called Chikuta.

The Survey records (Table 4) show that during the first months, most of the specimens examined were breeding, but that during May, June, and July the number of breeding fish is very small. Native records (Table 6) also show that there are greater numbers breeding in the early months of the year and that they decrease after May or June. The Sani figures suggest that possibly the number is beginning to increase again by October.

The smallest breeding fish seen by the Survey was 31 cm. in length, and the smallest examined by the native recorders was 20 cm.

One hundred and nineteen stomachs were examined. Eighty-six were empty, and among the rest, 19 contained remains of fish, including one cichlid and the bones of a catfish ; two contained fish remains with rice or sand and weed in addition ; two contained kassava ; two had pieces of crab ; two had mud ; two had insects, including a grasshopper and the legs of a locust ; one had a rat of 5 inches ; one had four large fruits ; one had a large snail ; and in one the contents were unrecognisable.

Sapuwa. These fish belong to the group of *Clarias* with short broad heads. They are less abundant than *Mlamba*, but were seen in many places round the lake. All figures show that the majority of the fish examined were breeding. The smallest breeding specimen was 52 cm. in Survey records, and 40 cm. in native records.

The range of length was from 25 to 107 cm. and of weight from 100 to 11,000 gm., but they are said to grow to a larger size than this.

Twenty-nine stomachs were examined and 24 of these were empty. The contents of the remaining five stomachs were : two specimens of Utaka of 10 cm. ; one large locust ; one, eggs ? ; one, grass fragments and other vascular plants.

Nkomo. This fish is extremely like Sapuwa, except that it is generally dark in colour. Monkey Bay natives gave this name to fish seen there and at several other places round the lake.

The range of length was from 37 to 97 cm.

Not enough specimens were examined to give any idea of the breeding season, and this name does not appear in the native records.

Thirty-eight stomachs were examined : 30 were empty, and among the rest, five contained remains of fish including one Utaka ; one had a fish-tail and crab limbs ; one had plankton and a large mass of Kungu flies ; and one had sand, vegetable debris, and insect remains.

Nkwazula. This is very similar to the last two kinds. It was seen at Monkey Bay, Old Livingstonia, Likoma, Chilowelo, and Che Linda.

The range of length was from 33 to 77 cm. Not enough specimens were seen to get any information on the breeding and none appear in the native records.

Twelve stomachs were examined : six were empty ; two contained remains of fish, including one Utaka and one *Lethrinops* (13 cm.) ; three contained mud ; and one contained plankton.

Sawasawa. This is the Kota Kota name of a large fish belonging also to the group with short broad heads.

Four from 84 to 115 cm. long were seen by the Survey ; three of these were taken at Kota Kota in seines and traps, and one on a night-line at Sani. Thirty-one from 40 to 102 cm. were examined between June and October by native recorders—nine at Kota Kota and twenty-two at Sani. They were caught in seines, gill nets, and on lines.

The gonads of two specimens were examined by the Survey and they were both males, one " quiet " and one " starting." Of 13 gonads examined by native clerks there were four females—one " ripe " and three " quiet," and nine males—eight " big " and one " small."

Two stomachs were opened : one contained a *Tilapia squamipinnis* of 25 cm., and one contained part of another cichlid.

Sute (*Clarias mellandi*). This species can be recognised at once if the mouth is examined. Instead of the usual narrow bands of granular teeth, there is a large semi-elliptical patch of teeth on the palate.

This fish does not seem to be caught in large numbers and only six were seen by the Survey : three at Fort Johnston ; one from a long-line at Marembo ; and two from traps at Chilowelo. Native records show one specimen of 36 cm. in the Shire River in March. The range of length was from 36 to 43 cm., weight from 260 to 510 gm. The gonads of five specimens were examined : two were females—one "ripening " and the other " quiet," and three were males—all " quiet."

Five stomachs were examined : one was empty ; one contained vegetable debris, maize, and rice grains, two small snail shells, a larger shell, and a fish egg ? ; one contained fragments of grains and a grass-like plant ; one contained various insect fragments, apparently both terrestrial and aquatic, and a few small bivalve molluscs ; and one contained leaves and other vegetable matter, bivalve molluscs, and a very small fish fry. It is important to note that this species, unlike all the other Catfish, does not seem to feed on fish. For this reason it may be found suitable for introduction into impounded waters.

Bwanamuzu. Three specimens were seen—two in 5 inch gill-nets at Marembo and Nkata Bay and one on a long line at Limbauli. Their lengths ranged from 67 to 87 cm., and their weights from 2,000 to 2,400 gm. All three were females—two " ripe " and one " spent," and all the stomachs were empty.

Bombe. Three from 96 to 97 cm. long and weighing about 7,000 gm. were seen in a seine net haul at the Bar at Fort Johnston. One was a " spent " female and two were " spent " males. Two stomachs were empty and one contained two Chambo of 31 to 32 cm.

Lumbalisilo. One specimen of 102 cm. and 6,500 gm. was taken in the same haul as the Bombe mentioned above. It was a " spent " female with an empty stomach.

Nyamba Nyamba. Two specimens were taken in 5 inch gill-nets—one at Monkey Bay and the other at Fort Maguire. They were 96 cm. in length and 6,500 and 6,900 gm. in weight. Both were females with " ripening " gonads, and both stomachs were empty.

Lumbulule. This fish was not seen by the Survey, but 14 are recorded from Sani by the native clerks between April and October. The lengths range from 50 to 109 cm., and they were all caught on night-lines. Six fish were opened and they were all males with enlarged gonads.

Barilius microlepis. (Appendix VI, Tables J., 1–4.)

NATIVE NAMES.

Mpasa, Nyengiri (young).

DESCRIPTION.

This fish is silvery in colour and rather like a salmon in appearance. It has a large, though toothless, mouth, and the stream-lined build of a powerful swimmer. It is sometimes called the Nyasa salmon and it even has pink flesh, but it belongs to a different family and even order from the true salmon. The distinguishing characters are shown in the key (p. 22).

ECONOMIC IMPORTANCE.

Mpasa is a valuable fish from the economic standpoint, and in parts of the lake—particularly in the north—it is the most important economic species. Its fishery, however, is much more local than that of any of the preceding species. The fish are mainly caught in traps in some of the bigger rivers, but only during certain seasons. They grow to a large size and are highly prized by the natives. At Karonga some Arab traders were seen who had come all the way from Mbeya to catch these fish in order to take them back salted to sell in the Mbeya region.

DISTRIBUTION.

This species is widespread in its distribution in the lake. During most of the year it lives in the open water and few are seen in the shore fisheries. A little way out from the shore it can often be caught by trolling with a spoon bait. At certain seasons of the year it comes inshore and runs up the larger rivers to spawn. During the Survey considerable numbers were seen in and near the Ruchuru River in early April, and a few were seen near Mwaya and Msumba in the same month. Nearly all the specimens examined from catches near these rivers had fully developed gonads. It was said that by April the main season was already over and that earlier in the year the numbers of fish had been much larger. At Chipoka in January the water in the Lintippe River was said to be boiling with Mpasa, and the natives had apparently scooped them out with hand nets as the fish tried to make their way upstream. In most large rivers fences and traps are put up which almost block the river, and these must catch a high proportion of the fish. Since at these times the fish are just about to spawn, it is clear that there is a great deal of waste in the fishery. After the breeding season is over the traps are taken down and very little effort is made to catch the fish until the next season.

It is not yet known whether all the breeding fish go into the rivers, or whether there are spawning grounds in the lake as well.

METHODS OF CAPTURE.

Ninety-seven specimens were seen by the Survey, and these were mostly caught in large native seine nets near river-mouths and in fence traps across rivers. (Table 3.)

SIZE.

Sizes ranged up to 66 cm. and weights up to 2,700 gm. The condition factor ranged from 0·6 to 1·4, with an average of 0·95. Small specimens were seen in many places, but wherever this species was being fished for intensively, nearly all the fish were over 35 cm. long.

BREEDING.

The gonads of 45 specimens were examined. The sexes appear to be about equal in number and size. The smallest breeding fish seen by the Survey were 38 and 39 cm. in length, though native records show a breeding male of only 21 cm. (Table 4.)

Mpasa were seen by the Survey only during February, March, and April, and during this time nearly all the bigger fish of both sexes had enlarged gonads. Native records show that occasional breeding

fish were taken in August and September. Unfortunately, there are no data as to when the breeding season starts, but it probably ends in about April in the northern part of the lake, and rather earlier further south.

The habit of this species of running up the rivers to spawn has already been described. There is no information yet as to what proportion of the fish leave the lake, when the migration starts, how far up the river the fish travel, nor what the spawning grounds are like.

FOOD.

Thirty-eight stomachs were examined, but they give little information about the feeding habits, because the fish do not appear to feed while they are breeding. Thirty-four of the stomachs were empty, three contained fish remains, including two cichlids, and in one the contents were unrecognisable. This examination of stomach contents suggests that Mpasa is a predator and this is further indicated by the large mouth and the short intestine, which are typical of predatory species.

Barilius microcephalus. (Appendix VI, Tables K., 1–4.)

NATIVE NAME.

Sanjika.

DESCRIPTION.

This fish is very closely related to *B. microlepis*, but it can be separated by its smaller size, its bigger scales and the fact that it is more brilliantly silver in colour. The distinguishing characters are given in the key (p. 22).

ECONOMIC IMPORTANCE.

Sanjika is probably important economically, for although it is small in size, it is extremely abundant. It is not usually caught in large numbers in the bigger seine hauls, but in many parts there are small meshed nets kept especially for this species. It is said to be good to eat, but, as in all members of the family Cyprinidae, the flesh is full of sharply-pointed bones.

DISTRIBUTION.

This fish is very widespread in its distribution. Like Mpasa, it lives most of the year in the open water, and at the breeding season it goes into the rivers to spawn. It is said to run up many of the small rivers all round the lake, but none were seen in the rivers during the Survey. It can almost always be caught by trolling in any part of the lake, either close to the shore or in the open water.

METHODS OF CAPTURE.

Most of the 27 fish seen by the Survey were caught by trolling, and only six were seen in native catches (Table 3). The small numbers recorded by the native clerks (Table 4) are due to the fact that Sanjika was not being fished for deliberately, and does not mean that it is scarce in the lake.

SIZE.

The range of size was from 20 to 37 cm., and the largest recorded by the natives was 30 cm.

BREEDING.

About half the specimens examined by the Survey—from February to April—had enlarged gonads, and native records show breeding specimens in September. It is said to go into rivers to spawn, but there are no data yet as to when the breeding season occurs.

FOOD.

Twelve stomachs were examined: 10 were empty; one contained fish remains; and in one the contents were unrecognisable. Like Mpasa, this fish has a large mouth and short intestine, and it is almost certain that it also is a predator.

Barbus eurystomus. (Appendix VI, Tables L., 1–4.)

NATIVE NAMES.

Kadyakola, Kuyu, Nkasu, Nkwekwe, Mbosi.

DESCRIPTION.

These fish are rather like bream in appearance, with large scales and a toothless mouth. They are green in colour on the back, yellow underneath. The diagnostic characters of the genus *Barbus* are given in the key (p. 22). This species can be distinguished from the other kinds of *Barbus* in the lake by the presence at each side of the mouth of two barbels, which are about equal in length and are longer than the diameter of the eye.

ECONOMIC IMPORTANCE.

This fish is greatly prized by the natives for food, and has a rich oily flesh, but it is not caught in large enough numbers to be of any great importance.

DISTRIBUTION.

This *Barbus* was seen in considerable numbers all round the lake. A few were taken in native seine hauls on the main fishing beaches, but gill-nets seem to be the most efficient method of catching them. This suggests that they tend to keep a little way out from the shore, but the fact that they are feeding largely on small molluscs shows that they cannot live far from the shallow water. Most of the specimens were caught in regions of fairly shallow water, and the fish were scarcer in the deeper parts of the lake.

METHODS OF CAPTURE.

One hundred and thirty-three specimens were handled by the Survey, and the majority of these were caught in gill-nets, a 4 inch mesh being the most effective. (Table 3.)

The range of length was from 18 to 58 cm., and of weight from 220 to 2,400 gm. The condition factor varies from 0·8 to 1·9 with an average of 1·3. Native records (Table 4) show a range of length from 13 to 66 cm., and they also give indications that the fish caught are rather larger in the Fort Johnston than the Kota Kota region.

BREEDING.

One hundred and ten specimens were opened by the Survey for gonad examination, and, among these, females were rather more abundant than males and were also a little larger in size. In the native records, however, for the Kota Kota region, males are considerably more numerous than females, and the sexes are about equal in size. The smallest breeding fish seen by the Survey were 41 and 35 cm. for females and males respectively, but the native clerks found fish of only 30 and 25 cm. with enlarged gonads.

Neither set of records gives any positive information about the breeding habits of this *Barbus*, but they both show that there is no marked breeding season between the months of January and October. Only a very small proportion of the females had enlarged gonads. The high proportion of the males with enlarged testes is probably explained by the fact that the male gonad both enlarges and diminishes more slowly than the female, and it is more difficult to decide its state of development.

FOOD.

Out of the 50 stomachs that were examined, 24 were empty, 18 contained the remains of molluscs, two contained seed pods, two had fragments of seeds, two had white floury material, one had vegetable debris, and one had roots from a small plant. The main food of this fish, therefore, seems to be molluscs, and these are often present in large numbers both in the stomach and throughout the intestine. In most stomachs the molluscs were small conical snails, but in a few cases there were also small bivalves.

Barbus rhoadesii. (Appendix VI, Tables M., 1–4.) See fig. 7.

NATIVE NAMES.

Tamba, Idlwale.

DESCRIPTION.

These fish are silvery in colour and are much slimmer and faster swimmers than the other species of *Barbus*. The head is pointed, the mouth is large, and the barbels are very small, the anterior one being minute and the posterior less than half the diameter of the eye.

ECONOMIC IMPORTANCE.

During most of the year these fish are not caught in sufficient numbers to be of any real economic importance.

DISTRIBUTION.

They were seen in many places all round the lake, but they were rarely taken in shore seine nets. Either they are too swift to be taken in a seine, or they live a little further out from the shore. Considerable numbers were taken both in Survey and native gill-nets at Kota Kota, and in Survey nets in many parts of the lake. Many were seen in the small rivers at Kota Kota in June during the windy season where they were being caught in traps. The majority of the fish examined in the rivers had spent gonads, so it may be that some of these fish go into the rivers to spawn.

METHODS OF CAPTURE.

One hundred and fifty-six specimens were handled by the Survey, and most of these were caught in gill-nets, the 3 inch mesh being the most effective. (Table 3.)

SIZE.

The range of length was from 20 to 44 cm.; of weight from 90 to 1,000 gm.; and of condition factor from 0·4 to 1·2, with an average of 0·9. Both Survey and native records suggest that the two sexes are about equal in size and number, and that they start breeding at about the same size (26 cm.) though one female of 22 cm. had its gonads starting to enlarge.

BREEDING.

Only a small proportion of the fish were breeding during the Survey, and there are very few data on breeding season or habits. Native records (Table 4) at Kota Kota show that " spent " individuals were taken from April to August, and that specimens with " starting " and " ripening " gonads were taken during September and October. It is worth noting that during the time from April to August most of the fish were caught in traps at the edge of the lake or in rivers, whereas those in September and October were mostly taken in the lake in gill-nets or on hooks.

FOOD.

Sixty-four stomachs were examined: 50 were empty; 10 contained remains of fish; two had insect remains; one had pieces of a vascular plant; and in one the contents were unrecognisable. This species seems to be mainly predatory in its habits.

Engraulicypris sardella

NATIVE NAME.

Usipa.

DESCRIPTION.

This is a very slender and brilliant silvery little fish with a large, toothless mouth, and a short dorsal fin set far back. It rarely grows longer than 10 cm.

ECONOMIC IMPORTANCE.

It is probably very important in the economy of the lake. It is highly valued by natives—both for food and for bait—and it is at times taken in great quantities in fine nets. It also forms one of the chief foods of the predators in the open water.

DISTRIBUTION.

This fish is said to swim in enormous shoals, both near the shore and far out in the lake. The shoals are often so dense that the fish may be scooped out in large numbers with baskets, hand-nets, or body cloths. It is said that when shoals of Usipa appear all fishing will be good.

Very few of these fish and no big shoals were seen by the Survey. Several specimens were examined but they gave little information about the breeding or feeding habits. By analogy with *Engraulicypris* spp. in other regions, and since it can live out in the open water, it may be assumed that the Nyasa species feeds on the zooplankton. Worthington (1933 a, p. 307) showed that some of the fish collected by Christy contained planktonic crustaceans, diatoms, and blue-green algae in their stomachs. Native, records from Likoma in June show that among 11 fish examined, eight were females, three were males, and only one female was breeding.

Other Cyprinidae.

The most important members of this family—*Labeo mesops, Labeo cylindricus, Barilius microlepis, Barilius microcephalus, Engraulicypris sardella, Barbus eurystomus,* and *Barbus rhoadesii*—have already been described. There are several other species which are not sufficiently abundant to be of general importance, but which may be valuable locally.

Barbus johnstoni.

NATIVE NAMES.

Ngumbo, Mkumbwa, Mbakale, Kopokopo, Chimwe (?).

DISTRIBUTION.

This fish was seen in small numbers in many parts of the lake, but it was more abundant in the north. Among the 27 specimens seen by the Survey, 18 were caught in a single seine net haul at Mwaya.

This species is also important because it can live in the upper waters of the streams in the mountains. In the Kalira and Chirua Rivers near Chintembwe (Nchisi) seven small specimens were seen, and these are practically the only kind of fish that are found so far up the rivers. They are greatly prized by the hill natives, who otherwise get no fresh fish.

SIZE.

In the specimens from the lake, the range of length was from 19 to 67 cm., and of weight from 320 to 3,500 gm.

Of the river fish six specimens measured from 8 to 13 cm., and there was one of 23 cm. weighing 200 gm.

BREEDING.

Among the 11 lake specimens that were opened, seven were females (six from 32 to 46 cm. with ripening ovaries, and one of 43 cm. " quiet ") and four were males (two from 45 to 55 cm. with " ripening " testes, and two from 40 to 44 cm. " quiet ").

In the specimens from the river the fish of 23 cm. was a female with ripening ovaries, two of 10 to 11 cm. were males with developing gonads, and in the rest it was impossible to determine the sex.

FOOD.

Seven stomachs of fish from the lake were examined : four were empty ; one contained a small fish and cichlid scales ; one had some far digested vegetable matter ; and one was empty, except for a little yellow slime. The fact that two specimens were caught on a spoon bait and one on a baited long-line suggests that these fish are predatory, and the natives at Mwaya say that they feed on Usipa (*Engraulicypris*).

Six stomachs of the river fish were examined : four contained fragments of land insects with a little moss and seed fragments ; one had seed fragments alone ; and one was empty, except for a little vegetable material.

NATIVE RECORDS.

One Ngumbo of 45 cm.—a male with an enlarged gonad—was recorded from the Shire River in June.

Ten Chimwe were recorded from Kota Kota during the months from February to October, and these probably belong to this same species. They ranged in length from 18 to 43 cm. Of the five fish opened two were females ; one of 30 cm. with a spent gonad and one of 33 cm. with an ovary starting to enlarge ; two from 43 to 45 cm. were males—both with enlarged gonads ; and in one of 26 cm. the sex was not determined.

Varichorinus nyasensis.

NATIVE NAMES.

Chilulumawe, Kuyu.

This fish seems to be scarce and only six were seen by the Survey—five at Mwaya and one at Msumba. They ranged in length from 24 to 42 cm., and in weight up to 700 gm. Among these specimens there were five females—three " spent," two " ripening," and one " quiet "—and one male with an enlarging gonad.

Four stomachs were examined : two were empty ; and the remaining two contained white vegetable material.

Serranochromis thumbergi. (Appendix VI, Tables N., 1–4.) See fig. 7.

NATIVE NAMES.

Sungwa, Chiuwa, Lisenje, Kukwa.

DESCRIPTION.

This is a cichlid fish with a very large mouth and sharp teeth. It is usually green in colour and probably grows to a larger size than any other fish of this family in Lake Nyasa. An outline drawing is given in fig. 2.

ECONOMIC IMPORTANCE.

This fish is not caught in large enough numbers to be of any real economic importance, but it is valued whenever it is taken. It is caught in small numbers by the natives in shore seines and traps, but there is no special fishery dependent upon it.

DISTRIBUTION.

This fish was seen in small numbers all round the lake, but was scarce in the deeper parts. It was taken on sandy beaches, but the larger specimens seemed to keep rather further offshore and were usually caught near rocks, probably because Utaka are found near rocks.

METHODS OF CAPTURE.

One hundred and five specimens were handled by the Survey. Most of these were taken in native seines and native traps, but 28 were caught on spoon baits by members of the Survey. (Table 3.)

SIZE.

The range of length of these specimens was from 21 to 42 cm., and males were rather larger than females. Sixty-five weighed fish varied from 100 to 1,100 gm., and gave a range of condition factor from 0·8 to 1·7, with an average value of 1·3. Native records give a range in length from 16 to 41 cm. for females and from 15 to 49 cm. for males, and they show that the commonest size caught is from 27 to 33 cm.

BREEDING.

At maturity the females and males seem to be 21 and 23 cm. long respectively, according to Survey records (Table 2) and 19 and 20 cm. respectively, according to native records (Table 4).

In both sets of figures the large proportion of fish with spent gonads during the early months of the year shows that the breeding season must have started well before January. The scarcity of breeding fish in the months after April suggests that, like *Tilapia* spp., this fish probably has an intensive breeding season which occurs during the rainy months.

FOOD.

Forty-six stomachs were examined, and these showed that this species is predacious, for 37 were empty and in the rest were fish remains. Among these, five contained unrecognisable fish, two contained cichlids, together with some sand and pieces of grass, and in one there were three Utaka (*Haplochromis* spp.).

Rhamphochromis spp. (Appendix VI, Tables O., 1–4.) See fig. 7.

NATIVE NAMES.

Mcheni, Sangwe, Kekena, Sangwinole, Lilumboro.

DESCRIPTION.

These are slender fish, silvery in colour with large, fierce mouths, and pointed teeth. There are several species in the lake, but they are difficult to distinguish in the field, and are here all considered together.

ECONOMIC IMPORTANCE.

They are not caught in large enough numbers to be of any commercial importance, though common in many places all round the lake. They are considered to be particularly good to eat.

METHODS OF CAPTURE.

One hundred and forty-four specimens were seen by the Survey, and most of these were taken in seine nets, by trolling, or in gill-nets, the 3 inch being the most effective. (See Table 3.)

SIZE.

The range of length was from 12 to 43 cm., and weight from 60 to 800 gm.

BREEDING.

The state of the gonads of the 94 specimens opened suggests that the breeding season occurs in the early part of the year, but the data are few.

FOOD.

These fish are active predators as can be seen by their readiness to take a spoon bait. Fifty-six stomachs were examined: 39 were empty and the rest contained remains of fish—all unrecognisable except for one Usipa (*Engraulicypris*).

Mormyrus longirostris. (Appendix VI, Tables P., 1–4.)

NATIVE NAMES.

Panda, Mbelewele, Chigondi.

DESCRIPTION.

All members of the family Mormyridae are peculiar in appearance, and there is great variation in the shape of the head and the length of the fins. The fish all have very small thin scales which do not shine like the scales of other fish, the bodies are all grey or bronze in colour, and the heads are covered with a soft thick skin. *Mormyrus* can be distinguished from the other Mormyrids in the lake by the fact that the mouth is at the end of a long curved snout, and the dorsal fin is about five times as long as the anal fin. An outline drawing is given in fig. 2 (see also fig. 7B).

ECONOMIC IMPORTANCE.

This fish does not seem to be taken in large numbers in the fisheries, although it is very abundant in the lake. It is valued when it is caught, but it is not at present of any real economic importance.

DISTRIBUTION.

Mormyrus is abundant round the lake and it was caught at most places where gill-nets were set. It usually lives a little way out from the shore and it was rarely taken in seine nets. It seems to live mainly on or near the bottom. At Nkata Bay where nets were set both at the surface and on the bottom the bottom nets caught 32 fish and the surface nets took only five. It sometimes seems to swim in shoals. At Sani in January, three hauls were seen to contain considerable numbers of these fish, and then no more were seen in all the rest of the hauls there.

METHODS OF CAPTURE.

Two hundred and eighty-five specimens were handled by the Survey, and the majority of these were caught in gill nets, the 4 inch mesh being the most effective. (Table 3.)

SIZE.

The range of length according to Survey records was from 17 to 60 cm.; according to native records from 38 to 66 cm. The weights ranged from 40 to 1,400 gm., and the condition factor was from 0·5 to 1·2, with an average of 0·77. This fish is elongate in shape which explains the low value of the condition factor. Males and females seem to be caught in about equal numbers and to be of about the same size.

BREEDING.

The majority of the fish were breeding throughout the early part of the Survey and as late as the end of May. During June and July most of the fish were quiet. The figures suggest that this fish has a long drawn out breeding season which starts before January and ends about May. The fish seem to reach maturity at a length of about 30 cm.

FOOD.

The examination of 60 stomachs supports the idea that these fish live largely on the bottom: 14 were empty; 30 contained chironomid worms which are fly larvae that live in the sand or mud, and many of these stomachs contained sand and pieces of weed in addition; 11 contained sand and vegetable debris; and five contained insect remains which included many cases of caddis fly larvae. The long snout is probably useful in collecting the food from the bottom and in burrowing for the animals living buried in the sand or mud.

Other Mormyrids.

There are three other species of Mormyridae in the lake. These are not of importance economically because they are only taken in small numbers in the present fisheries, but considerable numbers were taken in the Survey gill-nets in several parts of the lake.

Mormyrops deliciosus.

NATIVE NAMES.

Nyanda, Njolo, Nkupe, Ngondi.

DESCRIPTION.

This fish is elongate and like *Mormyrus* in appearance, but can be distinguished by the shorter snout and the shorter dorsal fin (which is shorter than the anal fin). There are about 20–36 teeth in each jaw.

Thirty-eight specimens were seen, and all were taken in Survey gill-nets: 19 at Monkey Bay, 12 at Kota Kota, and the rest from places in the northern part of the lake. None were seen in native nets and none appear in the native records.

SIZE.

The range of length was from 28 to 79 cm., and of weight from 150 to 2,400 gm.

BREEDING.

All the fish were opened: 15 were females, but only four of these had ovaries "starting" or developing; 10 were males, all but one being "quiet"; in the rest the sex could not be determined with certainty.

FOOD.

The examination of 21 stomachs shows that this fish is a predator: six were empty and the rest contained remains of fish. In a few there were remains of crabs and insects in addition.

Gnathonemus spp.

NATIVE NAMES.

Mputa, Ntachi, Panda.

DESCRIPTION.

This fish is less elongate than the previous species; the mouth is at the end of the head; the snout is not prolonged, and there are less than 10 teeth in each jaw.

Twenty-seven of these fish were taken in gill-nets: 17 at Monkey Bay, eight near the Dwafisi River, and two from Florence Bay. They ranged in length from 14 to 25 cm., and five stomachs showed that they were feeding on insects, mostly ephemerid and chironomid larvae.

Marcusenius discorhynchus.

NATIVE NAMES.

Ntachi, Mputa, Mbombo, Mbobwe.

DESCRIPTION.

These fish are smaller than the other species of Mormyridae, and they can be recognised by the round front to the head, the inferior mouth, and the dorsal and anal fins of about equal length.

Sixteen of these fish were seen in native seine nets at Kota Kota and Mwaya, and 11 were taken in gill-nets at Monkey Bay, Florence Bay, Karonga, and Mbaha. They varied from 13 to 20 cm. in length. Seventeen were opened, and of these seven were "ripe" females, six "quiet" females, three

"ripe" males, and one "quiet" male. Examination of seven stomachs showed that the fish had been feeding on insects, mainly chironomid larvae, hemipterans, and dragonfly nymphs. Many contained also shrimps, snails, bivalves, and vegetable debris.

Synodontis zambesensis.

NATIVE NAMES.

Kolokolo, Njekayeka.

DESCRIPTION.

This is a small catfish with three very strong, serrated spines, one in the front of the dorsal and one in each of the pectoral fins, a bony shield extending back from the head, three pairs of barbels, and a patch of curved movable teeth on the lower jaw. It is greyish in colour, marked all over with black spots which are variable in size and the extent to which they are confluent.

DISTRIBUTION AND IMPORTANCE.

These fish are common in many parts of the lake, but they are not important commercially, mainly because they are difficult to handle, the spines being both sharp and capable of being locked at right angles to the body. The fish are not often taken in large numbers by native fishing methods, though special traps are sometimes said to be set for them. A few large catches of them were seen from seine nets at Ngo. Considerable numbers were taken in Survey gill-nets of small mesh at many places, particularly at Monkey Bay and Nkata Bay.

SIZE AND HABITS.

These are small fish and were not seen above a length of 25 cm. No specimens with ripe gonads were examined, and nothing is known about the breeding habits. The examination of 45 stomachs suggests that these fish feed by scavenging on or near the bottom: 23 were empty, but the rest contained sand, vegetable debris, remains of insects and their nymphs and larvae, fish scales, molluscs, and shrimps.

Alestes imberi.

NATIVE NAME.

Nkalala.

DESCRIPTION.

This is a small, silvery fish, with large scales, a small adipose dorsal fin, a non-protrusible mouth with large, many-cusped teeth.

DISTRIBUTION AND IMPORTANCE.

This fish is rarely taken in native nets and is of no importance in the fisheries. It is, however, common round the lake and was taken in considerable numbers by the Survey's fine mesh seine at many places, particularly Kota Kota, Karonga, and Mwaya.

SZIE AND HABITS.

The range of length for 70 fish was from 11 to 20 cm. Only two of these had enlarged gonads, and nothing is known of the breeding habits. Examination of 40 stomachs suggest that this is an inshore species, because the contents were mostly fragments of plants, often seeds and pieces of grass blades, and occasional remains of insects and insect larvae.

Other Cichlidae.

There are numerous fish, other than those already described, belonging to this family, which may be of local importance. On the whole they are either too small or too scarce to be significant in the fisheries.

Other species of Haplochromis.

Of the 102 species of *Haplochromis* many are too small to be caught in the large-meshed seines. Those that are large enough are mainly fish-eating species that prey on the young of Cichlids and *Barilius* and on the shoals of *Engraulicypris* (Usipa). Large specimens of *H. lepturus* and *H. nototaenia* (Khota, Dimba) are eaten readily by adults, while the smaller species are the perquisites of the little boys and play an important part in their nutrition.

Three blotched and spotted "hyaena fish" *H. polystigma*, *H. livingstoni*, and *H. fuscotaeniatus* (Liwele, Fisi, Gufifi), and the following species *H. rhoadesii* (Kavunguti), *H. heterotaenia* (Mbowe), *H. atritaeniatus* (Tong'o) and *H. woodi* (Mbawala, Katsatsi) are fish-eating species that appeared fairly frequently in both the Survey and the native records. *H. kiwinge* (Binga or Kivinga, Dzani) is one of the most abundant species, but appears to live more in the open water than the others. It could frequently be seen congregated in large numbers waiting for refuse from the ship, but it was not commonly taken in nets. It is easily identified by its colour—turquoise blue to pale green—marked with a black band along the middle of the side.

H. melanonotus and the related *H. semipalatus* (Sasamchenga, Sagomeza, Tokotoko) seem to be carnivores and scavengers. The general colour is brassy yellow with a black oblique band on the back from the nape to the middle of the root of the caudal fin. A breeding male was electric blue. The name Sasamchenga (sand-scraper) was sometimes applied at Sani to other species, including *H. auromarginatus*

Lethrinops. (Tondo, Chigong'o, etc.).

This genus contains about 20 species, all with a small mouth situated at the lowest point of the head, the upper profile of the snout curving markedly downwards. They are probably very abundant and appeared in large numbers and great variety in the fine-meshed shore seine. The two largest species (up to 30 cm. in length) *L. praeorbitalis* and *L. laticeps* (Chete and Vwivwi) appeared in considerable numbers in the large seines in the Kota Kota region, about 2,500 Chete being recorded by the native clerks at Sani. The jaws and teeth are weak and the fish are apparently bottom-feeders, living largely on chironomid larvae.

Chilotilapia rhoadesii. (Ndukufiona, Kansupa, Kapumphu.)

This fish appeared frequently in the native records from Kota Kota. The female is silvery with two dark bands along the side; the breeding male is brilliant electric blue. The jaws are short and strong, set with large, blunt teeth, which are probably used to break the shells of water snails, so that the soft parts alone are swallowed. Stomach contents also suggest that molluscs are the main food.

Corematodus. (Two species.)

C. shiranus. (Nankerere, Chaombamwera, Yinga.)

This fish bears a strong superficial resemblance to *Tilapia squamipinnis*, but has a bigger mouth and a characteristic dentition, each jaw being set with a broad file-like band of teeth. It is caught in small numbers with the shoals of *Tilapia* and the stomach and intestine in the six specimens examined were full of minute scales of the type found on the tail fin of Cichlids. As there was nothing else in the gut it appears that *Corematodus* feeds by snapping at the tail fins of the *Tilapia* with which it swims.

It grows to a length of 27 cms., but it is not abundant enough to be of any economic importance; nor does its way of feeding give it importance as an enemy of *Tilapia*.

C. taeniatus. (Chindikhila.)

This fish has the same file-like dentition, but only reaches 19 cm. in length, and it has a different colour pattern, consisting of an oblique band from the nape to the middle of the root of the tail fin. The gut was examined in six specimens and contained minute scales as in the previous species. *C. shiranus* appears to mimic *Tilapia squamipinnis* in its colour pattern, and it may be that some of the many Cichlidae with an oblique black band are the models and the victims of the smaller *Corematodus*.

Docimodus johnstoni. (Chiluma, Chindikhila, Kawisa, Nchesu.)

This fish is well named Chiluma—"the thing that bites"—for it has a short, heavy, underhung jaw with large cutting teeth. The breeding male is a rich blue, and females and non-breeding fishes are silvery with an oblique black band from the nape to the middle of the base of the tail fin. Breeding males were seen from January to May. Stomach contents suggest that the cutting teeth may be used to bite pieces from the fins of other fishes; or, perhaps, *Docimodus* may be a general scavenger. It was often taken in seine nets, but more than one or two specimens were rarely seen in a single haul.

In the native records a number of names occur that were not met by the Survey, so it is impossible to know to what fish they refer. Most of these names belong to fish that were scarce in the catches, and only one or two specimens are recorded, but Gwenje appears to be common in the nets at Kota Kota and Silimbanga, Chisawasawa, and Nagangata are sometimes abundant at the Bar at Fort Johnston.

SUMMARY OF THE DISTRIBUTION, BREEDING, AND FEEDING HABITS OF THE MORE IMPORTANT FISH.

Distribution.

Although most of the important economic species are widespread in the lake, the predominant forms are different in the different regions. In the southern part of the lake where the water is mainly shallow, species of *Tilapia* (Chambo) are by far the most abundant fish. In the northern regions where the water is mostly deeper, *Tilapia* are again common, but there is also a high proportion of the family Cyprinidae, represented by *Labeo* (Nchira), *Barilius* (Mpasa), and *Barbus* spp. (Ngumbo, Kadyakola). In the deeper and more rocky areas in the middle section of the lake, species of *Haplochromis* (Utaka) seem to be the most abundant fish, though shoals of *Engraulicypris* (Usipa) may also be important at times. All round the lake, both in shallow and in deep water, species of catfish, *Bagrus* and *Clarias*, occur in considerable numbers.

The economic importance of the various species depends not only on their abundance, but also on the ease with which they can be caught. The commonest method of fishing among the natives is with shore seine nets,* though traps, open water seines and gill-nets may also be used. In the fisheries of the southern region large shore seine nets are used extensively, and these catch mainly species of *Tilapia*. Most of the other important species also occur in this region, but their numbers in the total catch are small compared with those of *Tilapia*. During the windy season when shore seines are difficult to work, *Labeo* from gill nets, catfish from lines, and *Barbus* from traps may also become important.

In the northern part of the lake where the beaches are less extensive, smaller seine nets are used, and there is a greater amount of trap fishing. The catches often consist largely of *Tilapia*, but in many places members of the Cyprinidae may be equally, or even more, important. It is interesting to note

* See Section C for description of fishing methods.

that in these regions the large meshed seine nets were sometimes called " Nchira " nets, after the name of the fish caught in them, rather than " Chambo " nets, which is the usual name in the south. River fisheries in the north also play a greater part than in the south, and the main catches are *Barilius* and *Labeo*.

Near steeply-shelving, rocky shores, the *Tilapia* seem to be replaced as the main economic fish by small species of *Haplochromis* (Utaka). These are caught in open water seines, which, with the exception of lines, are the only gear used by natives in deep water.

Breeding habits.

SPAWNING. The females of most families of fish have very large numbers of eggs, and once these are shed and fertilised, the parents pay no more attention to them. In the Cichlidae, however, the females have relatively few eggs, and after spawning, the eggs, and later the young fry, are often protected by the parents. The Cichlidae mate in pairs and the males usually assume brilliant colours at the breeding season. In some species, including *Tilapia squamipinnis* and *lidole*, the eggs and young are carried in the mouth of the mother. In those "mouth-breeding" Cichlidae that have been examined in detail, a basin-shaped nest is hollowed out of the sand. Eggs are laid and fertilized in the nest and are then taken into the mouth of the female who shelters them until they hatch, and the young fry return to the maternal mouth for shelter until they reach a size which varies with the species. In other species of *Tilapia*, including a close relative of *T. melanopleura* in other waters, the eggs are laid on stones or other smooth surfaces and they and the young are guarded by both parents. The observations of the survey on the *Tilapia* spp. cover only the later phases of breeding behaviour from the time when the young are still living on the egg yolk, but a *Haplochromis* was seen with eggs in the mouth. Abandoned nests were observed in several places, but mating and egg-laying were never seen. There are no data yet about spawning in the other families of fish. There is no change of colour during breeding in these families.

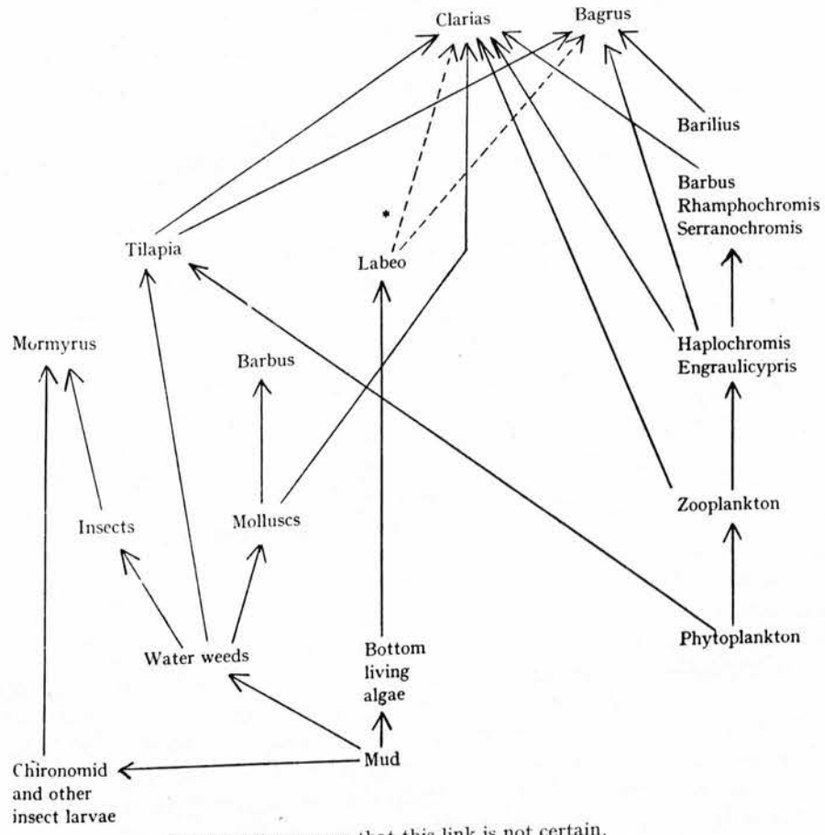
BREEDING MIGRATIONS. Many fish migrate to definite breeding grounds at certain times of year. The *Tilapia* spp. congregate in the shallow water to breed, as described above, but this migration is not very marked because many of the fish live in the shallow water during most of the year. Several members of the family Cyprinidae, however, leave the lake and run into the rivers to spawn. The larger *Barilius* (Mpasa) go only into the big rivers, but *Labeo* (Nchira) and the smaller *Barilius* (Sanjika) enter many of the small rivers and streams all round the lake.

BREEDING SEASON. The breeding season for most of the fish occurs during the rains, but the time, length, and intensity of the season varies with the different species. The season for *Tilapia* spp. probably starts in September or October and continues at its height till early February. During this time practically every fish examined had ripe or recently spent gonads. Later the number of breeding fish decreased rapidly and after April males with breeding colouration disappeared and did not appear again until September. The season for *Labeo* was also at its height before January and continued till the middle of April when it ended rather abruptly. *Barilius* were running up the rivers from December to April and nearly all specimens taken during this period near rivers had ripe or ripening gonads. Most of the other fish appeared to have a more prolonged season with a small proportion of the population breeding during most of the year. The group of *Haplochromis* species known as Utaka were found to have ripe gonads in April in the middle region of the lake, but the limits of the season are not so far known.

Feeding habits.

A description of the great variety of feeding habits among the fish of the lake has already been given (p. 18). A brief summary is made here of the food of the more important species and the extent

to which they depend on one another. The information is most easily shown by a diagram. (See below.) For the open waters data are scarce, but probably there is a simple food chain from the small fish feeding on the plankton to the larger predators. The commonest zooplankton-eaters are *Haplochromis* spp. (Utaka) and *Engraulicypris* (Usipa). Feeding on these are the predators, *Barilius*, *Barbus johnstoni*, *B. rhoadesii*, *Rhamphochromis*, *Serranochromis*, *Bagrus*, and *Clarias*. It is not known, however, to what extent these species extend far from the shore. In the shallower water at the edge



* Dotted lines mean that this link is not certain.

of the lake, there is more variety in the food supply for the fish. Living on the mud of the bottom there are algae, insect larvae and nymphs, and water weeds, which in turn support an insect and mollusc fauna. Among the inshore fish, the *Tilapia* feed on phytoplankton, water weeds, and vegetable debris, the proportion of fragments of higher plants in the stomachs varying with the species. *Labeo* also feeds on vegetable matter, mostly on the bottom-living algae. *Barbus eurystomus* lives largely on snails from the water weeds, and *Mormyrus* feeds on insects and insect larvae from the bottom mud. The non-predacious fish mostly live in shoals, at least for part of the time, but the predators are usually solitary.

FURTHER BIOLOGICAL INFORMATION NEEDED.

The knowledge available on the biology of the more important fish has been described above, but there are clearly gaps in the information. These gaps must be filled by further observation before the life of the fish can be fully understood and before the best use can be made of the resources of the lake. The subjects on which further information is most needed are summarised below for the different species.

Tilapia squamipinnis. More collections of this fish, also of *T. lidole* and *T. karongae* should be made, including specimens of all sizes and taken at different times of year. These will show the relations of the species to one another, and make it possible to name the smaller specimens. They will also show the species and significance of the " Black Fish." Distributions should also be studied to determine the predominant species in the northern part of the lake.

Observations should be made to find when the breeding season starts, where the eggs are shed, and the time the young fry are held in the mouth of the parent. Much of this work could be done in ponds or tanks. It is important to discover whether the fish also live in the open water, whether they congregate round sandy beaches or rivers, whether they move from one part of the lake to another, and whether they are more active by day or by night.

Tilapia shirana. Similar information on the life history and movements of this species is needed.

Labeo and *Barilius* spp. Studies should be made to find the breeding grounds of these species, to discover what proportion of the fish go into rivers to spawn, and what proportion return to the lake. The season during which the fish start spawning in different parts of the lake should be investigated, together with the effect of the trap fishery on the stock of *B. microlepis.*

Haplochromis spp. and *Engraulicypris.* Data are wanted on the fishing season, habitat, and breeding habits of these fish and on the food of *Engraulicypris.*

Clarias spp. Studies of these fish should be made to find how many species are represented, and whether they differ in their habits.

Barbus johnstoni. The habits of this species in the rivers should be investigated because it is the main species present in the hill streams.

Predators. Studies on the food of the larger predators should be continued to discover to what extent they are feeding on the commercial fish. It is clear that if the fisheries are concentrated on the non-predacious species, such as *Tilapia* and *Labeo*, the proportion of the predators in the lake may increase so that they take a larger and larger toll of the smaller fish. Unless the food of these fish, and particularly of *Bagrus* and *Clarias* spp., is known in detail, it will not be possible to estimate the damaging effect they may have on the stock if their relative numbers do increase.

Fish-eating birds, crocodiles, and water-tortoises. The food of these animals should also be investigated to see to what extent they are feeding on the commercial species.

CENTRAL WATERS OF THE LAKE.

Only the biology of the fish living in the inshore waters has so far been studied in detail, and little is known about forms living in the centre of the lake a long way from shore. The main difficulty is that such fish are not easy to catch. Shoaling fish or surface living species can be taken to a certain extent in open-water seines, gill-nets, and tow-nets. Bottom-living fish could, perhaps, be taken in trawls, but it is always extremely difficult to catch mid-water fish, though lines may be a possible method. It is important to know whether the commercial species extend far out into the lake or whether they are confined to the inshore waters.

GENERAL.

Nothing is yet known of the time factor in the biology of the Nyasaland fish, nor of the potential rate of increase of the different species. This rate depends on the reproductive capacity of the fish, their rate of growth and their natural mortality. The reproductive capacity is dependent upon the number of eggs produced, the proportion that reach maturity, and the frequency with which the fish breed. The rate of increase is extremely difficult to determine. The actual number of eggs can always be estimated by examination of the ovaries, though this method is not entirely satisfactory. Attempts at scale-reading to show the age have so far been without success, but should be continued. The difficulty is that in tropical regions there is not sufficient seasonal variation to alter the rate of growth and so form distinct rings on the scales. Otoliths should also be studied. The growth rate can be determined by marking experiments (see Section E) by keeping specimens in ponds and measuring the growth directly,* and by analysing the size of fish in the catches of a fishery,† but none of these methods alone is satisfactory. The other factors can only be arrived at by careful observations and studies carried on over long periods.

C. Description of Fisheries.

The greater part of the fishing on Lake Nyasa is done by natives, but two European fishing concerns have started operations within the last four years. The European fishing stations probably catch a larger quantity of fish than any single native station, but the latter are so much the more numerous that the total of all their catches is considerably greater than those from the European stations. A large proportion of the fish caught at the European stations is exported, and the distribution of the rest is practically confined to the townships and their immediate neighbourhoods. All the fish caught by native fishermen is sold in the Protectorate, and has a much wider distribution amongst the ordinary villages than does that from the European stations.

1. NATIVE FISHERIES.

Methods of fishing.

There is considerable variety in native fishing methods, the particular one in use at any given place being determined by the physiography of the neighbourhood, and the kinds of fish that are present.

The important methods are as follows :—

A. Nets ..	..	(1) Shore seines.
		(2) Open water seines.
		(3) Gill-nets.
		(4) Scoop or hand nets.
B. Traps ..	..	(1) Fence traps in river or at lake edge.
		(2) Single open water traps.
C. Hooks	..	(1) Hand lines with single hooks.
		(2) Set or night lines with many hooks.
D. Fish poisons.		

* It must be remembered that the environment greatly influences the rate of growth and it is only by studying these measurements in conjunction with other data that they will help to show the rate of growth in the lake.

† Where a fish is known to have only one breeding season in a year, certain deductions may be possible. For example, if the catches show that specimens about, say, 10 cm. and about 20 cm. long were much more abundant than intervening sizes, then it may be assumed that the fish belong to two year groups and the rate of growth is 10 cm. in a year.

A. Nets.

(1) SHORE SEINE. (Native name = Khoka.)

This net is worked from the beach and is similar to the European shore seine (Davis, 1936, pp. 66–8). It is set in a straight line parallel to the beach from a canoe, and drawn into a semi-circle by pulling on the end ropes. As the net approaches the shore the end ropes are gradually brought closer together, so that the net encloses a long narrow body of water. It catches the fish by surrounding them so that its effectiveness is limited by its length and depth as well as by the number of fish which habitually swim in the inshore waters.

The mesh and size of seine nets in use vary considerably. Factors influencing this variation are :—

(1) the species which is predominant ;
(2) the length of shore-line which is without obstructions ;
(3) the economic status of the net owner.

Where the larger species, such as *Tilapia* and *Labeo*, are predominant, the mesh at the centre is usually about 2 inches (diagonal measurement,* Davis, 1936, p. 18[*b*]) and the wing mesh from 4 to 5 inches. Where the small fish of the " Utaka " (*Haplochromis* spp.) type outnumber the other species, the centre mesh is usually about $\frac{3}{4}$ inch, and the wing mesh 2 inches. The majority of nets for Utaka are about 150 × 6 feet at the centre, while the large meshed nets vary from 450 × 16 feet to 1,400 × 20 feet. Long nets with small mesh would probably be too heavy for convenient pulling. The small meshed nets are often set rather farther from the shore than the large meshed type, and may have end ropes 250 to 300 yards long.

In general the larger meshed seines are to be found where there are long sandy beaches and shallow water, while the " Utaka " seines are used on the small, sharply shelving beaches in the more rocky parts of the lake. The use of the shore seine requires an inshore bottom free from stumps or rocks. Where a beach contains these obstructions the net has to be pulled through the gaps between them, and the largest seines are then not always practicable.

Natives with small resources of cash or labour cannot afford to purchase or construct the largest nets. Although an impecunious owner may build up a net from one which was originally small by the addition of strips of netting as time and circumstances permit, few nets appear to remain in being long enough to reach a very large size in this way. Thus Kota Kota has many nets under 500 feet long, though the beach is quite suitable for two 1,000 foot nets which are used there. The price of a large meshed seine about 600 feet long is approximately £3 according to native quotations, while that of a small meshed seine of 150 feet is about £1 10s.

Tables in Appendix VIII show the composition and size of the catches of large meshed seines at Kota Kota, Sani, Fort Johnston Bar and Shire River, according to native records. Most of the larger species are caught in these nets, but *Tilapia* spp., *Labeo* spp., *Bagrus*, and *Clarias* spp. are most numerous. The records show catches of over 10,000 fish at Sani, but it should be noted that figures above about 2,000 should be regarded as estimates.† The largest catch in a native seine net seen by the Survey was 844, and the average number in 29 hauls was 205 fish. (See Table 1 in Appendix VII.) Table 6 in Appendix VIII shows the sizes of the catches in four large meshed seine nets of known dimensions at Kota Kota. Small meshed seines catch mainly fish of the Utaka group, together with a

* = the diagonal distance across the mesh when the net is stretched from head to foot so that the space is closed. Thus a 4-inch mesh net is made up of meshes, which are 2 inches square.

† In the case of very large catches, the recorders were told to count the number of fish that filled one canoe and then to find how many canoes were needed to take the rest.

(1) (*Photo. E.T.*)

(2) (*Photo. E.T.*)

(3) (*Photo. C.K.R.*)

Fig. 8. Hauling a Native Shore Seine Net.

(1) and (3) at Kota Kota, (2) at Monkey Bay. In (1) and (3) note the bark strip ropes with many knots, the wooden floats on the net and the large numberof people holding the net in the final stages of hauling. The net in no. 2 is a product of a net-making concern in Nyasaland run by a European, Mr. Sharpe, and employs European materials.

(1)

(2)

(3) (*Photos. C.K.R.*)

Fig. 9. Fishing with an Open Water Seine Net (Chilimila).

(1) Off Nkata Bay, (2) and (3) off Chilowelo. The net is towed through the water by two canoes, hauled to the surface and the catch is put into one of the canoes which lie alongside at the end of the haul.

few specimens of the young of other species. The average catch of a 150 foot net seemed to be about 300 fish.

Shore seining is the commonest method of fishing in the lake, particularly in the southern end where there are extensive beaches. Far greater numbers of fish are caught in this way than by any other method.

(1*a*) Small shore seine. (Native name = Cheche.)

This is a small meshed inshore seine generally used at night. It is without end ropes, and is set close to the beach by two canoes starting from a central point off-shore and paying out the net in opposite directions till its ends reach the beach. The net is then hauled on shore like an ordinary seine. It may also be set in a similar manner by men wading.

This type of net is from 40 to 50 yards long, with a mesh of about 2 inches over its whole length. The catch is said to be mainly Sanjika (*Barilius microcephalus*).

(1*b*) Subsidiary seine net. (Native name = Chalera.)

This is a small net used in conjunction with the large meshed seine. It is a simple strip of netting about 30 × 3 feet attached to a straight stick at either end. It is held upright in the water outside and behind the seine in the closing stages of hauling, and is intended to catch fish which succeed in escaping either under, over or through the seine itself.

(2) Open water seine. (Native name = Chilimila.)

Open water seines are worked from two canoes in the deeper water. They are proportionately very wide in the middle, being about 100 × 50 feet. At the two ends the net is attached to wooden poles about 4 feet long, and the hauling ropes are about 90 feet long. The upper edge is buoyed and the foot is weighted with stones.

The net is paid out to form a long vertical wall of netting. The canoes then paddle in a direction at right angles to the net, so towing it through the water for a short distance as a wide-mouthed, shallow bag. The net is now hauled in from the two ends, the head and foot ropes being pulled so that the net comes up as a horizontal trough. The two canoes finally come to lie alongside one another, with the bag of the net between them.

The net is generally used near rocks or reefs, which are often marked with a buoy. Sometimes a man is put over the side to swim down and find whether the moment is opportune for hauling. The chilimila is commonly cast for Utaka and other fish of similar size, but also for Usipa (*Engraulicypris*) when shoals of this species appear.

The greater part of a chilimila for Utaka is 2 inch mesh, but there is a patch at the centre, about 16 feet square, where the mesh is $\frac{1}{2}$ or $\frac{3}{4}$ inch. This small meshed part forms the " bag " in which the fish are finally lifted out of the water. No chilimila nets for Usipa were examined, but they are said to be of very much smaller mesh, with the central patch sometimes made from mosquito gauze.

The price of an average chilimila was quoted at £6.

Chilimila fishing can only be done in calm weather, since it has to be carried out from canoes in deep water. This limits its use to an hour or two in the early morning or evenings during the windy season, and there are many days on which it cannot be used at all. Another factor limiting its use is the scarcity of canoes, which is becoming increasingly acute. Shore seines only require one canoe which operates close inshore and need not be very large or sound, whereas the chilimila requires two large canoes in seaworthy condition. Nevertheless the net is extensively and vigorously used in the northern parts of the lake.

The average of the few catches observed by the expedition was about 200 small fish of the Utaka type, but all chilimila fishermen interviewed said that they frequently caught 2,000 or 3,000 fish at a single cast. Observations by the native recorder at Likoma Island (Table 5 of Appendix VIII) show an average of one " msechi " basket or about 600 fish, at a cast, over the period March 27 to July 4. But chilimila fishermen are seldom content with a single cast, and usually go on fishing until they have caught at least three basketfuls. The average of a day's catch for a single net according to the native records is about 13 baskets, or approximately 8,000 fish.

(3) GILL-NET. (Native name = Ndangala.)

This resembles a European gill-net or set-net (Davis, 1936, pp. 7, 49–53) and is a wall of netting slung between a buoyed head rope and weighted foot rope and anchored at either end, usually by stones. The net and anchors are usually arranged so that the net floats a few feet from the bottom, there being a large surface buoy to mark its position. The net is set at night, and fish, failing to see it, swim into it and become entangled. Occasionally, it is said, a canoe carrying a grass flare is paddled backwards and forwards across the net to attract the fish. The net is set at various distances up to $\frac{3}{4}$-mile from the shore, often being lashed end to end with four or five others to form a fleet.

Gill-nets vary from about 30 × 3 feet to about 220 × 100 feet. The mesh may be anything from 2 inches to 5 inches, but the majority of nets are about 3 inches. The size of mesh seldom varies within a single net. The nets with the largest meshes are said to catch mainly the big *Clarias* spp. The smallest meshes catch *Barilius microcephalus* and Utaka, while intermediate nets catch *Bagrus, Labeo, Barbus, Barilius* spp. and *Clarias*. (See Tables in Appendix VIII.)

The price of a moderately large native gill-net is quoted at £1 10s., but most fishermen make their nets themselves.

The use of gill-nets appears to be seasonal. Only two nets were seen in action during the whole tour round the lake, but there were some in use at Kota Kota and Sani during the last month of the Survey. They seem to be used when the weather is too rough for seine or other fishing, only short periods of calm being necessary for setting and hauling. In the interval they can be left unattended, sometimes remaining in the water for two or three days. Possibly the practice of setting the net at the bottom, where wave action is likely to be less, has arisen from the chance that they may have to be left. Normally, however, they are set in the evening calm and hauled in the morning before the wind has got up.

Gill-nets suffer from the disadvantage that they are liable to be torn by crocodiles or tortoises trying to eat the fish trapped in them. This disadvantage was the main reason given by natives to account for the fact that they were not more generally used, but in any case they are not considered very effective.

Figures for the average catches of gill-nets of known lengths cannot be estimated with any accuracy, as the records were not kept in sufficient detail. The records show that of 424 catches from gill-nets of unspecified lengths, the average was six fish. (Tables 1c and 2c in Appendix VIII.)

(4) SCOOP NET OR HAND NET. (Native name = Pyasa.)

This is a shallow bag or net slung between two long sticks lashed at an acute angle. The fisherman holds the sticks near the lashing, and pushes the net in front of him, scooping the fish out of the water. The nets vary in size from about a foot in width with sticks about $2\frac{1}{2}$ feet long to large nets 6 or 7 feet wide, on 10 foot sticks.

The small nets are generally used in shallow water. In the upper reaches of the rivers in the Kota Kota district they are used to catch small fish, particularly *Barbus* spp., the nets being pushed

(1)

(2) (*Photos, C.K.R.*)

Fig. 10. Scoop or Hand Nets. (Pyasa.)

(1) A small net in use in the upperwaters of the Chirua River, near Chintembwe. (2) A large net in the Chia Lagoon, south of Kota Kota.

(1) (*Photo. C.K.R.*)

(2) (*Photo. E.T.*)

(3) (*Photo. C.K.R.*)

Fig. 11. Native Fence Traps.

(1) A large fish fence across the Rukuru River, near Karonga. (2) A fence across a small river near Msumba, with barricades between the traps to prevent the fish jumping over. (3) A single trap from this fence.

along the bottom and among the rocks like shrimp or prawn nets. Small pyasa nets are also used at the mouth of the Rukuru River when the water is low, and the Mpasa (*Barilius microlepis*) are going up the river to spawn. The nets are used over the shallow bars not far inside the river, hunts being made for individual fish whose passage across the shoals is betrayed by the wakes in the water. The large nets are used in the deeper waters of the Chia and Malombe lagoons, generally at night, from the bow of a canoe which is paddled about at random. When fish are plentiful the net is also used in the daytime, and it is then pushed under weeds at the edge of the water. The catches seen at Chia and Malombe consisted mainly of *Tilapia shirana*.

B. Traps.

All traps used by natives are basket traps, made of split cane or bamboo. The commonest type acts on the lobster pot principle, being tubular in shape, closed at one end and partially closed at the other by re-entrant spikes arranged as a funnel. The trap is usually set lying on its side in the water and varies in size from 2 feet long by 1 foot wide to 6 × 3 feet. The spaces between the canes differ with the size of the trap and the fish it is intended to catch. Such traps are set singly, or several together may be built into fish fences.

Single traps are used, either baited or unbaited, in channels among the reeds, in rivers, or at the edge of the lake. They may also be set in the open water, lying on the bottom baited with kassava or a cake of "kungu"* flies, or attached—mouth upwards—to a ring of floating weed, to catch fish feeding and playing at the surface.

Fish fences are built of stakes and reeds, and are placed as barriers, either across rivers, or across openings of small lagoons at the edge of the lake. Traps in fences in the larger, fast-flowing rivers are usually set to catch fish going up the river to spawn and are unbaited. Some fences go completely across the river, every possible hole and crack being stopped with grass or reeds. At Msumba a reed platform, covered with dried grass, was built on top of the fence, to catch fish attempting to jump over the barrier.

Traps in fences across the openings of small lagoons or inlets, or across the smaller rivers, are intended for fish going in to spawn, or for those swimming in search of food or shelter.

The traps in lagoons or reeds are said to remain in position practically the whole year, but fish fences in the larger rivers are usually removed or reduced during part of the year.

Generally traps are examined once or twice a day. Catches from those set in reeds consist mainly of *Tilapia* spp. and occasional *Clarias* spp. The open water baited traps are set mainly for *Synodontis*, while those at the surface catch *Clarias*. The fish fences in the bigger rivers catch the large *Barilius*, while those in the smaller rivers catch *Tilapia*, *Labeo*, *Barbus*, small *Barilius*, and occasional *Clarias*. The catches of traps at Kota Kota are shown in Table 1 (*f*) in Appendix VIII.

Another type of trap used, the "Chisako," is an open boat-shaped basket, of variable size, the largest seen being 5 feet long, 2½ feet wide, and 3 feet deep. The basket is held on its side in shallow water by one man and fish are driven into it by several helpers.

The observations of the Survey on 145 catches from "lobster-pot" traps in reeds and lagoons in various parts of the lake show an average of six fish per trap per day set. (Table 2 of Appendix VII.)

Inshore traps are to be found in most parts of the lake where there are suitable conditions, but they are usually few in number, and their catches form only a small proportion of the total number of fish

* Small flies which often appear over the lake in large clouds.

landed. In the reeds and lagoons of Kota Kota and Domira Bay, however, traps are numerous and the catches accordingly are of more importance. At Karonga and Msumba catches from fence traps in rivers are large in proportion to the rest of the fishing.

Traps used in the open water were less important than those used inshore. Surface traps for *Clarias* were described to the Survey at Kota Kota only, while bottom traps for *Synodontis* were seen in use at Kota Kota, Kobwe, and a few other places.

C. Hooks and Lines.

Long-lines bearing from one to 25 baited hooks attached by snoods are usually set at night. The line is anchored and marked by a stick or buoy. Long-lines were also used by day, but the more general daylight fishing is with hand-lines, bearing single baited hooks, from canoes. Fish is the usual bait, either small fish threaded whole on to the hook, or larger species, such as *Labeo*, cut into small pieces. *Engraulicypris sardella* is considered the best bait, but this species appears to have been somewhat scarce lately, and fishermen in some villages state that they have given up line fishing on this account. Artificial spinners are used often from sailing canoes between Likoma Island and the eastern mainland. The hooks used for hand and night-lines vary from $\frac{1}{4}$ to $\frac{3}{4}$ inch in the barb.

Hook and line fishing is mostly done in the rocky areas, as these are said to be the best fishing grounds. Where there are no rocks, lines are usually fished some considerable distance from the land. Line fishing from the shore was seen only at Likoma and Ngo, where the beaches shelve so steeply that a short line is enough to carry the hook into deep water.

Night lines catch mainly *Bagrus* and *Clarias*, while hand lines catch *Bagrus*, *Clarias*, *Rhamphochromis*, *Barbus*, and many other predators.

Very large fish may be taken on hooks and lines, but the total weight of fish caught is probably small compared with that caught by other methods, except perhaps at Benji Island.

Tables 1 (*g*) and 2 (*e*), Appendix VIII, show the catches, by hook and line at Sani and Kota Kota, according to native recorders.

Fish Poisons. (Native names = Katupe, Dama.)

Fish poisons are known to the natives, but their use is illegal and none were seen in use.

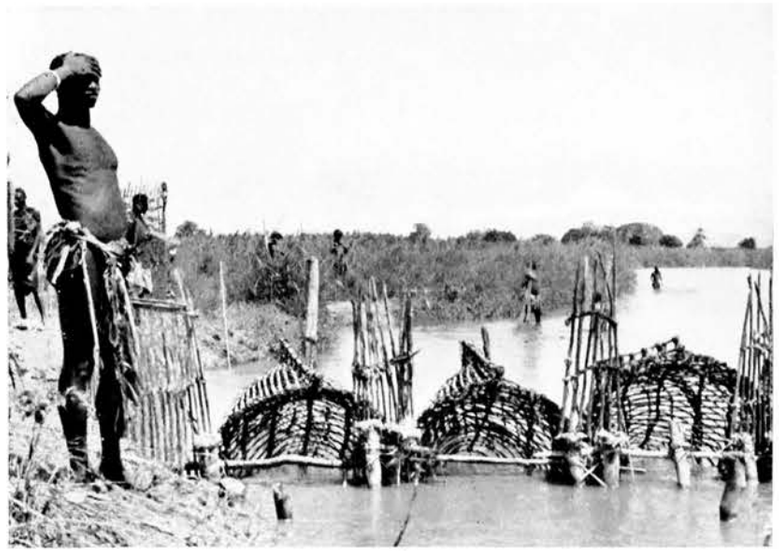
There are many varieties, all being made from the leaves, bark or roots of various plants. A common poison is "Katupe," made by pounding up the large tubers of a species of *Mucuna*. Other plants used are *Tephrosia nyasae*, *T. vogelii*, *T. zombensis*, *Mundulea sericea*, *Lasiosiphon kraussianus*, *Combretum ternifolium*. The native name "Katupe" is properly applied to *L. kraussianus*, and "Dama" to *C. ternifolium*, but these names are also used for other fish poisons.

The method of using all fish poisons is to scatter the pounded mixtures in river pools during the dry season when the amount of water in rivers is small. The fish become senseless, float to the surface, and are collected by the natives.

MATERIALS FOR THE FISHERIES.

Nets.

Nets of all types are made by the fishermen themselves, usually from local materials. The thread is commonly prepared from fibres of *Poulzolzia hypoleuca* (native names = bwazi, chopwa) which grows as a small bush in the fishing villages. The fibres are stripped off the branches, dried and separated into narrow strips. Two of these are placed close together and spun into a single thread by a rolling movement of the hand on the thigh. The fishermen are extremely dexterous at this operation, and produce a surprisingly neat thread.



(1)

(2) (*Photos. C.K.R.*)

Fig. 12. Native Fence Traps

(1) Part of the fish fence in the Rukuru River near Karonga. (2) A small fence across an inlet at the side of the lake at Kota Kota.

(1) (*Photo. C.K.R.*)

(2) (*Photo. E.T.*)

Fig. 13. *Barilius* from Fish Fence in the Rukuru River.
(1) A newly-caught fish. (2) Specimens being dried over a fire.

Threads are made in several sizes. Specimens of thread for a 2 inch gill-net, 3 inch gill-net, and large meshed seine were brought to England and submitted to the Imperial Institute for testing and comparison with other twines. The results are summarised below :—

Native twine	*European twine of comparable size*	*Breaking load of native twine*	*Breaking load of flax twine*
2-inch gill net	2 ply 18 lea flax*	5·1 lbs.	—
3-inch gill net	2 ply 9 lea flax	12·3 lbs.	22 lbs.
Seine net	2 ply 3½ lea flax	29·1 lbs.	—

* In the flax trade a lea yarn is one giving 300 yards to the pound weight, a two lea yarn gives 600 yards to the pound, etc. A two ply two lea twine would be one made from a pair of two lea yarns twisted together.

The tests showed that the native twines are inferior in strength to flax and hemp twines of the same size, but are approximately equal to twines made from jute fibres. It was the opinion of the tester, however, that the Nyasaland fibres would, if spun by machinery, give breaking loads approaching, if not equal to, flax.

On the southern shores of the lake, nets are often made partly from threads picked out from the canvas in old motor tyres, and these are said to be considerably stronger than the local threads.

Ropes.

Hauling ropes for seines vary considerably with the locality. The commonest are made from bark strips, about 2 inches wide, which are torn off the trees in lengths of a few feet and knotted together. Bark of species of *Brachystegia* is commonly chosen for this purpose, but other trees are also used. Specimens of bark strip of this type when tested by the Imperial Institute showed breaking loads varying from 405 to 950 lbs. when new, and in an air-dry state.* The natives on the northern shores of the lake, and as far south as Usisya on the west, and Liuli on the east, use properly twisted bark ropes. The bark is torn off the tree, divided into narrow strips and made supple by soaking in water. Several strips are then twisted together into yarns, and three yarns are twisted into a single rope. These layed ropes seemed stronger and more pliable than the bark strips. Hauling ropes for chilimila nets are layed ropes similar to the above. At Fort Maguire stems of lianes were also used.

The head and foot ropes of all nets are made of layed ropes. The head rope of a seine usually has a circumference of about 1 inch. Three new seine head ropes of 7/8, 1 and 1½ inches circumference were sent to the Imperial Institute for testing and showed breaking loads of 270 pounds, 242 pounds, and 335 pounds respectively. For comparison a three-ply 1 inch manilla rope, of grade three quality, has a breaking load of 8½ cwts.

Lines and Hooks.

Hand lines are made of ordinary native twine, about the thickness of seine net twine, but the central part of a night line is sometimes made of very thin, layed bark rope.

Hooks are made by the natives from any suitable pieces of wire or iron and are often barbless. Hooks of European manufacture may be bought at a store.

Artificial spinning baits are locally made of tin or wood and appear to be copies of a European mackerel spinner.

* It must be pointed out that tests of this nature on single fibres not layed into ropes are only a rough measure of efficiency, and are not strictly comparable with layed ropes.

Life of nets and ropes.

Nets require repairs of some kind after almost every haul. Small tears are mended by knitting in new meshes, but when the net begins to get rotten, whole sections are removed and replaced by strips of new netting. After a time there is none of the original net left, so that it is very difficult to determine its length of life. The natives estimate the life of netting as one year if untreated, or two years if treated with preservative.

Nets are sometimes preserved with an infusion of the bark of one of several trees, and in particular *Trichilia emetica* (Msikezi). The bark is chopped into small pieces and boiled with water, the resulting infusion being poured while still hot over the net, which lies folded up in the bottom of a canoe. The net is then left to soak for a day, and is afterwards removed and dried.

Layed ropes are said to last a year, but the bark strips are said to deteriorate after one month, and they are continually breaking during fishing.

Canoes.

These are dug-out canoes, made from large trees—particularly *Acacia albida*, *Cordyla africana*, and *Khaya nyasica*. The trees are felled, and shaped where they fall. The ends are tapered and pointed. The bottom is slightly flattened and the interior of the trunk is cut out through a narrow slit so that there is usually only room to stand in the finished canoe. The craft varies from about 12 to 35 feet in length. They are usually surprisingly stable and their chief advantages are that they are light to move and the lack of keel means that they can easily be hauled up on the beach.

Canoes are moved by poles in the shallows and by paddles in deep water. In the northern regions good, broad bladed paddles of wood are made, but at other places they consist of a few slats of wood or cane lashed across a stout stick. Sails are occasionally used. These are generally square sails for use in a following wind, but at Likoma Island a canoe with a kind of lug-sail was seen sailing quite well in a quartering wind.

No preservatives are used on canoes, but if made of good wood they are said to last about nine or 10 years with care.

The price of a canoe varies according to size and to the position of the tree from which it is made, because the expense of paying helpers to drag it down to the lake adds greatly to the cost. The price of a moderately large canoe is probably about £10 to £15.

Natives seem quite satisfied with their present canoes, and do not hesitate to make journeys of considerable length in them. Nevertheless, they are rather limited craft and there is great wastage of wood in their construction. Moreover, trees of suitable species and size are not now common in accessible places and it becomes more and more difficult to replace worn out canoes.

It would clearly be an advantage if better boats could be made locally. These should be more seaworthy so that the fishermen could not only go to more distant fishing grounds, but could use the boats for transporting their catches about the lake and bringing them near to the main market areas.

SUMMARY OF FISHING AT RECORDING STATIONS.

Detailed records of fishing at Kota Kota, Sani, at the Bar and in the Shire River at Fort Johnston, were kept by the native recorders from February to October, 1939.* Recording in less detail was done for the chilimila fishing at Likoma Island from the end of May to the beginning of July.

* The records at Kota Kota apply to fishing from the Kaombe mouth southwards to the southern corner of Kota Kota Bight. Those at Sani cover fishing within about two miles either side of Sani Point. Those at the Bar deal with fishing on the south-eastern lake shore within four miles of the Shire River entrance. Those in the Shire River apply to the banks of this river at Fort Johnston and south along its course for about two miles. (See Appendix VI for details of native records.)

Analysis of the figures for Kota Kota (see Table 1 in Appendix VIII) shows that the average catch from a single haul with a seine net was 396 fish (Table 1*a*). During this period 373 seine hauls were made, and this gives an estimated total of 147,000 fish caught by seines from February to October. Similar data show that about 11,000 fish were caught in traps (Table 1*e*) and 3,000 in gill nets (Table 1*c*) during this period. The total of fish landed at Kota Kota thus appears to be of the order of 160,000 fish. These figures are converted into weights in Tables 1*b*, *d*, *f*, by multiplying the estimated numbers of each species by the weight of a single specimen of that species.*

The estimated weight of all fish landed at Kota Kota between February and October works out at approximately 73 short tons (1 short ton = 2,000 lbs.). It must be remembered that this is a rough approximation, and is only intended to give some idea of the extent of the fishing.

Similar estimates for Sani and the two Fort Johnston stations give 199,000 fish or 92 short tons at Sani from February to October, 181,000 fish or 71 short tons at the Bar, and 233,000 fish or 103 short tons in the Shire River, from March to October. (Tables 2, 3, 4 in Appendix VIII.)

Fishermen at Sani and the Bar do not use traps to any extent. There are some traps in the Shire River, but as they are few, they are not included in the estimates. Hook and line fishing at all stations is also omitted, because of lack of data, but it is probable that the catches at Kota Kota, Sani, and the Bar were of the same order as those from the gill nets. A few gill nets were said to be used in the Shire River, but none are recorded for the Bar.

At Likoma Island 68 chilimila nets were set between June 2 and July 5. The average catch for a day's fishing with a single net was about 13 " msechi " baskets, so that approximately 884 baskets, or about 530,000 small fish, were caught during this period.

METHODS OF CURING.

The greater part of the fish caught are eaten fresh, but some are cured at the lake shore for transport to the hills. The simplest method of curing used is sun-drying. Fish are cut open, gutted, and laid in the sun to dry for three or four days. Medium-sized fish are said to last a week without going rotten if cured by this method, but larger fish are said to deteriorate more quickly.

Another method is to dry the fish over a wood or charcoal fire for a period, and then continue drying in the sun. Fish so processed appear half-cooked rather than dried. The usual practice seems to be to gut the fish, spread the body out flat by a system of cane skewers, and put over the fire for periods from 15 minutes to several hours. Fire curing, however, is said to be more elaborate than this when it is intended to make the cure effective over long periods. Curing then entails leaving the fish over a small fire for one or two days, and in the sun for about two days. No particular wood is preferred for making the fire, and generally no special care seems to be taken over its construction, except at Bana where the fire is said to be made in a pit. The longer a fish is left over the fire, the longer it is supposed to keep, and periods from two weeks to six months were given as the effectiveness of a two-day fire cure. The usual expectation seemed to be about one month, and, judging by some experimental work done by the Survey (see Section E), this does not seem to be an over-estimate. A proportion of the fish are always lost by insect attack.

* In the *Tilapia spp*, *Labeo*, and *Bagrus* the figure taken for the weight of a single fish is the average weight of the specimens of commonest size, as shown by the Survey records. In other species the figures are chosen somewhat arbitrarily, but always so as to lie within the range of values determined by the Survey. Since the numbers of these species are small, errors in determining the average weight of a single fish are insignificant in the final result. In the case of the native gill nets, individual weights for *Bagrus*, *Barbus* and *Clarias spp*. have been fixed lower than for the same species in the seine net tables, because it was considered unlikely that the larger members of these species would be caught in gill nets.

No other methods of preservation are in general use. At one village it was stated that large fish were sometimes cured by rubbing with salt and sun-drying, but that salt was too expensive for this method to be used on a large scale. The possibility of using salt in this way appeared to be known in other parts of the lake, but for reasons of expense it is not employed.

Oil is sometimes extracted from fish in the neighbourhood of Fort Johnston. The viscera of *Tilapia* are boiled with water and the oil skimmed off the surface. The oil so obtained is painted over fish as they lie drying in the sun, and is supposed to have some preservative effect.* The extraction of oil by boiling seemed to be known in other parts of the lake, but there appears to be no particular use for the oil, though it is occasionally burnt for illumination.

Fish meal appeared to be unknown.

Fish are cured to a certain extent in all parts of the lake, but on a large scale only on Likoma and Chisamulu Islands, where fish are fire-cured for transport to the mainland, and at Mkumbaleza in Kota Kota. Likewise along the southern arms *Tilapia* are sun-dried for transport to Blantyre. Little or no attempt appears to be made to cure and store fish during the fishing season for use in times of scarcity.

EXTENT AND DISTRIBUTION OF FISHERIES AND FISH TRADE.

This section is based on general observation by the Survey, and information given by natives. Most of the places were visited during March and April, when the fishing season was not at its height, and information about activity at the middle of the season was often vague and contradictory. These remarks are therefore impressions and not statements of fact.

All communities living close to water engage in fishing activities of one sort or another, according to the opportunities offered by the locality, but the scope and purpose of their efforts vary considerably.

Lake fisheries.

In many communities the only purpose of fishing is to provide food for the fisherman and his dependants. Occasionally it may happen that some lucky haul will result in requirements being exceeded, and when this occurs fish may be traded with the non-fishing population. Trading under such circumstances may be on a cash basis, but often fish is exchanged for flour. But the fishermen make no special effort to catch fish for trade. They cannot rely on supplies of flour in exchange for fish because there is no regular over-production of flour by the non-fishing population.

Fishermen in many parts, however, do habitually catch fish for trade. Since they rarely make any effort to sell the fish themselves and are inclined to wait until someone comes to buy, the amount of trade depends largely on the number of purchasers that visit the beach in search of fish. Some of the buyers are ordinary villagers coming to exchange flour for fish, but most of the buying is done by native traders. These traders make systematic expeditions to the lake, on bicycles or on foot, and then return to sell the fish at a profit in the townships or in the hills. The traders either take stalls in regular markets or hawk the fish from village to village. The number of traders depends on the proximity of towns and markets. For this reason there is more fishing for trade in the southern part of the lake which is near the developed areas and bigger towns of the Protectorate, than in the northern regions.

Only in a few places is all the fishing done for trade. At Mkumbaleza, Salima, Benji Island and Mtandu,† the beaches are visited by fishermen from other parts of the lake who fish intensively during

* In Lake Rukwa the large catfish are boiled and the oil produced is painted over *Tilapia spp.* during sun-drying to increase the fat content of the cure (Ricardo, 1939).

† Between Fort Maguire and Che Linda.

the season. Although the fishing activity at these places is entirely commercial, the individuals who fish there only spend part of the year on the beaches, and probably rely on agriculture as well as fisheries for their personal subsistence. The only communities which really depend entirely on fishing are the people of Likoma and Chisamulo Islands. The fishermen here regularly catch a greater quantity of fish than the local population can eat. The excess is then taken over to the mainland to be exchanged for flour which cannot be grown on the islands in large enough quantities to support the population.

On most of the larger beaches, fishing is only partly for trade, and is thus semi-commercial. The fishermen fish for trade during part of the year and do to some extent replace their agriculture by their fishing. The fisheries, at Kota Kota, Sani, and the two recording stations at Fort Johnston, are semi-commercial. The Kota Kota fishermen trade with the large local population and with the hills. The villages about Sani Point have their own local consumption and also trade with Kota Kota and the hills. The Fort Johnston stations have a trade with Zomba, Blantyre, Mlanje, and the hills to the east of the Upper Shire valley. A summary of the fishing at these places has been given above, p. 72, and their relative importance can be estimated from the records.

Nkudzi Bay, Monkey Bay, Che Linda, and Old Livingstonia in the south are also semi-commercial centres and appear about equal to Kota Kota in importance, though more seasonal in their activity. They all have a trade with Zomba, Blantyre, and the south generally, being visited during the season by numbers of native buyers from the towns. Approximately fifteen such buyers are said to visit Kkudzi Bay in an average week during the season and to take back about 100 fish each. Marembo was probably once as important as the above places, but the rise of the lake has restricted the fishable beach to a few yards. Nevertheless the fishermen who remain still fish commercially during the season, and trade with Blantyre, Ncheu, and Dedza districts.

In the north, Mbampa Bay, Mwaya, and possibly Kobwe, approach but do not appear to equal Kota Kota in importance. Mwaya has a small external trade with Mbeya, Mbampa Bay with Songea, and Kobwe with the nearby hill country. Both Mbampa Bay and Kobwe have a fairly large local consumption in addition to their external trade.

Bana, Usisya Bay, and Florence Bay are of considerably less importance than Kota Kota. Fishermen here appear to fish primarily for their own wants, though there is occasional trade with the hills.

Lake fishing at the other points visited apparently supplied local requirements only.

River fisheries.

River fishing is usually on a much smaller scale than that of the lake. The upper reaches are sometimes fished systematically, but only to supply the small local wants. The lower reaches are of more importance.

Apart from the Shire River recording station where seine nets are used, the most important river fishery seen by the Survey was that on the Northern Rukuru, at Karonga. Here, from January to April, an average of about 40 Mpasa (*Barilius microlepis*) are said to be caught per day. The majority are caught in one or other of the two trap fences which extend across the river, at half a mile, and a mile from the mouth. (See Fig. 11, 12.) These barriers, which are stout and complete, contain about 50 traps each, and are in position during the above months when *Barilius microlepis* is ascending the river to spawn. The traps are reinforced by a number of scoop nets and by seines. There is a small external trade in this particular species, some being sent as far away as Mbeya.

The *Barilius* fisheries in the Songwe and Lintippe rivers are said to be about equal to that in the Rukuru, while the fishery at Msumba is somewhat smaller.

The table in Appendix IX shows information given by native inhabitants on the number of nets at the fishing villages visited by the Survey, together with the type and season of fishing.

Prices.

Bargaining is usual, but approximate prices for some species are given below.

Fish	*Prices at Lake Shore*
Tilapia squamipinnis ..	2–3 per 1d.
Tilapia shirana	Slightly cheaper.
Bagrus	3d. to 1/6 each according to size.
Clarias spp.	3d. to 1/6 each according to size.
Barilius microlepis ..	3d. to 1/– each according to size at Karonga and Mwaya. 1d. to 3d. (smaller) at Msumba.
Utaka	20 per 1d. (usually). 30 per 1d. at Marembo. 8 per 10 cents at Mbaha.

The price of fish carried to the hills seems to be about 70 per cent higher than at the lake shore.

It is not at present possible to calculate the yearly profit of a single fisherman. Seine nets are usually owned, at least nominally, by one man. At places where the fishing is purely commercial there is a regular crew for each net, who receive a monthly cash payment of approximately 6/– during the season, together with fish for food. In return they are required to fish and repair the net under the direction of the owner. The owner sells the whole of the catch so far as he is able, and the profit is his.

At the semi-commercial places the system is the same when the owner is fishing for trade, but at other times there is only the nucleus of a regular crew. Much of the work of repair and fishing is done by casual hands and both they and the regular members receive fish in return for their help. The bulk of the catch is distributed in this way, but the owner takes a larger share than the rest of the fishermen.

At places where fishing is for local requirements only, the catch is divided amongst those who take part in the hauling, and repairing the net is done chiefly by the owner himself, assisted at times by other members of the community.

Traps, gill nets, and night lines are usually made, fished, and repaired by single individuals, so that the question of payment for their working does not arise.

2. EUROPEAN FISHERIES.

There are two European fishing stations working on Lake Nyasa. One, owned by Messrs. Yiannakis, is situated about seven miles from Fort Johnston, on the western shore of the south-east arm, and the other, owned by Mr. Tylor, is near Salima on the west side of the lake. The Survey made a short stay at Messrs. Yiannakis' beach during February, and paid two visits there during May and July. Mr. Tylor's station was visited for a few days in March.

(*a*) Messrs. Yiannakis' station.

Fishing is done from a single beach about 300 yards long, which has been cleared of tree stumps and other obstacles by the owners of the station. The nets in use at the time of the Survey were shore seine nets of European manufacture about 670 yards long by 23 feet wide at the centre. The meshes

(1)

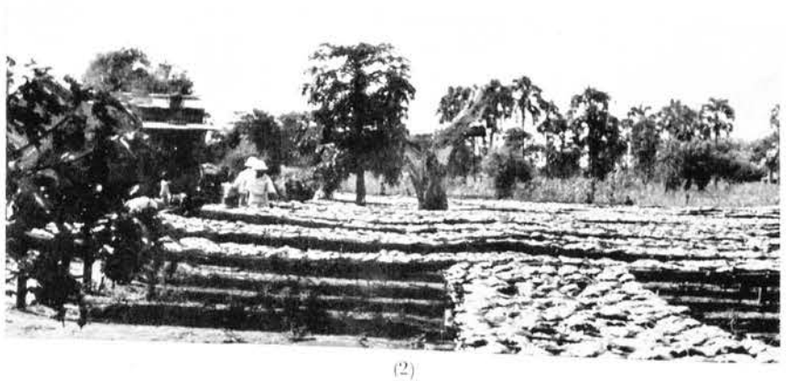
(2)

(3) (*Photos, G.A.C.H.*)

Fig. 14. Messrs. Yiannakis' Seine Net.

(1) and (2) Stages of hauling in the net. In (1) note the net forming an enclosure in which some of the fish caught can be kept alive. (3) Part of a catch from the net. Most of the fish are *T. squamipinnis*, but there are occasional catfish.

(1)



(2)

(3) (*Photos. C.K.R.*)

Fig. 15. Gutting and Sun-drying *Tilapia* at Messrs. Yiannakis' Beach. The fish are cut down the back, opened out, gutted, and then laid out in the sun for a short period before smoking.

of the two nets in use were 5 inches in the wing and $3\frac{1}{2}$ inches at the centre, and $4\frac{1}{2}$ inches in the wing and $2\frac{1}{2}$ inches at the centre respectively. Similar nets are said to have been in use during 1937 and 1938. These nets are set as far as a quarter of a mile out in the lake, and pulled to shore in the same manner as has been described for the native seines (p. 66).

The catches from these nets consisted almost entirely of *Tilapia squamipinnis* and allied *Tilapia* species, but a certain number of the other genera commonly represented in native seine catches were also caught. At the time of the May visit the seine catches were poor, and long lines were in use to supplement them. The catches from these consisted largely of *Bagrus meridionalis* together with a few specimens of *Clarias* spp.

The size of the catches appears to be very variable. In February a seine catch was seen, which was said to be a record, and the number of fish was estimated at 14,000. Catches seen later during this visit were estimated at 7,000 and 10,000 respectively. During July two hauls were seen, estimated at 2,000 and 5,000 fish. On the other hand a haul seen during May contained only about 10 fish, and the drying tables were quite empty, showing that no fish had been caught for some time. Figures supplied by Messrs. Yiannakis show total catches of 74,700 fish or 56 short tons in 1937 ; 507,900 fish or 390 short tons in 1938 ; and 679,200 fish or 509 short tons in 1939 (January to October). These figures include the fish caught on long lines, but the latter form a very small proportion of the total catch for the year.

The station trades in both fresh and cured fish, almost entirely of the species *Tilapia squamipinnis*. The trade in fresh fish is mainly with Zomba and Blantyre, fish being transported from the beach to the towns by motor lorry. Some is sold direct to the consumers, but considerable numbers are also bought by native traders who sell them in the surrounding villages. The trade in cured fish is mainly with Southern Rhodesia, where large quantities are bought by employers to feed their native labourers. Estimates supplied by Messrs. Yiannakis show that the export trade has increased greatly. In 1937 all the fish were sold locally, in 1938 just over half the fish were exported, and in 1939 from January to October a little over 60 per cent were exported.

The curing process consists of partial sun-drying followed by smoking in houses. The process seems closely allied to European hot-smoking. Figures from the Nyasaland Railways show that the weight of dried fish carried by rail was 3,576 lbs. in 1937, 115,056 lbs. in 1938, and 122,111 lbs. in 1939 up to October.

(*b*) **Mr. Tylor's station.**

The fishing is done from a natural beach about 300 yards in length. The nets in use at the time of the Survey were shore seines of a size and mesh comparable with the average native seine, but of European manufacture. Long lines were not used, and flax gill nets, of 5-inch mesh, had been tried without much success.

The seine catches seen in March were rather more variable in species than those at Messrs. Yiannakis' beach, and were similar to catches from native nets in other parts of the lake. It was stated, however, that the fishing season at Mr. Tylor's beach was practically over, and that the catches accordingly were not representative of the station at its best, *Tilapia squamipinnis* being the predominant species during the main season.

The size of the catches was small, the maximum of five counted by the expedition being 300 fish, of which about 250 were *Tilapia shirana*. Unfortunately no figures are available to show the number of fish caught per year, but since nearly all the fish caught at this station leave by rail, some impression of the number can be gained from the figures of total weights carried on the railway (5,682 lbs. in 1937,

13,435 lbs. in 1938, and 12,684 lbs. in 1939—January to October). All the fish were cured, and since dried fish are approximately a quarter of the live weight, it is necessary to multiply the number of pounds by four to arrive at an estimate of the live weight. This calculation gives 11 short tons in 1937, 27 short tons in 1938, and 25 short tons in 1939 up till October. These figures also include a number of fish bought from native fishermen by Mr. Tylor, and subsequently processed by him. All such fish are *Tilapia*, because other species are not used to any extent for trade.

The station trades chiefly in cured fish, of which the maiority are sent to Southern Rhodesia.

The curing seen at Mr. Tylor's station was by smoking, and appeared to resemble the European hot-smoking process.

D. Fish in Native Economy.

The Fishery Survey had to spend much of its time travelling round the lake to see the different fishing beaches, so that it was impossible to make any intensive study of fish in native economy at any of the places visited. In the Kota Kota district, however, the part played by fish in villages by the lake shore, in the foot-hills and in the hills, was studied in detail by the Nutrition Survey. An urbanised area near Blantyre was also investigated. Most of the information in this section comes from their report.

FISH AS FOOD.

Fish is rarely used as the main food for a meal, but is generally used as a " relish " or " side dish " to be eaten with the cereal or kassava flour that forms the staple diet. The main food (porridge) is never eaten unless accompanied by one or more side dishes (usually leaves, fungi, insects, fish, or occasionally meat) so that these dishes form an important part of the diet. When kassava, itself poor in protein and vitamins, is the staple food, the side dish is the main source of both these components. When a cereal such as maize forms the staple, the side dish provides a useful alternative source of protein as well as supplying additional vitamins.

Amounts and types consumed.

In many parts of the lake shore fish is considered to be one of the best side dishes and is eaten in large quantities. It is sometimes said to be not worth bothering to cook a meal unless there is fish to go with it. In the hills it is also highly valued, but it is not often eaten, partly because only small quantities of fish are taken into the hills and partly because they are expensive when they have been carried long distances. In the lake shore village (Kasamba)* studied by the Nutrition Survey, fish is often eaten with the two main meals a day at least three or four times a week when the supplies are plentiful. Most of this is eaten fresh (an average of 64 gm. edible portion per head per day)† but a small proportion of dried fish (three gm. edible portion per head per day)† is also consumed. In the villages that are not within easy reach of a fishing beach, only dried fish are eaten, except for occasional small fish taken from the rivers. Dried fish are readily bought both in the foothill and hill villages, but supplies are scarce and it was only eaten about twice a month (3·7 gm. edible portion per head per day)† and once a month respectively from October to May and rarely during the rest of the year.

The fish most commonly eaten in the Kota Kota district are *Tilapia* spp., though considerable numbers of *Labeo* and *Barbus* spp. and occasional *Bagrus* and *Clarias* are also used. The small number of catfish eaten is due to their scarcity in the nets and is not because they are not liked by the natives.

* This village is about three miles from the lake shore.
† Average weights per head per day for period of Survey, December–September.

In other parts of the lake different amounts of fish are eaten and different species form the main food fishes, but there are no other detailed figures.

The value of fish as a food lies mainly in its protein content and among many of the natives it provides almost the only animal protein in the dietary. Fish also contains considerable quantities of vitamins, particularly A and D ; the former, other than in the form of one of its precursors is often lacking in the food of the natives, especially those living in the hills. As fish bones are eaten, these give an additional source of calcium in a diet which otherwise provides only a small quantity of this element. It is interesting to see that even at the lake shore, fish only yield a small proportion (5 to 6 per cent) of the calories derived from the diet as a whole.

Cooking and wastage.

Fresh fish are usually cooked by boiling or roasting. The fish are first cleaned. Small specimens are only washed and scraped and are eaten whole including the bones, so that there is almost no waste. Larger fish may be scaled, gutted, the fins cut off, the larger spines and bones removed, and the gill tissue and operculum cut away. The amount of waste varies from about 5 to 25 per cent of the weight depending on the kind of fish and the amount that it is cleaned.

For boiling the fish are packed tightly into an earthenware or metal pot, salt is sprinkled over them, a little water is added, and the fish are cooked from one to three hours till they are soft and break when handled. The water they are boiled in is used as gravy, so that after cleaning the only further wastage is the bones that are too hard to eat. Since the bones are softened during cooking, the longer the boiling, the lower is the wastage. Sometimes a large supply of fish is cooked at once and the pot may then be boiled up on several successive days so that finally the fish are very thoroughly cooked and all the bones are soft.

For roasting the fish is suspended over a clear fire, but this method is less used than boiling.

Dried fish may be boiled, roasted, or occasionally fried in ground nut oil. The guts are usually removed before drying and may be thrown away or sometimes the oil is extracted from them. After drying and cooking the only waste is the large hard bones. There is usually more waste at the lake shore, where fish are plentiful than in the hill villages.

FISH AS WEALTH.

Most of the fish caught in the fisheries is for local consumption, but some is sold to obtain money, some is exchanged for other goods, and some is used to pay wages. A brief description of the fish trade in the different parts of the lake has been given in the previous section. (See p. 142.) In the Kota Kota district much of the fishing is to supply the fisherman and his friends. Where fish is traded, it is usually sold for money, both in the hills and by the lake shore, but some is exchanged for flour, bananas, or dried kassava. Fish may be used for payment of people who help with the fishing or for wages of people hoeing in the gardens. It is also used for tributes to chiefs or headmen who own the fishing rights in various regions.

NUMBER OF PEOPLE EMPLOYED IN THE FISHERIES AND THE TIME SPENT IN FISHING.

There are few data available on these subjects. An attempt is made in the previous section (see pp. 74–76 and Appendix IX) to estimate the importance of the fishing at various places and to compare it with that of the Kota Kota region, where there are a few figures from native records. At Kota Kota, where the population is 3,736, there are said to be 26 people owning seine nets, 45 owning gill nets and about 60 owning traps. At Sani, where the population is 731, there are 16 seine net owners

and 14 gill net owners. This means that about 130 and 30 people respectively own fishing gear, but a much greater number than this must be involved in the fishery. Although gill nets, traps, and lines, can be fished by a single man, seine nets need many people, particularly during the last stages of hauling.

If the number of hauls with nets be examined (Appendix VIII) during the period from February to October (about 245 days), it will be found that at Kota Kota an average of one and a half seine nets and three gill nets were hauled each day. At Sani, the figure for seine nets is a little higher and that for gill nets slightly lower. It must be pointed out that the figure for seine nets is certainly too low for the year because the recording period covered the windy season when seine fishing is difficult and did not cover the autumn months when this type of fishing is said to be at its height. A seine net may take from three-quarters of an hour to three hours to haul, depending on the size of the net, the nature of the beach, and the number of times the rope breaks. A gill net can be set or hauled in about half an hour. Traps and long lines also do not take long to set or examine.

Although these figures suggest that very little time is spent in fishing, a great deal of work has to be done in repairing and preparing the nets between each haul. In spite of this, fishing is certainly not a full-time occupation for anyone in Kota Kota or Sani, though it may be the main occupation during part of the year. During the months from October to January the fishermen are said to fish intensively, some on their home beaches and others migrate to other and better beaches in the neighbourhood, particularly Mkumbaleza. When the rains start, however, agriculture at once becomes important and although fish are still abundant and the weather calm, the amount of fishing decreases rapidly, and the fishermen return home and spend their time working in the gardens. In the villages studied by the Nutrition Survey, very little time was spent in fishing even in the village Kasamba, which is only about three miles from the lake shore, and only one man there owns a net. Most of the fish has to be bought from the neighbouring villages. One man in the hill village also owns a net. In other parts natives from the hills migrate to the main fishing beaches with the lake people during the fishing season.

FISH AS A NATURAL RESOURCE OF THE COUNTRY.

The fish of Lake Nyasa form a valuable supply of food for the natives, which if further exploited rationally should help to raise the general standard of health in the country.

E. Experimental Work.

In addition to the survey work described in the previous sections, some experiments were started to learn more about the fish and to find methods of helping the native fisheries. The experiments included :—

Fish marking, to discover the movements of the fish in the lake and the proportion of the stock being removed by the fishery.

Use of gill nets, long lines, and trawl, to study the composition of the catches and the efficiency of these methods of fishing.

Fish curing, to find the effectiveness of native cures and to investigate the possibilities of other curing methods.

Stocking of impounded waters, to increase the supply of fish in the hills.

The results of these experiments are described below and recommendations are made as to how they should be continued. The curtailment of the Survey made it impossible to carry out some of the work planned, but it is suggested that experimental work should be extended to the improvement of fishing materials, and the effect of weather conditions on fishing.

MARKING EXPERIMENTS.

Movements of fish.

The first aim of the marking experiments was to try and discover the movements of the fish in the lake. Until the technique had been tried and some experience of fish marking gained, it was considered best to work only on one species, though later it was hoped to deal with other species as well. The most important commercial species, *T. squamipinnis*, was chosen, and these were marked in the usual way. The marks used were ebonite discs with serial numbers, and they were attached a little behind and below the posterior edge of the dorsal fin by pieces of silver wire pushed through the muscles of the back. During marking the fish were generally held in tins of fresh lake water, and they were then put back into the lake from the shore. A system was arranged through the Administration by which any fisherman catching a marked fish might, by reporting the locality and date of the catch and returning the disc, claim a reward of 3d.

The capture of marked fish will clearly show the extent to which the fish have moved since they were previously caught, and when large numbers have been marked, they should give a general idea of the movements of the species as a whole. The three main possibilities for the nature of the movements of *T. squamipinnis* are :—

(1) that the fish do not make extensive movements about the lake, but only move inshore during the breeding season ;
(2) that they make extensive but unvarying migrations, always going back to the same beaches during the breeding season ;
(3) that they circulate generally throughout the lake and approach any suitable beach that happens to be close when the breeding season comes round.

The fish marking experiments should show which of these movements is taking place. This information would be of value to the fisheries because it would help to show whether it would be worth starting or enlarging the fishing on some of the smaller beaches when fish are scarce on the main beaches. It would also show whether intense fishing at any one place has a local effect only or whether it affects the numbers of fish all over the lake.

The fish marking in Lake Nyasa has not yet proceeded far enough to justify any deductions. Three hundred and thirty-two fish were marked between March 22 and July 20, but so far only four have been returned. It will be necessary to mark a far larger number of fish before any significant figures can be expected. It also takes time for the news of the reward system to spread to the fishermen all round the lake.

Other information from marking.

Much more than the study of movements can be determined from fish marking, and recommendations are made later (p. 161) for enlarging the scope of the experiments started in Lake Nyasa. In the North Sea fish marking can be used (see Graham 1938, Borley 1916, Wollaston 1933, and others) :—

(1) to determine the rate of growth of the fish,
(2) to determine the intensity or rate of fishing,
(3) to estimate the size of the total stock,
(4) to estimate the rate of natural mortality.

(1) Growth is measured simply by noting the increase in the size of the fish since it was marked. When sufficient numbers have been measured, the rate of growth for the species can be calculated. It was at first considered impossible in Lake Nyasa to attempt to determine the rate of growth, because

the fish would be caught by native fishermen who have no means of measuring them. If it could be arranged that some of the recaptured fish should be measured accurately, valuable information about growth would be obtained.

(2) The rate of fishing means the catch during a definite period expressed as a percentage of the average stock during that period. This can be determined from the returns of fish marks. Assuming that the marked stock is representative of the total stock, then the proportion of marked fish caught to the whole marked stock will be the same as the proportion of the total catch to the total stock during a certain period of time. Hence a measure of the rate of fishing of the total stock has been found.

It has been usual to measure the " intensity of fishing " which is the number of marked fish caught expressed as a percentage of the number originally marked, but this must always be approximate in that it does not take into account the rate of natural mortality in the marked stock, nor the losses inherent in marking, e.g. shedding of marks, death due to marking, loss of marks after capture. Mr. Graham, however, has developed a calculation to determine a rate of fishing which is intended to eliminate the errors described above. (See Graham 1938, pp. 76–90.)

(3) It follows that if the intensity of fishing is known over a definite period and also the size of the actual catches, then the average total stock during that period can be calculated.

It is clearly of importance in a fishery to have some idea of the total stock, and still more important to know what proportion of that stock is being removed by the fishing. Without these figures it is difficult to know whether the stock is being overfished. All these calculations have to be based on very large numbers of experiments, the marking has to be carried out under fairly uniform conditions, and both marking and fishing must be done continuously and evenly through all the seasons for several years.

In Lake Nyasa the conditions are very different from the North Sea, and it is difficult both to collect and to use the data in the same way. The environment is varied, there is a definite season when most of the fishing takes place, and it is difficult to get fish at all during the off season. In spite of this it should be possible, by marking large numbers of fish on particular beaches, to get some idea of the total stock available in the region of that beach and also the rate of fishing at that place during the fishing season. Since the fishing season is also largely the breeding season, the fish are unlikely to be moving about the lake to any great extent, and it is of vital importance to know what proportion of the stock is being removed. Unless means can be found to mark and catch fish in considerable numbers all the year round, in deep as well as in shallow water, these experiments will not give estimates of the total stock of the lake.

(4) In temperate regions the total mortality is generally calculated from an age census and noting the reduction in numbers in the older age groups. The natural mortality is then the total mortality minus the rate of fishing. In the tropics, however, where the age of the fish is usually difficult to determine, an approximation to the mortality rate can be made from marking experiments. From the rate at which the number of returned marks decreases with time after the original marking, subtract the rate of fishing, and the remainder is an approximation to the natural mortality rate. This will be an over-estimate, because it includes the losses due to marking.

It is possible that this method might be used one day in Lake Nyasa, but not until reliable fishing rates have been determined.

Ultimately the data from fish-marking experiments, combined with statistics on numbers and size of fish caught, should indicate the optimum fishing rate of the stock in Lake Nyasa and show when the dangers due to overfishing begin to appear.

Recommendations for further marking.

(1) Specimens of *Tilapia squamipinnis* should be marked in as large numbers* and in as many parts of the lake as possible, to demonstrate the movements of the fish and any interdependence of the various beaches.

(2) The marking should be extended to other species, particularly to *Labeo* and *Barilius*, to study their movements and to see whether they always go into the same rivers to spawn. Different coloured marks should be used so that there is no confusion over marks returned by native fishermen.

(3) As far as possible marked fish should be measured, before they are released and when they are recaptured, to give information on the rate of growth.

(4) Marking should be carried out intensively at particular beaches during the fishing season to get an idea of the proportion of the stock available at that beach which is being taken by the fishery.

GILL NETS, LONG LINES, AND TRAWL.

Gill nets.

Fine flax gill nets were used by the Survey to find out which fish can be taken by this method and to compare the efficiency of nets of European manufacture with native nets. The Survey nets were of 5-, 4-, 3-, and 2-inch mesh, and their specifications are given below.

Mesh	*Size of twine*	*Breaking load of twine*	*Dimensions of mounted net*
5-inch	35/5 ply	9 lbs.	66 × 3 yards
4-inch	35/5 ply	9 lbs.	66 × 3 yards
3-inch	40/2 ply	5¾ lbs.	66 × 3 yards
2-inch	110/2 ply	1½ lbs.	66 × 1 yard

The nets were mounted in the usual manner (Davis 1936, pp. 7, 49–53), and four, one of each mesh, were usually set, tied end to end. They were generally set at the surface, but the floats soon became waterlogged, so that the nets sagged below the surface between the two large buoys which were fastened at the ends of the series. The nets were not treated with preservatives and were used very frequently during the Survey. During the latter part of the period they were considerably torn, so that the effective fishing area was probably smaller than the actual area. The nets did not appear to suffer badly from the struggles of large fish, nor from handling, but were sometimes badly torn by crocodiles, and to a lesser extent by tortoises. Most of the larger tears, however, were the result of gradual wear, and much damage would have been avoided had there been time to repair them.

Nets were set at various places round the lake, and series of sets were made at Kota Kota and Monkey Bay. At Kota Kota nets were set on alternate days during June and July, about half a mile from shore in the southern corner of the bight. The Monkey Bay sets were made in May in various parts of the bay.

The size of the catches from these nets of different meshes are summarised in Tables 1, 2, and 3 in Appendix X. The tables show that among nets of equal area the 3-inch mesh caught the largest number of fish, but that the 5-inch and 4-inch meshes caught the largest weight. The 2-inch mesh caught a

* Fish from gill nets are not suitable for marking because they are usually slightly damaged.

large number of individuals, but the size of the fish was so small that the weights were considerably less than in the larger nets.

The numbers of the more important species in the catches are given in Tables 4, 5, 6 in Appendix X. Summaries of these figures (Tables 7, 8, 9) show that the proportion of larger predators to larger non-predators is high, and considerably higher than that shown in either native seines or traps. In the gill nets the proportion of the larger predators to the larger non-predators varied between 26 per cent and 68 per cent in the 5-inch, 4-inch, and 3-inch nets, whereas in the seines it was between 1 per cent and 5 per cent, and in traps about 12 per cent (Tables 10, 11). In the gill nets the predators were represented mainly by *Bagrus, Clarias* spp., and sometimes *Barbus rhoadesii*, while the non-predacious species were usually *Labeo, Barbus eurystomus*, and *Mormyrus*, instead of the *Tilapia* spp. which predominate in the native seine nets and traps.

There are as yet only a few data on the efficiency of the native gill nets as compared with those of the Survey. The native nets are usually shorter and narrower than the European nets, and are made of a coarser twine. The action of a gill net is to entangle the fish, and it therefore seems probable that nets of fine twine would be more effective than those of coarse twine.

Certain figures* for the numbers of fish caught per square yard of both native and Survey gill nets have been calculated, and are set out in Appendix X, Tables 13 and 1, 2, and 3, but the data are not strictly comparable and no conclusions can yet be drawn.

The catches of native gill nets (summarised in Table 12) include a smaller proportion of predators than the catches of the Survey nets. The high proportion of non-predators is chiefly due to the large numbers of *Labeo*, and these may be present as a result of the native practice of setting gill nets close to the bottom. The fact that the native nets would be more in contact with this abundant, bottom-living genus would also put the total catches higher than those of the Survey nets.

The results of the work with gill nets are summarised :—

(1) The catches of the Survey nets consist mainly of *Bagrus, Clarias* spp., *Labeo, Mormyrus*, and *Barbus* spp. *Tilapia* spp. are caught only in small numbers.
(2) Gill nets catch a higher proportion of predators than either seine nets or traps.
(3) The evidence on the efficiency of the Survey nets compared with the native nets is insufficient for conclusions to be drawn.

Recommendations for further experiments with gill nets.

The advantage of gill nets is that they tap a supply of fish in the lake which is not exploited to any great extent by the present fisheries. Further, they are effective in catching predators, and it has already been pointed out (p. 64) that the proportion of predatory fish in the lake is probably in danger of increasing. The use of gill nets would therefore increase the supply of fish from the lake and at the same time tend to help the main stock of *Tilapia squamipinnis*. Before recommendations for general use of gill nets can be made, more should be learnt of their catches at different seasons, the size of the fish caught in the different meshes, and the most suitable size of twine for their construction.

(1) Gill nets should continue to be set experimentally until there are data on the catches all through the year. Information on the fish caught by nets of different mesh should be collected and the mesh finally to be recommended for general use should be the one that catches the greatest weight of fish, and which does not catch immature specimens of the important non-predacious species.

*It must be realised however that while the Survey nets were used experimentally, the native nets would be set exclusively in places known to be good fishing grounds.

(2) Gill nets of fine flax twine should be set among native nets of similar mesh on a wide variety of fishing grounds to see which are the more effective. If the finer twine catches a greater number of fish, the possibilities of improving the local gill net twine and of importing either twine or nets of European manufacture should be investigated.
(3) Gill nets should also be set out in the open part of the lake, both at the surface and in deeper water, to get information about the fish that live far from the shores.

Long lines.

Long lines were used by the Survey in many parts of the lake, and the catches consisted mainly of *Clarias* spp. and a few *Bagrus*. (See Table 14 in Appendix X.) Long lines should be tried in the middle of the lake to find out more about fish in that region. It is also recommended that all line fishing should be encouraged in order to remove some of the larger predators from the lake.

There have in the past been suggestions that some fish, such as the Tiger fish, *Hydrocyon*, from the lower Shire River, or the Black Bass, both active, predatory fish, should be introduced into the lake for sporting purposes. In view of the probable increase in the numbers of the present predators, it would clearly be unwise to add a new predatory species, whose effect in the lake would be quite unknown and impossible to estimate.

Trawl.

Five hauls were made with a small otter trawl* in shallow water (from 1½ to 6 fathoms), one off Kota Kota, two off Kobwe, one in Nkudzi Bay, and one near the Bar in the Fort Johnston region. The first four hauls caught nothing, and the last only took nine fish, including six *Tilapia shirana*, two *Serranochromis thumbergi*, and one *Clarias mossambicus*.

It is suggested that valuable information about the fish might be gained from the experimental use of a commercial trawl in various places in the deeper waters. The use of the very small trawl tried by the Survey gives no real indication of the possible effectiveness of this method of fishing.

FISH CURING.

Experiments in curing were made to find out how long fish cured by native methods remains fit for consumption, and to investigate the possibilities of improving these methods. The advantages of improved cures would be that fish caught during the fishing season could be stored for use in time of scarcity and that the cured fish could be more widely distributed throughout the territory. The experiments were of a preliminary nature and were carried out in order to gain experience on the problems involved before seeking fuller information on theory and practice in Great Britain.

Native method.

The first experiment was to cure a few fish by the native method of fire and sun-drying. The fish were gutted as soon as possible after capture, spread out flat by means of bamboo splints, and dried over a fire for fifteen to thirty minutes. They were then laid on tables in the sun for a few days, being removed into shelter each evening, and finally were put into storage. Ten fish of various species were treated in this way. Two catfish became infested with maggots during sun-drying and had to be destroyed, but the results with the others are given in Tables A in Appendix XI. The fish all appeared to be partially fried after being held over the fire, and were very oily on the surface, but in most cases the oiliness gradually disappeared during their exposure to the sun. During storage and up to the final inspection, they were dry and hard, and not unsatisfactory in appearance, though much shrivelled. The fish were left in Africa, and it is not yet known how long they remained good.

* Lent by Mr. Cazes.

Other methods.

In curing, the object is to destroy or prevent the action of autolytic enzymes, and bacteria, in the body of the fish before they start to break down the tissues. One method of preventing the action of the enzymes is by dehydration, and all the curing at present carried out in Nyasaland depends on the removal of water from the flesh of the fish. In the tropics this kind of curing is more difficult than in temperate regions because the action of the enzymes is far more rapid and starts as soon as the fish dies so that dehydration has to be carried out very quickly.

In the native method, the fish are dried by the heat of the fire and by the sun, and the smoke probably has some disinfecting properties. The heat at the beginning probably destroys the autolytic enzymes quickly and then the rest of the drying can be carried out more slowly.

The curing in the European fisheries is rather similar to European hot-smoking processes (Tressler 1923). Although this method is effective, it was thought possible that the strong heat might lower the vitamin content. The results of analyses are not yet available.

Experiments were then made to see whether dehydration could be carried out effectively by other methods. The methods tried were :—

(1) Dry salting and sun-drying,
(2) Light salting followed by cold smoking,
(3) Short immersion in boiling water followed by smoking or sun-drying.*

1. Dry salting and sun-drying.

Enquiries amongst the native fishermen indicated that they would be unlikely to adopt any method which produced a strongly salted product, partly on account of the expense of salt, and to a lesser degree because intensely salt fish would not be relished by them. It was considered, however, that a lightly salted product might be acceptable and practicable. Experiments were made to produce such a product. Fish were gutted, a small quantity of salt was rubbed into the flesh, and they were then exposed to the sun to dry. The method is similar to the preparation of salt cod practised in New England (Tressler 1923, p. 319) with less emphasis on the salting. The results are shown in Tables B in Appendix XI. One catfish developed mould and had to be destroyed, but the rest were of moderately good appearance and seemed likely to keep satisfactorily. The process is an easy one, but it may not be practicable for all types of fish, and it remains to be seen whether the product would be acceptable to the native population. It is important also to see that the vitamins are not destroyed ; Van Veen (1936), working in the Dutch Indies, found that most of the vitamins A, B, and B_2 may disappear on salting and drying.

2. Light salting followed by cold smoking.

This method appears to be in general use in Europe and elsewhere, and was adapted to at least one tropical freshwater fish (*Tilapia esculenta* of Lake Victoria, by Graham in 1929). A few specimens of *Tilapia squamipinnis* and *Bagrus* were gutted, soaked in brine and finally smoked. The process was carried out as described by Graham (1929, p. 30), except that the smoke house was smaller and more primitive than his, and the time schedule was not strictly followed. The results seemed satisfactory and are shown in Tables C. This method seemed a very useful one and has the advantage that it does not require such large quantities of salt as dry-salting.

Smoking for all the experiments was carried out in a circular wattle and daub hut, without a roof, about 6 feet high by 4 feet across. The fish were hung on racks placed across the top, and when fire had been kindled inside a piece of tarpaulin was thrown over the top to hold the smoke in. Such a smoke house was considered sufficiently large for curing experimentally, and a house of this type would be more likely to be adopted by native fishermen than a larger and more elaborate one. The fire was made with green wood during the first smoking experiments, but after some time rice husk from the Kota Kota rice mill was tried. This did not give a heavy smoke, but it remained smouldering slowly for a considerable time, without flaring up and burning the fish or going out altogether, as the green firewood was apt to do. It produced a pleasant smell while burning, and seemed to dry and colour the fish as well as the ordinary smoke. Further enquiries about its probable effectiveness are proceeding.

* It should be noted that all the experiments were carried out by John Borley in June and July, the cool, dry months, and that conditions would be different at other times of year.

3. Immersion in boiling water followed by drying.

The idea of these experiments was to see whether a short immersion in boiling water was sufficient to destroy the autolytic enzymes so that the fish could then be dried in the sun or by cold smoking.

In the first experiment nine fish were gutted, and plunged into boiling water containing small quantities of salt for periods varying from half to one and a half minutes. They were then laid on tables in the sun to dry, remaining exposed during the day and being removed to shelter at night. The results of these experiments are given in Tables D in the Appendix. One fish was satisfactory, but all the others became infested with fly larvae during sun-drying or storing. Two had to be destroyed but the rest were satisfactory after the maggots had been removed. Increase in the quantity of salt in the boiling water had apparently no effect in preventing the attack of insects.

Attempts were then made to dry the fish by the sun, followed by smoking. Only two fish were treated in this way. Although the smoking was sufficient to kill the maggots which developed, the fish began to putrefy internally, though superficially they appeared to be proceeding satisfactorily. (See Table E.1.) The converse of this experiment, with smoking before sun-drying, was tried on one fish and was unsatisfactory. (See Table E.2.)

The method of drying the fish entirely by smoking after immersion in boiling water was tried on six fish. These were satisfactory except that there were slight traces of mould by the backbone in three of them. (See Table F.)

Analysis.

Specimens which seemed to be successfully prepared in the experiments described above were sent to the Imperial Institute at South Kensington for analysis. They were unpacked there about November 1, and were said to be satisfactory in preservation though many had been attacked by insects (apparently the larvae of the hide beetle *Dermestes vulpinus*). The results of the analyses will be incorporated in a report of the Nutritional Survey by Dr. B. S. Platt.

Conclusions.

Since the experiments were only of a preliminary nature and only small numbers of fish were treated, it is clear that no very definite conclusions can be drawn. The work, however, does indicate several important points.

(1) The experiments with the fire- and sun-drying method used by the natives showed that some of the smaller, cured fish lasted at least a month and probably much longer. This means that the fish could be distributed all through the Protectorate.
(2) Methods using salt, both for dry salting, or for light salting followed by smoking, were effective, but their main disadvantage to the native fishermen is the expense of salt.
(3) The experiments on the effect of dipping the fish into boiling water before drying are inconclusive because there are so far no control experiments with fish being dried by the same methods without having been dipped.

(4) The work shows that unless the fish are salted or smoked early in the curing process they usually become infested with fly maggots.

(5) The figures for the percentage loss of weight of dried fish* are approximately the same whether the drying has been due to the sun or to smoking. This shows that although it may be slower, the sun finally caused as much dehydration as smoking.

Extraction of oil.

Efforts were made to extract the body oil from *Tilapia*, *Barbus*, and *Clarias*, and oil from the viscera of *Tilapia* and *Bagrus*. The method used was to boil the fish or viscera in water and to skim off the oil. The experiments were mostly unsuccessful chiefly owing to the scarcity of fish at the time of the work and the lack of suitable apparatus for separating the oil. A specimen of body oil from *Tilapia squamipinnis* was found on analysis† to contain only a trace of vitamin A, which is the usual finding with body oils.

The objects of the experiments to extract fish oil were to discover the amount and characteristics of oil in different fish and in different parts of fish, and to see whether it is of value either medicinally or commercially (e.g. for local illuminant, paint, fuel, soap, etc.). If the experiments showed it to be possible it was hoped that use could be made of the fish guts in places where they are thrown away and that new uses for the big catfish might be found.

Recommendations for further curing experiments.

1. More information should be collected on the efficiency of the native curing methods, both from specimens prepared experimentally and from those cured by the fishermen. The effect of the seasons on the curing and the lasting qualities of the dried fish should be studied.

2. The experiments with salting, cold smoking, immersion in boiling water and sun-drying should be continued along the lines started, to find the most effective cure that is both practicable for native fishermen and acceptable to the consumers. The experiments should include trials with different kinds of salt,‡ different materials for producing smoke, different temperatures for smoking, and attempts to prevent the attack of insects during drying. The effect of stacking the fish in large piles periodically during drying should also be investigated. This is to make the fish sweat and to prevent "case hardening" (Huntsman 1927) with moisture left in the inner part.

3. The effect of cleaning fish thoroughly, by scrubbing them with water or with salt solution before curing should be studied.

4. The experiments with fish oil should be continued. First of all, experimental samples§ of oil from the bodies, livers, and other viscera, should be collected separately from the different kinds of fish, for analysis. If the oil is believed to be of value, methods of extraction, particularly by boiling and pressing, should be studied.

5. Fish meal should be prepared experimentally to see whether it could ever be acceptable to the native population for food. The advantage is that it keeps well and is easy to transport in large quantities. It is suggested that bony fishes such as *Nchira* and *Barbus* which are not very highly valued when dried in the usual way, would be suitable for fish meal.

* See figures for the fish A.1, C.1, C.7 (*Bagrus*), and A.2b, C.3, C.9 (*Clarias*) in Appendix XI, where all values were between 56% and 68%.

† By Dr. Lovern of the Torry Research Station.

‡ Some impure salts make the fish brittle, but dirty sea salt is sometimes valuable because it contains iodine.

§ For experimental purposes samples are best collected by means of anhydrous sodium sulphate. The fish sample is minced, weighed, mixed with an equal bulk of Na_2SO_4, and either sealed up in this condition or the oil is extracted from the mixture with ether. Alternatively, the fish may be cut into small pieces, buried in salt, and sent home in salt for analysis.

Simple presses (such as that made by Murphy, 1939) should be constructed for pressing the oil out of the fish, and the residue should be dried and ground. It may be that partly-cooked fish are better than raw fish for making meal, as the bones may be softer and the oil easier to expel. Since oil has to be expelled before fish meal can be produced, it is clear that the processes for producing oil and meal are dependent on one another.

6. The possibilities of producing* "nuoc-mam" (Indo-China) (Hardy and Richet 1933) or "belachan" (Malay) should be studied. These are "fish soups" or "fish pastes" formed by the breaking down of the fish by their own enzymes (auto-digestion).

7. The use of vinegar or other vegetable acids as preservatives should be investigated. (Deraniyagala 1933.)

8. Experiments should be made with simple methods of canning.† This method might be valuable in the European fisheries, but care must be taken because canning can be dangerous in irresponsible hands.

9. Refrigeration is one of the most widely used methods of preservation. On grounds of expense it is at present probably impossible in Nyasaland, but it should be borne in mind if the fishing develops on a large scale.

10. The possibilities of storing salted or dried fish in vegetable oil should be investigated. The fish may be covered with oil, the container exhausted by heat or vacuum pump and sealed.

11. The possibilities of marketing live fish and cooked fish should not be forgotten.

12. The uses and value of fish as manure should be investigated.

STOCKING OF IMPOUNDED WATERS.

Stocking of Nutrition Survey dams.

The stocking of some impounded waters in the hills near Chintembwe with fish from the lake was started. Four ponds and lakes resulted from experimental dams which were built by the Nutrition Survey, in order to drain, irrigate, and cultivate an otherwise water-logged valley. The waters varied in area from approximately 1,395 to 9,520 square feet, and in maximum depth in the wet season from 4 to 10 feet.

Large numbers of small fish were transported from the lake shore at Kota Kota and from the Kampambe Lagoon to the ponds in the hills. Most of the fish belonged to the species :—

Tilapia shirana	Nkututu
Tilapia sparrmani	Chimbenti
Tilapia melanopleura	Ninguichali
Tilapia squamipinnis	Kasawala (young)
Barbus spp. (small)	Kongora
Clarias sp.	Kobo

These are all mainly vegetarian or insect-feeding species, but it is probable that individuals of a few fish-eating species, particularly *Haplochromis* spp., Kolokota, Kamoto, and *Serranochromis thumbergii*, Sungwa were also included. Most of the fish survived the four-hour journey by car and the change of altitude‡ and temperature, but there are not enough data yet available to know what proportion of the

* A brief summary of the methods of curing used in other tropical fisheries is being prepared.

† Small steam cookers working at a pressure of about 15 lbs. are suitable for experimental purposes. Simple gear for sealing tins can be obtained.

‡ The altitude of the dams is just under 5,000 feet while that of the lake itself is 1,600 feet.

fish introduced lived successfully in their new environment. It appeared that larger fish travelled better than very small specimens.

The object of stocking impounded waters is to increase the supply of fish in the hills where the natives rarely get any animal food. The possibilities of increasing the supply by improved curing methods has already been described, but it is also important to discover whether more fish can be produced in these regions. The problem in stocking is to find fish which will not only live in small expanses of water in the hills, but which are suitable for cultivation. The most important points for cultivation are that the fish should feed on vegetable matter or possibly to a certain extent on snails and insects, and that they should grow quickly. In China and Malaya fish culture is an important industry, and very large yields of fish are taken from small ponds.

Recommendations for further stocking.

1. Further experiments should be made with fish from the lake to find out whether any of the species are suitable for cultivation on a large scale. One line of approach is to study the different species in ponds near the lake shore where supplies of fish are easy to obtain. It is important to find out the feeding habits of the fish, the rate of growth and whether this rate can be increased by extra feeding, e.g. chopped grass or maize meal, etc. Another line is to continue taking species likely to be suitable up to the waters in the hills, and to see which establish themselves successfully and continue to grow quickly under the new conditions. The best methods of transport and the best size of fish for transportation should also be studied.

2. The fish from the lake that are most likely to be suitable for cultivation are *Tilapia* spp., *Barbus* spp., *Labeo* and *Clarias mellandi*, most of which feed on vegetable matter. Among the *Tilapia*, *T. squamipinnis* and *T. lidole* live more in the open water in the lake than other species and are less likely to be suitable for impounded waters unless these are large and rich in plant plankton. *T. shirana*, *T. melanopleura*, and *T. sparrmani* tend to live among reeds, and are probably the most suitable in waters where there is vegetation round the edge. The disadvantage of *T. sparrmani* is its small size.

Barbus johnstoni from the rivers and *Labeo mesops* should also be tried. The catfish *Clarias mellandi* feeds mainly on snails and might be suitable, but practically all other catfish feed on fish and should not be introduced.

3. Experiments in fish cultivation should be made in ponds with running and with stagnant water. In China the fish ponds are usually made with no outlet. Grass and other vegetation grown at the edge of the water may often increase the food supply of the fish.

4. If none of the fish from Lake Nyasa seem to be suitable for cultivation, experiments should be made with rapid-growing carp or other fish imported from regions where they are reared on a large scale, e.g. China, Malaya, India, Philippine islands. (Birtwistle 1931, a, b ; *Report of the Committee on Fisheries in Madras*, 1929 ; Fowke 1939 ; Roxas and Umali 1937.)

IMPROVEMENTS IN FISHING MATERIALS.

Experiments should be made to see how the strength of ropes and twines used in fishing nets and lines could be increased and how the life of these could be prolonged.

1. It is important to determine the strength of the fibres from various trees and shrubs to see which are the most efficient. If none of the indigenous plants prove satisfactory, the possibilities of introducing plants known to have valuable fibres should be considered.

2. Simple methods of twisting and spinning the fibres for ropes and twines should be investigated because laid ropes are considerably stronger than bark strips, and evenly twisted ropes and twines are stronger than rough hand-twisted ones.

3. The effect of native preservatives for nets and ropes should be studied, and the length of life of treated and untreated nets compared. At present very little use is made of preservatives by the natives.

4. Various preservatives* used in fisheries in Europe should be used experimentally to determine their efficiency in tropical waters and to compare their effect with that of the native bark infusions. It is suggested particularly that the cutch made in Europe from the bark of the South African mimosa, *Acacia decurrens*, should be tried. If this is found to be more effective than the indigenous method, the possibility of growing the *Acacia* in Nyasaland should be investigated.

The European copper soaps are likely to be the most effective preservatives, but they are probably too expensive to be used in the native fisheries.

EFFECT OF WEATHER CONDITIONS ON FISHING.

It is important to discover the effect of weather conditions on fishing and to find out if it is possible to forecast when catches are likely to be large.

1. Detailed records of the weather, including temperature, winds, clouds, etc., should be kept all through the seasons at particular places, together with the size of the catches of fish. Gradually information will be collected showing whether fish are abundant with particular conditions and whether the native forecasts are reliable.

2. Nets should also be hauled during the windy weather and at other times when the natives say that it is useless, in order to see whether it is really the scarcity of fish or the difficulty of working the nets that stops the native fishing.

* See Atkins (1936).

PART III.
Discussion and Conclusions.

In the earlier part of this report, the aims of the Fishery Survey are set out and the results of six months work in the field are described. It now remains to summarise the results and to draw the conclusions.

THE EFFECT OF EXISTING FISHERIES ON THE STOCK OF FISH.

As a result of the Survey it is believed that the existing fisheries in Lake Nyasa are not exhausting the supply of fish, that fish are abundant in the lake, and that an increase in the fisheries should be possible without damage to the stock. Further evidence over a longer period is, of course, very desirable to confirm this conclusion. The view that the stock is large is based on the facts that fish are caught in large quantities all round the lake. The conclusion that the stock is not being over-fished is based on the fact that there are vast areas of the lake that are quite untouched by the fisheries. Even though most of the important commercial species live mainly in the shallow inshore waters where they are easy to catch, the parts of the shore from which they are fished occupy only a minute proportion of the whole shore-line. Much of the edge of the lake is covered with thick reeds, or is full of old tree stumps caused by the rise in level of the lake, or is steep or rocky, and with the methods of fishing at present in use in the lake, only open sandy beaches can be used for fishing on a large scale. It is possible that the fish congregate round the open beaches, particularly during the breeding season, but there must nevertheless be huge areas of shallow water and shore-line that are suitable for fish and yet unsuitable for nets.

The main commercial fish at the present time is, and probably always will be, *Tilapia squamipinnis*, though *T. shirana* is nearly equal in importance. The *Tilapia* spp. are very abundant in the lake, they are easy to handle, and most of the larger fisheries are dependent on them. In most parts of the lake the shore seine net is used far more than any other method of fishing, though traps and open water seines may be used extensively in some places. The seine nets can only be used in shallow water and where there is a large, clear, sandy beach. The number of sites where a large seine net can be used is thus very limited, unless the difficult job of clearing the beach is undertaken.

REASON FOR ENLARGING THE FISHERIES.

It is now well established that many of the natives of Africa including the hill peoples of Nyasaland, are suffering from certain deficiencies in their diet. An increase of fish in the diet can do much to remedy these, and even where there are no marked deficiencies, the additional supply of proteins, vitamins, and calcium provided by fish helps to improve the diet and hence the general state of health of the people.

It is therefore clearly important that as much fish as possible should be made available to the natives. To this end, the fisheries should be encouraged to increase the rate of fishing as far as possible without endangering the future supply. *It is, however, of vital importance that any enlargement in the fisheries should be carried out under the control of some officer fully competent to judge the effect of the extension.* Without proper control an increase in the fisheries could seriously damage the stock of fish in a relatively short time.

PRINCIPLES OF RATIONAL EXPLOITATION.

In order to make the best use of a stock of fish the rate of fishing should be such that it is about equal to the rate of natural increase of the stock.* If this rate is exceeded, overfishing ensues. Without special evidence and studies, the best fishing rate can only be determined by trial and error, relying on statistics to show when the stock is being overfished.

* See Graham 1938 b, 1939.

It should be possible, however, to find out more about the rate of natural increase of the stock by experimental methods and by biological observations. This rate of increase must depend on the size of the stock, its reproductive capacity, the rate of growth of the fish, their length of life, and the rate of natural mortality. It also depends to a certain extent on the density of the stock in its environment, because if the area of water is fully stocked there may be competition for food or breeding grounds with a consequent fall in the rate of growth or decrease in the reproduction rate. An approximation to the size of the stock can be obtained from marking experiments. These experiments show the proportion of the stock that is being removed by the fishery, and since the actual amount taken by the fishery can be known, it follows that an idea of the size of the total stock can be gained. The other factors determining the rate of natural increase of the stock can only be determined by detailed biological studies. These are difficult to carry out, but it is of the utmost importance that they should be continued so that a picture can be built up of the bionomics of the different species. The effect of enemies, including predatory fish, fish-eating birds, and crocodiles, should also be investigated, and the effect of wind and weather conditions.

Since the rate of increase of a stock depends on so many factors it is extremely hard to determine it in practice. In Lake Nyasa it would be particularly difficult owing to the variable environment and the fact that no record can be kept of a large part of the fishing. In spite of this is is believed that a great deal could be learnt about the stock of fish and the optimum rate of fishing by keeping statistics wherever possible, by continuing the marking experiments, and by detailed biological observations on the different species that go to make up the total stock of fish.

ENLARGEMENT OF FISHERIES: EUROPEAN OR NATIVE.

In Lake Nyasa there are fisheries run both by Europeans and by natives. At present there are two European concerns, and although one of these catches more fish than any single native fishing beach, the total number handled by the Europeans must be small compared to the number caught by the native fisheries as a whole. The markets for the products from the two kinds of fisheries are rather different, and should be noted. A large proportion of the fish from the European fisheries is exported, and the rest, which is sold within the Protectorate, mainly goes to the townships and regions where transport is easy. The fish are sold only for money. The fish from the native fisheries have a much wider local distribution, and they can reach many of the smallest villages which may be far from roads or towns. In these villages the fish can often be bought by barter with flour, or some other commodity, instead of with money.

It is outside the scope of this report to suggest which of the fisheries would be best enlarged from the point of view of the economics of the Territory, but as far as the stock of fish is concerned, it is believed that a limited increase in the European fisheries as well as enlargement of the native fisheries should be possible without damaging the supply of fish.

RECOMMENDATIONS FOR EUROPEAN FISHERIES.

If there is to be any increase in the European fisheries, the following conditions are essential :—

(*a*) The number of licences granted should be limited. It is difficult to give a figure for the number of licences that could be allowed because the number must depend on the size of the concerns. It is suggested that the licences should be allotted so that the total output of future European

fisheries should not be more than three times the output of the present European fisheries. This figure must be provisional until there are are more data available.

(*b*) The licensee should keep statistics of his fishery and thus co-operate with the officer in control of fisheries in finding out the size of the stock and the amount of fishing it can support.

(*c*) The sites for new fisheries should be chosen so that they do not interfere with any established native fishing beach.

(*d*) The licensee should submit to mesh regulations if they are found to be necessary in the future. At present it is suggested that no new seine nets for use in the lake should have a mesh of less than 3½ inches and no gill nets of less than 5 inches (diagonal measurement).

Fisheries run on these lines should not interfere in any way with native fisheries. They would increase the supply of fish available for native consumption and they should be regarded as useful experiments and sources of information about the supply of fish in the lake.

RECOMMENDATIONS FOR NATIVE FISHERIES.

The native fisheries clearly play a very important part in the economy of the natives, and it is recommended that they should be encouraged as much as possible. At present the limiting factor is not the catching of the fish, but the methods of curing and marketing. The fishing methods practised by the natives are effective, and until there is better organisation for the disposal of the catches it is not of great importance to try to improve them, though suggestions are given later for improvements of the tackle used. The question of curing needs further study, but the main problem in trying to enlarge the native fishery is to build up and organise a fish trade.

(*a*) Fish trade.

At present the fishing is mainly for local consumption, but if there is a surplus, some effort is made to sell the excess. The effort is usually half-hearted, and the fish are sold only if someone comes down to the beach to buy them. In the hills there is a real need for fish in the diet of the natives, but, except in the regions near Zomba and Blantyre, they rarely take the initiative necessary to obtain them. Efforts should be made therefore to create a conscious demand for fish among the hill people, to encourage the fishermen to fish always for a surplus, and to stimulate a trade between the hill and lake peoples, either on a monetary basis, or by exchange of fish and flour.

To do this the purchasing power of the hill natives should be investigated to find out their resources and what proportion could be used to obtain supplies of fish.

CURING.

The methods of curing must be improved, so that the fish may be more widely distributed in the country. At present there is a great deal of waste due to fish going bad or being attacked by insects. Experiments have been started with different curing methods, particularly smoking, dry salting, light salting followed by smoking, and dipping in boiling brine followed by smoking or sun-drying. It is strongly recommended that these experiments should be continued and that every effort should be made to help the natives to produce a cure that will last longer than the present primitive methods of sun- or smoke-drying and which will not impair the nutritional value.

TRANSPORT AND MARKETING.

The next things to be studied are the possibilities of organising the transport and of starting markets in the hills.

It may be possible in the future to build up co-operative societies among the fishermen so that they could help one another by sharing the purchase of better fishing materials, by constructing simple

communal smoke houses, by sharing in some sort of motor transport, and, probably most important of all, in establishing markets in various parts of the country away from the lake.

The supply of fish in the hills could also be increased by stocking impounded waters, and it is recommended that the experiments started to find suitable fish should be continued.

(*b*) Improvements in fishing tackle.

The main improvements in the fishing tackle in use among the natives would probably be the introduction of preservatives for nets and ropes, the manufacture of stronger twines and ropes, the construction of cheaper and better boats, and the clearing of beaches.

1. PRESERVATIVES.

In a few parts of the lake some kinds of bark are used for preserving nets, and it is recommended that these substances should be compared with the preservatives used in fisheries in Europe. If the European preparations are found to be more effective than the indigenous method, investigations should be made as to whether similar preservatives can be produced in Nyasaland.

2. ROPES AND TWINES.

The strength of ropes could probably be greatly increased, and suitable materials and simple methods of rope twisting should be investigated. The strength of twines could be increased by improved methods of twisting the strands. This would mean that twines could be made finer without loss of strength, which would be an advantage in gill nets.

3. CANOES.

Although the dug-out canoes at present in use are effective, they are becoming scarcer and more expensive as the large trees from which they are made become fewer and further from the lake shore. Simple methods of constructing planked boats should be investigated, so that the fishermen can have larger and more seaworthy craft and be able both to go to more distant fishing grounds and to transport their catches on the lake to the nearest point to the consuming areas.

4. BEACHES.

It has been pointed out above that one of the factors limiting the use of shore seine nets is the scarcity of clear beaches. In most places, time is wasted, nets are torn, ropes are broken, and catches are lost because the net gets foul of some obstacle on the bottom, and the effect of clearing more beaches of tree stumps and other obstacles would be greatly to help the fishermen. It has been pointed out (p. 17) that it is impossible to clear the beaches on a large scale unless the level of the lake has been stabilised.

(*c*) Control.

The effect of any enlargement of the fisheries will have to be watched carefully, and it is recommended that records should be kept (see below, statistics) of the amount of fishing. If at any time the stock is found to be suffering, the possible methods of control are :—

(1) restriction of the amount of fishing in any area ;

(2) restriction on the use of the small meshed nets in the lake ;

(3) making known to the fishermen the rule, already existing, that fish fences across rivers should leave 5 per cent of the width of the river unobstructed. It is particularly important that this rule should be enforced in the case of the larger rivers where the Mpasa (*Barilius microlepis*) are caught.

(4) The introduction of a close season or period to allow the stock to recover.

EXPLOITATION OF OTHER FISH.

There are several other kinds of fish in the lake apart from the *Tilapia* spp. that could be exploited, and in particular species of *Labeo*, *Barbus*, *Mormyrus*, *Bagrus*, and *Clarias*. These fish are all abundant, but they are not caught to any great extent in the shore seine net fishery, possibly because they are too quick for these nets, or because they live outside the zone fished by them, or because they are mostly solitary, non-shoaling fish. The exploitation of these species would greatly increase the supply of fish from the lake and the removal of numbers of *Bagrus* and *Clarias* would benefit the stock of *Tilapia*. These fish both grow to a large size and they are both predators feeding on the smaller fish of the lake, including *Tilapia*. At present very little effort is made to catch them, and since all the large scale fishing falls on the *Tilapia*, the proportion of predator to prey must be increasing rapidly, and, unless controlled, the predators* will take a larger and larger toll of the stock of smaller fish. It is clearly important that they should be reduced in numbers and that fisheries for them should be encouraged.

The main difficulties in the exploitation of these fish are that the cyprinids, *Labeo* and *Barbus*, are very bony and less good to eat than the *Tilapia*, and that the catfish are oily and difficult to cure. Further, the natives are conservative in their tastes, and will not readily take to different fish or different cures. When caught in the present fishery, however, the fish are treated in the same way as *Tilapia*, though the cyprinids are usually not so highly valued. It is recommended that the possibilities of making fish meal, of extracting a valuable fish oil, of simple methods of canning, and of making fish manure, should be further investigated, so that the best use can be made of these fish and the fishermen should think it worth while to make special efforts to catch them.

USE OF GILL NETS.

All the fish mentioned in the previous paragraph can be taken in gill nets, and the predators can be taken on long lines as well. It is recommended that both these methods should be used more extensively than at present. It is not possible to give any detailed recommendations for further use of gill nets until more experimental work has been carried out on the problem of suitable mesh. Since gill nets are usually highly selective as to the sizes of fish that they catch, the mesh has to be such that only well-grown fish are caught. Until more is known both about the sizes caught by nets of different mesh and the sizes at which different fish reach maturity, it is recommended that *no imported gill nets of less than 5-inch mesh should be used in the lake.*

The main difficulty in determining the best size of mesh for a mixed fishery is that no mesh can be entirely suitable for all the species concerned. In most of the African lakes so far investigated, the *Tilapia* spp. have been one of the main fish caught in gill nets, and since these are deep-bodied fish, the mesh has had to be large, 5 inches, in order to prevent the catching of immature specimens. In Lake Nyasa, however, *Tilapia*, with the possible exception of *T. lidole*, do not seem to be caught to any considerable extent in gill nets, and it is mostly the slimmer cyprinids and catfish that are taken. If further work shows that *Tilapia* are always scarce in gill net catches and that smaller mesh nets catch a greater weight of fish, it should in this lake be possible to allow a reduction in the size of mesh that can be used. The figures collected by the Survey suggest that 5-inch and 4-inch are the most effective meshes if the weight of fish, rather than the number, is taken into account.

The recommendation to exploit fish other than the *Tilapia* applies both to European and native fisheries. The reduction of predators is of real importance to the stock of fish in the lake, and all fisheries

* In this connection it is strongly recommended that no additional predators, such as Tiger-fish or Black Bass, should be introduced into the lake for sporting purposes.

should make attempts to catch them. The extended use of gill nets is recommended because these nets can both tap a new source of supply of fish in the lake and help to reduce the number of predators. The figures of the Survey show that gill nets, with the exception of long lines, catch a higher proportion of predators than any other method of fishing used in the lake.

STATISTICS.

The need for collecting statistics has been mentioned above, and it is now necessary to show why they are important and how they should be collected.

Importance.

The main use of statistics is to show whether the fishing is damaging the stock. The commonest dangers to the stock are overfishing and the catching of immature and spawning fish. Overfishing results not only in reduction in the size of the total stock, but the reproductive capacity of the stock is also diminished. Once the reproductive capacity of the stock is reduced the size of the stock will fall more and more rapidly as long as overfishing continues. The catching of immature or spawning stock is obviously very wasteful.

Overfishing can be detected if careful statistics are kept of the amount of fishing that occurs together with the amount of fish that are caught. The records must be kept over a number of years before conclusions can be reached so that annual and seasonal variations can be taken into account. If after some years it is found that with a constant or an increased rate of fishing, the size of the catches gets consistently smaller, it is probable that overfishing is taking place. If at the same time the average size of the fish decreases and the proportion of immature fish in the catches rises, then it is certain that the stock is being seriously overfished.

It is important to know the movements of the fish in the lake in order to discover whether overfishing in any one place affects only the stock of fish in that region or whether it affects the stock of the whole lake. The marking experiments started in the lake should, if continued, gradually give an idea as to how much the fish move about and to what extent the stocks in different parts are dependent on one another.

In order to prevent the continuation of overfishing, methods of control have to be introduced. If the damage is not serious it can be prevented from going further by restrictions that prevent the catching of small sized and immature fish. Mesh regulations for nets are the most usual restrictions of this type. If the stock has been badly reduced, however, it may be necessary to take more drastic steps such as limiting the amount of fishing, or introducing close periods during which fishing is prohibited in order to enable the stock to recover.

Statistics to show whether the stock is being overfished must therefore be designed to collect information on the following points :—

(*a*) the amount of fishing taking place ;
(*b*) the amount of fish caught ;
(*c*) the average size of the fish caught ;
(*d*) the proportion both of immature and spawning fish in the catches.

These data must be collected for each method of fishing separately so that both the efficiency and the wastefulness of the various methods may be determined.

Methods of collecting statistics.

In fisheries run by Europeans statistics should be kept for each type of fishing gear in the following way :—

(*a*) Continuous records should be kept of the amount of fishing during every month. This means records of the number of hauls made with seine nets, and the number of gill nets, long lines, and traps that are set during each month.

(*b*) Continuous records should be kept of the total quantity of fish, either by weight or by number, caught during each month.

(*c*) Detailed examination of hauls should be made, if possible in the presence of the officer in control of fisheries, four times a year. On these occasions hauls on at least three successive days should be examined, and the number of each different species determined. Further, all the fish, or, in the case of very large hauls, a random sample, should be measured and sexed to show the average size of the fish and the proportion of immature and breeding specimens.

In the native fisheries it is recommended that continuous records similar to those kept by native clerks during the Survey (see Appendix VI) should be kept, and that the recorders should be supervised by the officer in control of fisheries. The records show the amount and type of fishing that goes on in particular places, the quantity and range of size of fish that are caught in random hauls, and the size and state of enlargement of the gonads of a random sample from each haul. These data will show the amount of fishing at particular places, a rough approximation to the amount of fish caught, the seasonal variation in the catches, and they will give information about the breeding season and size of the different fish.

It is clearly impossible to obtain statistics of the native fisheries as a whole, but detailed records at a few particular places will gradually collect useful information which will give some idea of the magnitude of the fishing at those places. Together with the statistics from the European fisheries, they should give the data necessary both to guard the stock from serious damage and to learn more about the various fish and how better uses might be made of the resources. It is also clearly extremely difficult to exercise control over the native fishery because it is so widespread in its distribution and so variable in its methods and incidence. Certain restrictions for preventing waste could probably be introduced and enforced if in the future they are found to be necessary, but complete control is impossible. It is inevitable, therefore, that most of the policies of control for protecting the stock will fall on the European fisheries, but this should be fair, because large scale concerns, unless properly organised, are more likely than the natives to overfish the stock.

APPENDICES.

APPENDIX I.

Details of Itinerary.

KOTA KOTA FORT JOHNSTON

S.S. *MALONDA*

Dec.	29.	E.T. and C.K.R. left Southampton by ship.
	30.	G.A.C.H. left Southampton by plane.
Jan.	7.	G.A.C.H. arrived Nyasaland, went to Chintembwe.
	17.	E.T. and C.K.R. arrived Lilongwe, met by H.J.H.B. (Fishery party).
	18.	Fishery party to Chintembwe.
	22.	Fishery party to lake at Kota Kota. Stayed at Sani. Working at Sani and Kota Kota. Started native recorders at Sani and Kota Kota.
Feb.	3.	Moved to Kota Kota.
	7.	Visited by B.P. and G.A.C.H.
	8.	Fishery party left Kota Kota southbound on S.S. *Guendolen*.
	10.	Called at Chipoka.
	11.	Arrived Fort Johnston. Working in Shire River and by the Bar. Started native clerks in Shire and at Bar. Heavy gear (nets, etc.) from England arrived.
	17.	E.T. and C.K.R. to Zomba and Blantyre.
	19.	E.T. and C.K.R. back to Fort Johnston.
	21.	Fishery party to Messrs. Yiannakis fishing beach.
	24.	Fishery party returned to Fort Johnston.
	27.	C.K.R. and H.J.H.B. to Zomba to study methods of chemical analyses.
March	2.	C.K.R. and H.J.H.B. returned to Fort Johnston.
	4.	E.T. and C.K.R. to Lake Malombe for day.
	8.	Fishery party left Fort Johnston on S.S. *Malonda* on survey trip round the lake. Stayed Ndala M'Kumba.
	9.	Called Nkudzi and arrived Monkey Bay. E.T. stayed two days.
	10.	Left Monkey Bay and arrived Chelinda.
	11.	Left Chelinda and arrived Monkey Bay. E.T. rejoined ship.
	12.	Called Old Livingstonia and arrived Marembo.
	15.	Left Marembo, arrived Chapman's beach, Salima. Shown Mr. Tylor's fishing.
	18.	Left Salima, arrived Leopards Bay.
	19.	Left Leopards Bay and arrived Domira Bay, anchored off Makanjila's village.
	20.	Left Domira Bay and arrived Nkula, south end of Mkumbaleza beach.
	21.	Left Nkula and arrived Kota Kota, met by G.A.C.H., who returned to Chintembwe next day.
	25.	H.J.H.B. and C.K.R. to Chintembwe for day, and returned Kota Kota.
	26.	Left Kota Kota and arrived Bana.
	28.	Left Bana and arrived Nkata Bay.
	31.	Left Nkata Bay and arrived Ruarwe.
April	1.	H.J.H.B. to Usisya Bay and back.
	2.	Left Ruarwe and arrived Florence Bay.
	4.	Left Florence Bay and arrived Ngara.
	5.	Left Ngara and arrived Karonga and anchored in Kambwe Lagoon, by Rukuru River.
	8.	Left Kambwe Lagoon and arrived Mwaya.
	10.	Left Mwaya and anchored two miles south of Vua.
	11.	Left anchorage and arrived Deep Bay.
	12.	Left Deep Bay, stopped in mid-lake, arrived Manda.
	14.	Left Manda and arrived Mbaha.
	16.	Left Mbaha and arrived Njambe.
	17.	Left Njambe and arrived Liuli.
	18.	Left Liuli and arrived Mbampa Bay.
	20.	Left Mbampa, stopped off Nuangwe Island and arrived Chiwindi.
	21.	Left Chiwindi and arrived Limbaula.
	22.	Left Limbaula and arrived Kobwe.
	24.	Left Kobwe and arrived Likoma.
	29.	Left Likoma and arrived Ngo.
	30.	Left Ngo and arrived Msumba.

DETAILS OF ITINERARY—*continued*.

S.S. *MALONDA*

May 1. Left Msumba and arrived Mtengula.
2. Left Mtengula and arrived Mluluka.
3. Left Mluluka and arrived Chilowelo.
5. Left Chilowelo, called Luangwa, and arrived Msinje.
6. Left Msinje and arrived Fort Maguire.
8. Left Fort Maguire and arrived Old Livingstonia.
9. Left Old Livingstonia and arrived Fort Johnston, met by G.A.C.H.
12. To Messrs. Yiannakis beach, E.T. to Monkey Bay.
13. G.A.C.H., C.K.R., and H.J.H.B. to Chintembwe, to work on dams and streams.
23. H.J.H.B. to Zomba and Blantyre.
30. G.A.C.H. and C.K.R. to Kota Kota.

June 1. G.A.C.H. and C.K.R. to Chia Lake, Sani and back.
2. H.J.H.B. to Kota Kota.
4. E.T. arrived Kota from Monkey Bay.
5. G.A.C.H. returned to Chintembwe.
8. C.K.R. and H.J.H.B. to Chintembwe and C.K.R. to England by plane.
9. H.J.H.B. to Kota Kota.
15. E.T. left lake and to England by ship.
20. G.A.C.H. to Tanganyika.
25. H.J.H.B. left Kota Kota for south end of lake.
27. Arrived Marembo.

July 1. Left Marembo and arrived Fort Johnston. Visited Messrs. Yiannakis beach.
2. To Blantyre.
8. Returned Kota Kota.
24. Left Kota Kota for England by ship.

B.S.P. .. Dr. Platt.
G.A.C.H. .. Dr. Herklots.
E.T. .. Dr. Trewavas.
C.K.R. .. Miss Ricardo (now Mrs. Ricardo Bertram).
H.J.H.B. .. Mr. Borley.

At Sani the members of the Survey lived in a house kindly lent by Dr. Fitzmaurice.
At Kota Kota they lived in a house rented by the Survey.
At Fort Johnston they lived in a house lent by the Government.
During the journey round the lake from March 8 to May 9 they lived on board the S.S. *Malonda*, which was ably captained by the owner, Mr. Hughes.

2. STATION LIST.

Station	Date	Locality	Nature of data
1	Jan. 22	Sani	Native trap.
2	23	Kota, Kampambe Lagoon	Native fishing.
3	23	Kota beach	Seine.
4	24	Kota beach	Traps.
5	24	Sani, north point	Seine.
6	25	Sani rocks	Bought.
7	25	Sani rocks	Nought.
8	25	Sani rocks	Night line.
9	26	Sani rocks	Bought.
10	26	Sani, north point	Seine.
11	26	Sani	Bought.
12	27	Kota beach	Seine.
13	28	Sani rocks	Bought.
14	29	Sani, north beach	Seine.
15	30	Sani, north beach	Seine.
16	31	Sani, off rocks	Night line.
17	31	Sani, south beach	Seine.
18	31	Sani, north point	Seine.

2. STATION LIST—*continued*.

Station	Date	Locality	Nature of data
19	Feb. 1	Sani, south beach	Seine.
20	1	Sani, south beach	Seine.
21	1	Sani, north point	Seine.
22	1	Sani, north point	Seine.
23	2	Sani, south beach	Seine.
23a	2	Kota	Seine.
24	3	Sani, south beach	Seine.
25	3	Sani, north beach	Seine.
26	3	Kota	Traps.
27	4	Kota, Kampambe Lagoon	Traps.
28	4	Kota, beach	Seine.
29	6	Kota, Kampambe Lagoon	Traps.
30	6	Kota beach	Traps.
31	7	Kota	Traps.
32	7	Kota Spit	Traps.
33	7	Kota beach	Seine.
34	8	Kota, south spit	Seine.
35	8	Kota beach	Seine.
36	10	Chipoka	Seine.
37	12	Fort Johnston, Shire River	Trolling.
38	13	Fort Johnston, Shire River	Seine.
39	14	Fort Johnston, Shire River	Seine.
40	16	Fort Johnston, Shire River	Trolling.
41	16	Fort Johnson, Shire River	Trolling.
42	16	Fort Johnson, Bar	Seine.
43	16	Fort Johnson, east Bar	Seine.
44	16	Fort Johnston, Shire	Trolling.
45	17	Fort Johnston, Bar	Seine.
46	18	Fort Johnston, Shire	Seine.
47	20	Fort Johnston, Shire	Seine.
48	20	Fort Johnston, Shire	Bought.
49	21	Fort Johnston, Lake	Trolling.
50	22	Fort Johnston, Yiannakis beach	European seine.
51	23	Fort Johnston, Yiannakis beach	Trolling.
52	23	Fort Johnston, Yiannakis beach	European seine.
53	24	Fort Johnston, Lake	Trolling.
54	27	Fort Johnston, Shire	Seine.
55	27	Fort Johnston, Shire	Seine.
56	March 4	Fort Johnston, Lake Malombe, south	Scoop nets.
57	4	Fort Johnston, Lake Malombe, east	Traps.
58	8	Ndala Mkumba	Long line.
59	9	Nkudzi	Cloth.
60	9	Nkudzi	Lines from ship.
61	9	Monkey Bay	Long line.
62	10	Monkey Bay	Lines from ship.
63	10	Chelinda	Deep line fishing.
64	10	Chelinda	Traps.
65	10	Chelinda	Seine.
66	10	Monkey Bay	Drop fishing.
67	10	Monkey Bay	C.D.F.,* seine.
68	10	Monkey Bay	Gill nets, 3″.
69	12	Marembo	Gill nets, 5″, 4″, 2″.
70	13	Marembo	Drop fishing.
71	13	Marembo	Long line.
72	14	Marembo	C.D.F., seine.
73	14	Marembo	Long line.
74	15	Marembo	Lines from ship.
75	15	Salima, Chapman's beach	Mr. Tylor's seine.

* Colonial Development Fund = e.g. Survey.

2. STATION LIST—*continued.*

Station	Date	Locality	Nature of data
76	Mar. 16	Salima, Chapman's beach	Mr. Tylor's seine.
77	16	Salima, Chapman's beach	Trolling.
78	17	Salima, Chapman's beach	Mr. Tylor's seine.
79	19	Domira Bay, Makanjila	Line fishing.
80	19	Domira Bay, Makanjila	Traps.
81	19	Domira Bay, Makanjila	Native gill net.
82	19	Domira Bay, Makanjila	Gill nets, 5″, 4″, 3″.
83	21	Kota, off spit	Trawl.
84	21	Kota, off spit	Stramin tow net.
85	21	Kota, off spit	Plankton nets, etc.
86	22	Kota beach	Seine.
87	23	Sani rocks	Pond net.
88	23	Kota	Traps.
89	24	Kota	Seine.
90	24	Kota	Cloth.
91	25	Kota, Kampambe Lagoon	Traps and cloth.
92	25	Kota	Bought.
93	27	Bana	Gill nets, 3″, 2″.
94	27	Bana	C.D.F., seine.
95	27	Bana	Trolling.
96	27	Bana	Seine.
97	28	Bana	Trolling.
98	29	Nkata Bay	Gill nets, two of 5″, two of 4″, 3″, 2″.
99	30	Nkata Bay	C.D.F., seine.
100	30	Nkata Bay, mouth of bay	Temperature and chemistry, plankton.
101	30	Nkata Bay	Temperature and chemistry, plankton
102	30	Nkata Bay	Chilimila net.
103	30	Nkata Bay	Gill nets, 5″, 4″, 3″.
104	31	Ruarwe	Seine.
105	31	Ruarwe	Gill nets, two sets 5″, 4″, 3″, 2″.
106	April 1	Ruarwe	C.D.F., seine.
107	1	Ruarwe	Long lines.
108	2	Florence Bay	Gill nets, 5″, 4″, 3″, 2″.
109	3	Florence Bay	Traps.
110	3	Florence Bay, two miles outside bay	Temperature and chemistry.
111	3	Florence Bay	Line and pond net from ship.
112	3	Florence Bay	Traps.
113	4	Ngara	C.D.F., seine.
114	4	Ngara	Gill nets, 5″, 4″, 3″, 2″.
115	5	Karonga, Rukuru River mouth	Gill nets, 5″, 4″, 3″, 5″.
116	6	Karonga, Kambwe Lagoon	Arab seine.
117	7	Karonga, Rukuru mouth	Arab seine.
118	7	Karonga, Rukuru mouth	C.D.F, seine.
119	7	Karonga, Kambwe Lagoon	Gill nets, 5″, 5″, 4″, 3″.
120	8	Mwaya, Mbaka River mouth	Seine.
121	8	Mwaya, Mbaka River mouth	C.D.F., seine.
122	8	Mwaya, Mbaka River mouth	Long line, native.
123	9	Mwaya, Mbaka Creek	Traps.
124	9	Mwaya, mouth of creek	Gill nets, 5″, 4″, 3″, 2″.
125	10	Mwaya, Mbaka River mouth	Seine.
126	11	Deep Bay	C.D.F., seine.
127	11	Deep Bay	Trolling.
128	11	Deep Bay	Seine.
129	11	Deep Bay	Long line and gill nets, 5″, 4″, 3″, 2″.
130	12	Deep Bay	Chilimila net.
131	12	Deep Bay	Plankton nets.
132	12	Open water nine miles west Manda	Temperature and chemistry.
133	13	Manda	Seine.
134	14	Mbaha	Gill nets, 5″, 4″, 3″, 2″.
135	14	Mbaha	Seine.

2. STATION LIST—*continued.*

Station	Date	Locality	Nature of data
136	April 14	Mbaha	Plankton nets.
137	15	Mbaha	Gill nets, 5″, 4″, 3″, 2″.
138	16	Njambe	C.D.F., seine.
139	17	Liuli	C.D.F., seine.
140	17	Liuli	Seine.
141	17	Liuli	Gill nets, 5″, 4″, 3″, 2″, long line.
142	18	Mbampa Bay	C.D.F., seine.
143	18	Mbampa Bay, middle of bay	Temperature and chemistry.
144	18	Mbampa Bay	Long line and gill nets, 5″, 4″, 3″, 2″.
145	19	Mbampa Bay, outside bay	Temperature, chemistry, and plankton.
146	19	Mbampa Bay	Seine.
147	19	Mbampa Bay	Chilimila nets.
148	19	Mbampa Bay	Trolling.
149	20	South-west Nguangwe Island, open water two miles out	Temperature, chemistry, and plankton.
150	20	Chiwindi	Gill nets, 5″, 5″, 4″, 3″, 2″.
151	21	Limbaula	C.D.F., seine.
152	21	Limbaula	C.D.F., seine.
153	21	Limbaula	Long line.
154	22	Kobwe	C.D.F., seine.
155	22	Kobwe	Seine.
156	22	Kobwe	Trolling.
157	22	Kobwe	Gill nets, 5″, 4″, 3″, 2″.
158	23	Kobwe, to Kobwe River	Trawl.
159	23	Kobwe	Trolling.
160	24	Kobwe	Trolling.
161	24	Likoma	Seine.
162	24	Likoma	Gill nets, 5″, 4″, 3″, 2″.
163	25	Likoma, Chiyani village	Seine.
164	25	Likoma	Chilimila nets.
165	25	Likoma	Bought.
166	25	Likoma, Yofu village	Seine.
167	25	Likoma	Chilimila nets.
168	25	Likoma, Yofu village	Seine.
169	25	Likoma	Trolling.
170	25	Likoma	Long line.
171	26	Likoma, Yofu village	Seine.
172	26	Likoma, Makalawe	Seine.
173	26	Likoma, Makalawe	Cloth.
174	26	Likoma	Chilimila nets.
175	26	Likoma	Gill nets, 5″, 5″, 4″, 3″, 2″.
176	27	Likoma	Plankton nets.
177	27	Likoma	Gill nets, 5″, 4″, 3″, 2″.
178	28	Likoma	C.D.F., seine.
179	28	Likoma, Makalawe	Bought.
180	28	Likoma	Long line.
181	29	Ngo, spit	Seine.
182	29	Ngo	Gill nets, 5″, 4″, 3″, 2″.
183	30	Msamba, Lunyo River	Traps.
184	May 1	Msamba, Lunyo River	Traps.
185	1	Mtengula	Trolling.
186	1	Mtengula	Bought.
187	1	Mtengula	Gill nets, 5″, 4″, 3″, 2″.
188	2	Mtengula	Traps.
189	2	Mluluka	Chilimila nets.
190	2	Mluluka	Long line.
191	3	Chilowelo	Seine.
192	3	Chilowelo	Native gill net.
193	3	Chilowelo, Dwafisi River mouth	Long line.
194	4	Chilowelo, Dwafisi River mouth	C.D.F., seine.

2. STATION LIST—*continued.*

Station	Date	Locality	Nature of data
195	May 4	Chilowelo	Seine.
196	4	Chilowelo, Dwafisi River mouth	Gill nets, 5″, 4″, 3″, 2″, and long line.
197	5	Luangwa	Seine.
198	5	Luangwa River	Traps.
199	5	Msinje	Gill nets, 5″, 4″, 3″, 2″.
200	6	Fort Maguire	Trolling.
201	6	Fort Maguire	Seine.
202	6	Fort Maguire	Gill nets, 5″, 4″, 3″, 2″.
203	7	Fort Maguire	Trolling.
204	7	Fort Maguire	Seine (night).
205	8	Old Livingstonia	Seine (night).
206	8	Old Livingstonia	Gill nets, 5″, 4″, 3″, 2″.
207	9	Nkudzi Bay	Trawl.
208	9	Off Bar, Fort Johnston	Trawl.
209	11	Fort Johnston, Shire	Seine.
210	11	Fort Johnston, Shire	Traps.
211	12	Fort Johnston, Yiannakis	European seine.
212	12	Fort Johnston, Yiannakis	Long lines, European.
213	*31	Kota, Kaombe River	Traps.
214	June 1	Chia Lake and River	Scoop nets and chemistry.
215	1	Sani, north beach	Seine.
216	2	Kota, Kampambe Lagoon	Traps and chemistry.
217	2	Kota, north beach	Seine and chemistry.
218	3	Kota, Kaombe River	Chemistry.
219	5	Kota, Kampambe Lagoon	Traps.
220	8	Kota	Traps.
221	May 13	Monkey Bay, Zambo beach	Seine.
222	14	Monkey Bay	Seine.
223	14	Monkey Bay, Zambo	Seine.
224	15	Monkey Bay, Nkudzi Point	Trolling.
225	15	Nkudzi	Seine.
226	15	Nkudzi	Native lines.
227	16	Monkey Bay	Seine.
228	16	Monkey Bay, Zambo	Seine.
229	16	Monkey Bay	Gill nets, 4″, 3″, 2″.
230	17	Monkey Bay	Seine.
231	17	Monkey Bay	Long line.
232	17	Monkey Bay	Gill nets, 4″, 3″, 2″.
233	18	Monkey Bay, Zambo	Seine.
234	18	Monkey Bay	Gill nets, 5″, 4″, 3″, 2″, and hook.
234a	18	Monkey Bay, Zambo	Seine.
235	21	Monkey Bay	Gill nets, 5″, 4″, 3″, 2″
236	21	Monkey Bay	Long line.
237	23	Monkey Bay	Gill nets, 5″, 4″, 3″, 2″.
238	24	Monkey Bay	Seine.
239	25	Monkey Bay	Long line.
240	26	Monkey Bay	Gill nets, 5″, 4″, 3″, 2″.
240a	26	Monkey Bay	Hand net.
241	27	Monkey Bay	Seine.
242	29	Monkey Bay	Gill nets, 5″, 4″, 3″, 2″.
243	30	Monkey Bay	Gill nets, 5″, 4″, 3″, 2″.
244	June 1	Monkey Bay	Gill nets, 5″, 4″, 3″, 2″.
250	7	Kota, south part bight	Gill net, 2″.
251	9	Kota	Long line.

* From May 14 to May 30 part of Survey party at Chintembwe, working on dams and rivers.
From May 12 to June 1 part of Survey party at Monkey Bay, stations 221–244.

2. STATION LIST—*continued.*

Station	Data	Locality	Nature of data
252	June 11	Kota	Gill net, 2″.
253	11	Kota, north beach	Seine.
254	12	Kota, north beach	C.D.F., seine.
255	12	Kota, north beach	Seine.
256	12	Kota	Gill net, 2″.
257	13	Sani, north beach	Seine.
258	13	Sani	C.D.F., seine.
259	13	Kota	Gill net, 2″.
260	14	Kota	Native gill net.
261	15	Kota	Seine.
262	16	Kota	Gill nets, 5″, 4″, 3″, 2″.
263	17	Kota	Gill nets, 5″, 4″, 3″, 2″.
264	19	Kota	Trolling.
265	19	Kota	Gill nets, 5″, 4″, 3″, 2″.
266	20	Kota	Long line.
267	21	Kota	Seine.
268	21	Kota	Plankton net.
269	21	Kota	Gill nets, 5″, 4″, 3″, 2″.
270	22	Kota	Temperature.
271	22	Kota	Gill nets, 5″, 4″, 3″, 2″.
272	27	Fort Johnston, Shire River	Temperature.
273	28	Marembo	Seine.
274	28	Marembo	Temperature.
275	28	Marembo	Seine.
276	29	Marembo	Line fishing.
277	30	Marembo	Seine.
278	30	Marembo, north-east corner	Seines.
279	30	Marembo	Temperature.
280	July 1	Fort Johnston, Yiannakis	European seine.
281	June 26*	Kota	Gill nets, 5″, 4″, 3″, 2″.
282	27	Kota	Long line.
283	28	Kota	Gill nets, 5″, 4″, 3″, 2″.
284	29	Kota	Long line.
285	30	Kota	Gill nets, 5″, 4″, 3″, 2″.
286	July 2	Kota	Temperature.
287	3	Kota	Temperature.
288	3	Kota	Gill nets, 5″, 4″, 3″, 2″.
289	4	Kota	Long line.
290	5	Kota	Gill nets, 5″, 4″, 3″, 2″.
291	6	Kota	Long line.
292	7	Kota	Gill nets, 5″, 4″, 3″, 2″.
293	10	Kota	Temperature.
294	10	Kota	Gill nets, 5″, 4″, 3″, 2″.
295	11	Kota	Seine.
296	11	Kota	Long line.
297	12	Kota	Gill nets, 5″, 4″, 3″, 2″.
298	13	Kota	Seine.
299	13	Kota	Seine.
300	13	Kota	Long line.
301	14	Kota, Kampambe Lagoon	Traps.
302	14	Kota	Seine.
302a	14	Kota	Plankton net.
303	14	Kota	Gill nets, 5″, 4″, 3″, 2″, and long line.
304	15	Kota	Seine.
305	17	Kota	Chemistry.
306	17	Kota	C.D.F., seine.

* Stations 281–291 recorded by native clerk during J.B.'s absence.

2. STATION LIST—*continued.*

Station	Date	Locality	Nature of data
307	July 17	Kota	Chemistry.
308	17	Kota	Seine.
309	17	Kota	Gill nets, 5″, 4″, 3″, 2″, and long line.
310	18	Kota	Seine.
311	18	Kota	Seine.
312	19	Kota	Temperature.
313	20	Kota	Seine.
314	20	Kota	Examination stomachs, station 301.
315	20	Kota	Gill nets, 5″, 4″, 3″, 2″, and long line.
316	22	Kota	Temperature.
317	23	Kota	Seine.
318	23	Kota, near spit beacon	Gill nets, 5″, 4″, 3″, 2″ bottom, and 5″, 4″ at surface.

APPENDIX II.

1. HYDROGRAPHICAL NOTES.

(*a*) CLEARNESS OF WATER by means of Secchi disc.

Station number	Locality	Depth at which disc disappeared
—	Nkudzi	4 m.
62	Monkey Bay	5 m.
—	Marembo	1½ m.
—	Domira Bay	⅓ m.
100	Nkata Bay	11 m.
110	Outside Florence Bay	14 m.
143	Mbampa Bay	9 m.
145	Outside Mbampa Bay	11 m.
149	South-west Nuangwe Island ..	10 m.

(*b*) SURFACE TEMPERATURES.

Date	Locality	Reading	Time
March 8	Ndala M'Kumba	27·2 C.	1615
9	Nkudzi	27·4	0630
		27·4	1000
10	Monkey Bay	27·8	1315
11	Off Chelinda	27·5	1900
11	Chelinda	27·5	0700
12	Old Livingstonia	28·1	1400
12	Marembo	27·9	1200
14	Marembo	28·0	1700
15	Marembo	27·6	1500
		27·1	0600

1. HYDROGRAPHICAL NOTES—*continued.*

SURFACE TEMPERATURE—*continued.*

Date	Locality	Reading	Time
Mar. 19	Domira Bay	26·5	1500
20	Domira Bay	27·0	1130
21	Off Kota Kota	27·1	1300
28	Bana	26·4	0830
30	Nkata Bay	26·9	1200
31	Nkata Bay	26·2	0730
31	Ruarwe	27·2	1445
April 1	Ruarwe	26·9	1530
3	Off Florence Bay	26·5	0900
6	Kambwe Lagoon, Karonga	27·1	0900
12	9 m. west Manda	27·1	1130
16	Njambe	26·0	2000
18	Mbampa Bay	26·1	1600
19	Off Mbampa Bay	25·9	0800
30	Ngo	26·2	0900
May 2	Mluluka	26·1	1400
6	Fort Maguire	25·1	1000
9	Fort Johnston	23·4	2200
10	Fort Johnston	23·0	0800
June 1	Chia River	23·5	1200
2	Kota Kota	23·7	1600
12	Kota Kota	22·6	1100
13	Sani	23·8	1130
14–26	Kota Kota	21·4–24·7	1200
27	Shire River	21·4	1000
28–29	Marembo	23·5–24·1	1200
27–30	Kota Kota	21·4–22·6	1200
July 1-22	Kota Kota	21·7–24·8	1200

Total range 21·4 to 28·1° C. Average of 67 readings 24·9° C.

(For deep water temperatures see No. (*g*).)

(*c*) *pH* determined by standard colorimetric methods using Thymol Blue, Phenol-Red, Chlor-phenol-red, and Brom-thymol-blue as indicators matched with Clark's colour chart (1928, p. 64).

Station	Locality	Value for surface water
—	Ndala M'kumba	8·2–8·4
—	Nkudzi	8·4
—	Marembo	8·4
—	Domira Bay	8·2
85	Off Kota Kota	8·6
—	Bana	8·6
100	Nkata Bay	8·6
—	Ruarwe	8·5
110	Off Florence Bay	8·6
—	Kambwe Lagoon, Karonga ..	8·4
132	9 miles west Manda	8·5
145	Mbampa Bay	8·5
149	South-west Nuangwe Island ..	8·6
217	Kota Kota	8·2
305	Kota Kota	8·6

Average value for 15 surface readings = 8·4.

1. HYDROGRAPHICAL NOTES—*continued.*

(*d*) ALKALINITY, determined by titrating water sample with standard N/100 H_2SO_4 using Brom-phenol-blue as indicator.

Average for 11 readings from stations 100, 110, 132, 149, 217, and 305 = ·0025N.
Total range for surface and deep water readings (highest value came from a depth of 300 metres) = ·0025 to ·0026N.

(*e*) PHOSPHATE determined by standard colorimetric method in measuring cylinders and calculated in parts per million.

The range for six determinations in surface water is from 0·012 p.p.m. to 0·11 p.p.m. (stations 100, 110 132, 145, 149, 217).

(*f*) OXYGEN. The volume of dissolved oxygen was determined by the standard Winkler method.

Station	Locality	Surface value
101	Nkata Bay	5·2 ml/litre
110	Off Florence Bay..	5·1 ml/litre
132	9 miles west Manda	5·1 ml/litre
145	Mbampa Bay	5·2 ml/litre

The average for four surface readings is .. .. 5·15 ml/litre.
Average barometer reading .. .. 28·55″.
Average temperature reading for these stations .. .. .. 26·4° C.
At this temperature and pressure saturation is .. .. .. 5·6 ml/litre.

(*g*) DEEP WATER STATIONS.

Station No.	Depth		Temperature	pH	Oxygen	Phosphate
	Metres	Fathoms	°C.		ml/litre	p.p.m.
100	0	0	26·88	8·6	—	0·1
	9	5	26·60	—	—	—
	18	10	26·61	—	—	—
	27	15	26·57	—	—	—
	37	20	26·53	8·6	—	—
	73	40	—	8·6	—	0·15
101	0	0	26·85	—	5·2	—
	37	20	26·52	—	5·1	—
	73	40	23·27	—	4·0	—
110	0	0	26·56	8·6	5·1	0·02
	37	20	26·84	8·6	5·1	—
	73	40	26·64	8·6	5·0	—
	91	50	22·78 [22·80]*	8·2	3·1	—
	113	62	22·57 [22·57]	8·2	1·5	0·055
	60	33	26·63	—	—	—
	82	45	23·19 [23·20]	—	—	—
132	0	0	27·1	—	5·1	<0·02
	37	20	26·02	8·4	5·1	0·02
	73	40	22·83 [22·88]	8·2	3·1	0·05
	91	50	22·56 [22·62]	8·2	2·2	—
	146	80	22·31 [22·32]	7·9	1·0	0·1
	302	165	22·12 [22·11]	7·9	0·5	0·1
143	0	0	26·14 [26·13]	—	—	0·02
	27	15	26·03 [26·02]	—	—	—
	37	20	26·03 [26·02]	—	—	—
	55	30	26·03 [25·92]	—	—	0·025

* Two reversing thermometers were used in the frame, but one did not record above 26·2° C. Readings for both thermometers are given wherever the values are below 26·2° C.

Station No.	Depth		Temperature	pH	Oxygen	Phosphate
	Metres	Fathoms	°C.		ml/litre	p.p.m.
145	0	0	25·92 [25·90]	8·5	5·2	0·02
	46	25	25·94 [25·93]	8·5	5·0	0·025
	64	35	25·43 [25·42]	—	—	—
	91	50	24·52 [24·49]	8·1	4·0	0·055
149	9	5	25·95 [25·94]	8·6	5·0	—
	55	30	—	—	5·0	0·035
	91	50	25·13 [25·12]	8·5	4·7	0·05
	128	70	23·18 [23·16]	8·1	3·6	0·05
	210	115	22·48 [22·45]	8·0	2·0	0·05

± 0·05.

(*h*) DATA FOR LAGOONS, RIVERS, PONDS, AND DAMS.

Locality	Date	Tempera-ture	pH	Alkalinity	Phosphate
Kampambe Lagoon, Kota Kota ..	June 2	24·4° C.	6·8	0·0003 N	0·02 p.p.m.
Chia River	June 1	23·5° C.	—	0·002 N	0·01? p.p.m.
Kaombe River, lowest bridge ..	June 3	21·0° C.	7·0	0·002 N	0·15 p.p.m.
Kalira River	May 20	—	7·7	0·0009 N	0·005 p.p.m.
Chirua River	May 20	—	7·7	0·0007 N	0·005 p.p.m.
Chintembwe Mission Dams	June 26	16·0° C.	5·8	0·0005 N	0·007 p.p.m.
Nchisi boma pond	June 25	16·2° C.	5·7	0·0004 N	0·12 p.p.m.
Nutrition Survey Dams	June 26	18·5° C.	7·3–8·4	0·001 N	0·007 p.p.m.

2. AIR SHADE TEMPERATURES.

Date	Locality	Readings ° F.	
		Maximum	Minimum
Feb. 21–March 6	Fort Johnston	80–92	71–75
March 23–March 25	Kota Kota ..	78–82	70–71
April 25–April 27	Likoma ..	82–89	70
June 12–June 30	Kota Kota ..	71–77	60–68
July 1–July 23	Kota Kota ..	72–80	58–72

3. WIND DIRECTIONS ON LAKE OR AT LAKE SHORE.

Period	Days of fresh or strong northerly	Days of fresh or strong southerly	*Days of calm or light variables
Jan. 24–31 ..	—	—	8 (N. to E.)
Feb. 1–24	7	1	16 (N. to E.)
March 7–31 ..	5	15	5 (E. to S.)
April 1–30 ..	1	16	13 (S.E. to S.W.)
May 1–12 ..	—	4	8 (S.E. to S.W.)
June 14–30 ..	—	10	5 (S.E. to S.W.)
July 1 and 8–23	—	10	7 (S.E. to S.W.)
131 days— Jan. 24–July 24	13	56	62

* In brackets are indicated the arcs through which the light winds varied.

APPENDIX III.

List of Fish Recorded from Lake Nyasa with Native Names and Notes on their Abundance.

Scientific name.		*Native names.*	*Abundance.*
MORMYRIDAE.			
Mormyrops deliciosus		Nyanda (M.B., D.B., N.B.)* .. .. .. Njolo (Li.) Ngondi (K.K., Ch.)	Fairly common.
Petrocephalus catostoma ..		Ntachi (K.K.)	Scarce.
Marcusenius discorhynchus ..		Mputa (M.B.) .. .. Ntachi (M.K.)	Fairly common.
Gnathonemus nyasensis / *G. macrolepidotus* ..		Mbombo (F.B. Mb.). Mbobwe (Mw.) Mputa (M.B., Ch.) .. .. Ntachi (K.K.) Panda (F.B.)	Fairly common.
Mormyrus longirostris		Chigondi (F.J., M.B.) .. .. Mbelewele (M.B.) Panda (O.L., K.K., N.B., Ru. Li. F.M.) Nyanda (Mb.)	Common.
CHARACINIDAE			
Alestes imberi		Nkalala (Ma., K.K., Ba., Ka., Mw., Ch.)	Common.
CYPRINIDAE			
Barilius microcephalus ..		Sanjika (F.J., Sa., Ba., Mw., Mn., Ko., Li., Ms., Mj., F.M.)	Very common.
Barilius microlepis		Mpasa (F.J., M.B., Ma., Sa., K.K., Ba., N.B., Ka., Mw., De.B., Mn., Ko., Ms.)	Very common
	Young	Nyengiri (Ru.)	
Engraulicypris sardella ..		Usipa (all over lake)	Abundant.
Labeo altilevis†			
Labeo mesops		Nchira (F.J., M.B., O.L., Ma., Sa., D.B., K.K., Ba., N.B., Mb.B., Li., Ms., Ch., Mj., F.M.) ..	Abundant.
	Young	Ntuwa (F.B., De.B., Mn.). Msila (Ka.) Kasomela (F.J.). Mbolobolo (K.K.) Mpondo (Ng.)	
Labeo cylindricus		Ningwi (M.B., D.B., K.K., N.B., Mw., Li., Ch., F.M.) .. .. Mpuwa (Ru., F.B.). Limboti (Mb.) Mbununu (K.K.)	Common.
Labeo intermedius†		– – – –	
Varicorhinus nyasensis ..		Chilulumawe (Mw.) .. .. Kuyu (Ms.)	Scarce.
Barbus rhoadesii		Tamba (F.J., M.B., Ma., D.B., K.K., N.B., Ru., F.B., Ms., Ch. Che.) .. .. Idlwale (Mw.)	Common.
Barbus eurystomus		Kadyakola (F.J., M.B., Ma., Sa., D.B.) .. .. Kuyu (K.K., Li.) Nkasu (Ru., Mb.). Nkwekwe (F.B.) Mbosi (Mw.)	Common.
Barbus johnstoni		Mkumbwa (F.J.). Kopokopo (Sa.) Chimwe ? (K.K.) yg. Mpolopolo (Ru.) .. .. Ngumbo (M.B., F.B.) Mbakale (Mw.). Chikongo (Li.). (Mpondo (Chin))	Scarce.
Barbus globiceps†		– – –	

* See end of list for abbreviations of place-names.
† = not seen by the Survey.

Appendix III—*continued.*

Scientific name.		*Native names.*	*Abundance.*
Barbus, ten small species / *B. nyassae* / *B. trimaculatus* / *B. paludinosus* / *B. eutaenia* / *B. choloensis* / *B. banguelensis* / *B. innocens* / *B. arcislongae* / *B. rogersi* / *B. macrotaenia*	not distinguished in the field	Matemba (M.B.) .. .. Kongora (K.K.). Lumbulwe (Mw.)	Fairly common.
SCHILBEIDAE			
Eutropius depressirostris† ..		– – –	
BAGRIDAE			
Bagrus meridionalis	yg	Kampango (all round lake)	Abundant.
	big	Kansosole (F.J.). Ntungumba (Mw.) Mbuvu (Ru., F.B., Mw.)	
CLARIIDAE			
Clarias mossambicus		Mlamba (F.J., M.B., O.L., Ma., K.K., Ka., Li., Ch., Che.) .. .. Bwanka (F.B.)	Very common.
	big	Chikuta (F.J., K.K.)	
Clarias mellandi		Sute (F.J., Ma., La.).. .. .. Mlamba (K.K.)	Scarce.
Clarias, several large species, including / *C. nyasensis* / *C. longibarbis* / *C. carsonii* / (not distinguished in the field)		Kwazula (M.B., O.L., K.K., F.B., Li., Che.) .. Sapuwa (O.L., Ma., Sa., D.B., K.K., Ba., N.B., Ch., Che.) Chipafu (Mw.). Pwefu (F.B., Ch.) Mpalapala (Ch.). Sasawa (K.K.) Nkomo (M.B., O.L., Ma., Ru., Li., Mt.) Bombe (F.J., Ch.). Nyambanyamba (M.B., F.M.) Bwanamuzu (Ma., N.B., Ko.). Kambale (Che.) Chimwamapumba (N.B.). Iwonde (Mb.) Kabutu (M.B.). Lumbalisilo (F.J.) Lumbulule (K.K.)	Common.
Clarias theodorae		Kobo (K.K., Kampambe L.)	Scarce.
AMPHILIIDAE			
Amphilius platychir†		– – –	
MOCHOCHIDAE			
Synodontis zambesensis ..		Kolokolo (M.B., Ma., N.B., F.B., Mb., Li., Ng., Ms., F.M.) .. .. Njekayeka (K.K.)	Common.
MALOPTERURIDAE			
Malopterurus electricus† ..		– – –	
CYPRINODONTIDAE			
Nothobranchius orthonotus† ..		– – –	
Aplocheilichthys johnstoni† ..		– – –	
ANABANTIDAE			
Ctenopoma multispinis† ..		– – –	
Ctenopoma ctenotis†		– – –	
MASTACEMBELIDAE			
Mastacembelus shiranus† ..		– – –	
CICHLIDAE			
Tilapia squamipinnis		Chambo—general name for both sexes and all ages; also used at all these places, except K.K., more strictly for mature females (F.J., M.B., O.L., Ma., Sa., D.B., Mb.B., Ko., Li., Ms., Mt., La., Mj., F.M., Che.)..	Very abundant.

† = not seen by the Survey.

Scientific name.	*Native names.*	*Abundance.*
	Sanga (F.B., Mw., Mn.) Igege (Ka.)	
	Young Katungulu (K.K., N.B., Ko., Li.) Kambuzi (up to ca. 12 cm.) (K.K.) Kababa (12 to ca. 22 cm.) (K.K.)	
	Kasawala (20 to ca. 26 cm.) (K.K.)	
	Kambuzi (up to ca. 12 cm.) (F.J., M.B.) Kasawala (12 to ca. 24 cm.) (F.J., M.B.)	
	Females Chambo (as above, omitting K.K.) Kayawa (K.K.) Zeya (small) (F.J.) Makumba (Lu.) Matuwa. (De. B.)	
	Males Ching'anga (F.J., Sa., Chi.) Nchesichesi (F.J., Ma.) Ngwaru or Ngwalu (K.K., N.B.) Ling'ara (F.B., Ka.)	
	Very dark :—Chinkulu (Sa.), Lingula (Mn.), Mamula (Mn.), Biliwili (K.K.)	
	Blotched or speckled :—Langasime or Mlangasime (F.J.). Vyambo (M.B.)	
	Doubtfully this sp. :—Tsaka	
	Very large w. reduced gonads—sex ? :— Ngong'o (F.J.). Kumba (F.J.) Makumba (M.B.)	
T. lidole	Lidole (F.J., M.B., F.M.)	Abundant.
	Lolo (K.K.) Galamula (F.J., Sa., Ch.) Muhadjiri (F.J.)	
T. karongae	Saka or Tsaka (black male only ?) (Ka.).. ..	Probably abundant at north end of lake.
T. shirana	Katukusi (partim) (F.J., Che.)	Very abundant.
	Fwirili or Fwilili (M.B., Sa., Ch., La., F.M.) Silili or Sirili (Mb., B.) Nkututu (K.K., Ba., N.B.) Guruguru (Ru.) Tokotoko (F.B.) Lindweke (Ka., Mw., Mn.) Igege (Mw.)	
	Large Makumba (F.J.). Pelela (F.J.)	
T. melanopleura	Katukusi (F.J.)	Fairly common.
	Ninguichali or Nyunguchali (K.K., Mt., La.) ..	
	Nyankarua (F.B., Ka.)	
T. sparrmani	Chimbente (K.K. (Kampambe Lagoon))	Local.
Pseudotropheus 11 spp. ..	Chindongo (M.B., Li.)	Abundant locally.
	Chimbuzi (K.K.)	
P. elegans *P. livingstoni* *P. zebra* *P. williamsi* *P. lucerna* *P. fuscus* *P. auratus* *P. novemfasciatus* *P. microstoma* *P. tropheops*	Chindemba (Li.)	
P. macrophthalmus		
Petrotilapia tridentiger ..	Chindongo (M.B.)	Local.
	Chimbuzi (K.K.) Kindongo (Mb.) Namagunda (Li.)	

Scientific name.	*Native names.*	*Abundance.*
Labeotropheus fuelleborni ..	Chindongo (M.B.)	Abundant locally.
	Chimbuzi (K.K.) Mbuna (Li.)	
Cyathochromis obliquidens ..	Chindongo (M.B., Li.)	Fairly common.
	Chimbuzi (K.K.)	
Cynotilapia afra†		
Gephyrochromis moorii ..	Chindongo (M.B.)	Local.
Melanochromis 5 spp.		
M. melanopterus†		
M. vermivorus†		
M. brevis†		
M. perspicax†		
M. labrosus†		
Genyochromis mento†		
Labidochromis vellicans†		
Haplochromis. 101 Nyasa species are recognised.		
H. philander	Kamoto (K.K. (Kampambe Lagoon))	Local.
H. callipterus	Kolokoto (K.K.)	Abundant.
	Dondo or Dondolo (F.J., M.B.)	
H. livingstoni	Fisi (Sa., K.K., F.M.)	Fairly common.
H. pardalis†		
H. polystigma	Gufifi (Li.)	
H. maculimanus		
H. venustus†		
H. fuscotaeniatus	Liwele (F.J.)	
	Mbele (M.B.)	
H. johnstoni	Kachimanga (M.B.)	Abundant locally.
	Sindwala (M.B.)	
H. rostratus	Chimbenje (M.B., K.K., Li.)	Common.
H. compressiceps	Kapula (F.J.)..	Fairly common.
	Chimpeni (M.B.)	
	Kalikolombe (Li.)	
H. macrostoma		
H. polyodon†		
H. maculiceps†		
H. urotaenia	Kachimanga (M.B.)	Scarce.
H. spilopterus	Kamwena (K.K.)	Sporadic.
	Mbaba (F.J.)	
	Kamnung'oli (F.B.)	
	Kadyapota (M.B.)	
	Sadyakapolo (M.B.)	
	Kambuzi (Li.)	
H. triaenodon†		
H. fenestratus		
H. similis	Yera (K.K.)	?
	Namdyatsini (M.B.)	Common.
	Chidyabango (M.B.)	
	Kambuzi (Ml.)	
H. marginatus	♀ Mbaba, ♂ Nyali (K.K.)	Common.
H. leuciscus	Kadyemphoka or Chidyemphoka (K.K.)	Scarce.
	Temba (M.B.)	
H. spilonotus†		
H. insignis		
H. annectens†		
H. taeniolatus		
H. breviceps	Chionge (F.B.)	Local.
	Chimalambeu (Mn.)	
H. microcephalus	Mbundangi (Mn.)	
	? Chitowawa (M.B.)	
H. nigritaeniatus†		
H. serenus†		
H. purpurans†		
H. pleurotaenia†		
H. kirkii	Mbaba (F.J.)	Common.
H. labridens		

† = not seen by Survey.

Scientific name.	*Native names.*	*Abundance.*
H. virgatus		
H. phenochilus		
H. festivus†		
H. ornatus		
H. lobochilus†		
H. euchilus	Namlepetu (Li.)	Local.
H. holotaenia	Kakorombe (Mb.)	Local ?.
H. kiwinge	Chilingwi (M.B.)	
	Binga (K.K., N.B., Ko.)	Abundant.
	Lavinga (Mj.)	
	Mbinga (De. B.)	
	Dzani (F.J., M.B.)	
H. strigatus	? Undulo (K.K.)	
	Mudyamphoka (K.K.)	Common.
H. subocularis†	Palala (F.J.)	
H. lateristriga		
H. incola		
H. mola		
H. sphaerodon		
H. ericotaenia		
H. plagiotaenia†		
H. balteatus†		
H. melanotaenia†		
H. epichorialis		
H. spilorhynchus	Tabwa (F.J.)	Common.
	Dumphila (M.B.)	
	Njeruwa (Mw.)	
	Mbuchi (De. B.)	
	Kalembalemba (in common with all striped fish, Ch.)	
H. caeruleus	Nchyochyo (M.B.)	
H. melanonotus	Sasamchenga (K.K.)	Common.
	Sagwomeza (K.K.)	
	Tokotoko (M.B.)	
H. semipalatus		Scarce.
H. guentheri†		
H. mollis†		
H. orthognathus		
H. lepturus	Khota (K.K.)	Common.
	Mgungo (M.B.)	
	? Dimba (M.B.)	
H. nototaenia	? Chilingwi (M.B.)	
	Dimba (M.B., K.K.)	
H. rhoadesii	Ngungu (F.J.)	Common.
	Kavunguti (M.B.)	
H. heterotaenia	Khota (K.K.)	Common.
H. atritaeniatus	Mbowe (M.B.)	
H. oculatus	Tong'o (F.J., M.B.)	Common.
H. spectabilis†	Tong'o	Common.
H. obtusus		
H. formosus†		
H. gracilis†		
H. spilostichus†		
H. ahli		
H. pleurospilus†		
H. auromarginatus		
H. ovatus	Chakuta (M.B., Li.)	
H. woodi	Pichirico (F.J.). Katsatsi (M.B.). Mbawala (K.K.)	Common.
H. pholidophorus†		
H. tetrastigma	Mbaba (F.J.)	Abundant locally.
H. heterodon		

† = not seen by Survey.

Scientific name.	*Native names.*	*Abundance.*
H. tetraspilus	Chidyabango (M.B.)	
H. chrysogaster	Chidyamwanda (M.B.)	Scarce.
H. labifer		?
H. speciosus	Saguga (M.B.)	Scarce.
H. decorus	Kambuzi Wa Vumanga (Ko.)	?
H. argyrosoma		
H. selenurus		
H. moorii	Chinkongo (K.K.). Kabale (K.K.). Kabibi (Ko.)	Common.
H. placodon	Chamwala (K.K.). Tumwala (F.J.)	Common.
	Mlama Mutu (Li). Ndowolo (Li.)	
H. nitidus	Kabanana (Li.)	Scarce.
	Mbaba Katsatsi (M.B.)	
H. pictus	Mbaba Mkwatami (Ch.)	
H. intermedius	Yera (K.K.)	Scarce.
	Mbaba Katsatsi (M.B.)	
H. inornatus		
H. eucinostomus		
H. prostoma	Utaka (whole lake)	Abundant.
H. chrysonotus	Ntaka (De. B., Mb. B.)	
H. cyaneus		
H. quadrimaculatus		
H. pleurostigma	Chakuta (Mt., Ch.)	Fairly common.
H. longimanus†		
H. micrentodon†		
Coremalodus shiranus	Yinga (K.K.)	Common.
	Chaombamwere (M.B.)	
C. taeniatus	Nankerere (F.J.)	
	Mukumba (F.B.)	
Docimodus johnstoni	Chindikila (M.B.)	Common.
	Sadyakapola (M.B.)	
Chilotilapia rhoadesii	Chindikila (M.B.)	Common.
	Chiluma (K.K.)	
	Kawisa (N.B.)	
	Kansupa (F.J., M.B.)	Common.
	Kapumphu (F.J.)	
	Sadyakapola (M.B.)	
	Ndukufiona (K.K.)	
	Tumbaliri (Ru.)	
Hemitilapia oxyrhynchus ..	Namdyatsini (M.B.). Mbaba Katsatsi (M.B.) ..	Common.
Rhamphochormis, 8 spp.		
R. longiceps	Mcheni (F.J., M.B., O.L., Sa., D.B., F.M., Che.)..	Common.
R. macrophthalmus	Sangwe (K.K., Ba., N.B.)	
R. brevis	Mcheni Kingsangwe (M.B. *R. brevis* only ?)	
R. woodi	Sangu (Ba., N.B., Ru.)	
R. ferox	Changwe (Ml., Mt.)	
R. lucius	Sangwinole (N.B., *R. woodi*)	
R. esox	Kekene or Kekena (K.K., N.B.)	
R. leptosoma	Modi (Mb., *R. lucius*)	
	Mpompo (K.K., *R. leptosoma*)	
	Nkungune (Ba.)	
	Chinomwe (Ba.)	
	Kaweja (N.B.)	
	Lilamboro (Mn.)	
Diplotaxodon argenteus ..	Mcheni Madzi (M.B.)	Scarce.
Lichnochromis acuticeps ..	? Mpyompyo (K.K.)	Scarce.
Aristochromis christyi ..	Chimpopo (M.B.)	Scarce. ?
Serranochromis thumbergi ..	Sungwa or Tsungwa (F.J., M.B., O.L., La., F.M.)	Common.
	Ndiyembundiyani (F.J.)	
	Chiuwa (K.K., Ba.)	
	Kukwa (F.B., Ko.)	
	Senje or Lisenje (Mn., Mb.)	
Lethrinops, 24 spp., collectively	Tondo (M.B.) Chigong'o (Mb., Mb. B., Ko., Li.)	Most spp. probably common.
L. variabilis	Kanyanti (K.K.)	
L. lituris		
L. brevis	Kambuzi Wa Chigong'o (Li.)	

Appendix III—*continued.*

Scientific name.	*Native names.*	*Abundance.*
L. trilineata		
L. intermedia		
L. microstome		
L. parvidens	Kukuku or Ukoko (K.K.). Tondo (M.B.)	
L. macrophthalmus		
L. aurita		
L. longimanus		
L. macracanthus		
L. cyrtonotus		
L. alta		
L. argentea		
L. lethrinus		
L. leptodon		
L. lunaris		
L. oculata		
L. alba		
L. furcifer		
L. furcicauda		
L. christyi		
L. laticeps	Vwivwi ? (K.K.)	
L. praeorbitalis	Cheti (K.K.)	
Trematocranus		
T. brevirostris		
T. microstoma		
T. auditor		
Aulonocara		
A. nyassae		
A. rostrata	Tondo (M.B.)	Local ?.
A. macrochir		

Abbreviations of Place-names used in the List of Fish.

The places are arranged in their geographical order, starting from Fort Johnston and going round the lake in a clockwise direction. The usual language spoken at each place is added.

		Language.
F.J.	= Fort Johnston	Chiyao.
M.B.	= Monkey Bay	Chinyanja. Chiyao.
O.L.	= Old Livingstonia	Chinyanja.
Ma.	= Marembo	Chinyanja.
Chi.	= Chipoka	Chinyanja. Chiyao.
Sa.	= Salima	Chinyanja (Chichewa dialect).
D.B.	= Domira Bay	Chinyanja (Chichewa dialect).
K.K.	= Kota Kota	Chinyanja (Chichewa dialect).
Ba.	= Bana	Chitonga. [Chinyanja (Chichewa).]
N.B.	= Nkata Bay	Chitonga.
Ru.	= Ruarwe	Chitonga. Chihenga.
F.B.	= Florence Bay	Chitumbuka.
Na.	= Ngara	Chinkonde.
Ka.	= Karonga (Kambwe Lagoon)	Chinkonde. Kiswahili.
Mw.	= Mwaya	Chinyakusa. Kiswahili.
De. B.	= Deep Bay	Chitumbuka. Chihenga.
Mn.	= Manda	
Mb.	= Mbaha	
Lu.	= Liuli	
Mb. B.	= Mbampa Bay	Chinyanja dialects or languages allied to Chinyanja.
Lb.	= Limbaula	
Ko.	= Kobwe	
Li.	= Likoma	
Ng.	= Ngo	Chitonga. Chinyanja (Chichewa dialect).
Ms.	= Msamba	
Mt.	= Mtengula	
Ml.	= Mluluka	Chinyanga dialects or languages allied to Chinyanja.
Ch.	= Chilowelo	
La.	= Luangwa	
Mj.	= Msinje	
F.M.	= Fort Maguire	Chinyanja. Chiyao.
Che.	= Che Linda	
(Chin.	= Chintembwe)	Chichewa. Chingoni.

APPENDIX IV.

Glossary of Native Names.

The place named in the last column is the home of the native or natives from whom the name in the first column was obtained. The usual language spoken at each of these places is given in Appendix III, but is not necessarily the ultimate source of the fish's name. For instance, although the name NDUKUFIONA was met nowhere but at Kota Kota and in its neighbourhood, its meaning, unknown to the natives of Kota Kota, who are Chewa, was immediately obvious to a Yao.

Local name.	*Scientific name.*	*Locality.*
BILIWILI	*Tilapia squamipinnis* ? (very dark specimen)	Kota Kota.
BINGA, pl. MAVINGA (see also LAVINGA and KIVINGA)	*Haplochromis kiwinge*	Kota Kota, Nkata Bay, Deep Bay, Likoma, and Kobwe.
BOMBE	*Clarias* sp.	Fort Johnston and Chilowelo.
BWANAMUZU	*Clarias* sp.	Maremba, Kobwe, and Nkata Bay.
BWANKA	*Clarias mossambicus*	Florence Bay.
CHAFINYA	*H. quadrimaculatus* group	Likoma.
CHAKUTA	*Haplochromis ovatus*	Monkey Bay and Likoma.
CHAKUTA	*Haplochromis pleurostigma*	Mtengula and Chilowelo.
CHAMBO	*Tilapia squamipinnis* (can be used for both sexes at all stages, generally for females and unripe males)	Kota Kota, Likoma, and lake south of these two places.
CHAMWALA	*Haplochromis placodon*	Kota Kota.
CHANGWE	*Rhamphochromis ferox*	Mluluka and Mtengula.
CHAOMBOMWERA or CHAOMBAMWERA	*Corematodus shiranus*	Monkey Bay.
CHENGA	*Lethrinops argentea*	Chilowelo.
CHETE or CHETI	*Lethrinops praeorbitalis*	Kota Kota.
CHIBWALE	*Haplochromis chrysonotus* (breeding male)	Kota Kota.
CHIBWILE	*Haplochromis auromarginatus* ..	Florence Bay.
CHIDYABANGO	*Haplochromis similis*	Monkey Bay.
	H. tetraspilus	Monkey Bay.
CHIDYAMWANDA	*Haplochromis chrysogaster*	Monkey Bay.
CHIDYEMPHOKA or KADYEMPHOKA ..	*H. leuciscus*	Kota Kota.
CHIGONG'O	*Lethrinops* spp.	Likoma, Kobwe, Mbampa Bay, and Mbaha.
CHIKONGO	*Barbus johnstoni*	Likoma.
CHIKUFENJI	*Tilapia shirana* (large, dark specimen)	South end of lake, Kota Kota.
CHIKUTA	*Clarias mossambicus* (large) ..	Fort Johnston and Kota Kota.
CHILINGWI	*Haplochromis lepturus*	Monkey Bay.
CHILULUMAWE	*Varicorhinus nyasensis*	Mwaya.
CHILUMA	*Docimodus johnstoni*	Kota Kota.
CHIMALAMBEU	*Haplochromis breviceps*	Manda.
CHIMBENJE, pl. VIMBENJE	*Haplochromis rostratus*	Monkey Bay, Kota Kota, and Likoma.
CHIMBENTE, pl. VIMBENTE	*Tilapia sparrmani*	Kampambe Lagoon and Kota Kota.
CHIMBUZI or CHIMBUZA	*Pseudotropheus* spp.	Kota Kota.
	Cyathochromis spp. (and related genera)	
CHIMPENI	*Haplochromis compressiceps* ..	Monkey Bay.
CHIMPOPO	*Aristochromis christyi*	Monkey Bay.
CHIMWAMAPUMBA	*Clarias* sp.	Nkata Bay.
CHIMWE	*Barbus johnstoni*	Kota Kota.
CHINDEMBA	*Pseudotropheus tropheops*	Likoma.
CHINDIKILA	*Corematodus taeniatus*	Monkey Bay.
	Docimodus johnstoni	Monkey Bay.
CHINDONGO	*Pseudotropheus*	Monkey Bay and Likoma.
	Cyathochromis	
	Labeotropheus (and related genera)	
CHING'ANGA	*Tilapia squamipinnis* (male) ..	Shiré River and south end of lake.
CHINKULU	*Tilapia* sp., perhaps *squamipinnis*	Kota Kota and south end of lake.

Local name.	*Scientific name.*	*Locality.*
CHINGUWE	*Haplochromis quadrimaculatus*	Florence Bay.
CHINKONGO	*Haplochromis moorii*	Kota Kota.
CHINOMWE	*Rhamphochromis* spp.	Bana.
CHIONGE	*Haplochromis breviceps*	Florence Bay.
CHIPAFU	*Clarias* sp.	Mwaya.
CHISAWASAWA	*Haplochromis phenochilus*	Likoma.
CHITOWAWA ?	*H. microcephalus*	Monkey Bay.
CHITUVI	*Haplochromis argyrosoma*	Njambe and Limbaula.
CHITUWI	*H. chrysonotus*	Manda.
CHYALA	*Haplochromis chrysonotus*	Likoma.
CHIUWA	*Serranochromis thumbergi*	Kota Kota and Bana.
DINGA = BINGA q.v.		
DIMBA ?	*H. lepturus*	Salima.
	H. nototaenia	Monkey Bay.
DIYENGWI	*Haplochromis ovatus*	Monkey Bay and Kota Kota.
DOLE, sing. LIDOLE, pl. MADOLE	*Tilapia lidole*	Mbaha.
DONDO, DONDOLO	*Haplochromis callipterus*	South end of lake.
DUMPHILA	*Haplochromis spilorhynchus*	Fort Johnston and Monkey Bay.
DULUDULU	*Haplochromis placodon*	Monkey Bay.
DZANI, pl. = MAYANI	*Haplochromis kiwinge*	Ruarwe.
FISI	*Haplochromis fuscotaeniatus*	Fort Johnston and Monkey Bay.
	H. livingstoni	Kota Kota.
	H. polystigma	Salima.
FWILILI or FWIRILI	*Tilapia shirana*	Fort Maguire.
GALAMULA, MGALAMULA	*Tilapia lidole*	Monkey Bay, Nkudzi, Salima, Fort Maguire, Luangwa, and Chilowelo.
GUFIFI	*Haplochromis polystigma* (and related species)	Fort Johnston, Salima, and Chilowelo.
GURUGURU	*Tilapia shirana*	Likoma.
IDLWALE	*Barbus rhoadesii*	Ruarwe.
IGEGE	*Tilapia squamipinnis* and *T. shirana*	Mwaya.
IWONDE	*Clarias* sp.	Karonga and Mwaya.
KABABA	*Tilapia squamipinnis* (young 12 to 22 cm.)	Mbaha.
KABALE	*Haplochromis selenurus*	Kota Kota.
	H. moorii	Kota Kota.
KABANANA	*Haplochromis nitidus*	Kota Kota.
KABANGA	*Haplochromis ericotaenia*	Likoma.
KABIBI	*Haplochromis moorii*	Fort Johnston.
KABUTU	*Clarias* sp.	Kobwe.
KACHIMANGA	*Haplochromis johnstoni*	Monkey Bay.
	H. urotaenia	Monkey Bay.
KADYAKOLA	*Barbus eurystomus*	Monkey Bay.
KADYAPOTA	*Haplochromis spilopterus*	Fort Johnston and west side of lake up to Domira Bay.
KADYEMPOKA (see CHIDYEMPHOKA).		
KAKENA or KIKENA	*Rhamphochromis brevis*	Monkey Bay.
KAKOROMBE	*Haplochromis holotaenia*	Kota Kota and Nkata Bay.
KALEMBALEMBA, pl. MALEMBALEMBA	Any snall Cichlid with oblique or longitudinal stripe	Mbaha.
KALIKOLOMBE	*Haplochromis compressiceps*	Chilowelo.
KAMBALE	*Clarias* sp.	Likoma.
KAMBUZI	*Tilapia squamipinnis* (young up to about 12 cm.)	Che Linda.
KAMBUZI	*Haplochromis johnstoni*	River Shiré and south end of lake and Kota Kota
	H. spilopterus	Likoma.
	H. similis	Likoma.
KAMBUZI WA VUMANGA	*H. argyrosoma*	Mluluka.
KAMINYARA	*Haplochromis decorus*	Kobwe ?
KAMNUNG'OLI	*H. rhoadesii* ?	Kobwe.
	H. spilopterus	Kota Kota.
		Florence Bay.

Local name.	*Scientific name.*	*Locality.*
KAMOTO	*Haplochromis philander*	Kasamba and Kota Kota.
KAMPANGO	*Bagrus meridionalis*	All round lake.
KAMPULA	*Haplochromis prostoma*	Kobwe.
KAMWENA	*Haplochromis spilopterus*	Kota Kota.
KANSOSOLE	*Bagrus meridionalis* yg.	Fort Johnston.
KANSUPA	*Haplochromis semipalatus*	Monkey Bay.
	Chilotilapia rhoadesii	Fort Johnston and Monkey Bay.
KANYANTI	*Lethrinops variabilis*	Kota Kota.
KAPESA	*Haplochromis chrysonotus*	Deep Bay.
KAPULA	*Haplochromis compressiceps*	Extreme south end of lake.
KAPUMPHU	*Chilotilapia rhoadesii*	Fort Johnston.
KAPWITI KABUIDI	*Lethrinops aurita*	Kota Kota.
KASAWALA	*Tilapia squamipinnis* (young 15 to 20 cm.)	Fort Johnston and Monkey Bay.
	(young 20 to ca. 26 cm.)	Kota Kota to Florence Bay.
KASOMELA	*Labeo mesops* yg.	Fort Johnston.
KATONGOTI	*Lethrinops lunaris*	Florence Bay.
KATSATSI	*Haplochromis woodi*	Monkey Bay.
KATUKUZI	*Tilapia shirana* and *T. melanopleura*	Fort Johnson, Che Linda.
KATUNGULU	*Tilapia squamipinnis*, yg.	Kota Kota, Nkata Bay, Kobwe, and Likoma.
KAVUNGUTI	*Haplochromis rhoadesii*	Monkey Bay.
KAWEJA	*Rhamphochromis* spp.	Nkata Bay.
KAWISA	*Docimodus johnstoni*	Nkata Bay.
KAYAWA	*Tilapia squamipinnis* (mature females and some non-breeding males)	Kota Kota and Chipoka.
KHOTA or KOTA	*Haplochromis lepturus*	Kota Kota.
	H. rhoadesii	Kota Kota.
KINDONGO (see CHINDONGO)	*Petrotilapia* (and related genera ?)	Mbaha.
KIVINGA = BINGA q.v.		
KOBO	*Clarias theodorae*	Kampambe and Kota Kota.
KOLOKOLO	*Synodontis zambesensis*	Round most of lake.
KOLOKOTO	*Haplochromis callipterus*	Kota Kota.
KONGORA	*Barbus* small spp.	Kota Kota.
KONGORO	*H. quadrimaculatus* (breeding male)	Mbampa Bay.
KONKO	*Lethrinops praeorbitalis*	Florence Bay.
KOPOKOPO	*Barbus johnstoni*	Salima.
KUKUKU or UKUKO	*Lethrinops parvidens*	Kota Kota.
	Trematocranus auditor	
KUKWA	*Serranochromis thumbergi*	Florence Bay and Kobwe.
KUYU	*Barbus eurystomus* (once used for *Varicorhinus*)	Kota Kota, Likoma, and Msumba.
KWAZULA	*Clarias* sp.	Monkey Bay to Florence Bay and Likoma to Che Linda.
LANGASIME or MLANGASIME	*Tilapia squamipinnis* ?	Fort Johnston.
LIDOLE	*Tilapia lidole*	South end of lake.
LILAMBORO	*Rhamphochromis* spp.	Manda.
LIMBOTI	*Labeo cylindricus*	Mbaha.
LINDWEKE, pl. MANDWEKA	*Tilapia shirana*	Manda, Karonga, and Mwaya.
LING'ARA (see NG'ARA).		
LING'ONO	*Haplochromis ericotaenia*	Mbaha.
LING'ONO	*Lethrinops argentea*	Mbaha.
LINGULA	*Tilapia squamipinnis* (male)	Manda.
LIVINGA = BINGA q.v.	*H. kiwinge*	Msinje.
LIWELE, pl. MAWELE (see also MBELE)	*Haplochromis livingstoni*	Fort Johnston.
	H. polystigma	
	H. fuscotaeniatus	
LOLO, pl. MALOLO	*Tilapia lidole*	Kota Kota.
LUMBALISILO	*Clarias* sp.	Fort Johnston.
LUMBULWE	*Barbus* small spp.	Mwaya.
MADOLE, pl. of LIDOLE	*Tilapia lidole*	South end of lake.
MAKALEURA	*Tilapia melanopleura*	Karonga.

Local name.	*Scientific name.*	*Locality.*
MAKUMBA	*Tilapia shirana* (large specimens)	L. Malombe and Fort Johnston.
MAMULA	*Tilapia squamipinnis* ? (very large fat specimens)	Monkey Bay and Liuli.
MANDULULU	*T. squamipinnis* (dark-coloured, ripe male)	Manda.
MANDWEKE (? pl. of LINDWEKE, q.v.)	*Tilapia squamipinnis* yg.	Manda.
MATEMBA	*Tilapia shirana*	Karonga, Mwaya, and Manda.
MATUWA	*Barbus* small spp.	Monkey Bay.
MBABA	*Tilapia squamipinnis*	Deep Bay.
	Almost any small Cichlid for which no special name is known, especially those with two or three spots on each side, the number of species with this name varying with locality and informant	Shiré to Kota Kota.
MBABA KATSATSI	*Haplochromis nitidus*	Monkey Bay.
	H. intermedius	Monkey Bay.
MBABA MKWATAMI	*Hemitilapia oxyrhynchus*	Monkey Bay.
MBAKALE	*Haplochromis pictus*	Chilowelo.
MBALULE or MBARULE	*Barbus johnstoni*	Mwaya.
	Haplochromis chrysonotus	Ruarwe.
	Haplochromis quadrimaculatus	Likoma, Mbampa Bay to Fort Maguire.
MBALULE	*H. quadrimaculatus* ♀	Monkey Bay.
MBAWALA	*Lethrinops laticeps* ?	Mbaha.
	Haplochromis woodi	Kota Kota.
MBELE, pl. MAWELE (see also LIWELE)	*Tilapia squamipinnis* ? yg.	Kota Kota.
	Haplochromis polystigma (related species)	Monkey Bay.
MBELEWELE	*Mormyrus longirostris*	Monkey Bay.
MBOBWE	*Marcusenius discorhynchus*	Mwaya.
MBOLOBOLO	*Barbus johnstoni* yg.	Ruarwe.
MBOMBO	*Labeo mesops* yg.	Kota Kota.
MBOSI	*Marcusenius discorhynchus*	Florence Bay.
MBOWE	*Barbus eurystomus*	Mwaya.
MBUCHI	*Haplochromis heterotaenia*	Monkey Bay.
	Haplochromis spilorhynchus	Deep Bay.
	H. nototaenia	Florence Bay.
	H. placodon (see also CHAMWALA, probably more correct name)	Few miles south of Kota Kota.
MBUNA	*Labeotropheus fuelleborni*	Likoma.
MBUNDANGI	*Haplochromis microcephalus*	Manda.
MBUNUNU or MBUNYUNYU	*Labeo cylindricus*	Kota Kota.
MBUVU	*Bagrus meridionalis* (large)	Ruarwe, Florence Bay, and Mwaya.
MCHENI	*Rhamphochromis* spp.	From Shiré to Domira Bay and Fort Maguire.
MCHENI KINSANGWE	*Rhamphochromis brevis* ? and *ferox* ? (large specimens)	Monkey Bay.
MCHENI MADZI	*Diplotaxodon argenteus*	Monkey Bay.
MGALAMULA	*Tilapia lidole*	Salima.
MGUNGO or NGUNGU	*Haplochromis lepturus*	Monkey Bay.
	H. nototaenia	Fort Johnston.
MKAZIWACHITETE	*Haplochromis ornatus*	Kota Kota.
MKAZI WA NJELU shortened to KAZINJELU	*Haplochromis quadrimaculatus* (in part)	Likoma.
MKUMBWA	*Barbus johnstoni*	Fort Johnston.
MLAMAMUTU	*Haplochromis placodon*	Likoma.
MLAMBA	*Clarias mossambicus* (once used for *C. mellandi*)	Nearly all over lake (Kota Kota).
MODI	*Rhamphochromis* spp. (*R. lucius*)	Mbaha.
MPALAPALA	*Clarias* sp.	Chilowelo.
MPASA	*Barilius microlepis*	All round lake.

Local name.	*Scientific name.*	*Locality.*
MPOMPO	*Rhamphochromis leptosoma*	Kota Kota.
MPONDO	*Labeo mesops*	Ngo.
	Barbus johnstoni	Chintembwe.
MPUTA	*Gnathonemus* spp.	Monkey Bay and Chilowelo.
	Marcusenius discorhynchus	
MPUWA	*Labeo cylindricus*	Ruarwe and Florence Bay.
MPYOMPYO ?	*Aulonocara rostrata*	Kota Kota.
	Lichnochromis acuticeps	Kota Kota.
MSALULE	*Haplochromis quadrimaculatus* (in part)	Likoma.
MSILA	*Labeo mesops*	Karonga.
MUDYAMPOKA	*Haplochromis strigatus*	Kota Kota.
MUHADJIRI	*Tilapia lidole*	Fort Johnston.
MKUMBA	*Corematodus shiranus*	Florence Bay.
NAMAGUNDA	*Petrotilapia tridentiger*	Likoma.
NAMDYATSINI, pl. MDYATSINI	*Haplochromis similis*	Monkey Bay.
	H. ericotaenia	Monkey Bay.
	Hemitilapia oxyrhynchus	Monkey Bay.
NAMLEPETU	*Haplochromis euchilus*	Likoma.
NANKERERE, pl. MAKERERE	*Corematodus shiranus*	Fort Johnston.
NCHESICHESI	*Tilapia squamipinnis* (breeding male)	South end of lake, especially Salima.
NCHESU	*Docimodus johnstoni*	River Lunyu, near Msumba.
NCHIRA	*Labeo mesops*	Southern part of lake.
NCHYOCHYO	*Haplochromis caeruleus*	Monkey Bay.
NDIYEMBUNDIYANI	*Serranochromis thumbergi*	Fort Johnston.
NDOWOLO	*Haplochromis auromarginatus*	Monkey Bay.
	Haplochromis placodon	Monkey Bay and Likoma.
NDUKUFIONA or DUKOFYONA	*Chilotilapia rhoadesii*	Kota Kota.
NDULULU	*Tilapia squamipinnis* yg.	Manda.
NDWEKE (see LINDWEKE).		
NG'ARA or LING'ARA, pl. MANG'ARA	*Tilapia squamipinnis* ? (breeding male)	Florence Bay and Karonga.
	Haplochromis chrysonotus (breeding male)	Manda.
	H. quadrimaculatus (breeding male)	Mbaha.
NGEGE	*Tilapia squamipinnis*	Karonga.
NGIRI	*Tilapia shirana*	Mwaya.
NGONDI or CHIGONDI	*Haplochromis quadrimaculatus*	Ruarwe.
NGONG'O	*Mormyrops deliciosus*	Kota Kota and Chilowelo.
	Tilapia squamipinnis ? (very large, fat, non-breeding specimens)	South end of lake.
NGONG'O	*Haplochromis inornatus*	Nkata Bay.
NGUMBO	*Barbus johnstoni*	Monkey Bay and Florence Bay.
NGUNGU (see MGUNGO).		
NGUWA	*Haplochromis cyaneus*	Nkata Bay.
NGWALU or NGWARU	*Tilapia squamipinnis* (breeding males)	Kota Kota and Nkata Bay.
NINGWI	*Labeo cylindricus*	Round most of lake.
NINGWICHALI or NYUNGUCHALI	*Tilapia melanopleura*	Kota Kota, Mtengula, and Luangwa.
NJEKAYEKA	*Synodontis zambesensis*	Kota Kota.
NJERUKA	*Haplochromis sphaerodon*	Monkey Bay.
NJERUWA	*Haplochromis spilorhynchus*	Mwaya.
NJOLO	*Mormyrops deliciosus*	Likoma.
MKALALA	*Alestes imberi*	All round lake.
NKASU	*Barbus eurystomus*	Ruarwe and Mbaha.
NKOMO	*Clarias* sp.	Round most of lake.
NKUNGUNE	*Rhamphochromis* sp.	Bana.
NKUTUTU	*Tilapia shirana*	Kota Kota, Bana, and Nkata Bay.
NKWEKWE	*Barbus eurystomus*	Florence Bay.
NSESE	*Haplochromis prostoma*	Monkey Bay.

Local name.	*Scientific name.*	*Locality.*
NTACHI	*Gnathonemus* spp. *Marcusenius* and *Petrocephalus*	Kota Kota
NTAKA or MTAKA = UTAKA q.v.	*Haplochromis inornatus* (related species)	Deep Bay and Mbampa Bay.
NTUNGUMBA	*Bagrus meridionalis*	Mwaya.
NTUWA	*Labeo mesops*	Florence Bay, Deep Bay, and Manda.
NYALI	Brightly coloured males of *Haplochromis marginatus*	Kota Kota.
NYAMBANYAMBA	*Clarias* sp.	Monkey Bay and Florence Bay.
NYANDA	*Mormyrops deliciosus*	Monkey Bay, Domira Bay, and Nkata Bay.
	Mormyrus longirostris	Mbaha.
NYANKARUA	*Tilapia melanopleura*	Florence Bay.
NYANKALUWA	,, ,,	Karonga.
NYENJIRI	*Barilius microlepis* yg.	Ruarwe.
PALALA	*Haplochromis strigatus*	Fort Johnston and Monkey Bay.
PANDA	*Mormyrus longirostris*	Kota Kota to Ruarwe and Likoma to Old Livingstonia.
	Gnathonemus sp.	Florence Bay.
PELELA	*Tilapia shirana* (large, dark specimens)	Lake Malombe and Fort Johnston.
PFWILILI (see FWILILI).		
PICHIRICO	*Haplochromis woodi*	Fort Johnston.
PWEFU	*Clarias* sp.	Florence Bay and Chilowelo.
SADYAKAPOLO	*Corematodus taeniatus*	Monkey Bay.
	Chilotilapia rhoadesii	Monkey Bay.
	Haplochromis spilopterus	Monkey Bay.
SAGUGA	*Haplochromis speciosus*	Monkey Bay.
SAG'OMEZA or SAGWOMEZA	*Haplochromis melanonotus*	Kota Kota.
SAKA, TSAKA	*Tilapia squamipinnis* ? (dark male)	Karonga.
	Tilapia karongae (black male only)	Karonga.
SANGA	*Tilapia squamipinnis*	Florence Bay, Mwaya, and Manda.
SANGU	*Rhamphochromis* spp.	Nkata Bay, Bana, and Ruarwe.
SANGWE or SANGWI	*Rhamphochromis* spp.	Kota Kota, Bana, and Nkata Bay.
SANGWINOLE	*Rhamphochromis woodi* (and other spp.)	Nkata Bay.
SANJIKA	*Barilius microcephalus*	All round lake.
SAPUWA	*Clarias* sp.	Round most of lake.
SASAMCHENGA	*Haplochromis melanonotus*	Kota Kota.
	Haplochromis auromarginatus	Sani.
SASAWA or SAWASAWA	*Clarias* sp.	Kota Kota.
SAVUGA	*Haplochromis speciosus*	Monkey Bay.
SEMA CHIPANDA	*Haplochromis strigatus* (see also MUDYAMPOKA)	Kota Kota.
SENJE	*Serranochromis thumbergi*	Manda and Mbaha.
SINDWALA	*Haplochromis johnstoni*	Monkey Bay.
SILILI = FWIRILI q.v.	*Tilapia shirana*	Mbampa Bay.
SUNGWA	*Serranochromis thumbergi*	South end of the lake.
SUTE	*Clarias mellandi*	Fort Johnston, Marembo, and Luangwa.
TABWA, sing. LITABWA, pl. MATABWA	*Haplochromis spilorhynchus*	Extreme south end of lake.
TAGWA	*Haplochromis auromarginatus*	Ruarwe.
TAMBA	*Barbus rhoadesii*	Round most of lake.
TAP or TAPILESI	*Haplochromis quadrimaculatus*	Manda.
TEMBA	*Haplochromis leuciscus*	Monkey Bay.
TOKOTOKO	*Haplochromis melanonotus*	Monkey Bay.
TOKOTOKO	*Tilapia shirana*	Florence Bay.
TONDO	*Lethrinops* spp. and *Aulonocara rostrata*	Monkey Bay.
TONG'O	*Haplochromis atritaeniatus* *H. oculatus*	Monkey Bay. Monkey Bay and south end of lake.

Local name.	*Scientific name.*	*Locality.*
TSAKA or SAKA	*Tilapia squamipinnis* ?	
	Tilapia karongae	Karonga.
TUMBALIRI	*Chilotilapia rhoadesii*	Ruarwe.
TUMWALA	*Haplochromis placodon*	Extreme south end of lake.
UKONGOLA	*Haplochromis inornatus*	Chilowelo.
ULYONGO	*Haplochromis argyrosoma*	Kobwe.
UNDULO or UNDURO	*Haplochromis kiwinge* ?	Kota Kota.
	H. strigatus	Kota Kota.
USIPA or NSIPA	*Engraulicypris sardella*	All round lake.
UTAKA	General name for *Haplochromis* species with strongly protractile mouth, namely *H. inornatus* to *H. quadrimaculatus* in table	Whole lake.
VWIVWI	*Lethrinops laticeps* ?	Kota Kota.
VYAMBO	*Tilapia squamipinnis* (large specimens with pigment arranged irregularly or to give speckled effect; those examined males)	Monkey Bay.
YERA	*Haplochromis fenestratus*	Kota Kota.
	H. argyrosoma	Likoma.
	H. intermedius	Kota Kota.
YINGA, pl. MAYINGA	*Corematodus shiranus*	Kota Kota.
ZEYA	*Tilapia squamipinnis* (small females)	Fort Johnston.

NAMES OCCURRING IN NATIVE RECORDS, BUT NOT HEARD BY THE SURVEY.

SANI.

Kabawi.
Tyolabango.

KOTA KOTA.

Gwenje.
Kaweluwelu.
Mkuvi.
Mutengo.

BAR.

Chimatula.
Chimbege.
Chisawasawa.
Chisupe.
Fiyonde.
Guda mwara (or Tongo).
Kalalabu.

BAR—*continued.*

Kasupe.
Kumbilakazo.
Likalo.
Likusa.
Liyela.
Mgugu.
Mjendu.
Nakawalika.
Naluma.
Nagangata.
Nandeleza.
Nkotoma.
Ntuli.
Silimbanga.
Teteka.
Tukufuku.
Yimatula.
Yindyamaluwa.

SHIRE.

Chibwira.
Kaliya.
Kasasi.
Mkopo.
Ngonga.
Supa.
Suwisuwi.

LIKOMA.

Chabweta.
Chisala.
Chisinga.
Kapyala.
Mchise.
Mkazimpipi.
Mjolwa.

APPENDIX V.

Geographical Distribution of the Species.

194 Species endemic in Lake Nyasa.*

Distribution of the twenty-nine non-endemic Species.

Analysis of Tables published by Worthington (1933, 1 and 2), Worthington and Ricardo (1937), and Ricardo (1939), with additions.

	Elsewhere.
Nyasa, Zambesi basin, and Bangweulu Region.	
Marcusenius discorhynchus	Lake Tanganyika, Lake Rukwa.
Gnathonemus macrolepidotus	Lake Ngami, Lake Rukwa.
Mormyrus longirostris	Lake Mweru, Lake Tanganyika, Lake Rukwa.
Alestes imberi	Congo, Rovuma, Lake Rukwa, Limpopo, South Rhodesia, Transvaal.
Labeo altivelis.	
Barbus trimaculatus	Transvaal, Zululand.
B. paludinosus	East Africa (Abyssinia to Natal), Lake Rukwa, Orange River, Angola.
B. eutaenia	Transvaal, Angola.
B. banguelensis	Congo (Kafubu River).
Clarias mossambicus	East Africa (Abyssinia to Zambesi), Lake Tanganyika, Lake Rukwa.
C. mellandi.	
C. theodorae	Natal, Zululand, Lake Mweru, Lake Ngami.
Tilapia melanopleura	Senegal to Angola, Transvaal, Lake Mweru, Upper Congo.
T. sparrmani	Angola, Namaqualand, Transvaal, Lake Mweru, Katanga.
Serranochromis thumbergi	Angola, Lake Ngami, Katanga.
Haplochromis philander	Angola, Bechuanaland, Katanga, Transvaal, Natal, Mozambique.
Ctenopoma multispinis	Bechuanaland, Lake Mweru.
Nyasa and Bangweulu Region, but not recorded from Zambesi.	
†*Malopterurus electricus*	Nile and nearly all tropical Africa.
Ctenopoma ctenotis	Rivers west of Lake Tanganyika (i.e. Congo system).
Nyasa, Lake Tanganyika, and Congo system. (B) = including Bangweulu Region.	
Mormyrops deliciosus	West Africa.
Marcusenius discorhynchus (B).	
Mormyrus longirostris (B).	
Alestes imberi (B)	Rovuma to Limpopo.
Clarias mossambicus (B)	Abyssinia, Lake Victoria, Lake Rukwa, East Africa, Lake Kivu.
Clarias theodorae (B)	Natal, Zululand, Angola, Ngami.
Nyasa, Tanganyika, and East African rivers.	
Alestes imberi	(See above.)
Labeo cylindricus.	
Amphilius platychir	Lake Rukwa.
Clarias mossambicus	(see above.)
Clarias carsonii	Uganda, Lake Kivu.
Clarias theodorae	(see above.)
Nyasa, but neither Bangweulu Region nor Lake Tanganyika.	
Petrocephalus catostoma	Rovuma.
Barbus innocens	Lake Rukwa, Wami and Mkata Rivers (Tanganyika Territory).
Barbus rogersi	Upper Zambesi, Angola.
Eutropius depressirostris	South-east Africa.
Synodontis zambesensis	Zambesi and rivers of East Africa, Lake Rukwa.
Nothobranchius orthonotus	Mozambique, Beira, Tanganyika Territory.

* Lake Nyasa, including its affluent rivers and the Shiré River above the Murchison Rapids.
† Probably in Shiré only.

APPENDIX VI.

Methods of Collecting Data.

1. Survey Records.

Data were collected from fish caught by the Survey itself and by native fishermen. In both cases

(i) the catch was sorted into the different species, and the number of each species was counted.

(ii) The length and weight of the largest and smallest specimen of each species was measured to give the range of size. (The *length* was measured from the end of the snout to the tip of the tail fin and was recorded to the nearest centimentre below the actual length, e.g. fish from 7·0 to 7·9 were recorded as 7 in the log books. To give true values therefore 1·0 cm. has been added wherever a range of lengths is shown and 0·5 cm. wherever there is an average length. The *weight* was determined by means of small spring balances and was noted in grammes to the nearest 10 gm. between 0 and 1000 gm. and to the nearest 100 gm. over 1000 gm.)

(iii) A number of each kind of fish were taken for detailed examination. Generally all the fish caught by the Survey were examined, but in the native catches only a proportion of the fish could be bought for examination.

These fish were then :

(*a*) Measured and weighed. (From these figures it is possible to calculate the condition factor from the formula—

$$\text{Condition factor} = \frac{\text{Weight} \times 100}{(\text{Length})^3}$$

The condition factor for any particular species is fairly constant, though certain changes take place during growth. It is generally at a maximum just before breeding and then falls off later. It is not always convenient to weigh large numbers of fish in the field and once the condition factor of a species is known, it is easy to calculate the weight of a specimen as long as the length is known. Large numbers of condition factors have been worked out in the important species from fish of all sizes and stages of development, so that in future weights can be calculated from lengths where it is impossible to weigh the fish accurately.)

(*b*) Opened and the sex and development of the gonads noted. For each sex the stages of development were recorded in the log-book as—

" undeveloped " where the sex could not be determined without special microscopical examination ;
" quiet " (qt) where the sex could be determined, but the gonads were very small ;
" starting " (stg) where the gonads were becoming enlarged ;
" ripening " (rpg) and " ripe " (rp) where the sexual products were nearly ready or ready to be shed ;
" spent " (sp) where the sexual products had recently been shed and the gonads were empty.

(*c*) Examined for their stomach contents. In the larger predacious species the stomachs were examined on the spot, but in the others the stomachs were preserved temporarily and examined at a later date with a microscope. Most of these stomachs were studied during the survey, but a few were brought back to England for fuller examination.

2. Native Records.

Continuous records of the native fishing were kept by native clerks at five places on the lake shore : Kota Kota and Sani in the Kota Kota district ; the Bar and the Shiré River in the Fort Johnston district ; and on Likoma Island. There were two clerks trained by the Survey working at each of these places except at Likoma, where there was only one. At Kota Kota and Fort Johnston there was also a head clerk, in both cases a former District Office head clerk, to supervise the work.

The work of these clerks was to :

(i) Visit all the fishermen and find out how many nets, traps, and lines were being used every day and how many times each was fished.

(ii) Examine in detail one catch every day. This was done in exactly the same way as described for the Survey records except that—

(*a*) The fish were measured only and not weighed (they were measured to the nearest cm.).

(*b*) A total of ten fish each day was bought for the determination of sex and gonad development. (The terms used for the stages of development usually were " small " and " big " for the males, and " small," " eggs " (or " big ") and " spent " for the females.)

In these records " small " = " quiet," but probably often includes " starting " and " spent " individuals, particularly among males.

In the males, " big " = " ripening " and " ripe."

In the females " eggs " = " ripe." For greater accuracy the records of eggs are kept distinct from all other stages of enlargement of the female gonad, which in the following tables are summarised as " developing."

N.B.—The column " developing " in the females is believed to be accurate at Kota Kota and Sani, but is probably unreliable in the Fort Johnston region.

(*c*) No stomachs were examined.

Arrangements were made with the fishermen whereby the clerks were allowed to examine a haul, count and measure the different species, and cut open ten fish for the price of sixpence for large and threepence for small cataches.

The clerks were watched at their work as often as was possible, but most of the time they had to work without the supervision of the Survey. Though the native recorders were apparently reliable, it has been thought best that their records be kept separate throughout this report from the data obtained by the members of the Survey.

DATA FOR EACH SPECIES.

A. *TILAPIA SQUAMIPINNIS.*

1. TOTAL NUMBER HANDLED BY THE SURVEY: 8,460.

PLACE	DATE	Chambo	Ching'anga	Kasawala	Zeya
Kota Kota	Jan. 22–Feb. 8	2,970	1,138	—	—
Fort Johnston	Feb. 11–March 8	1,170	138	50	50
Malonda	March 8–May 9	1,160	134	127	—
Monkey Bay	May 12–June 1	40	—	71	—
Kota Kota	June 7–July 24	90	—	23	—
Marembo	June 27–July 1	1,270	—	29	—
		6,700	1,410	350	
(Yiannakis	Feb. 21–Feb. 24	30,000 fish seen)			
(,, ...	July 1	7,000 ,, ,,)			

2. SIZE.

	Chambo	Ching'anga	Kasawala	Zeya
Range of length (1,150 measurements)	11–37 cm.	19–36 cm.	6–25 cm.	23–30 cm.
Range of weight (865 weights)	50–850 gm.	250–820 gm.	40–280 gm.	200–470 gm.
Range of condition factor (865 calculations) ..	1·1–2·7	1·5–2·3	0·9–2·6	1·4–2·3

3. DETAILS OF SIZE OF FISH—numbers at different lengths.

Lgth (cm)	Number of Females				Number of Males				No. of unde-veloped	Total	Range weight	Range C.F.	No. wghd	Av. wt. (gm.)	Av. C.F.	No. from native records
	sp	rp	stg	qt	sp	rp	stg	qt								
5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	2	2	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	2	2	—	—	0	—	—	—
8	—	—	—	—	—	—	—	—	3	3	—	—	0	—	—	—
9	—	—	—	—	—	—	—	—	2	2	—	—	0	—	—	—
10	—	—	—	—	—	—	—	—	3	3	—	—	0	—	—	1
11	—	—	—	—	—	—	—	—	7	7	—	—	0	—	—	6
12	—	—	—	—	—	—	—	—	15	15	—	—	0	—	—	8
13	—	—	—	—	—	—	—	—	23	23	—	—	0	—	—	15
14	—	—	—	—	—	—	—	—	15	15	—	—	0	—	—	8
15	—	—	—	—	—	—	—	1	12	13	40– 60	1·2–1·8	2	50	1·5	21
16	—	—	—	—	—	—	—	—	4	4	70–100	1·2–2·4	2	85	1·8	12
17	1	—	—	—	—	—	—	—	6	7	50–110	0·9–2·2	3	80	1·6	23
18	2	—	—	4	—	—	—	1	4	11	100–130	1·7–2·2	10	105	1·8	28
19	—	1	—	4	—	1	1	1	7	15	100–150	1·4–2·2	10	120	1·8	48
20	3	1	—	7	—	—	—	1	14	26	110–190	1·4–4·5?	18	145	1·8	116
21	2	2	—	1	—	—	—	2	8	15	110–230	1·2–2·5	9	175	1·9	110
22	5	—	—	—	—	—	—	1	4	10	190–220	1·8–2·1	9	195	1·8	104
23	7	2	—	1	—	2	—	—	8	20	200–320	1·6–2·6	17	245	2·0	114
24	9	1	—	1	—	2	1	—	6	20	220–310	1·6–2·2	14	265	1·9	120
25	27	5	1	10	3	6	1	9	11	73	220–350	1·4–2·2	58	290	1·9	209
26	29	14	3	6	2	14	—	6	12	86	280–400	1·6–2·2	79	330	1·9	162
27	32	3	9	14	2	20	3	15	10	108	300–450	1·5–2·3	91	375	1·9	229
28	31	17	9	10	1	25	1	17	6	117	310–520	1·4–2·4	109	420	1·9	205
29	31	5	3	5	1	25	3	12	8	93	350–560	1·4–2·3	78	460	1·9	199
30	22	4	2	11	1	27	1	15	9	92	310–610	1·1–2·3	75	515	1·9	368
31	22	1	1	7	1	18	4	12	12	78	350–800	1·2–2·7	70	565	1·9	199
32	23	3	1	5	3	14	2	15	10	76	500–750	1·5–2·3	64	595	1·9	125
33	18	3	2	3	—	8	3	6	5	48	590–850	1·6–2·4	43	700	1·9	84
34	12	1	—	1	1	5	5	9	3	37	460–820	1·2–2·1	33	725	1·8	35
35	3	—	1	3	—	1	—	3	4	15	670–850	1·6–2·0	14	770	1·8	25
36	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
37	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
	279	63	32	93	15	168	25	126	235	1036*	40–850	0·9–2·7	807*		1·9	—

* These totals fall short of the numbers of measurements and weights given above because in some cases only the smallest and largest of a number of fish were measured to get the range and those figures are not included in the table as they would give a false idea of the number of fish of any particular length.

4. NUMBER OF GONADS EXAMINED: 1,205 (815 Chambo, 200 Ching'anga, 141 Kasawala, 49 Zeya).

Place	Date	Females	Females doubtful	Males	Males doubtful	Gonads undeveloped
K.K.	Jan. 22 ..	170	1	64	6	16
F.J.	Feb. 11 ..	193	12	152	40	41
Mal.	March 8 ..	108	—	32	11	89
M.B.	May 12 ..	11	—	10	2	7
K.K.	June–July ..	51	2	45	5	12
Mar.	June 27–30 ..	48	—	22	—	1
Yian.	Feb. and July	19	—	34	1	—
		600	15	359	65	166

5. STATE OF ENLARGEMENT OF THE GONADS.

Place	Date	Females					Males				Queries
		Spt	(Fry) *	Rpg	Stg	Quiet	Spent	Rpg	Stg	Quiet	
K.K...	Jan. 22 ..	130	(4)	18	1	21	—	40	2	20	2 M
F.J. ..	Feb. 11 ..	145	(14)	37	1	9	1?	125	6	19	1 F 1 M
Mal. ..	March 8 ..	104	(5)	2	—	2	3?	19	—	6	4 M
M.B. ..	May 12 ..	10	—	—	—	1	1?	—	—	9	—
K.K...	June–July ..	2	—	2	6	34	3	7	7	24	7 F 4 M
Mar. ..	June 27–30	2	—	15	20	10	—	—	4	18	1 F
Yian.	Feb. & July	—	—	—	4	15	—	—	7	27	—
		393	(23)	74	32	92	8?	191	26	123	20

* Carrying fry in mouth.

6. DETAILS OF EACH CLASS OF FISH.

Length (cm.)	Spent				Ripe, ripening, and starting				Quiet			
	Total	No. wghed	Av. wt. (gm.)	Av. C.F.	Total	No. wghed	Av. wt. (gm.)	Av. C.F.	Total	No. wghed	Av. wt. (gm.)	Av. C.F.
a. *Females.*												
17	1	—	—	—	—	—	—	—	—	—	—	—
18	2	1	100	1·7	—	—	—	—	4	4	100	1·8
19	0	—	—	—	1	1	140	2·0	4	3	105	1·5
20	3	2	155	1·9	1	0	—	—	7	4	150	1·9
21	2	1	190	1·8	2	0	—	—	1	0	—	—
22	5	3	205	1·9	0	0	—	—	0	—	—	—
23	7	7	255	2·0	2	0	—	—	1	1	300	2·5
24	9	7	245	1·8	1	1	290	2·1	1	1	290	2·1
25	27	26	285	1·8	6	5	325	2·0	10	7	305	1·9
26	29	28	325	1·9	17	15	345	1·9	6	5	350	2·0
27	32	29	340	1·8	12	11	395	2·0	14	11	395	2·0
28	31	29	380	1·8	26	23	420	1·9	10	9	410	1·9
29	30	24	420	1·7	9	5	470	1·9	4	4	460	1·9
30	22	15	495	1·9	6	5	540	2·0	11	9	510	1·9
31	22	18	560	1·9	2	1	590	2·0	7	6	580	1·9
32	24	19	580	1·8	4	2	625	1·9	5	5	640	1·9
33	18	16	655	1·8	5	4	755	2·1	3	3	700	1·9
34	12	9	680	1·7	1	1	790	2·0	1	1	720	1·8
35	3	3	815	1·9	1	1	780	1·8	3	3	795	1·8
	279	237		1·82 *	96	75		1·95 *	92	76		1·91 *
b. *Males.*												
15	—	—	—	—	—	—	—	—	—	—	—	—
16	—	—	—	—	—	—	—	—	1	1	60	1·8
17	—	—	—	—	—	—	—	—	0	—	—	—
18	—	—	—	—	—	—	—	—	0	—	—	—
19	—	—	—	—	—	—	—	—	1	1	120	2·1
20	—	—	—	—	2	0	—	—	1	—	—	—
21	—	—	—	—	—	—	—	—	1	—	—	—
22	—	—	—	—	—	—	—	—	2	2	145	1·5
23	—	—	—	—	—	—	—	—	1	1	200	1·9
24	—	—	—	—	2	1	250	2·1	0	—	—	—
25	—	—	—	—	3	1	310	2·2	0	—	—	—
26	—	—	—	—	7	3	300	1·9	9	9	295	1·9
27	—	—	—	—	14	11	350	2·0	6	6	335	1·9
28	—	—	—	—	22	17	380	1·9	15	15	380	1·9
29	—	—	—	—	27	24	440	2·0	19	18	420	1·9
30	—	—	—	—	30	26	470	1·9	12	12	455	1·9
31	—	—	—	—	28	20	520	1·9	17	15	545	2·0
32	—	—	—	—	24	19	565	1·9	15	13	580	2·0
33	—	—	—	—	19	15	600	1·8	16	15	630	1·9
34	—	—	—	—	9	8	685	1·9	6	6	700	1·9
35	—	—	—	—	10	10	750	1·9	9	8	735	1·9
	—	—	—	—	1	—	—	—	3	3	760	1·8
	—	—	—	—	198	155		1·92 *	134	125		1·90 *

* This figure is the average given by all the weighed specimens and is not merely the average value of this column.

8. NUMBERS CAUGHT BY DIFFERENT FISHING METHODS.

	Native seines	Native traps	C.D.F.† seine	C.D.F. Gill nets			
				5″	4″	3″	2″
Chambo ..	5,135	647	2	11	39	8	0
Ching'anga ..	1,345	0	0	0	2	0	0
Kasawala ..	120	15 (Zeya)	26	0	0	36	7
Totals.. ..	*6,600 (90 hauls)	662	28	11	41	42	7
Range of length	10–35 cm.	22–34 cm.	5–24 cm.	25–35 cm.	25–32 cm.	10–26 cm.	13–21 cm.

* This number only includes the hauls in which all the fish were counted and does not include many hauls where estimates only of the size of the catch were made.

† C.D.F. = belonging to the Survey.

7. NUMBER OF STOMACHS EXAMINED : 245 (including 147 Chambo, 53 Ching'anga, 12 Kasawala, and 33 Zeya).

9. NATIVE RECORDS.

SANI. KAYAWA.

Date	Total no.	No. exam.	Range length (cm.)	Av. length (cm.)	Females	Males	Sex ?	Females				Males	
								Spent	Eggs	Dev	Sm	Big	Sm
6.2–14.4	19,516	92	14–34	28	84	4	4	67 (5)*	0	10	7	2	2
17.4– 3.6	5,903	55	24–33	28	55	0	0	52	0	0	3	0	0
7.6–29.7	2,120	63	19–32	28	63	0	0	22	0	1	40	0	0
31.7–27.10	15,789	106	19–33	28	97	9	0	1	0	5	91	3	6
	43,328	316	14–35†		299	13	4	142 (5)	0	16	141	5	8
NGWALU.													
6.2–14.4	10,284	88	22–35	30	0	88	0	0	0	0	0	83	5
17.4– 6.6	631	8	25–30	28	0	8	0	0	0	0	0	8	0
7.6–29.7	0	0	—	—	—	—	—	—	—	—	—	—	—
31.7–27.10	71	14	28–33	30	0	14	0	0	0	0	0	14	0
	10,986	110	18–35		0	110	0	0	0	0	0	105	5
KOTAKOTA. KAYAWA.													
10.2–14.4	3,955	224	15–33	27	224	0	0	215 (4)	3	2	4	0	0
14.4–12.6	763	78	17–33	—	78	0	0	70	0	2	6	0	0
12.6–31. 8	1,747	68	20–35	28	63	5	0	7	2	3	51	1	4
1.9–28.10	20,589	63	24–33	29	45	18	0	1	3	3	38	4	14
	27,054	433	13–35		410	23	0	293 (4)	8	10	99	5	18

* Number carrying fry in the mouth.

NGWALU.

Date	Total no.	No. exam.	Range * length (cm.)	Av. length (cm.)	Females	Males	Sex ?	Females				Males	
								Spent	Eggs	Dev	Sm	Big	Sm
10.2–14.4	1,599	18	21–32	28	0	18	0	0	0	0	0	10	8
14.4–12.6	0	0	—	—	—	—	—	—	—	—	—	—	—
2.6–31.8	0	0	—	—	—	—	—	—	—	—	—	—	—
1.9–29.10	962	17	27–31	29	0	17	0	0	0	0	0	14	3
	2,561	35	21–32		0	35	0	0	0	0	0	24	11

BAR. CHAMBO.

9.3–29.4	5,216	110	20–36	30	70	40	0	60 (4)	7	0	3	36	4
2.5–19.6	1,076	119	18–37	29	82	37	0	65	3	8	6	28	9
20.6– 1.8	463	99	19–35	28	76	23	0	22	6	11	37	14	9
4.8–31.10	2,130	87	19–35	29	66	21	0	1 (1)	13	18	34	9	12
	8,885	415	13–39		294	121	0	148 (5)	29	37	80	87	34

CHING'ANGA.

9.3–29.4	183	36	20–32	25	0	36	0	0	0	0	0	36	0
2.5–19.6	0	0	—	—	—	—	—	—	—	—	—	—	—
20.6– 1.8	0	0	—	—	—	—	—	—	—	—	—	—	—
4.8–31.10	23	4	26–35	—	0	4	0	0	0	0	0	4	0
	206	40	20–35		0	40	0	0	0	0	0	40	0

KASAWALA.

9.3–29.4	1,302	35	8–25	16	11	7	17	6	0	1	4	1	6
2.5–19.6	344	57	12–28	20	19	13	25	5	1	4	9	8	5
20.6– 1.8	155	28	10–29	20	14	14	0	2	0	6	6	6	8
4.8–31.10	157	38	11–28	19	16	22	0	0	0	6	10	6	16
	1,958	158	8–29		60	56	42	13	1	17	29	21	35

SHIRE RIVER. CHAMBO.

4.3– 8.4	1,290	136	16–36	27	110	26	0	46 (22)	29	20	15	15	11
10.4– 6.6	3,396	247	12–36	25	213	34	0	83 (2)	6	94	30	30	4
7.6–23.8	3,129	269	18–35	25	153	116	0	19	30	61	43	83	33
24.8–27.10	3,845	213	20–35	28	90	123	0	4 (4)	17	49	20	90	33
	11,660	865	12–36		566	299	0	152 (28)	82	224	108	218	81

CHING'ANGA.

4.3– 8.4	101	46	21–32	26	0	46	0	0	0	0	0	42	4
10.4– 6.6	13	8	21–27	24	0	8	0	0	0	0	0	7	1
7.6–23.8	0	0	—	—	—	—	—	—	—	—	—	—	—
24.8–27.10	428	56	26–33	29	0	56	0	0	0	0	0	51	5
	542	110	21–35		0	110	0	0	0	0	0	100	10

KASAWALA.

4.3– 8.4	282	6	12–21	18	6	0	0	2 (1)	0	2	2	0	0
10.4– 6.6	10,981	115	11–24	19	101	12	2	0	0	86	15	3	9
7.6–23.8	4,282	75	13–23	19	54	21	0	0	0	1	53	3	18
24.8–27.10	786	35	16–26	21	13	22	0	0	0	11	2	3	19
	16,331	231	11–26		174	55	2	2 (1)	0	100	72	9	46

* The range of length and average length apply to the fish that were examined and not to the total number. The range of length given at the bottom of each section is the range for the total number.

TILAPIA (of doubtful identity). NATIVE RECORDS.

10. LANGASIME. SHIRE.

Date	Total no.	No. exam.	Range length (cm.)	Av. length (cm.)	Females	Males	Sex ?	Females				Males	
								Spent	Eggs	Dev	Sm	Big	Sm
*10.4– 6.6	32	9	29–36	32	4	5	0	1	0	3	0	5	0
7.6–23.8	87	44	21–37	31	14	30	0	1	12	1	0	28	2
24.8–27.10	235	76	21–35	31	68	8	0	34 (22)	16	18	0	7	1
	354	129	21–37		86	43	0	36 (22)	28	22	0	40	3

(commonest 31–34 cm.)

11. CHINKULU. SANI.

7.6–29.7	1	0	—	—	—	—	—	—	—	—	—	—	—
31.7–27.10	2,674	38	29–36	32	0	38	0	0	0	0	0	38	0
	2,675	38	29–36		0	38	0	0	0	0	0	38	0

(commonest 30–33 cm.)

KOTA KOTA.

1.9–28.10	77	5	31–39	35	0	5	0	0	0	0	0	5	0

12. BILIWILI. SANI.

7.6–29.7	28	8	29–33	34	0	8	0	0	0	0	0	8	0
31.7–27.10	392	50	27–35	31	0	50	0	0	0	0	0	50	0
	420	58	16–36		0	58	0	0	0	0	0	58	0

(commonest 30–35 cm.)

KOTA KOTA.

12.6–31.8	202	32	27–35	29	0	32	0	0	0	0	0	31	1
1.9–28.10	60	10	27–34	30	0	10	0	0	0	0	0	9	1
	262	42	24–35		0	42	0	0	0	0	0	40	2

(commonest 29–30 cm.)

13. SAKA. SHIRE.

7.6–23.8	23	18	24–35	29	3	15	0	0	3	0	0	14	1
24.8–27.10	32	26	23–35	28	0	26	0	0	0	0	0	21	5
	55	44	21–35		3	41	0	0	3	0	0	35	6

BAR.

4.8–31.10	18	0	30–32	—	—	—	—	—	—	—	—	—	—

* None till June.

B. *TILAPIA LIDOLE.*

1. TOTAL NUMBER HANDLED BY THE SURVEY: 277.

Place	Date	Number
Kota Kota	Jan. 22 ..	64
Fort Johnston	Feb. 11 ..	153
Malonda	March 8 ..	30
Monkey Bay	May 12 ..	30
Kota Kota, etc.	June–July ..	0
		277

2. SIZE: Range of length (202 measurements)—22 to 40 cm.
Range of weight (160 weights)—210 to 1100 gm.
Range of condition factor (160 calculations)—1·5 to 2·8.

3. NUMBER, AVERAGE WEIGHT, AND CONDITION FACTOR OF FISH OF DIFFERENT LENGTHS.

Length (cm.)	K.K.	F.J.	Mal.	M.B.	Total	No. weighed	Average weight (gm.)	Average C.F.	No. from native records
22	—	1	—	—	1	1	210	2·0	1
23	—	—	—	—	0	0	—	—	1
24	—	3	—	—	3	3	264	1·9	—
25	—	2	—	—	2	2	275	1·8	2
26	—	1	—	—	1	1	300	1·7	—
27	—	—	—	—	0	—	—	—	2
28	—	—	—	—	0	—	—	—	1
29	1	3	1	—	5	4	505	2·1	—
30	1	3	2	—	6	4	525	1·9	9
31	3	5	—	—	8	4	525	1·8	14
32	2	8	1	—	11	6	605	1·8	15
33	1	14	3	5	23	20	670	1·9	23
34	1	24	5	7	37	32	740	1·9	19
35	1	20	4	12	37	33	815	1·9	34
36	1	12	7	5	25	23	885	1·9	14
37	—	5	3	3	11	11	935	1·8	9
38	—	1	1	—	2	2	1010	1·8	6
39	—	—	1	—	1	1	1100	1·8	2
	11	102	28	32	173	147		1·89	

4. NUMBER OF GONADS EXAMINED: 178 (including 132 females, 32 males, and 14 not determinable).

Place	Date	Females					Males				
		Sp	(Fry)	Rpg	Stg	Quiet	Spent	Rpg	Stg	Quiet	Queries
K.K...	Jan. 22 ..	11	(7)	—	—	—	—	—	—	—	—
F.J. ..	Feb. 11 ..	92	(33)	—	—	—	—	1	—	—	—
Mal. ..	March 8 ..	18	(2)	1	—	—	1?	1	1	—	6 M
M.B...	May 12 ..	10	—	—	—	—	1	—	—	21	—
		131	(42)	1	0	0	2	2	1	21	6
Range of length (cm...		29–39		29	—	—	37	33–40	35	33–38	
Range of weight (gm.)		450–1100		680	—	—	850	620–1100	820	790–980	

5. METHODS OF CAPTURE.

	Native seine	C.D.F. Gill nets	
		5″	4″
Number	231	45	1
Range of length ..	22–39	33–40	37 cm.

6. NATIVE RECORDS.

SANI. LOLO.

Date	Total no.	No. exam.	Range length (cm.)	Av. length (cm.)	Females	Males	Sex ?	Females				Males	
								Spent	Eggs	Dev.	Sm	Big	Sm
6.2–14.4	253	28	23–36	33	28	0	0	26 (23)	1	0	1	0	0
14.4– 3.6	3	2	31–33	32	2	0	0	2 (1)	0	—	0	0	0
7.6–29.7	4	3	33–36	35	3	0	0	2	0	—	1	0	0
31.7–27.10	70	10	30–36	33	10	0	0	0	3	—	7	0	0
	327	43	23–40		43	0	0	30 (24)	4	—	9	0	0

KOTA KOTA. LOLO.

10.2–14.4	83	9	27–39	35	9	0	0	9 (6)	0	—	0	0	0
14.4–10.6	0	—	—	—	—	—	—	—	—	—	—	—	—
12.6–31.8	2	2	28–33	—	2	0	0	0	0	1	1	0	0
1.9–28.10	323	14	31–36	34	14	0	0	0	1	3	10	0	0
	408	25	27–39		25	0	0	9 (6)	1	4	11	0	0

BAR. LIDOLE.

9.3–29.4	379	45	27–38	34	42	3	0	41 (26)	0	1	0	3	0
2.5–19.6	6	0	—	—	—	—	—	—	—	—	—	—	—
20.6– 1.8	0	0	—	—	—	—	—	—	—	—	—	—	—
4.8–30.10	0	0	—	—	—	—	—	—	—	—	—	—	—
	385	45	25–39		42	3	0	41 (26)	0	1	0	3	0

SHIRE RIVER. LIDOLE.

4.3– 8.4	10	3	32–36	34	3	0	0	2 (2)	0	1	0	0	0
10.4– 6.6	6	1	33	—	1	0	0	0	0	1	0	0	0
7.6–23.8	3	2	31–34	32	1	1	0	0	1	0	0	1	0
24.8–27.10	23	16	31–37	33	15	1	0	13 (8)	—	2	0	1	0
	42	22	29–38		20	2	0	15 (10)	1	4	0	2	0

C. *TILAPIA SHIRANA.*

1. TOTAL NUMBER HANDLED BY THE SURVEY: 1,205.

Place	Date	Number
Kota Kota	Jan. 22–Feb. 8	310
Fort Johnston ..	Feb. 11–March. 8	217
Malonda	March 8–May 9	581
Monkey Bay ..	May 12–June 1	57
Kota Kota ..	June 7–July 24	31
Marembo	June 27–July 1	9
		1,205

2. SIZE: Range of length (340 measurements)—7 to 36 cm.

Range of weight (250 weights)—80 to 760 gm.

Range of condition factor (250 calculations)—0·5 to 2·7.

3. NUMBERS OF FISH AT DIFFERENT SIZES.

Length (cm.)	K.K.	F.J.	Mal.	M.B.	K.K.	Mar.	Total	No. wghd	Av. wt. (gm.)	Av. C.F.	No. from native records
7–15	—	—	Few	—	—	—	—	—	—	—	15
16	1	1	1	—	—	—	—	—	—	—	13
17	—	2	2	—	—	1	4	1	100	2·4	21
18	1	1	2	—	—	1	5	4	105	2·2	31
19	—	3	2	—	1	—	5	3	105	1·9	35
20	—	3	1	—	2	—	7	7	135	1·9	45
21	1	5	5	1	1	—	5	4	155	2·0	51
22	—	12	2	—	1	1	14	10	160	1·7	76
23	—	11	3	1	3	1	18	18	200	1·9	126
24	1	10	4	1	1	—	16	15	230	1·9	121
25	—	18	9	2	—	3	20	16	260	1·9	198
26	1	19	8	1	5	—	29	27	285	1·8	144
27	1	13	10	2	4	—	34	32	330	1·9	133
28	4	13	7	1	6	—	30	25	370	1·9	112
29	1	9	4	—	1	—	31	21	415	1·8	139
30	3	6	9	—	3	—	15	13	455	1·8	197
31	—	8	—	—	—	—	21	18	510	1·8	75
32	1	3	1	—	1	—	8	5	505	1·7	67
33	1	1	3	—	1	—	6	5	625	1·9	43
34	—	1	—	—	—	—	6	5	605	1·7	14
35	—	—	1	—	—	—	1	1	600	1·7	12
36	—	—	—	—	—	—	1	1	760	1·8	4
37	—	—	—	—	—	—	—	—	—	—	2
	16	139	74	9	31	7	276	231		1·85	—

4. NUMBER OF GONADS EXAMINED: 340 (including 153 females, 100 males, and 87 sex undetermined).

Place	Date	Females					Males				Queries
		Spent	(Fry)	Rpg	Stg	Quiet	Spent	Rpg	Stg	Quiet	
K.K...	Jan. 22 ..	47	(10)	6	—	—	—	7	—	11	6 F
F.J. ..	Feb. 11 ..	59	(4)	5	1	3	—	8	—	19	—
Mal. ..	March 8 ..	14	—	—	—	—	1	4	3	16	6 M
M.B...	May 12 ..	1	—	—	—	—	—	—	—	5	—
K.K...	June–July	1	—	—	—	8	—	1	1	18	—
Mar. ..	June 27 ..	—	—	—	—	2	—	—	—	—	—
		122	(14)	11	1	13	1	20	4	69	12
Range of length (cm.)		20–32	—	22–29	19	19–27	25	25–35	25–34	17–34	
Range of weight (gm.)		130–550	—	250–350	120	110–300	270	250–660	330–650	170–740	

5. METHODS OF CAPTURE.

	Native seines	Native traps	Native scoop nets	C.D.F. seine	C.D.F. trawl	C.D.F. gill nets			
						5″	4″	3″	2″
Number ..	966	171	44	1	6	1	13	3	0
Length (cm.) ..	14–35	7–33	21–36	21	27–31	33	26–31	21–27	—

6. NATIVE RECORDS.

SANI. NKUTUTU.

Date	Total no.	No. exam.	Range length (cm.)	Av. length (cm.)	Females	Males	Sex ?	Females				Males	
								Spent	Eggs	Dev	Sm	Big	Sm
6.2– 4.4	298	34	20–34	30	14	20	0	6	0	2	6	14	6
17.4– 3.6	616	31	18–31	27	4	27	0	1	0	0	3	19	8
7.6–29.7	235	25	17–31	28	9	16	0	5	0	2	2	6	10
31.7–27.10	317	18	24–33	28	5	13	0	0	0	1	4	5	8
	1,466	108	17–34		32	76	0	12	0	5	15	44	32

KOTA KOTA. NKUTUTU.

10.2–14.4	2,206	126	12–35	25	38	80	8	28	4	0	6	62	18
14.4–10.6	865	79	14–32	—	32	47	0	19	0	1	12	34	13
12.6–31.8	1,124	60	17–34	27	28	31	1	5 (1)	1	3	19	20	11
1.9–28.10	541	20	18–34	27	12	8	0	2 (2)	1	4	5	5	3
	4,736	285	12–35		110	166	9	54 (3)	6	8	42	121	45

BAR. KATUKUSI OR MAKUMBA.

Date	Total no.	No. exam.	Range length (cm.)	Av. length (cm.)	Females	Males	Sex ?	Females				Males	
								Spent	Eggs	Dev	Sm	Big	Sm
9.3–29.4	4,868	120	17–35	30	56	60	4	37	2	0	17	43	17
2.5–19.6	5,892	225	16–37	26	130	95	0	83	2	22	23	56	39
20.6– 1.8	3,127	176	12–36	26	114	62	0	41	3	14	56	27	35
4.8–31.10	2,903	128	15–35	25	53	75	0	0	1	23	29	18	57
	16,790	649	12–37		353	292	4	161	8	59	125	144	148

PELELA.

9.3–29.4	10	5	23–29	26	1	4	0	0	0	—	1	2	2
2.5–19.6	29	10	18–32	26	4	6	0	2	1	1	0	4	2
20.6– 1.8	2	2	26–27	26	1	1	0	1	0	—	0	1	0
4.6–31.10	7	4	21–30	—	1	3	0	0	0	1	0	3	0
	48	21	18–32		7	14	0	3	1	2	1	10	4

SHIRE RIVER. KATUKUSI OR MAKUMBA.

4.3– 8.4	1,008	113	13–37	26	82	29	2	37 (8)	10	23	12	19	10
10.4– 6.6	1,932	153	12–36	25	106	47	0	26 (2)	3	46	31	40	7
7.6–23.8	1,252	165	15–34	25	75	90	0	16	18	19	22	53	37
24.8–27.10	477	130	17–37	26	45	85	0	0	1	19	25	29	56
	4,669	561	11–37		308	251	2	79 (10)	32	107	90	141	110

PELELA.

4.3– 8.4	53	24	11–33	25	16	8	0	5 (3)	5	6	0	6	2
10.4– 6.6	39	28	16–32	25	15	13	0	7	0	6	2	12	1
7.6–23.8	18	13	20–32	26	5	8	0	3	0	2	0	5	3
24.8–27.10	4	4	20–28	—	1	3	0	0	0	1	0	2	1
	114	69	11–36		37	32	0	15 (3)	5	15	2	25	7

D. *TILAPIA MELANOPLEURA.*

1. TOTAL NUMBER HANDLED BY THE SURVEY: 59.

Place	Date	Number	Range of length	Range of weight	Range of condition factor
Kota Kota ..	Jan. 22 ..	30	25–34 cm.	—	—
Fort Johnston ..	Feb. 11 ..	2	20–33 cm.	200 gm	—
Malonda ..	March 8 ..	20	3–35 cm.	850 gm.	1·7–2·4
Monkey Bay ..	May 12 ..	5	28–31 cm.	490–650 gm.	2·2–2·4
Kota	June–July ..	1	25 cm.	380 gm.	2·4
Marembo ..	June 27 ..	1	27 cm.	—	—
		59	20–35 cm.	200–850 gm.	Av. C.F. 2·2

2. NUMBER OF GONADS EXAMINED: 25 (including 9 females, 7 males, and 9 sex undetermined).

Place	Date	Females				Males				Queries
		Spent	Rpg	Stg	Quiet	Spent	Rpg	Stg	Quiet	
K.K. ..	Jan. 22 ..	3	0	0	0	0	1	1	0	1 F
F.J. ..	Feb. 11 ..	1	0	0	0	0	0	0	1	—
Mal. ..	March 8 ..	1	0	0	0	0	0	0	4	—
M.B. ..	May 12 ..	2	0	0	0	0	0	0	0	—
K.K. ..	June–July ..	0	0	0	0	0	0	0	0	1 F
		7	0	0	0	0	1	1	5	2 F
Range of length		20–30	—	—	—	—	32	27	29–35 cm.	
Range of weight		200–550	—	—	—	—	—	—	500–850 gm.	

3. METHODS OF CAPTURE.

	Native seines	Native traps	Native hand nets	Trolling
Number ..	42	10	6	1
Length	20–35 cm.	24–35 cm.	3–6 cm.	32 cm.

4. NATIVE RECORDS.

SANI.

Date	Total no.	No. exam.	Range length (cm.)	Av. length (cm.)	Females	Males	Sex ?	Females				Males	
								Spent	Eggs	Dev	Sm	Big	Sm
6.2–14.4	49	12	21–38	28	2	10	0	0	0	0	2	9	1
17.4– 6.5*	6	2	26	26	0	2	0	0	0	0	0	0	2
7.6–29.7	23	8	24–33	28	4	4	0	0	1	0	3	1	3
31.7–27.10	44	9	20–30	27	4	5	0	0	3	0	1	4	1
	122	31	13–38		10	21	0	0	4	0	6	14	7

KOTA KOTA.

10.2–14.4	197	50	14–32	27	9	41	0	7	0	2	0	35	6
14.4–10.6	78	30	15–32	—	15	15	0	13	0	0	2	12	3
12.6–31.8	47	25	25–39	29	15	10	0	1	0	0	14	9	1
1.9–28.10	31	7	25–30	27	4	3	0	0	1	1	2	2	1
	353	112	14–39		43	69	0	21	1	3	18	58	11

* Unfortunately the records for Sani from 6th May to 7th June are missing.

E. *LABEO MESOPS.*

1. TOTAL NUMBER HANDLED BY THE SURVEY: 830.

Place	Date	Number
Kota Kota	Jan. 22 ..	102
Fort Johnston	Feb. 11 ..	43
Malonda	March 8 ..	569
Monkey Bay	May 12 ..	73
Kota Kota	June–July ..	24
Marembo	June 27 ..	19
		830

2. SIZE: Range of length (411 measurements)—13 to 46 cm.
Range of weight (352 weights)—50 to 1100 gm.
Range of condition factor—0·7 to 1·6.

3. NUMBER OF FISH OF DIFFERENT SIZES.

Length (cm.)	K.K.	F.J.	Mal.	M.B.	K.K.	Mar.	Total	No. wghd	Av. wt. (gm.)	Av. C.F.	No. from native records
13	—	1									
14	—	1	—	—	—	—	1	1	24	1·1	1
15	—	—	—	—	—	—	1	1	26	0·9	1
16	—	1	—	—	—	—	0	—	—	—	2
17	—	—	—	—	—	—	1	1	44	1·1	1
18	—	—	—	—	—	—	0	—	—	—	6
19	—	1	2	—	—	—	0	—	—	—	1
20	—	—	3	1	3	—	3	3	95	1·4	6
21	—	2	4	—	4	—	7	5	100	1·2	10
22	—	1	12	2	1	—	10	10	100	1·1	12
23	—	1	3	3	2	—	19	18	110	1·0	17
24	—	—	4	2	2	—	8	8	155	1·2	23
25	—	2	1	2	—	—	8	8	150	1·1	16
26	—	—	4	—	1	—	5	5	170	1·1	25
27	—	—	5	1	—	—	6	6	205	1·2	16
28	—	—	10	—	—	—	8	7	230	1·2	23
29	1	—	13	1	—	—	11	11	265	1·2	27
30	3	—	32	3	—	—	15	14	275	1·1	48
31	—	2	22	—	2	—	40	37	325	1·2	72
32	1	1	16	2	4	—	24	22	345	1·1	36
33	2	4	24	3	2	1	25	21	370	1·1	59
34	—	3	14	—	—	—	35	31	425	1·1	54
35	2	2	16	1	1	1	18	18	425	1·1	35
36	—	3	8	—	—	—	23	20	520	1·2	62
37	—	4	6	1	—	—	12	12	540	1·2	46
38	1	1	12	—	—	—	11	11	595	1·2	38
39	1	2	13	1	—	—	15	12	680	1·2	39
40	3	2	9	2	—	—	18	15	720	1·2	27
41	2	2	12	—	—	—	16	13	800	1·2	16
42	—	1	6	—	—	—	16	13	830	1·2	22
43	—	2	3	—	—	—	7	7	785	1·1	9
44	—	—	2	—	—	—	5	5	1010	1·3	8
45	1	—	3	—	—	—	2	2	1100	1·3	2
							4	3	1045	1·1	3
	17	39	259	29	24	6	374	340		1·15	

4. NUMBER OF GONADS EXAMINED: 381 (including 155 females, 84 males, and 142 sex undetermined).

Place	Date	Females					Males				Queries
		Spent	(Fry)	Rpg	Stg	Quiet	Spent	Rpg	Stg	Quiet	
K.K...	Jan. 22 ..	6	—	5	—	—	—	3	—	1	1 F
F.J. ..	Feb. 11 ..	—	—	8	—	—	—	17	—	1	—
Mal. ..	March 8 ..	40	—	21	—	33	1	27	3	15	13 F
M.B...	May 12 ..	5	—	—	—	5	—	—	—	6	—
K.K...	June–July	—	—	—	—	14	—	—	—	9	—
Mar. ..	June 27 ..	—	—	—	—	4	—	—	—	1	—
		51	—	34	0	56	1	47	3	33	14 F
Range of length (cm.)		30–46	—	35–46	—	21–42	35	22–38	31–32	20–38	
Range of weight (gm.)		300–900	—	470–1100	—	100–800	520	260–550	430	70–560	

5. METHODS OF CAPTURE.

	Native seines	Native traps	Native gill nets	C.D.F. seine	C.D.F. gill nets			
					5″	4″	3″	2″
Number	486	2	5	1	12	44	163	117
Length	13–46	32	27–34	20	30–40	27–46	20–41	19–28 cm.

6. NATIVE RECORDS.

SANI.

Date	Total no.	No. exam.	Range length (cm.)	Av. length (cm.)	Females	Males	Sex ?	Females				Males	
								Spent	Eggs	Dev.	Sm	Big	Sm
6.2–14.4	426	43	17–42	31	33	7	3	27	0	2	4	3	4
17.4– 3.6	308	33	27–39	35	33	0	0	30	0	—	3	0	0
7.6–29.7	811	48	25–41	35	47	1	0	11	0	—	36	1	0
31.7–27.10	435	35	26–40	34	31	4	0	0	0	—	31	4	0
	1,980	159	17–43		144	12	3	68	0	2	74	8	4

KOTA KOTA.

10.2–14.4	1,864	39	20–41	31	31	7	1	11	15	0	5	2	5
14.4–10.6	238	37	22–40	—	35	2	0	28	0	1	6	1	1
12.6–31.8	526	40	26–42	32	38	2	0	5	0	0	33	1	1
1.9–28.10	460	34	25–38	31	31	3	0	0	3	2	26	2	1
	3,088	150	18–42		135	14	1	44	18	3	70	6	8

BAR. NCHIRA.

Date	Total no.	No. exam.	Range length (cm.)	Av. length (cm.)	Females	Males	Sex ?	Females				Males	
								Spent	Eggs	Dev	Sm	Big	Sm
9.3–29.4	549	66	23–41	33	33	33	0	27	3	0	3	30	3
2.5–19.6	189	56	29–40	34	16	40	0	13	0	3	0	38	2
20.6– 1.8	58	31	27–41	32	9	22	0	6	0	0	3	15	7
4.8–31.10	153	41	28–39	32	15	26	0	0	0	6	9	3	23
	949	194	12–42		73	121	0	46	3	9	15	86	35

KASOMELA.

9.3–29.4	912	52	14–33	23	16	29	7	5	3	0	8	13	16
2.5–19.6	184	29	12–33	26	6	23	0	1	0	1	4	10	13
20.6– 1.8	125	20	19–33	24	5	15	0	1	0	2	2	10	5
4.8–31.10	488	59	18–33	25	24	35	0	0	0	4	20	14	21
	1,709	160	11–33		51	102	7	7	3	7	34	47	55

SHIRE RIVER. NCHIRA.

4.3– 8.4	271	63	19–48	37	30	33	0	4	26	0	0	22	11
10.4– 6.6	13	10	30–44	37	6	4	0	5	0	1	0	4	0
7.6–23.8	1	1	45	45	1	0	0	0	0	0	1	0	0
24.8–27.10	60	13	36–45	40	13	0	0	0	0	12	1	0	0
	345	87	19–48		50	37	0	9	26	13	2	26	11

KASOMELA.

4.3– 8.4	0	—	—	—	—	—	—	—	—	—	—	—	—
10.4– 6.6	23	13	22–31	26	1	12	0	0	0	—	1	6	6
7.6–23.8	7	5	22–32	26	3	2	0	0	0	—	3	0	2
24.8–27.10	0	0	—	—	—	—	—	—	—	—	—	—	—
	30	18	19–32		4	14	0	0	0	—	4	6	8

F. *LABEO CYLINDRICUS.*

1. TOTAL NUMBER HANDLED BY THE SURVEY: 81.

Place	Date	Number
Kota Kota	Jan. 22 ..	9
Fort Johnston	Feb. 11 ..	0
Malonda	March 8 ..	60
Monkey Bay	May 12 ..	12
Kota Kota & Marembo ..	June–July ..	0
		81

2. SIZE: Range of length (81 measurements)—20 to 39 cm.

Range of weight (70 weights)—100 to 590 gm.

Range of condition factor—0·7 to 1·3.

3. NUMBER OF GONADS EXAMINED: 75 (including 34 females, 17 males, and 24 sex undetermined).

Place	Date	Females				Males				Queries
		Spent	Rpg	Stg	Quiet	Spent	Rpg	Stg	Quiet	
K.K. ..	Jan. 22 ..	—	1	—	—	—	—	—	—	—
Mal. ..	March 8 ..	14	10	—	5	—	5	1	5	—
M.B. ..	May 12 ..	1	—	—	3	—	—	—	6	—
		15	11	0	8	0	5	1	11	0
Range of length (cm.) ..		29–37	29–36	—	30–38	—	31–37	31	23–34	
Range of weight (gm.) ..		300–530	310–400	—	340–590	—	300–470	300	130–400	

4. METHODS OF CAPTURE.

	Native seines	Native hand-net	Native traps	C.D.F. gill nets			
				5″	4″	3″	2″
Number	7	3	1	1	1	62	6
Length	31–37	22–31	30	33	32	22–39	20–28 cm.

5. NATIVE RECORDS.

SANI.

Date	Total no.	No. exam.	Range length (cm.)	Av. length (cm.)	Females	Males	Sex ?	Females				Males	
								Spent	Eggs	Dev.	Sm	Big	Sm
6.2–14.4	2	0	24–26	25	—	—	—	—	—	—	—	—	—

KOTA KOTA.

10.2–28.4	13	5	28–34	30	3	2	0	0	0	3	0	1	1
12.6–31.8	9	8	23–35	28	6	2	0	1	0	0	5	1	1
1.9–28.10	2	2	30–37	33	2	0	0	0	0	0	2	0	0
	26	15	23–37		11	4	0	1	0	3	7	2	2

G. *HAPLOCHROMIS* SPP. (UTAKA.)

1. NATIVE RECORDS.

BAR.

Date	Total no.	No. exam.	Range length cm.)	Av. length (cm.)	Females	Males	Sex ?	Females				Males	
								Spent	Eggs	Dev	Sm	Big	Sm
9.3–29.4	357	5	10–14	12	2	0	3	1	0	0	1	0	0
4.8–28.10	1,560	19	10–18	12	18	1	0	1	7	8	2	1	0
	1,917	24	10–19		20	1	3	2	7	8	3	1	0

SANI, KOTA KOTA, and SHIRE. Rarely mentioned in records.

H. *BAGRUS MERIDIONALIS.*

1. TOTAL NUMBER HANDLED BY THE SURVEY: 564.

Place	Date	Number
Kota Kota	Jan. 22 ..	53
Fort Johnston	Feb. 11 ..	7
Malonda	March 8 ..	277
Monkey Bay	May 12 ..	144
Kota Kota	June–July ..	82
Marembo	June 27 ..	1
		564

2. SIZE: Range of length (493 measurements)—19 to 96 cm.
Range of weight (445 weights)—50 to 9500 gm.
Range of condition factor—0·4 to 1·8.

3. NUMBER OF FISH OF DIFFERENT SIZES.

Length (cm.)	K.K.	F.J.	Mal.	M.B.	K.K.	Mar.	Total	No. wghd.	Av. wt (gm.)	Av. C.F.	No. from native records
19	—	—	1	—	—	—	1	1	50	0·7	—
20	—	—	—	—	—	—	0	—	—	—	—
21	—	—	—	—	—	—	0	—	—	—	—
22	—	1	—	—	—	—	1	1	90	0·8	—
23	—	—	—	1	1	—	0	—	—	—	—
24	—	—	—	1	—	—	2	1	80	0·6	—
25	—	—	—	2	1	—	1	1	120	0·8	—
26	—	—	—	2	—	—	3	2	115	0·7	—
27	—	—	1	3	—	—	2	1	110	0·6	—
28	—	—	—	2	—	—	4	4	165	0·8	2
29	—	—	—	—	—	—	0	—	—	—	2
30	—	—	4	3	—	—	2	1	200	0·7	2
31	—	—	—	2	—	—	7	6	240	0·8	1
32	—	—	1	4	—	—	2	1	270	0·8	1
33	—	—	10	5	—	—	5	5	285	0·8	2
34	—	—	9	4	—	—	15	15	315	0·8	1
35	—	—	8	6	1	—	13	13	350	0·8	2
36	—	—	10	4	2	—	15	15	370	0·8	4
37	1	2	13	2	—	—	19	18	410	0·8	2
38	1	—	2	4	1	—	16	14	510	1·0	6
39	—	—	1	2	1	—	7	7	450	0·8	11
40	—	—	5	4	2	—	4	4	520	0·8	24
41	1	—	7	2	2	—	12	11	565	0·8	5
42	—	—	1	4	5	—	11	11	640	0·9	13
43	1	—	3	3	2	—	11	9	710	0·9	11
44	—	—	5	5	5	—	8	8	765	0·9	5
45	—	—	14	4	5	—	15	14	790	0·9	14
46	1	—	8	5	9	—	24	23	860	0·9	7
47	—	—	5	4	5	—	22	21	995	1·0	13
48	—	1	17	9	5	—	15	14	1000	0·9	21
49	—	—	12	3	3	—	31	29	1050	0·9	23
50	2	—	13	5	2	—	20	17	1150	0·9	44
51	—	—	7	2	3	—	20	19	1225	0·9	8
52	—	1	11	1	1	—	13	13	1300	0·9	18
53	—	—					13	13	1385	0·9	13

3. NUMBER OF FISH OF DIFFERENT SIZES—*continued.*

Length (cm.)	K.K.	F.J.	Mal.	M.B.	K.K.	Mar.	Total	No. wghd.	Av. wt (gm.)	Av. C.F.	No. from native records
54	—	—	7	1	2	—	10	8	1440	0·9	9
55	—	—	14	—	5	—	19	18	1400	0·8	6
56	—	—	8	3	3	—	14	13	1600	0·9	8
57	—	—	4	1	2	—	7	7	1725	1·0	19
58	—	—	8	3	3	—	14	14	1880	1·0	9
59	1	—	6	5	1	—	13	11	2045	1·0	16
60	2	—	4	2	—	—	8	6	2190	1·0	23
61	—	—	1	1	3	—	5	5	2200	1·0	10
62	—	—	3	2	—	—	5	5	2230	0·9	7
63	—	—	2	—	—	—	2	2	2150	0·8	16
64	—	—	1	1	—	—	2	2	2600	1·0	8
65	—	—	6	—	2	—	8	8	2715	1·0	7
66	—	—	2	1	1	—	4	4	2700	0·9	2
67	—	—	3	—	—	—	3	3	2800	0·9	9
68	1	—	2	—	—	—	3	2	2650	0·8	3
69	1	—	1	—	—	—	2	1	3600	1·1	2
70	—	—	1	—	2	—	3	3	3465	1·0	11
71	—	—	1	—	—	—	1	1	4000	1·1	4
72	—	—	1	—	1	—	2	1	3900	1·0	9
73	—	—	—	—	—	—	0	—	—	—	0
74	—	—	—	—	—	1	1	1	6000	1·5	2
75	—	—	1	—	—	—	1	1	3600	0·9	1
76	1	—	1	—	—	—	2	1	4200	1·0	1
77	—	1	—	—	—	—	1	1	8000	1·7	1
78	—	—	—	—	—	—	0	—	—	—	1
79	—	—	—	—	—	—	0	—	—	—	5
80	—	—	—	—	—	—	0	—	—	—	3
81	—	—	2	—	2	—	4	4	5900	1·1	3
82	—	—	1	—	—	—	1	1	8000	1·4	0
83	—	—	1	—	—	—	1	1	7000	1·2	2
84	—	—	—	—	—	—	0	—	—	—	0
85	—	—	1	—	—	—	1	1	7000	1·1	0
—	—	—	—	—	—	—	—	—	—	—	4
92	—	—	—	—	—	—	1	1	8500	1·1	0
95	—	—	—	—	1	—	1	1	9500	1·1	1
99	—	—	—	—	—	—	—	—	—	—	1
	13	6	250	118	84	1	472	439			

4. NUMBER OF GONADS EXAMINED: 455 (including 239 females, 205 males, and 11 sex undetermined).

Place	Date	Females				Males				Queries
		Spent	Rpg	Stg	Quiet	Spent	Rpg	Stg	Quiet	
K.K. ..	Jan. 22 ..	1	1	0	0	0	0	1	0	1 M
F.J. ..	Feb. 11 ..	1	0	0	0	0	1	1	1	0
Mal. ..	March 8 ..	29	29	7	74	0	6	18	74	1 M
M.B. ..	May 12 ..	3	0	1	49	0	2	3	55	2 M
K.K. ..	June–July ..	0	5	8	31	0	2	2	35	0
		34	35	16	154	0	11	25	165	4 M
Range of length (cm.) ..		28–82	38–82	43–96	19–82	—	36–67	43–50	24–71	
Range of weight (gm.) ..		390–8000	490–6000	690–9500	50–6100	—	400–3000	700–2200	80–3500	

5. METHODS OF CAPTURE.

	Native seines	Native lines	Native gill net	C.D.F. long line	C.D.F. gill nets			
					5″	4″	3″	2″
Number	82	15	1	11	105	179	140	31
Length (cm.) ..	22–78	38–82	—	54–82	37–96	37–68	19–67	24–57

6. NATIVE RECORDS.

SANI.

Date	Total no.	No. exam.	Range length (cm.)	Av. length (cm.)	Females	Males	Sex ?	Females				Males	
								Spent	Eggs	Dev	Sm	Big	Sm
6.2–14.4	279	26	40–72	57	15	11	0	9	3	3	0	6	5
17.4– 3.6	229	73	42–96	64	51	22	0	43	0	0	8	15	7
7.6–29.7	261	57	31–81	55	35	22	0	13	6	3	13	12	10
31.7–27.10	303	89	29–99	54	49	40	0	1	20	5	23	19	21
	1,072	245	29–105		150	95	0	66	29	11	44	52	43

KOTA KOTA.

10.2–14.4	222	18	31–93	48	9	9	0	6	3	0	0	2	7
14.4–10.6	38	13	32–81	—	9	4	0	4	0	1	4	1	3
12.6–31.8	223	37	30–58	47	27	10	0	1	5	10	11	3	7
1.9–28.10	272	50	29–86	36	26	24	0	0	10	3	13	8	16
	755	118	23–100		71	47	0	11	18	14	28	14	33

BAR.

9.3–29.4	233	14	50–80	58	11	3	0	8	0	3	0	3	0
2.5–19.6	15	7	47–83	59	3	4	0	3	0	0	0	4	0
20.6– 1.8	5	5	49–56	51	2	3	0	0	0	0	2	3	0
4.8–31.10	25	10	40–79	57	4	6	0	0	1	1	2	0	6
	278	36	40–83		20	16	0	11	1	4	4	10	6

KANSOSOLE.

9.3–29.4	17	9	30–90	46	5	4	0	4	0	0	1	3	1
2.5–19.6	8	6	40–64	51	2	4	0	2	0	0	0	4	0
20.6– 1.8	0	0	—	—	—	—	—	—	—	—	—	—	—
4.8–31.10	2	1	—	—	1	0	0	0	0	1	0	0	0
	27	16	30–90		8	8	0	6	0	1	1	7	1

SHIRE RIVER.

21.2– 8.4	32	7	36–50	43	2	5	0	1	0	1	0	2	3
10.4– 6.6	20	4	42–49	—	1	3	0	1	0	0	0	3	0
7.6–23.8	7	5	15–75	58	2	3	0	0	1	1	0	1	2
24.8–27.10	16	6	57–76	65	6	0	0	0	1	5	0	0	0
	75	22	15–76		11	11	0	2	2	7	0	6	5

KANSOSOLE.

Date	Total no.	No. exam.	Range length (cm.)	Av. length (cm.)	Females	Males	Sex ?	Females				Males	
								Spent	Eggs	Dev	Sm	Big	Sm
21.2– 8.4	12	5	37–40	39	1	4	0	0	0	1	0	3	1
10.4– 6.6	4	4	35–43	—	1	3	0	0	0	0	1	3	0
7.6–23.8	17	13	38–54	46	5	8	0	1	2	1	1	7	1
24.8–27.10	24	7	32–55	46	2	5	0	0	1	1	0	3	2
	57	29	31–55		9	20	0	1	3	3	2	16	4

I. *CLARIAS* SPP.

1. TOTAL NUMBER HANDLED BY THE SURVEY: 311.

Place	Date	Numbers				
		Mlamba	Sapuwa	Nkomo	Kwazula	Species ?
K.K. ..	Jan. 22 ..	25	39	0	0	5
F.J. ..	Feb. 11 ..	7	0	0	0	4
Mal. ..	March 8 ..	41	45	26	5	12
M.B. ..	May 12 ..	16	0	14	18	3
K.K. ..	June–July ..	51	0	0	0	0
		140	84	40	23	24

2. SIZE.

	Mlamba	Sapuwa	Nkomo	Kwazula	Species ?
Range of length	31–94	25–107	37–97	33–77	42–116 cm.
Range of weight	160–6100	100–11000	330–6500	250–2750	460– ? gm.
Range of C.F.	0·4–0·9	0·6–0·9	0·5–0·9	0·6–0·9	—
(commonest)	0·5–0·8	0·6–0·8	0·6–0·8	0·6–0·8	—

3. TOTAL NUMBER OF GONADS EXAMINED: 227.

Fish	Number	Females	Males	Undetermined
Mlamba	121	63	48	10
Sapuwa	33	16	16	1
Nkomo	41	17	23	1
Kwazula	16	9	7	0
Spp. ?	16	7	6	3
	227	112	100	15

4. STATE OF DEVELOPMENT OF GONADS.

Place	Date	Females				Males				Queries
		Spent	Rpg	Stg	Quiet	Spent	Rpg	Stg	Quiet	
					MLAMBA.					
K.K. ..	Jan. 22 ..	6	3	0	0	0	0	3	0	—
F.J. ..	Feb. 11 ..	1	0	0	1	0	0	0	0	1 F
Mal. ..	March 8 ..	9	2	1	5	0	3	3	8	1 M
M.B. ..	May 12 ..	2	0	0	3	0	0	0	8	—
K.K. ..	June–July ..	0	0	0	28	0	2	0	20	1 F
		18	5	1	37	0	5	6	36	3
	Length	32–73	34–56	41	30–71	—	44–94	31–61	32–79	cm.
					SAPUWA.					
K.K. ..	Jan. 22–Feb. 8	0	3	0	0	0	1	0	0	—
Mal. ..	March 8–May 9	4	8	0	1	0	11	0	3	1 M
		4	11	0	1	0	12	0	3	1
	Length	56–64	51–75	—	47	—	52–76	—	25–65	cm.
					NKOMO.					
Mal. ..	March 8–May 9	1	1	1	4	0	6	1	11	1 F
M.B. ..	May 12–June 1	4	1	0	3	0	1	1	3	1 F
		5	2	1	7	0	7	2	14	2
	Length	54–88	58–97	53	37–73	—	54–92	73–93	51–89	cm.
					KWAZULA.					
Mal. ..	March 8–May 9	1	1	0	0	0	0	0	0	1 M
M.B. ..	May 12–June 1	1	0	0	5	0	0	0	6	1 F
		2	1	0	5	0	0	0	6	2
	Length	49–77	76	—	33–42	—	—	—	37–77	cm.

5. METHODS OF CAPTURE.

Fish	Native seines	Native lines	Native traps	C.D.F. long line	Trawl	Gill nets				Bought	Hand line
						5″	4″	3″	2″		
					MLAMBA.						
Number	34	2	0	41	1	4	28	20	2	7	1
Length	31–49	44–46	—	42–94	70	55–73	47–73	32–50	30–35	—	—
					SAPUWA.						
Number	57	1	2	1	0	14	3	3	1	2	—
Length	50–81	60	74	106	—	51–68	52–65	52–57	25	—	—
					NKOMO.						
Number	0	0	0	17	0	5	6	11	1	0	—
Length	—	—	—	52–92	—	63–97	48–60	36–48	54	—	—
					KWAZULA.						
Number	0	4	0	1	0	1	5	11	1	0	—
Length	—	49–77	—	76	—	76	44–50	33–42	39	—	—
					SPECIES. ?						
Number	6	1	1	4	0	6	0	0	1	2	3
Length	84–103	115	94	—	—	62–98	—	—	54	—	42–58

6. NATIVE RECORDS.

SANI. MLAMBA.

Date	Total no.	No. exam.	Range length (cm.)	Av. length (cm.)	Females	Males	Sex ?	Females				Males	
								Spent	Eggs	Dev.	Sm	Big	Sm
6.2–14.4	13	6	20–47	33	1	5	0	1	0	0	0	5	0
17.4–11.5*	33	11	29–52	40	8	3	0	7	0	0	1	0	3
7.6–29.7	55	27	27–51	38	5	22	0	1	0	0	4	15	7
31.7–27.10	64	30	27–52	34	16	14	0	0	2	6	8	10	4
					CHIKUTA.								
[1]7.4– 4.5*	3	2	98–100	99	0	2	0	0	0	0	0	2	0
7.6–29.7	6	5	62–103	89	4	1	0	0	1	3	0	0	1
[3]1.7–27.10	5	3	73–101	87	2	1	0	0	0	0	2	1	0
	179	84	20–103		36	48	0	9	3	9	15	33	15
					KOTA KOTA. MLAMBA.								
[1]0.2–14.4	170	37	17–58	—	16	21	0	5	2	8	1	14	7
[1]4.4–10.6	96	53	18–58	—	29	24	0	12	2	11	4	15	9
[1]2.6–31.8	70	26	20–56	37	13	13	0	1	0	3	9	8	5
1.9–28.10	99	44	20–64	41	20	24	0	1	0	6	13	19	5
					CHIKUTA.								
10.2–14.4	2	0	—	—	—	—	—	—	—	—	—	—	—
14.4–10.6	2	2	60–73	—	1	1	0	0	0	1	0	1	0
12.6–31.8	1	1	97	—	0	1	0	0	0	0	0	1	0
1.9–28.10	20	12	61–108	99	3	9	0	0	0	2	1	9	0
	460	175	17–108		82	93	0	19	4	31	28	67	26
					BAR. MLAMBA.								
9.3–29.4	21	6	41–70	50	4	2	0	4	0	0	0	2	0
2.5–19.6	3	2	38–43	—	1	1	0	1	0	0	0	1	0
20.6– 1.8	2	2	40–51	—	1	1	0	0	0	0	1	1	0
4.8–31.10	12	7	35–62	44	3	4	0	0	1	0	2	1	3
					CHIKUTA.								
4.8–31.10	1	—	90	—	—	—	—	—	—	—	—	—	—
	39	17	35–90		9	8	0	5	1	0	3	5	3
					SHIRE RIVER. MLAMBA.								
21.2– 8.4	32	2	34–39	—	1	1	0	0	0	0	1	0	1
10.4– 6.6	17	0	—	—	—	—	—	—	—	—	—	—	—
7.6–23.8	0	0	—	—	—	—	—	—	—	—	—	—	—
24.8–27.10	4	0	—	—	—	—	—	—	—	—	—	—	—
					CHIKUTA.								
24.8–27.10	1	0	96	—	—	—	—	—	—	—	—	—	—
	54	2	26–96		1	1	0	0	0	0	1	0	1

* The records for Sani for part of May and early June are missing for this and some of the following species.

SANI. SAPUWA.

Date	Total no.	No. exam.	Range length (cm.)	Av. length (cm.)	Females	Males	Sex ?	Females				Males	
								Spent	Eggs	Dev	Sm	Big	Sm
6.2–14.4	177	15	43–79	59	11	4	0	9	1	1	0	3	1
17.4– 4.4*	19	3	53–70	—	2	1	0	2	0	0	0	1	0
7.6–29.7	8	7	41–57	49	3	4	0	1	0	0	2	3	1
31.7–27.10	17	9	43–80	54	3	6	0	0	0	1	2	5	1
	221	34	41–94		19	15	0	12	1	2	4	12	3
KOTA KOTA. SAPUWA.													
10.2–14.4	338	21	40–70	—	9	12	0	0	9	0	0	9	3
14.4–19.5	54	18	40–63	—	13	5	0	5	4	4	0	5	0
12.6–31.8	16	2	53–59	—	2	0	0	0	0	0	2	0	0
1.9–28.10	88	29	47–72	60	12	17	0	0	0	11	1	15	2
	496	70	35–87		36	34	0	5	13	15	3	29	5
BAR. SAPUWA.													
4.8–31.10	6	3	50–65	—	2	1	0	0	2	0	0	0	1
SHIRE. SAPUWA.													
24.8–27.10	9	2	45–92	—	1	1	0	0	0	0	1	1	0

J. *BARILIUS MICROLEPIS.*

1. TOTAL NUMBER HANDLED BY THE SURVEY: 97.

Place	Date	Number	Range of length	Range of weight	Range of condition factor
Fort Johnson ..	Feb. 2 ..	3	36–39 cm.	370–490 gm.	0·8–0·9
Malonda	March 8–May 5	93	2–66 cm.	2700 gm.	0·6–1·4
Monkey Bay ..	May 12 ..	1	4 cm.	—	—

Av. C.F. = 0·95 (for specimens over 35 cm.).

2. NUMBER OF GONADS EXAMINED: 45 (20 females, 19 males, 6 sex undetermined).

Females			*Males*		
spent	..	0	spent	..	0
rpg.	..	20 (39–66 cm.)	rpg.	..	9 (38–63 cm.)
stg.	..	0	stg.	..	6 (47–61 cm.)
quiet	..	0	quiet	..	4 (29–48 cm.)

3. METHODS OF CAPTURE.

	Native seine	Arab seine	Native traps	C.D.F. seine	C.D.F. gill nets				Trolling
					5″	4″	3″	2″	
Number	27	20	13	24	5	2	1	2	2
Length (cm.) ..	36–63	33–66	38–52	2–14	52–63	48–49	38	27–30	24–25

4. NATIVE RECORDS.

SANI.

Date	Total no.	No. exam.	Range length (cm.)	Av. length (cm.)	Females	Males	Sex ?	Females				Males	
								Spent	Eggs	Dev	Sm	Big	Sm
4.7–27.10	3	3	36–42	39	2	1	0	0	1	0	1	0	1
KOTA KOTA.													
10.2–31.8	7	6	23–50	39	3	3	0	1	1	0	1	2	1
BAR.													
9.3–29.4	2	1	50	—	0	1	0	0	0	0	0	1	0
SHIRE.													
– 3.	1	0	—	—	—	—	—	—	—	—	—	—	—
	13	10	23–59		5	5	0	1	2	0	2	3	2

K. *BARILIUS MICROCEPHALUS.*

1. TOTAL NUMBER HANDLED BY THE SURVEY: 27.

Place	Date	Number	Range of length	Range of weight	Range of condition factor
Kota Kota	Jan. 22 ..	1	37 cm.	—	—
Fort Johnston ..	Feb. 11 ..	11	24–31 cm.	110–160 gm.	0·5–0·7
Malonda	March 8 ..	15	20–34 cm.	50–330 gm.	– –0·9

2. NUMBER OF GONADS EXAMINED: 22 (7 females, 6 males, 9 sex undetermined).

Females			*Males*		
spent	..	0	spent	..	0
rpg.	..	6 (22–34 cm.)	rpg.	..	2 (22–31 cm.)
stg.	..	0	stg. ?	..	3 (– –31 cm.)
quiet	..	1 (20 cm.)	quiet	..	1 (29 cm.)

3. METHODS OF CAPTURE.

	Native seine	Native traps	C.D.F. gill nets				Trolling
			5″	4″	3″	2″	
Number	3	3	0	0	1	2	18
Length (cm.)	20–37	22–24	—	—	33	22–25	22–31

4. NATIVE RECORDS.

SANI.

Date	Total no.	No. exam.	Range length (cm.)	Av. length (cm.)	Females	Males	Sex ?	Females				Males	
								Spent	Eggs	Dev	Sm	Big	Sm
31.7–27.10	3	2	25–29	—	2	0	0	0	2	0	0	0	0
KOTA KOTA.													
10.2–31.8	66	7	21–30	25	5	2	0	0	0	2	3	1	1
BAR.													
9.3–19.6	4	3	20–22	—	3	0	0	0	2	1	0	0	0
4.8–31.10	1	1	21	—	0	1	0	0	0	0	0	0	1
	74	13	20–30		10	3	0	0	4	3	3	1	2

L. *BARBUS EURYSTOMUS*.

1. TOTAL NUMBER HANDLED BY THE SURVEY: 133.

Place	Date	Number	Range of length	Range of weight	Range of condition factor
Kota Kota	Jan. 22 ..	10	28–42 cm.	—	—
Fort Johnston ..	Feb. 11 ..	6	41–58 cm.	820–2000 gm.	1·1–1·3
Malonda	March 8 ..	48	18–58 cm.	220–2400 gm.	0·8–1·6
Monkey Bay ..	May 12 ..	9	38–52 cm.	600–1400 gm.	0·9–1·5
Kota Kota	June–July ..	60	29–56 cm.	260–1880 gm.	0·9–1·9
		133	18–58 cm.	220–2400 gm. (109 weights)	0·8–1·9 Av. 1·3

2. NUMBER OF GONADS EXAMINED: 110 (including 59 females, 36 males, and 15 sex undetermined).

Place	Date	Females				Males				Queries
		Spent	Rpg	Stg	Quiet	Spent	Rpg	Stg	Quiet	
K.K. ..	Jan. 22 ..	0	0	0	0	0	0	1	1	
F.J. ..	Feb. 11 ..	0	0	0	1	0	0	0	2	—
Mal. ..	March 8 ..	1	2	1	1	0	8	1	8	2 FM
M.B. ..	May 12 ..	1	0	0	1	0	0	0	3	2 FF
K.K. ..	June–July	3	1	1	42	0	3	1	7	1 F
		5	3	2	45	0	11	3	21	5
Range of length (cm.) ..		41–58	43–53	49–53	31–57	—	35–44	41–42	29–50	
Range of weight (gm.) ..		750–2400	1100–1600	1600–1900	260–2000	—	430–980	890–1000	270–1600	

3. METHODS OF CAPTURE.

	Native seine	Native gill net	C.D.F. gill nets			
			5″	4″	3″	2″
Number ..	38	1	32	45	15	2
Length ..	18–58 cm.	45 cm.	40–56 cm.	29–52 cm.	28–50 cm.	—

4. NATIVE RECORDS.

SANI. KUYU.

Date	Total no.	No. exam.	Range length (cm.)	Av. length (cm.)	Females	Males	Sex ?	Females				Males	
								Spent	Eggs	Dev	Sm	Big	Sm
6.2–14.4	37	15	23–46	35	1	11	3	0	0	0	1	8	3
17.4–12.5	28	11	34–50	41	0	11	0	0	0	0	0	6	5
7.6–29.7	64	23	22–49	36	12	11	0	2	0	0	10	8	3
31.7–27.10	30	3	35–40	37	2	1	0	0	1	0	1	1	0
	159	52	21–50		15	34	3	2	1	0	12	23	11
KOTA KOTA. KUYU.													
10.2–14.4	59	9	33–40	—	3	5	1	2	0	0	1	2	3
14.4–10.6	30	8	30–40	—	4	4	0	4	0	0	0	3	1
12.6–31.8	93	21	29–50	39	7	14	0	2	0	0	5	12	2
1.9–28.10	42	10	30–49	39	1	8	1	0	0	1	0	6	2
	224	48	13–51		15	31	2	8	0	1	6	23	8
BAR. KADYAKOLA.													
9.3–29.4	22	19	38–66	48	9	10	0	4	0	5	0	10	0
2.5–19.6	7	3	34–50	42	2	1	0	1	0	0	1	1	0
20.6– 1.8	4	2	38–41	—	1	1	0	1	0	0	0	1	0
4.8–31.10	3	1	52–72	—	0	1	0	0	0	0	0	0	1
	36	25	34–72		12	13	0	6	0	5	1	12	1
SHIRE. KADYAKOLA.													
21.2– 8.4	11	1	43	—	0	0	1	0	0	0	0	0	0
10.4– 6.6	11	0	—	—	—	—	—	—	—	1	0	0	0
7.6–23.8	6	1	42	—	1	0	0	0	0	0	0	1	0
24.8–27.10	4	1	41	—	0	1	0	0	0	0	0	1	0
	32	3	34–53		1	1	1	0	0	1	0	1	0

M. *BARBUS RHOADESII*.

1. TOTAL NUMBER HANDLED BY THE SURVEY: 156.

Place	Date	Number	Range of length	Range of weight	Range of condition factor
Kota Kota	Jan. 22 ..	8	23–39 cm.	—	—
Fort Johnston ..	Feb. 11 ..	4	25–32 cm.	150–290 gm.	1·0–1·1
Malonda	March 8 ..	34	22–40 cm.	100–700 gm.	0·4–1·2
Monkey Bay ..	May 12 ..	14	24–36 cm.	100–450 gm.	0·7–1·1
Kota Kota	June–July ..	96	20–44 cm.	90–1000 gm.	0·4–2·3
		156	20–44 cm.	90–1000 gm. (131 weights)	0·4–2·3 Av. 0·9

2. NUMBER OF GONADS EXAMINED: 143 (including 67 females, 60 males, and 16 sex undeterminable).

Place	Date	Females				Males				Queries
		Spent	Rpg	Stg	Quiet	Spent	Rpg	Stg	Quiet	
K.K. ..	Jan. 22 ..	0	2	0	0	0	1	0	3	—
F.J. ..	Feb. 11 ..	0	3	0	0	0	0	0	0	—
Mal. ..	March 8 ..	3	1	2	3	0	1	0	7	3 F
M.B. ..	May 12 ..	0	0	0	7	0	0	0	1	—
K.K. ..	June–July ..	2	0	1	40	0	4	0	40	3 M
		5	6	3	50	0	6	0	51	6
Range of length		32–40	27–40	22–36	20–39	—	26–32	—	20–38	cm.
Range of weight		240–700	200– ?	100–360	90–450	—	170–280	—	70–540	gm.

3. METHODS OF CAPTURE.

	Native seines	Native traps	Native gill nets	Lines	C.D.F. gill nets			
					5″	4″	3″	2″
Number	21	4	2	2	0	7	72	48
Length	23–40	31–40	32–34	34	—	37–44	27–39	20–31

4. NATIVE RECORDS. TAMBA.

SANI.

Date	Total no.	No. exam.	Range length (cm.)	Av. length (cm.)	Females	Males	Sex ?	Females				Males	
								Spent	Eggs	Dev.	Sm	Big	Sm
6.2–14.4	7	3	28–32	30	1	2	0	0	0	1	0	2	0
7.6–29.7	7	5	20–37	29	2	3	0	1	0	0	1	2	1
31.7–27.10	0	—	—	—	—	—	—	—	—	—	—	—	—
	14	8	20–38		3	5	0	1	0	1	1	4	1

KOTA KOTA.

Date	Total no.	No. exam.	Range length (cm.)	Av. length (cm.)	Females	Males	Sex ?	Females				Males	
								Spent	Eggs	Dev	Sm	Big	Sm
10.2–14.4	27	1	32	—	0	1	0	0	0	0	0	0	1
14.4–12.6	81	23	20–37	—	7	16	0	6	0	1	0	6	10
12.6–31.8	51	10	24–40	28	6	4	0	4	0	0	2	3	1
1.9–28.10	39	14	27–39	34	10	4	0	0	4	1	5	2	2
	198	48	19–40		23	25	0	10	4	2	7	11	14

BAR. None.

SHIRE.

21.2– 8.4	27	5	26–36	29	4	1	0	0	4	0	0	1	0
7.6–23.8	1	1	27	—	0	1	0	0	0	0	0	1	0
24.8–27.10	0	0	—	—	—	—	—	—	—	—	—	—	—
	28	6	19–36		4	2	0	0	4	0	0	2	0

N. *SERRANOCHROMIS THUMBERGI*.

1. TOTAL NUMBER HANDLED BY THE SURVEY: 105.

Place	Date	Number	Range of length	Range of weight	Range of condition factor
Kota Kota	Jan. 22 ..	25	21–42 cm.	—	—
Fort Johnston ..	Feb. 11 ..	22	21–40 cm.	100–950 gm.	1·1–1·6
Malonda	March 8 ..	40	23–42 cm.	140–1100 gm.	0·9–1·7
Monkey Bay ..	May 12 ..	2	34 cm.	510 gm.	1·3
Kota Kota	June–July ..	10	23–41 cm.	100–900 gm.	0·8–1·6
Marembo	July ..	6	22–36 cm.	120–600 gm.	1·1–1·4
		105	21–42 cm.	100–1100 gm. (65 weights)	0·8–1·7 Av. 1·3

2. NUMBER OF GONADS EXAMINED: 78 (including 32 females, 35 males, and 11 sex undeterminable).

Place	Date	Females				Males				Queries
		Spent	Rpg	Stg	Quiet	Spent	Rpg	Stg	Quiet	
K.K. ..	Jan. 22 ..	7	0	0	0	0	2	2	0	3 F 1 M
F.J. ..	Feb. 11 ..	4	4	1	0	0	2	1	2	3 M
Mal. ..	March 8 ..	8	3	0	0	6 ?	6	1	1	—
M.B. ..	May 12 ..	0	0	0	0	0	0	0	1	—
K.K. ..	June–July ..	0	0	0	1	0	0	0	6	—
Mar. ..	July ..	0	0	0	1	0	0	0	1	—
		19	7	1	2	6 ?	10	4	11	7
Range of length		26–39	27–33	21	25–27	35–42	23–42	32–38	32–41	cm.
Range of Weight		220–890	300–590	100	160–200	730–1100	140–1000	440–490	450–900	gm.

3. METHODS OF CAPTURE.

	Native seines	Native traps	C.D.F. trawl	Trolling	C.D.F. gill nets			
					5″	4″	3″	2″
Number	42	19	2	28	5	6	3	0
Length (cm.) ..	21–42	27–38	31–33	23–42	33–41	32–39	23–31	—

4. NATIVE RECORDS.

SANI. CHIUWA.

Date	Total no.	No. exam.	Range length (cm).	Av. length (cm.)	Females	Males	Sex ?	Females				Males	
								Spent	Eggs	Dev	Sm	Big	Sm
6.2–14.4	48	19	20–41	31	5	13	1	2	0	1	2	10	3
17.4–12.5	11	7	34–49	41	1	6	0	1	0	0	0	5	1
7.6–29.7	7	6	20–40	29	0	6	0	0	0	0	0	1	5
31.7–27.10	55	22	19–47	38	4	18	0	0	0	1	3	13	5
	121	54	17–49		10	43	1	3	0	2	5	29	14

KOTA KOTA. CHIUWA.

10.2–14.4	107	36	20–42	31	14	22	0	9	2	1	2	15	7
14.4–10.6	101	39	20–41	—	9	30	0	5	0	0	4	20	10
12.6–31.8	70	26	18–39	29	9	17	0	2	0	2	5	7	10
1.9–28.10	44	16	25–41	32	2	14	0	0	0	0	2	6	8
	322	117	15–42		34	83	0	16	2	3	13	48	35

BAR. SUNGWA.

9.3–29.4	130	49	15–39	28	22	27	0	11	8	0	3	21	8
2.5–19.6	71	44	21–39	31	16	28	0	9	4	0	3	20	6
20.6– 1.8	33	27	21–37	31	13	14	0	3	4	1	5	11	3
4.8–31.10	34	28	20–38	29	9	19	0	0	4	1	4	10	9
	268	148	15–39		60	88	0	23	20	2	15	62	26

SHIRE. SUNGWA.

4.3– 8.4	93	35	18–36	28	26	9	0	7	14	2	3	8	1
10.4– 6.6	111	48	16–40	30	25	23	0	16	3	4	2	19	4
7.6–23.8	12	8	22–38	29	4	4	0	4	0	0	0	3	1
24.8–27.10	6	4	33–37	—	1	3	0	0	0	1	0	3	0
	222	95	11–40		56	39	0	27	17	7	5	33	6

O. *RHAMPHOCHROMIS* SPP.

1. TOTAL NUMBER HANDLED BY THE SURVEY: 144.

Place	Date	Number	Range of length	Range of weight	Range of condition factor
Kota Kota	Jan. 22 ..	12	27–33 cm.	—	—
Fort Johnston ..	Feb. 11 ..	23	21–40 cm.	70–440 gm.	0·6–0·8
Malonda	March 8 ..	89	12–42 cm.	60–800 gm.	0·5–1·2
Monkey Bay ..	May 12 ..	9	30–43 cm.	270–710 gm.	0·9–1·3
Kota Kota	June–July ..	11	21–36 cm.	90–440 gm.	0·8–1·1
		144	12–43 cm.	60–800 gm.	0·5–1·3

2. NUMBER OF GONADS EXAMINED: 94 (including 43 females, 31 males, and 20 sex undeterminable).

Place	Date	Females				Males				Queries
		Spent	Rpg	Stg	Quiet	Spent	Rpg	Stg	Quiet	
K.K. ..	Jan. 22 ..	0	0	0	0	0	0	0	0	2 M
F.J. ..	Feb. 11 ..	7	0	0	0	0	1	0	5	1 F 1 M
Mal. ..	March 8 ..	22	2	1	0	1	3	0	7	1 M
M.B. ..	May 12 ..	6	0	0	0	0	0	0	1	2 M
K.K. ..	June–July ..	2	2	0	0	0	4	1	2	—
		37	4	1	0	1	8	1	15	7

3. METHODS OF CAPTURE.

	Native seine	Native chilimila	Native line	C.D.F. seine	Trolling	C.D.F. gill nets			
						5″	4″	3″	2″
Number ..	34	3	11	32	30	1	7	21	5
Length (cm.) ..	17–41	27–32	20–37	12–34	22–39	21	27–43	29–41	20–33

4. NATIVE RECORDS.

SANI. SANGWE.

Date	Total no.	No. exam.	Range length (cm.)	Av. length (cm.)	Females	Males	Sex ?	Females				Males	
								Spent	Eggs	Dev	Sm	Big	Sm
6.2–14.4	22	8	25–35	29	1	7	0	0	0	0	1	4	3
7.6–29.7	6	3	24–31	—	2	1	0	0	1	0	1	1	0
31.7–27.10	31	11	22–41	27	5	6	0	0	2	0	3	3	3
	59	22	20–41		8	14	0	0	3	0	5	8	6

KEKENA.

Date	Total no.	No. exam.	Range length (cm.)	Av. length (cm.)	Females	Males	Sex ?	Females				Males	
								Spent	Eggs	Dev	Sm	Big	Sm
14.4–29.7	2	2	35–36	—	1	1	0	0	1	0	0	1	0
31.7–27.10	10	10	28–49	35	7	3	0	0	4	0	3	3	0
	12	12	28–49		8	4	0	0	5	0	3	4	0

KOTA KOTA. SANGWE.

10.2–14.4	43	6	11–30	21	3	2	1	3	0	0	0	1	1
14.4–31.8	9	2	11–34	—	2	0	0	0	0	1	1	0	0
1.9–28.10	22	5	30–35	21	4	1	0	1	2	0	1	1	0
	74	13	11–36		9	3	1	4	2	1	2	2	1

BAR. MCHENI.

9.3–29.4	45	23	10–36	27	15	8	0	7	7	0	1	3	5
2.5–19.6	17	11	11–37	30	6	5	0	2	3	0	1	2	3
4.8–31.10	22	11	19–28	21	6	5	0	2	2	1	1	3	2
	84	45	10–37		27	18	0	11	12	1	3	8	10

SHIRE. MCHENI.

10.4–23.8	4	3	11–28	—	2	1	0	0	1	1	0	0	1
24.8–27.10	30	2	18–23	—	2	0	0	0	0	2	0	0	0
	34	5	11–28		4	1	0	0	1	3	0	0	1

P. *MORMYRUS LONGIROSTRIS*.

1. TOTAL NUMBER HANDLED BY THE SURVEY: 285.

Place	Date	Number	Range of length	Range of weight	Range of condition factor
Kota Kota	Jan. 22 ..	37	40–60 cm.	—	—
Fort Johnston ..	Feb. 11 ..	1	44 cm.	—	—
Malonda	March 8 ..	116	22–56 cm.	70–1400 gm.	0·5–1·2
Monkey Bay ..	May 12 ..	94	17–52 cm.	60–1300 gm.	0·6–1·0
Kota Kota	June–July ..	37	22–58 cm.	140–1300 gm.	0·6–0·9
		285	17–60 cm.	60–1400 gm. (164 weights)	0·5–1·2 Av. 0·77

2. NUMBER OF GONADS EXAMINED: 190 (including 76 females, 86 males, and 28 sex undeterminable).

Place	Date	Females				Males				Queries
		Spent	Rpg	Stg	Quiet	Spent	Rpg	Stg	Quiet	
K.K. ..	Jan. 22 ..	0	7	2	0	0	1	1	0	—
F.J. ..	Feb. 11 ..	—	—	—	—	—	—	—	—	—
Mal. ..	March 8 ..	0	14	3	1	0	26	1	15	2 M
M.B. ..	May 12 ..	0	13	2	9	0	13	3	11	1 F
K.K. ..	June–July ..	1	0	9	14	0	0	0	13	—
		1	34	16	24	0	40	5	39	3
Range of length (cm.) ..		35	29–55	30–60	20–53	—	39–56	41–55	22–58	
Range of weight (gm.) ..		390	220–940	220– ?	70–1100	—	500–1400	650– ?	70–1300	

3. METHODS OF CAPTURE.

	Native seines	Native traps	C.D.F. gill nets			
			5″	4″	3″	2″
Number ..	43	1	25	123	58	34
Length (cm.)	28–60	—	37–58	22–51	25–45	17–45c m.

4. NATIVE RECORDS.

SANI. PANDA.

Date	Total no.	No. exam.	Range length (cm.)	Av. length (cm.)	Females	Males	Sex ?	Females				Males	
								Spent	Eggs	Dev.	Sm	Big	Sm
6.2–14.4	49	3	42–49	—	0	3	0	0	0	0	0	2	1
17.4– 6.6	?	—	—	—	—	—	—	—	—	—	—	—	—
7.6–29.7	12	3	46–66	—	2	1	0	0	0	0	2	1	0
31.7–27.10	2	2	50–60	—	1	1	0	0	0	0	1	1	0
	63	8	38–66	—	3	5	0	0	0	0	3	4	1

KOTA KOTA. PANDA.

10.2–14.4	15	4	33–48	42	3	1	0	1	2	0	0	1	0
14.4–10.6	0	—	—	—	—	—	—	—	—	—	—	—	—
12.6–31.8	3	3	45–56	—	3	0	0	0	0	2	1	0	0
1.9–28.10	12	2	38–59	—	2	0	0	0	0	2	0	0	0
	30	9	32–62	—	8	1	0	1	2	4	1	1	0

BAR. CHIGONDI.

2.5–19.6	23	3	34–53	—	1	2	0	1	0	0	0	2	0
4.8–31.10	3	3	47–70	—	2	1	0	0	0	2	0	1	0
	26	6	34–70	—	3	3	0	1	0	2	0	3	0

APPENDIX VII.

Summary of Survey Records of Catches from Native Nets and Traps.

1. Large Meshed Seine Hauls.

Date	Locality	No. hauls	No. fish caught
27.1	Kota Kota	1	137
29.1	Sani	1	844
30.1	Sani	1	809
31.1	Sani	1	105
1.2	Sani	1	129
1.2	Sani	1	81
2.2	Kota Kota	1	663
2.2	Sani	1	239
7.2	Kota Kota	1	165
16.2	Fort Johnston (Bar) ..	1	128
16.2	Fort Johnston (Bar) ..	1	40
10.3	Che Linda	1	15
22.3	Kota Kota	1	253
27.3	Bana	1	63
17·4	Liuli	1	207
19.4	Mbampa Bay	4	88
26.4	Yofu ; Likoma ..	2	30
26.4	Makalawe, Likoma ..	2	22
1.6	Sani	1	694
28.6	Marembo	2	446
30.6	Marembo	2	50
30.6	Marembo	1	732
	Totals ..	29	5,940

Average = 205 fish per haul.

2. Trap Hauls.

Date	Locality	No. traps in fence	No. fish
22.1	Sani	1	2
24.1	Kota Kota	4	1
4.2	Kota Kota (Kaombe) ..	3	118
6.2	Kota Kota (Kaombe) ..	3	13
6.2	Kota Kota	8	109
7.2	Kota Kota (spit) ..	8	135
7.2	Lake Malombe ..	10	155
4.3	Che Linda	41	227
10.3	Domira Bay	7	11
19.3	Florence Bay	3	4
3.4	Florence Bay	5	14
3.4	Mtengula	5	21
2.5	Luangwa river delta ..	8	1
5.5		39	59
	Totals ..	145	870

Average = 6 fish per trap.

3. For gill nets hauls, see Appendix X.

APPENDIX VIII.

Summary of Fishing at Recording Stations and Estimates of the Amount of Fish Caught.

1. KOTA KOTA.

1a. Seine Fishing.

Period	No. hauls inspected	Size of catch	Average catch per haul	No. seines cast in period	Estimated total fish caught, i.e. product of columns 4 and 5
10.2 – 9.3	17	6,273	369	85	—
10.3 – 9.4	14	3,540	250	52	—
10.4 – 9.5	18	1,260	70	38	—
10.5 – 9.6	7	442	63	17	—
10.6 – 9.7	12	700	58	24	—
10.7 – 4.8	16	1,826	114	53	—
5.8 –21.8	—	—	—	24	—
22.8 – 9.9	11	2,813	255	32	—
10.9 – 9.10	12	17,100	1,425	30	—
10.10–28.10	9	5,743	638	18	—
Totals ..	116	39,697	396*	373	Approx. 147,000†

* Average worked from total number of hauls inspected and total number of fish caught during whole period, not an average of the monthly averages.

† 373 hauls at 396 fish per haul = approximately 147,000 fish caught by seine during period 10th February to 28th October.

1b. Composition of Catches and Weights of Fish from Seine Nets.

Fish	Percentages of species in inspected hauls	Range of length	Approximate weight of single specimen	Estimated totals caught in all hauls	Approximate total weights, i.e. product of columns 4 and 5
		cm.	gm.		kg.
Kayawa	64	13–35	450	94,080	42,500
Ngwaru	7	16–32	450	10,290	4,621
Malolo	1·1	28–38	780	1,610	1,255
Biliwili	·5	25–37	560	740	414
Chinkulu	·2	28–39	560	300	168
Nkututu	10	14–35	330	14,700	4,851
Nchira	6	18–40	320	8,820	2,822
Kuyu	·4	13–52	500	590	295
Kampango ..	2	23–120	1,000	2,940	2,940
Mlamba	·8	19–61	350	1,170	409
Clarias spp. ..	1·1	34–142	1,000	1,610	1,610
Chiuwa	·4	16–41	400	590	236
Tamba	·3	12–40	300	440	132
Mcheni	·2	11–35	200	300	60
Others	6	—	300	8,820	2,646
Total ..				147,000	

Approx. 64,000 kg.
= Approx. 140,800 lbs.
= Approx. 70 short tons

1c. GILL NETS.

Period	No. hauls inspected	Size of catch	Average catch per haul	No. nets cast in period	Estimated total fish caught, i.e. product of columns 4 and 5
10.2 – 9.3	—	—	—	13	—
10.3 – 9.4	—	—	—	1	—
10.4 – 9.5	—	—	—	13	—
10.5 – 9.6	21	69	3	58	—
10.6 – 9.7	62	378	6	144	—
10.7 – 4.8	49	184	3	98	—
5.8 –21.8	—	—	—	128	—
22.8 – 9.9	32	192	6	84	—
10.9 – 9.10	90	273	3	130	—
10.10–28.10	22	139	6	48	—
Totals ..	276	1,235	4·4	717	3,000

1d. COMPOSITION OF CATCHES AND WEIGHTS OF FISH FROM GILL NETS.

Fish	Percentages of species in inspected hauls	Range of length	Approximate weight of single specimen	Estimated totals caught in all hauls	Approximate total weights, i.e. product of columns 4 and 5
		cm.	gm.		kg.
Kayawa	10	15–32	450	300	135
Nchira	56	20–40	320	1,680	537
Kuyu	5	27–57	500	150	75
Kampango ..	10	24–83	500	300	150
Clarias spp. ..	4	20–102	500	120	60
Chiuwa	2	20–39	400	60	24
Tamba	3	20–40	300	90	27
Others	10	—	300	300	90
Total ..				3,000	

Approx. 1,100 kg.
= Approx. 2,420 lbs.
= Approx. 1 short ton.

1e. TRAP FISHING.

Period	No. fences inspected	No. fish caught in fences inspected	No. individual traps set	Estimated total fish caught by trap, i.e. column 4 multiplied by 6*
10.2 – 9.3	27	693	668	—
10.3 – 9.4	15	730	654	—
10.4 – 9.5	13	897	419	—
10.5 – 9.6	13	464	64	—
10.6 – 9.7	3	156	49	—
10.7 – 9.8	—	—	—	—
10.8 – 9.9	—	—	—	—
10.9 – 9.10	—	—	—	—
10.10–28.10	4	21	6	—
			26	—
Totals ..	75	2,961	1,886	11,000 approx.

* Average catch per individual trap = 6, according to Survey observations. (See Appendix VII, Table 2.)

1f. COMPOSITION OF CATCHES AND WEIGHTS OF FISH FROM TRAPS.

Fish	Percentages of species in inspected hauls	Range of length	Approximate weight of single specimen	Estimated totals caught in all hauls	Approximate totals weights, i.e. product of columns 4 and 5
		cm.	gm.		kg.
Kayawa	48	10–34	450	5,280	2,370
Nkututu	27	10–33	330	2,970	980
Nchila	4	23–42	320	440	140
Clarias sp. ..	2	38–72	1,000	220	220
Mlamba	4	17–58	350	440	154
Chiuwa	3	15–38	400	330	132
Tamba	3	19–39	300	330	99
Others	9	—	300	990	297
Total ..				11,000	

Approx. 4,000 kg.
= Approx. 8,800 lbs.
= Approx. 4 short tons.

1g. HAND-LINES AND LONG-LINES.

80 fish recorded between 10th September and 28th October : 7 Kampango, 40 Mlamba, 17 *Clarias*, and 16 Tamba.

2. SANI.

2a. SEINE FISHING.

Period	No. hauls inspected	Size of catch	Average catch per haul	No. seines cast in period	Estimated total fish caught, i.e. product of columns 4 and 5
6.2 – 5.3	25	15,304	612	60	—
6.3 – 5.4	21	16,218	772	48	—
6.4 – 5.5	18	8,992	499	28	—
6.5 – 5.6	—	—	—	35	—
6.6 – 5.7	13	1,731	133	32	—
6.7 – 5.8	16	4,385	274	31	—
6.8 – 5.9	11	2,366	215	79	—
6.9 – 5.10	18	14,505	805	52	—
6.10–27.10	18	1,351	75	53	—
Totals ..	140	64,852	463	418	Approx. 193,000

2b. COMPOSITION OF CATCHES AND WEIGHTS OF FISH FROM SEINE NETS.

Fish	Percentages of species in inspected hauls	Range of length	Approximate weight of single specimen	Estimated totals caught in all hauls	Approximate total weights, i.e. product of columns 4 and 5
		cm.	gm.		kg.
Kayawa	65	15–35	450	125,450	56,500
Ngwalu	17	18–34	450	32,810	14,800
Malolo	·4	23–40	780	772	602
Biliwili	·7	26–36	560	1,351	756
Chinkulu ..	5	28–38	560	9,650	5,404
Nkututu	1	17–36	330	1,930	636
Nchira	1	13–45	320	1,930	617
Kuyu	·1	21–50	1,500	193	196
Kampango ..	1	24–105	1,000	1,930	1,930
Mlamba	·1	20–69	350	193	67
Clarias spp. ..	·5	38–103	1,000	965	965
Chiuwa	·1	17–49	400	193	77
Mcheni	·1	12–41	200	193	38
Others	8	—	300	15,440	4,632
Total ..				193,000	

Approx. 86,000 kg.
= Approx. 189,200 lbs.
= Approx. 95 short tons.

2c. NATIVE GILL NETS.

Period	No. hauls inspected	Size of catch	Average catch per haul	No. nets cast in period	Estimated total fish caught, i.e. product of columns 4 and 5
6.2 – 5.3	—	—	—	5	—
6.3 – 5.4	—	—	—	12	—
6.4 – 5.5	—	—	—	3	—
6.5 – 5.6	—	—	—	7	—
6.6 – 5.7	64	469	7	116	—
6.7 – 5.8	57	593	10	231	—
6.8 – 5.9	6	34	5	175	—
6.9 – 5.10	21	263	12	141	—
5.10–28.10	—	—	—	7	—
Totals ..	148	1,359	9	697	Approx. 6,000

2d. COMPOSITION OF CATCHES AND WEIGHTS OF FISH FROM GILL NETS.

Fish	Percentages of species in inspected hauls	Range of length	Approximate weight of single specimen	Estimated totals caught in all hauls	Approximate total weights, i.e. product of columns 4 and 5
		cm.	gm.		kg.
Kayawa	18	16–33	450	1,080	486
Nchira	62	20–40	320	3,720	1,190
Kuyu	3	27–48	500	180	90
Kampango ..	10	31–67	500	600	300
Clarias spp. ..	1	32–96	500	60	30
Others	6	—	300	360	108
Total ..				6,000	

Approx. 2,000 kg.
= Approx. 4,400 lbs.
= Approx. 2 short tons.

2e. LONG-LINES AND HAND-LINES.

160 fish recorded between 6th February and 5th October : 77 Kampango, 34 Mlamba, and 49 *Clarias* spp.

3. FORT JOHNSTON. BAR.

3a. SEINE FISHING.

Period	No. hauls inspected	Size of catch	Average catch per haul	No. seines cast in period	Estimated total fish caught, i.e. product of columns 4 and 5
9.3 – 8.4	42	10,314	245	90	—
9.4 – 8.5	46	6,199	134	63	—
9.5 – 8.6	33	4,819	146	160	—
9.6 – 8.7	36	2,856	79	233	—
9.7 – 8.8	26	2,417	92	180	—
9.8 – 8.9	19	2,405	126	183	—
9.9 – 8.10	17	2,475	145	199	—
9.10–28.10	16	3,126	195	124	—
Totals ..	235	34,611	147	1,232	Approx. 181,000

3b. COMPOSITION OF CATCHES AND WEIGHTS OF FISH FROM SEINE NETS.

Fish	Percentages of species in inspected hauls	Range of length	Approximate weight of single specimen	Estimated totals caught in all hauls	Approximate total weights, i.e. product of columns 4 and 5
		cm.	gm.		kg.
Chambo	31	18–38	450	56,110	25,300
Kasawala ..					
Ching'anga ..	·6	20–35	450	1,086	488
Madole	1	25–38	780	1,810	1,411
Katukuzi ..	47	12–37	330	85,070	27,773
Nchira	7	11–42	320	12,670	4,054
Kasomela ..					
Kadyakola ..	·1	34–72	1,000	181	181
Kampango ..	·3	37–90	1,000	543	543
Mlamba	·1	33–70	350	181	63
Sungwa	·7	11–39	400	1,267	506
Mcheni	·2	10–37	200	362	72
Others	12	—	300	21,720	6,516
Total ..				181,000	

Approx. 66,000 kg.
= Approx. 145,200 lbs.
= Approx. 72 short tons.

4. SHIRE RIVER.

4a. SEINE FISHING.

Period	No. hauls inspected	Size of catch	Average catch per haul	No. seines cast in period	Estimated total fish caught, i.e. product of columns 4 and 5
4.3 – 3.4	44	2,467	56	160	—
4.4 – 3.5	41	7,603	185	249	—
4.5 – 3.6	38	10,744	282	205	—
4.6 – 3.7	39	8,295	212	214	—
4.7 – 3.8	23	1,035	45	210	—
4.8 – 3.9	20	377	18	181	—
4.9 – 3.10	34	2,111	62	219	—
4.10–27.10	23	3,805	165	245	—
Totals ..	262	36,437	139	1,683	Approx. 233,000

4b. COMPOSITION OF CATCHES AND WEIGHTS OF FISH FROM SEINE NETS.

Fish	Percentages of species in inspected hauls	Range of length	Approximate weight of single specimen	Estimated totals caught in all hauls	Approximate total weights, i.e. product of columns 4 and 5
		cm.	gm.		kg.
Chambo	} 78	11–36	450	181,740	76,330
Kasawala ..					
Ching'anga ..	1·5	21–35	450	3,496	1,468
Saka	·1	21–35	560	233	130
Mlangasime ..	1	21–37	560	2,330	1,300
Madole	·1	29–38	780	233	181
Katukuzi ..	11	11–36	330	25,630	8,457
Nchira	} 1	19–45	320	2,330	745
Kasomela ..					
Kadyakola ..	·05	39–53	1,500	116	58
Kampango ..	·3	17–76	1,000	699	699
Mlamba	·1	10–50	350	233	81
Clarias spp. ..	·05	15–96	1,000	116	116
Sungwa	·6	11–40	400	1,398	559
Tamba	·1	19–37	300	233	69
Mcheni	·1	10–40	200	233	46
Others	6	—	300	13,980	4,194
Total ..				233,000	

Approx. 94,000 kg.
— Approx. 206,800 lbs.
— Approx. 103 short tons.

5. LIKOMA.

CHILIMILA FISHING.

27th April to 4th July: 292 hauls were examined and amounted to 384 baskets of fish.

6. CATCHES FROM MEASURED SEINE NETS AT KOTA KOTA from 10th February, to 28th October.

Size of net	Number of nets inspected	Total catch	Average catch
1,400 × 20 feet	29	29,330	1,010
980 × 21 feet	12	1,786	149
870 × 17 feet	9	494	55
820 × 17 feet	27	3,910	145

APPENDIX IX.

SHOWING TYPES OF FISHING AND THE FISHING SEASON AT VARIOUS LOCALITIES.

Place	Length of beach	No. of large meshed seines	No. of small meshed seines	No. of chili-mila	No. of gill nets	No. of traps	Use of hooks and scoop nets	Main season	Method most used
Nkudzi Bay	1½ miles	9	—	—	Few	—	—	April to Dec.	Seine.
Che-Linda	2 miles	6	—	—	?	Few	Use H.	Feb. to April	Seine.
Monkey Bay	Small scattered beaches	20	—	—	—	Few	Use H.	—	—
Old Livingstonia	1 mile	Many	6	—	Few	—	Use H. & S.	April to Aug.	Seine.
Marembo ..	Very small	4	1	—	4	—	Use H.	May to Dec.	Seine.
Chipoka ..	1 mile	7	—	—	?	?	Use S. ? H.	—	Seine.
Salima ..	4 miles	? 16	—	—	Few	Few	Use H.	Oct. to March	Seine.
Makanjila ..	Very small	—	—	—	Many	100	Use H.	Dec. to Feb.	Traps.
Mkumbaleza	3 miles	Very many	—	—	—	—	—	Oct. to Jan.	Seine.
Kota Kota	2 miles	26	—	—	Many	Many	Use H.	Nov. to Feb.	Seine.
Sani ..	2 miles	16	—	—	—	—	Use H.	—	Seine.
Bana ..	1 mile	7	—	—	?	Few	?	Nov. to Feb.	Seine.
Nkata Bay	250 yards	1	—	6	Few	—	Use H.	March to Aug.	Chilimila.
Usisya Bay	2 miles	5	—	20	Many	—	Use H.	Sept. to March	Chilimila.
Ruarwe ..	300 yards	1	—	6	Many	—	Use H.	Indef.	Chilimila.
Florence Bay	¼ mile	20	—	Few	Few	—	Use H.	June, July	Seine.
Karonga .. (Kambwe lagoon and Rukuru)	Very small scattered	4	—	—	Few	100 (river)	Use S. in river	Dec. to March	Traps.
Mwaya ..	1 mile	10	—	—	Few	Few	Use H.	Aug. to Dec.	Seine.
Deep Bay ..	¾ mile (spoiled)	2 medium length. Many small	—	6	4	—	Use H.	Sept. to Jan.	Chilimila.
Mbaha ..	¼ mile	—	5	—	4	Few	Use H.	Aug. to Sept.	Seine.
Njambe ..	300 yards	—	3	—	Few	?	?	Indef.	Seine.
Liuli ..	¼ mile	Few	Few	Many	Few	—	Use H.	Nov. to Feb.	Chilimila.
Mbampa Bay	¾ mile	8	—	6	Many	—	Use H.	Oct. to Feb.	Seine.
Chiwindi ..	No beach	—	—	Few	Few	Few (open water)	Use H.	Indef.	Chilimila.
Limbaula ..	No beach	—	—	—	Few	—	—	Indef.	Gill net.
Kobwe ..	4 miles	8	Many	—	Many	10 (open water) few (river)	Use H.	April to May (utaka) Dec. (general)	Seine.

APPENDIX IX—*continued.*

Place	Length of beach	No. of large meshed seines	No. of small meshed seines	No. of chili-mila	No. of gill nets	No. of traps	Use of hooks and scoop nets	Main season	Method most used
Likoma ..	Many stretches of 50 to 100 yards	Few	Many	Very many	?	—	Use H.	Indef.	Chilimila.
Ngo ..	2 miles	1	3	—	Few	—	Use H.	July to Dec.	Seine.
Msumba ..	Spoiled	—	Few	—	Few	22 (river)	Use H.	March to May	Traps.
Mtengula ..	200 yards	Few	—	Few	Few	18 (river)	Use H.	Indef.	Chilimila.
Mluluka ..	Spoiled	—	—	4	Many	—	Use H.	Indef.	Chilimila.
Chilowelo ..	70 yards	—	3	1	12	Many (river)	Use H. & S. (river)	June to Feb.	Seine.
Fort Maguire	½ mile	—	4	—	Few	—	Use H.	May to June	Seine.

APPENDIX X.

CATCHES FROM GILL NETS.

SIZE OF CATCHES.

	5″	4″	3″	2″
1. Malonda.				
Number of sets	32	29	28	23
Number of fish caught	139	257	454	395
Average number of fish per set ..	4·3	8·9	16·2	17·0
Average weight of fish per set ..	6·4 kg.	7·9 kg.	5·3 kg.	1·3 kg.
Number of fish per square yard ..	·022	·045	·082	·25
2. Monkey Bay.				
Number of sets	8	9	9	9
Number of fish caught	60	98	206	313
Average number of fish per set ..	7·5	10·9	22·8	34·7
Average weight of fish per set ..	11·0 kg.	10·0 kg.	8·4 kg.	2·9 kg.
Number of fish per square yard ..	·038	·055	·11	·52
3. Kota-Kota.				
Number of sets	17	18	17	21
Number of fish caught	74	173	288	308
Average number of fish per set ..	4·3	9·6	16·9	14·6
Average weight of fish per set ..	7·1 kg.	7·3 kg.	2·9 kg.	0·7 kg.
Number of fish per square yard ..	·02	·048	·085	·22

APPENDIX X—*continued.*

COMPOSITION OF CATCHES.

4. Malonda.

		5″	4″	3″	2″
Chambo ..	Number	3	19	19	1
	Average length and weight	31 cm. 550 gm.	28 cm. 378 gm.	20 cm. 220 gm.	—
	Range ,,	29 cm. 390 gm. – 33 cm. 630 gm.	26 cm. 340 gm. – 32 cm. 620 gm.	18 cm. 100 gm. – 26 cm. 350 gm.	— – 16 cm. 100 gm.
Madole ..	Number	16	1	—	—
	Average length and weight	35 cm. 863 gm.	—	—	—
	Range ,,	33 cm. 700 gm. – 39 cm. 1·1 kg.	37 cm. 1·0 kg.	—	—
Nkututu ..	Number	—	—	1	—
	Average length and weight	—	—	—	—
	Range ,,	—	—	21 cm. 110 gm.	—
Nchira Mbununu	Number	2	38	184	58
	Average length and weight	—	39 cm. 764 gm.	30 cm. 364 gm.	21 cm. 123 gm.
	Range ,,	38 cm. 680 gm. – 39 cm. 740 gm.	32 cm. 400 gm. – 44 cm. 1·1 kg.	22 cm. 100 gm. – 37 cm. 590 gm.	19 cm. 70 gm. – 24 cm. 130 gm.
Kuyu ..	Number	3	9	17	2
	Average length and weight	42 cm. 1·2 kg.	43 cm. 1·1 kg.	36 cm. 465 gm.	—
	Range ,,	40 cm. 1·2 kg. – 46 cm. 1·4 kg.	39 cm. 800 gm. – 52 cm. 1·9 kg.	28 cm. 220 gm. – 52 cm. 1·6 kg.	—
Panda ..	Number	7	46	16	3
	Average length and weight	46 cm. 965 gm.	42 cm. 803 gm.	35 cm. 283 gm.	27 cm. 215 gm.
	Range ,,	37 cm. 620 gm. – 55 cm. 1·4 kg.	37 cm. 450 gm. – 48 cm. 840 gm.	27 cm. 160 gm. – 42 cm. 470 gm.	22 cm. 70 gm. – 37 cm. 360 gm.
Kampango ..	Number	65	97	71	3
	Average length and weight	55 cm. 1·5 kg.	50 cm. 1·2 kg.	37 cm. 460 gm.	38 cm. 641 gm.
	Range ,,	37 cm. 340 gm. – 75 cm. 3·6 kg.	38 cm. 450 gm. – 65 cm. 2·7 kg.	31 cm. 290 gm. – 57 cm. 1·7 kg.	28 cm. 140 gm. – 56 cm. 1·6 kg.
Clarias spp...	Number	22	26	9	1
	Average length and weight	65 cm. 2·5 kg.	52 cm. 1·1 kg.	40 cm. 454 gm.	—
	Range ,,	47 cm. 620 gm. – 96 cm. 6·9 kg.	48 cm. 610 gm. – 72 cm. 2·4 kg.	36 cm. 330 gm. – 44 cm. 660 gm.	25 cm. 100 gm.
Sanjika ..	Number	0	0	1	2
	Average length and weight	—	—	—	—
	Range ,,	—	—	33 cm. 330 gm.	22 cm. 100 gm. – 24 cm. 150 gm.
Mpasa ..	Number	2	4	2	2
	Average length and weight	—	52 cm. 1·4 kg.	—	—
	Range ,,	62 cm. 2·0 kg. – ?	48 cm. 1·0 kg. – 58 cm. 1·9 kg.	38 cm. ? – 52 cm. 1·6 kg.	27 cm. 120 gm. – 29 cm. 150 gm.
Chiuwa ..	Number	2	2	0	0
	Average length and weight	—	—	—	—
	Range ,,	33 cm. 460 gm. – 39 cm. 480 gm.	33 cm. 490 gm. – 38 cm. 590 gm.	—	—
Tamba ..	Number	0	0	13	6
	Average length and weight	—	—	33 cm. 332 gm.	23 cm. 106 gm.
	Range ,,	—	—	29 cm. 230 gm. – 38 cm. 450 gm.	22 cm. 100 gm. – 24 cm. 120 gm.

COMPOSITION OF CATCHES—*continued.*

4. Malonda—*continued.*

		5″	4″	3″	2″
Mcheni ..	Number	0	3	9	4
	Average length and weight	—	33 cm. 430 gm.	34 cm. 390 gm.	26 cm. 207 gm.
	Range ,,	—	27 cm. 310 gm.	30 cm. 270 gm.	20 cm. 100 gm.
		—	38 cm. 620 gm.	41 cm. 800 gm.	32 cm. 280 gm.
Nkupe ..	Number	2	1	14	2
	Average length and weight	—	—	39 cm. 393 gm.	—
	Range ,,	58 cm. 1·1 kg.	56 cm. 1·1 kg.	28 cm. 170 gm.	28 cm. 120 gm.
		78 cm. 2·2 kg.	—	45 cm. 600 gm.	45 cm. 480 gm.
Other species	Number	13	13	98	311
Total all species		137	259	454	395

5. Monkey Bay.

		5″	4″	3″	2″
Chambo ..	Number	4	—	10	—
	Average length and weight	34 cm. 755 gm.	—	19 cm. 139 gm.	—
	Range ,,	34 cm. 710 gm.	—	18 cm. 70 gm.	—
		35 cm. 800 gm.	—	21 cm. 180 gm.	—
Madole ..	Number	29	—	—	—
	Average length and weight	35 cm. 814 gm.	—	—	—
	Range ,,	33 cm. 700 gm.	—	—	—
		37 cm. 1·0 kg.	—	—	—
Nkututu ..	Number	—	—	—	—
	Average length and weight	—	—	—	—
	Range ,, ..	—	—	—	—
Nchira Mbununu	Number	1	4	28	52
	Average length and weight	—	40 cm. 855 gm.	30 cm. 370 gm.	23 cm. 142 gm.
	Range ,,	35 cm. 480 gm.	39 cm. 740 gm.	22 cm. 140 gm.	20 cm. 100 gm.
		—	42 cm. 900 gm.	35 cm. 650 gm.	27 cm. 220 gm.
Kuyu ..	Number	2	6	1	0
	Average length and weight	—	39 cm. 746 gm.	—	—
	Range ,,	41 cm. 1·0 kg.	38 cm. 600 gm.	39 cm. 800 gm.	—
		47 cm. 1·4 kg.	43 cm. 1·0 kg.	—	—
Panda ..	Number	5	30	30	29
	Average length and weight	48 cm. 930 gm.	43 cm. 653 gm.	29 cm. 230 gm.	21 cm. 101 gm.
	Range ,,	41 cm. 550 gm.	37 cm. 450 gm.	25 cm. 160 gm.	17 cm. 60 gm.
		51 cm. 1·3 kg.	50 cm. 1·0 kg.	40 cm. 500 gm.	25 cm. 130 gm.
Kampango ..	Number	14	41	58	27
	Average length and weight	57 cm. 2·0 kg.	49 cm. 1·2 kg.	39 cm. 543 gm.	31 cm. 297 gm.
	Range ,,	46 cm. 900 gm.	37 cm. 480 gm.	33 cm. 260 gm.	26 cm. 110 gm.
		62 cm. 2·7 kg.	64 cm. 2·5 kg.	66 cm. 3·0 kg.	42 cm. 630 kg.
Clarias spp...	Number	4	10	16	2
	Average length and weight	77 cm. 3·4 kg.	49 cm. 884 gm.	38 cm. 436 gm.	—
	Range ,,	64 cm.	44 cm. 670 gm.	34 cm. 250 gm.	39 cm. 460 gm.
		96 cm. 6·5 kg.	54 cm. 1·2 kg.	47 cm. 850 gm.	54 cm. 1·0 kg.

COMPOSITION OF CATCHES—*continued.*

5. Monkey Bay—*continued.*

		5″	4″	3″	2″
Sanjika ..	Number	0	0	0	0
Mpasa ..	Number	0	0	0	0
Chiuwa ..	Number	0	1	0	0
	Average length and weight	—	—	—	—
	Range ,, ..	—	34 cm. 510 gm.	—	—
Tamba ..	Number	0	0	12	2
	Average length and weight	—	—	32 cm. 356 gm.	—
	Range ,,	—	—	27 cm. 200 gm.	21 cm. 100 gm.
		—	—	35 cm. 450 gm.	25 cm. 150 gm.
Mcheni ..	Number	0	2	5	1
	Average length and weight	—	—	31 cm. 348 gm.	—
	Range	—	37 cm. 670 gm.	30 cm. 270 gm.	14 cm. ?
		—	42 cm. 710 gm.	35 cm. 450 gm.	—
Nkupe ..	Number	0	2	15	2
	Average length and weight	—	—	45 cm. 494 gm.	—
	Range ,,	—	57 cm. 1·0 kg.	39 cm. 350 gm.	28 cm. 150 gm.
		—	59 cm. 1·1 kg.	50 cm. 620 gm.	40 cm. 420 gm.
Other species	Number	1	2	31	198
Total all species		60	98	206	313

6. KOTA KOTA.

		5″	4″	3″	2″
Chambo ..	Number	4	21	15	7
	Average length and weight	28 cm. 410 gm.	27 cm. 362 gm.	18 cm. 112 gm.	15 cm. ?
	Range ,,	25 cm. 300 gm.	25 cm. 240 gm.	10 cm. 50 gm.	13 cm. ?
		33 cm. 650 gm.	29 cm. 560 gm.	21 cm. 160 gm.	21 cm. 180 gm.
Nkututu ..	Number	1	13	2	—
	Average length and weight	—	27 cm. 352 gm.	—	—
	Range ,,	—	26 cm. 140 gm.	20 cm. 130 gm.	—
		33 cm. 650 gm.	30 cm. 450 gm.	26 cm. 330 gm.	—
Malolo .. (Madole)	Number	—	—	—	—
	Average length and weight	—	—	—	—
	Range ,, ..	—	—	—	—
Nchira Mbununu	Number	1	3	4	13
	Average length and weight	—	30 cm. 336 gm.	30 cm. 320 gm.	21 cm. 107 gm.
	Range ,,	35 cm. 590 gm.	27 cm. 210 gm.	28 cm. 270 gm.	20 cm. 80 gm.
		—	32 cm. 400 gm.	32 cm. 390 gm.	24 cm. 140 gm.
Kuyu ..	Number	28	30	4	0
	Average length and weight	47 cm. 1·5 kg.	40 cm. 940 gm.	36 cm. 667 gm.	—
	Range ,,	42 cm. 1·0 kg.	29 cm. 270 gm.	30 cm. 260 gm.	—
		54 cm. 2·1 kg.	49 cm. 1·9 kg.	49 cm. 1·5 kg.	—
Panda ..	Number	9	22	8	0
	Average length and weight	51 cm. 1·1 kg.	43 cm. 627 gm.	34 cm. 306 gm.	—
	Range ,,	47 cm. 800 gm.	28 cm. 140 gm.	29 cm. 190 gm.	—
		57 cm. 1·3 kg.	57 cm. 1·2 kg.	40 cm. 580 gm.	—

6. Kota Kota—*continued.* COMPOSITION OF CATCHES—*continued.*

		5″	4″	3″	2″
Kampango ..	Number	19	46	13	2
	Average length and weight	62 cm. 2·7 kg.	50 cm. 978 gm.	42 cm. 573 gm.	—
	Range ,,	57 cm. 1·6 kg.	43 cm. 550 gm.	37 cm. 390 gm.	24 cm. 80 gm.
		95 cm. 9·5 kg.	61 cm. 2·0 kg.	48 cm. 950 gm.	26 cm. 120 gm.
Clarias spp...	Number	3	16	19	3
	Average length and weight	59 cm. 1·5 kg.	51 cm. 1·1 kg.	39 cm. 389 gm.	—
	Range ,,	56 cm. 1·4 kg.	45 cm. 650 gm.	32 cm. 190 gm.	30 cm. 160 gm.
		63 cm. 1·9 kg.	91 cm. 5·7 kg.	44 cm. 540 gm.	34 cm. 240 gm.
Sanjika ..	Number	0	0	0	0
Mpasa ..	Number	0	0	0	0
Chiuwa ..	Number	3	5	2	0
	Average length and weight	39 cm. 860 gm.	33 cm. 502 gm.	—	—
	Range ,,	39 cm. 830 gm.	30 cm. 400 gm.	23 cm. 100 gm.	—
		40 cm. 900 gm.	35 cm. 680 gm.	25 cm. 160 gm.	—
Tamba ..	Number	—	6	49	40
	Average length and weight	—	39 cm. 648 gm.	31 cm. 304 gm.	24 cm. 109 gm.
	Range ,,	—	38 cm. 600 gm.	27 cm. 200 gm.	20 cm. 60 gm.
			41 cm. 750 gm.	35 cm. 450 gm.	28 cm. 300 gm.
Mcheni ..	Number	1	1	8	1
	Average length and weight	—	—	30 cm. 281 gm.	—
	Range ,,	29 cm. 250 gm.	35 cm. 440 gm.	29 cm. 250 gm.	22 cm. 90 gm.
		—	—	32 cm. 350 gm.	—
Nkupe ..	Number	4	6	2	0
	Average length and weight	70 cm. 1·8 kg.	54 cm. 975 gm.	44 cm. 490 gm.	—
	Range ,,	61 cm. 1·2 kg.	53 cm. 900 gm.	43 cm. 480 gm.	—
		77 cm. 2·4 kg.	56 cm. 1·0 kg.	45 cm. 500 gm.	—
Other species	Number	1	9	162	242
Total all species	.. ..	74	178	288	308

SUMMARY OF CATCHES.

	5″		4″		3″		2″	
	%	Actual	%	Actual	%	Actual	%	Actual
7. Malonda.								
Non-predators*	22	31	43	113	52	237	16	64
Predators ..	68	93	51	133	26	119	5	20
Total all species		137		259		454		395
8. Monkey Bay.								
Non-predators ..	69	41	40	40	33	69	26	81
Predators ..	30	18	57	56	51	106	11	34
Total all species		60		98		206		313
9. Kota Kota.								
Non-predators ..	58	43	50	89	12	33	6	20
Predators ..	40	30	45	80	32	93	15	46
Total all species		74		178		288		308

* Only the more important species are considered.

10. NATIVE SEINE NETS.*

	Kota Kota		Sani		F. Johnston (Shire)		F. Johnston (Bar)	
	%	Actual	%	Actual	%	Actual	%	Actual
Larger non-predators ..	89	35,509	89	50,192	93	34,076	86	28,870
Larger predators ..	5	1,836	2	1,145	1	520	1	523
Total all species ..		39,697		55,860		36,437		—

11. NATIVE TRAPS.*

Larger non-predators ..	79	2,333	—	—	—	—	—	—
Larger predators ..	12	367	—	—	—	—	—	—
Total all species ..		2,959		—		—		—

12. NATIVE GILL NETS.*

Larger non-predators ..	71	880	83	1,134	—	—	—	—
Larger predators ..	18	225	12	161	—	—	—	—
Total all species ..		1,235		1,359		—		—

* Data from Appendix VIII.

13. CATCHES FROM MEASURED GILL NETS.*

	Kayawa	Nchira	Kuyu	Kampango	*Clarias*
Number	9	14	5	7	6
Average length	26·6	33·7	40	54	47
Range length	24–35	27–37	35–52	39–83	35–80

	Mpasa	Chiuwa	Tamba	Mcheni	Other Species
Number	1	1	1	1	16
Average length	—	—	—	—	—
Range length	41	36	34	35	—

Total all species	61
Total of sets	6
Average number fish per set	10
Average area per set	30 sq. yds.
Average number fish per square yard	·34

*Nets measured by J.B., but catches recorded by native clerk.

14. CATCHES FROM LONG LINES.

Station	No. hooks	Bait	*Bagrus*			*Clarias* spp.			Total number fish caught
			No. caught	Range length	Range weight	No. caught	Range length	Range weight	
16	7	— ..				—	—	—	
58	34	Chicken ..	1	68 cm.	—	—	—	—	1
61	34	Fish ..	—	—	—	—	—	—	—
71	34	,, ..	—	—	—	1	33 cm.	250 gm.	1
73	34	— ..	—	—	—	7	48–72 cm.	—	7
107	30	Fish ..	—	—	—	10	—	—	10
129	28	— ..	1	56 cm.	1·3 kg.	2	64–74 cm.	1·9–2·7 kg.	4*
141	28	Fish ..	—	—	—	1	—	—	1
144	28	— ..	1	68 cm.	2·6 kg.	3	58–72 cm.	1·3–2·2 kg.	4
153	28	Fish ..	—	—	—	—	—	—	—
170	30	,, ..	—	—	—	2	54–69 cm.	1·1–2·4 kg.	2
180	30	,, ..	—	—	—	3	56–79 cm.	1·0–3·2 kg.	3
190	30	,, ..	—	—	—	1	52 cm.	1·0 kg.	1
193	30	,, ..	—	—	—	—	—	—	—
231	27	— ..	—	—	—	4	52–78 cm.	1·0–3·3 kg.	4
236	—	— ..	1	54 cm.	1·0 kg.	3	46–59 cm.	·7–1·5 kg.	4
237	24	— ..	—	—	—	—	—	—	1†
251	27	Fish ..	—	—	—	3	47–91 cm.	·67–5·25 kg.	3
266	27	,, ..	—	—	—	1	62 cm.	1·6 kg.	1
282	27	,, ..	—	—	—	1	42 cm.	·54 kg.	1
284	27	,, ..	—	—	—	2	42–65 cm.	·35–1·9 kg.	2
289	27	,, ..	—	—	—	2	45–47 cm.	·5–·65 kg.	2
291	27	,, ..	1	81 cm.	6·1 kg.	1	92 cm.	4·4 kg.	2
296	27	,, ..	—	—	—	—	—	—	—
300	27	,, ..	1	72 cm.	6·0 kg.	—	—	—	1
303	27	— ..	—	—	—	—	—	—	—
309	27	Fish ..	—	—	—	3	42–93 cm.	·46–6·1 kg.	3
315	27	,, ..	—	—	—	—	—	—	—
						4	43–55 cm.	·45–·99 kg.	4
			6	54–81 cm.	1·0-6·1 kg.	54	33–93 cm.	·25–6·1 kg.	62

* One *Barbus johnstoni* of 40 cm. and 550 gm.
† One turtle.

CURING METHODS.

A. NATIVE METHOD.

Experimental No.	1	2a	2b	3	4	5
Species ..	**Labeo mesops*	*Bagrus*	*Clarias mossambicus*	†*Bagrus*	*Tilapia squamipinnis*	*Tilapia shirana*
Date of capture	14.6	20.6	20.6	29.6	29.6	13.7 ‡
Length ..	33 cms.	49 cms.	50 cms.	53 cms.	26 cms.	—
Weight ..	416 gms.	1·1 kg.	900 gms.	1·35 kg.	350 gms.	—
Weight when gutted ..	—	1 kg.	—	1·05 kg.	250 gms.	—
% previous weight lost ..	—	10%	—	22%	28%	—
Period fire drying ..	30 min.	15 min.	15 min.	15 min.	15 min.	15 min.
Weight after fire drying ..	253 gm.	—	—	730 gm.	200 gm.	—
% previous weight lost ..	—	—	—	30%	20%	—
Period sun drying ..	50 hrs.	33 hrs.	33 hrs.	100 hrs.	100 hrs.	42 hrs.
Weight after sun drying ..	103 gms.	—	—	320 gms.	80 gms.	—
% previous weight lost ..	59%	—	—	56%	60%	—
Date storing ..	21.6	—	—	18.7	18.7	20.7
Inspected after	24 days	—	—	—	—	—
Weight on inspection ..	87 gms.	—	—	—	—	—
% previous weight lost ..	15%	—	—	—	—	—
Date final inspection ..	24.7	—	—	24.7	24.7	24.7
Total period under observation ..	41 days	—	—	26 days	26 days	10 days
Remarks ..	Satisfactory on final inspection	Maggots developed during sun-drying. Fish destroyed	As for No. 2a.	Satisfactory on final inspection	Satisfactory on final inspection	Fish bought from native fisherman, hence no details of weights. Fairly satisfactory on final inspection but rather oily

* 3 specimens. Figures of weights are averages.
† 2 specimens. Figures of weights are averages.
‡ Two days elapsed between capture and start of curing.

B. DRY SALTING AND SUN-DRYING.

Experimental No.	A.1	A.1a	A.1b	A.2a	A.2b	A.3
Species ..	*Bagrus*	*Tilapia squamipinnis*	*Tilapia squamipinnis*	*Bagrus*	*Clarias* sp.	*Labeo mesops*
Date capture ..	15.6	15.6	15.6	16.6	16.6	4.7
Length ..	56 cms.	32 cms.	32 cms.	48 cms.	41 cms.	32 cms.
Weight ..	1·5 kg.	600 gms.	440 gms.	480 gms.	500 gms.	390 gms.
Weight when gutted ..	1·4 kg.	520 gms.	390 gms.	400 gms.	400 gms.	310 gms.
% previous weight lost	6%	13%	11%	16%	20%	20%
*Approx. weight salt used ..	80 gms.	50 gms.	50 gms.	24 gms.	24 gms.	?
Period in sun ..	47 hours	47 hours	47 hours	46 hours	46 hours	100 hours
Weight after sun-drying ..	620 gms.	140 gms.	200 gms.	160 gms.	150 gms.	100 gms.
% previous weight lost ..	56%	73%	49%	60%	62%	68%
Date storing ..	21.6	21.6	21.6	21.6	21.6	18.7
Inspected after	24 days	24 days	24 days	24 days	24 days	—
Weight on inspection ..	520 gms.	120 gms.	180 gms.	140 gms.	120 gms.	—
% previous weight lost ..	16%	14%	10%	12%	15%	—
Date of final inspection ..	24.7	24.7	24.7	24.7	24.7	24.7
Period under observation	40 days	40 days	40 days	39 days	39 days	21 days
Remarks ..	Satisfactory. Very slightly oily. Sent to I.I. for analysis	Satisfactory. Dry and hard. Sent to I.I. for analysis	As for A.1a	Hard and dry. Satisfactory. Sent to I. I. for analysis	Hard and dry, and satisfactory on 15.7, but developed slight surface mould by 24.7. Destroyed	Satisfactory condition on 24.7. Sent to I.I. for analysis

* Naturally not all the salt used was absorbed by the fish.

C. LIGHT SALTING FOLLOWED BY SMOKING.

Experimental No.	B.1	B.2	B.3
Species	*Tilapia shirana*	*Bagrus*	*Bagrus*
No. fish	4	2	1
Date capture	11.7	11.7	18.7
Average length	27 cms.	49 cms.	40 cms.
Average weight	347 gms.	1·07 kg.	530 gms.
Average weight prepared ..	295 gms.*	740 gms.*	460 gms.†
% previous weight lost ..	15%	30%	13%

* Fish both gutted and decapitated.
† Backbone and viscera removed but not decapitated.

C. LIGHT SALTING FOLLOWED BY SMOKING—*continued.*

Experimental No.	B.1	B.2	B.3
Species	*Tilapia shirana*	*Bagrus*	*Bagrus*
‡Length of brining	3 hours	3 hours	2½ hours
Period drained in sun ..	¼ hour	¼ hour	¾ hour
§Period smoked	24 hours	20 hours	60 hours
Fuel	Green wood	Green wood	Rice husk
Date stored	13.7	13.7	24.7
Date final inspection ..	24.7	24.7	24.7
Weight at final inspection ..	—	—	110 gms.
% previous weight lost ..	—	—	76%
Period under observation	14 days	14 days	7 days
Remarks	Satisfactory on final inspection. Sent to I. I. for analysis	As for B1	As for B.1.

‡ Concentration of brine 2 quarts salt to 4 gals. water.
§ Smoking not continuous. Figures given represent approximate total exposure to smoke.

D. IMMERSION IN BOILING WATER AND SUN-DRYING.

Experimental No.	C.1	C.2	C.3	C.4
Species	*Bagrus*	*Bagrus*	*Clarias mossambicus*	*Bagrus*
Date capture	16.6	17.6	17.6	17.6
Length	—	46 cms.	47 cms.	46 cms.
Weight	1·1 kg.	770 gms.	670 gms.	810 gms.
Weight when gutted	1·0 kg.	620 gms.	580 gms.	700 gms.
% previous weight lost ..	9%	19%	13%	13%
Time in boiling water ..	1½ minutes	1 minutes	1 minute	½ minute
Conc. salt (gm./litre)	30 gms.	30 gms.	30 gms.	30 gms.
Period in sun	46 hours	43 hours	34 hours	28 hours
Weight after sun	320 gms.	—	250 gms.	—
% previous weight lost ..	68%	—	57%	—
Date storing	21.6	—	21.6	—
Inspected after	24 days	—	—	—
Weight on inspection	250 gms.	—	—	—
% previous weight lost ..	22%	—	—	—
Date final inspection	24.7	—	24.7	—
Period under observation ..	39 days	—	38 days	—
Remarks	Hard and dry on final inspection. Satisfactory. Sent to I.I. for analysis	Maggots appeared during sun-drying. Fish destroyed	Maggots appeared during the period of storing, and were removed (23.6). After this the fish remained satisfactory up to final inspection. Sent to I.I.for analysis	Maggots appeared during the period of sun-drying, and fish was destroyed

Experimental No. ..	C.6	C.10a	C.10b	C.11a	C.11b
Species	*Bagrus*	*Clarias mossambicus*	*Bagrus*	*Bagrus*	*Clarias mossambicus*
Date capture	22.6	24.6	24.6	24.6	24.6
Length	47 cms.	50 cms.	47 cms.	47 cms.	49 cms.
Weight	920 gms.	840 gms.	910 gms.	910 gms.	700 gms;
Weight when gutted ..	840 gms.	750 gms.	800 gms.	800 gms.	640 gms.
% previous weight lost ..	8%	10%	—	—	—
Time in boiling water ..	½ min.	½ min.	½ min.	½ min.	½ min.
Con. salt (gm./litre) ..	60 gms.	90 gms.	90 gms.	150gms.	150 gms.
Period in sun	70 hours	79 hours	79 hours	79 hours	79 hours
Date storing	30.6	1.7	1.7	1.7	1.7
Date final inspection ..	24.7	24.7	24.7	24.7	24.7
Period under observation	33 days	31 days	31 days	31 days	31 days
Remarks	Maggots appeared during the sun drying and were removed. Fish seemed satisfactory on 24.7. Sent to I. I. for analysis	Maggots appeared during sundrying (26.6) and were removed. Fish subsequently satisfactory but slight traces of mould on surface on 24.7. Destroyed	As for C.10a	Maggots appeared during period of sun drying and were removed. Fish subsequently seemed satisfactory on 24.7. Sent to I. I. for analysis	As for C.10a

E.1. IMMERSION IN BOILING WATER FOLLOWED BY SUN-DRYING AND SMOKING.

Experimental No... ..	C.13a	C.13b
Species	*Bagrus*	*Clarias mossambicus*
Date of capture	18.7	18.7
Length	55 cms.	44 cms.
Weight	1·6 kg.	540 gms.
*Weight when gutted and prepared..	1·3 kg.	460 gms.
% previous weight lost ..	18%	14%
Time in boiling water ..	½ min.	½ min.
Conc. of salt (gm./litre) ..	30 gms.	30 gms.
Period in sun	16 hours	16 hours
Date smoking	20.7	20.7
Remarks	A few minutes after smoking started maggots hatched out. These were killed by the smoking, but fish was found to have started to putrefy internally and was destroyed	As for C.13a

* In these experiments the backbone as well as the viscera was removed.

E.2. IMMERSION IN BOILING WATER FOLLOWED BY SMOKING AND SUN-DRYING.

Experimental No.	C.5
Species	*Bagrus*
Date of capture	20.6
Length	70 cms.
Weight	3·5 kg.
Weight when gutted ..	2·7 kg.
% previous weight lost ..	22%
Time in boiling water ..	¾ min.
Conc. of salt (g./litre) ..	30 gms.
Period of smoking ..	5 hours
Date placed in sun ..	21.6
Period in sun	18 hours
Remarks	Maggots developed during period of sun-drying. Fish destroyed

Experimental No.	C.12a	C.12b	C.15
Species	*Clarias mossambicus*	*Bagrus*	*Clarias mossambicus*
Date capture	24.6	24.6	21.7
Length	52 cms.	52 cms.	55 cms.
Weight	1·1 kg.	1·1 kg.	990 gms.*
Weight when gutted	912 gms.	1·0 kg.	850 gms.
% previous weight lost ..	17%	9%	14%*
Time in boiling water	½ min.	½ min.	½ min.
Conc. of salt (gm./litre) ..	90 gms.	90 gms.	30 gms.
Period smoking	9·75 hours	9·75 hours	40 hours
Fuel	Green wood	Green wood	Rice husk
Weight after smoking ..	520 gms.	610 gms.	220 gms.
% previous weight lost ..	42%	39%	73%
Date storing	24.6	24.6	24.7

* In this experiment the backbone, as well as the viscera, was removed.

E.2. IMMERSION IN BOILING WATER FOLLOWED BY SMOKING AND SUN-DRYING—*continued.*

Experimental No.	C.12a	C.12b	C.15
Species	*Clarias mossaDbicus*	*Bagrus*	*Clar as mossambicus*
Inspected after	21 days	21 days	—
Weight on inspection	250 gms.	290 gms.	—
% previous weight lost	52%	52%	—
Final inspection	24.7	24.7	24.7
Period under observation	31 days	31 days	4 days
Remarks	Satisfactory except for traces of mould by backbone. Seen on 15.7. Still present on 24.7 when fish destroyed	As for C.12a	Satisfactory. Hard and dry. Sent to I. I. for analysis

F. IMMERSION IN BOILING WATER FOLLOWED BY SMOKING.

Experimental No.	C.7	C.8	C.9
Species	*Bagrus*	*Bagrus*	*Clarias mossambicus*
Date of capture	22.6	22.6	22.6
Length	57 cms.	51 cms.	56 cms.
Weight	1·6 kg.	900 gms.	1·4 kg.
Weight when gutted	1·4 kg.	810 gms.	1·2 kg.
% previous weight lost	12%	10%	14%
Time in boiling water	½ min.	½ min.	½ min.
Conc. of salt (gm./litre)	30 gms.	30 gms.	30 gms.
Period smoking	23 hours	23 hours	23 hours
Fuel	Green wood	Green wood	Green wood
Weight after smoking	590 gms.	340 gms.	450 gms.
% previous weight lost	58%	58%	62%
Date storing	24.6	24.6	24.6
Inspected after	21 days	21 days	21 days
Weight on inspection	400 gms.	250 gms.	330 gms.
% previous weight lost	32%	26%	26%
Date final inspection	24.7	24.7	24.7
Period under observation	33 days	33 days	33 days
Remarks	Satisfactory on final inspection except for slight trace of mould by backbone. Sent to I. I. for analysis	Satisfactory on final inspection. Sent to I. I. for analysis	Satisfactory. As for C.8

APPENDIX XII.

FISHING RULES.

Made by the Governor in Council under Section 3 of Cap. 70. The Laws of Nyasaland. (The Game Ordinance.) Promulgated by Government Notice 13 of 1931.

1. These rules may be cited as the Fishing Rules and shall apply to the waters of the Shire and Ruo Rivers and to the waters of all other permanent rivers entering Lake Nyasa for a distance of two miles from the mouths of such rivers. The Governor in Council may, by notice in the *Gazette*, extend the application of these rules to any other fresh water lakes, rivers or streams in the Protectorate as he may deem fit.

2. No non-native shall fish for purposes of trade or commerce without a permit first obtained from the Provincial Commissioner. Application for any such permit shall be made through the District Commissioner and may be granted for such period and subject to such conditions and restrictions as the Provincial Commissioner may deem fit to impose provided that any person to whom a permit has been refused may appeal to the Governor, whose decision shall be final.

3. The District Commissioner may in any case of emergency withdraw any permit granted under rule 2 hereof provided he shall forthwith report such withdrawal together with his reasons therefor to the Provincial Commissioner, who may make such order as he may deem fit.

4. Any person may fish with rod or hand line for purposes of sport provided that in so doing he shall not interfere in any wise with native fishing. The District Commissioner may prohibit such fishing in any place or area where he has reason to believe that the same is a hindrance to native fishing. Provided an appeal shall lie from the order of the District Commissioner to the Provincial Commissioner whose decision shall be final.

In all cases of appeal the order of the District Commissioner shall remain in force until reversed or otherwise by the Provincial Commissioner.

5. In all cases where fish weirs or staking nets extend from bank to bank of any stream or river a gap shall be left in midstream of approximately five per cent of the width of the stream or river provided that the District Commissioner may at his discretion order that the width of the gap be varied.

6. Any person committing a breach of these rules shall upon summary conviction be liable :—

(i) if a native—

(*a*) upon first conviction to a fine not exceeding six shillings and in default of payment to imprisonment for a term not exceeding one month ; and

(*b*) upon any subsequent conviction to a fine not exceeding £1 or in default of payment to imprisonment for a term not exceeding three months, or to both such fine and imprisonment.

(ii) if a non-native—

(*a*) upon first conviction to a fine not exceeding £5 or in default of payment to imprisonment for a term not exceeding one month ; and

(*b*) upon any subsequent conviction to a fine not exceeding £25 or in default of payment to imprisonment for a term not exceeding three months or to both such fine and imprisonment.

In exercise of the powers in him vested by Section 3 of the Game Ordinance the Acting Governor in Council has been pleased to extend the application of the Fishing Rules to the waters of Lake Nyasa in the Dowa and Dedza Districts and to the waters of Lake Nyasa and Lake Malombe in the South Nyasa District.

Made by the Acting Governor in Council at Zomba this twenty-seventh day of July, 1937. (Government Notice number 54 of 1937.)

Under the Game Rules made in exercise of the same powers as the Fishing Rules by the Governor in Council rule 3 states :—

(1) No person shall, without a written permit from the Governor, use any poison or explosive for killing fish.

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