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NIGERIA

OBSERVATIONS OH Tilapia IN KAINJI LAKE, WITH EMPHASIS ON T. galilaea

A report prepared for the Kainji
Lake Research (Man-made Lake) Project

by

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SUMMARY

The species of Tilapia reported by various investigators as occurring in the Niger River drainage are reviewed and corrections noted. Four species are presently known from Kainji Lake, incltiding T. galilaea. T. nilotica, T. zillii and T. dageti. Separation of very small T. galilaea and T. nilotica by dorsal spine counts appears to be possible in Kainji Lake, and some criteria for separating T. zillii and T. dageti are reviewed.

The relationship of length-weight for T. galilaea and of standard length-total length for T. galilaea and T, nilotica is described. Fry of T. galilaea and T. nilotica is described. Pry of T. galilaea and T. nilotica were found over shallow gently-sloping mud-and-debris bottoms7 particularly near village clothes-bashing sites. These were not accompanied by fry of T. zillii or T. dageti. Indirect evidence suggests most intense spawning of T. galilaea occurs during filling and full supply level of the lake, between October and February.

Observations of commercial catches indicate Tilapia have increased in the lake over the period 1971 to 1972. The Tilapia catch by various sampling methods was composed of at least *75%* T. galilaea which is presently dominant among the Tilapia species in the lake.

Size selectivity of gillnets and castnets for T. galilaea show a progressive increase with increasing mesh size. Assuming the mean length at maturity of this species to be similar to Volta Lake, the minimum mesh size for protection of the stock to allow one spawning season, is greater than 3-inoh stretched mesh.

Commercial harvest is largely by passive and active gillnetting, and castnetting. Management recommendations include the organization of a fisheries management agency, limitation of the number of fishing units, methods of restricting the use of small-mesh nets, and enforcing the prohibition against fish poisons.

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1. INTRODUCTION

1.1 TERMS OF REFERENCE

The Government of Nigeria, assisted by the United Nations Development Programme and the Food and Agriculture Organization are engaged in a project whose main purpose is to assist in the comprehensive development of man-made lake resources through research and surveys, the results of which will be made available to all regions of Nigeria. The project became operational on 12 August 1968 and as part of the project operation, FAO assigned a Fisheries Biologist (Mr. H.P, Johnson) from 3 June 1972 to 2 June 1973 with the following terms of referenoe:

1. Collects, compiles, analyses and interprets information concerning the living aquatic resources of the lake and the area affected by the project, especially information on the biological characteristics of major commercial fishes that affect their production and exploitation.
2. Continues activities investigating the sizes of fish stocks and optimum sustainable yield.
3. Participates in the formulation and implementation of the Centre's programme of research, development and management of ths fishery resources of Kainji Lake and the project area, for optimum exploitation.
4. Trains local workers in the above activities.
5. Prepares technical papers and reports on particular aspects of the fishery resources.
6. Performs other duties as may be assigned.

2. AREA AND METHODS OF OBSERVATION

2.1 BACKGROUND INFORMATION

Kainji Lake is a reservoir formed by the closure of the Niger River at the Kainji Dam in 1968, Figures 1 and 2. Descriptions of the river and the lake are given by Motwani, (FAO, 1970a), Turner (FAO, 1970b), Lelek (FAO, 1972) and Henderson (in press). Some details of the lake morphometric, hydrologic and physical-chemical characters are noted below:

Latitude: 9°50 to 11°00 N

At full supply level:

Elevation: 465 feet above sea level

Area: approx. 1 270 km^2

Volume:	approx. 14 km^3
Length:	136 km
Depth:	maximum 60 m mean 11 m

Annual drawdown: 10 m

Ratio annual outflow: volume is 4:1

Water fluctuation regime:

Full: November-March

Drawdown: April-August

Fillings: September-October

Water temperature:

December-January isothermal at 22-25°C

February-May stratification with deepening thermocline 25-29°C

June stratification destroyed by drawdown

July-November cooling (rain), 27-28°C

Notes Top metre of lake sometimes 32 - 37° C

Secchi disc transparency:

Maximum: 3 m May-June

Minimum: 0.1 m September

Total dissolved solids:

estimated 35-40 mg/1

Fish populations in the lake have been studied by catches of gillnet fleets; shoreline sampling by electrofishing, castnetting, seining, and rotenone poisoning; pelagic fish sampling by light attraction; and commercial catch assessment samples. Since these studies began in 1969 the results (FAO, 1970b, FAO, 1972, Ita, 1972) show that the fiah populations have been in a state of flux and may not stabilize for some time in the future. One of the recent developments is an increase in the Tilapia population (mainly T. galilaea) which now contribute substantially to the commercial catch.

2.2 SAMPLING METHODS

The fish which have provided material for this report were captured during 1969 to early 1973, by means of experimental gillnets, castnets, electrofishing. and dipnets (for locations see Figure 2). Gillnets included mesh sizes of 1^{1}/2, 2, 2\frb\1/2\fre\, 3, 3\frb\1/2\fre\, 4, 5, 6 and 7-inch stretched mesh, set overnight at both surface and bottom. Gillnet stations were located throughout the lake but most Tilapia were caught only in the shallow sets. Castnet catches in nets of 1\frb\1/2\fre\,2y2,3 and 5-inch stretched mesh by both experimental fishing crews (of professional fishermen) and commercial fishermen were examined from September 1972 to February 1973. Dipnet samples of Tilapia fry were made with a mosquito-mesh hand net in shallow water in November and February 1973 at five locations around the southern half of the lake. Electrofishing samples along short stretches of shoreline at various stations were made between October 1970 and January 1973, with a Smith-Root Electrofisher Type VI.

The gillnet and castnet samples of fish were measured in fresh condition, and all measurements for the relationship of length: weight and standard length: fork length are from these samples. Measurements of electrofishing and dipnet samples were made on material preserved in 10 percent formalin.

3. Tilapia spp. IN THE NIGER DRAINAGE

3.1 UPPER NIGER AND BENUE RIVERS

Daget (1949a; 1949b; 1954; 1956; 1957; 1959; 1961a; 1962), Blano, Daget and d'Aubenton (1955) and Monod (1945, 1949) have reported extensively on Tilapia sampled from the Central Niger River delta near Timbuktu in Mali. Species reported as occurring include Tilapia galilaea. T. nilctica. T. melanopleura. T. heudelotii. T. monodi. and T. zillii. Daget and Stauch (1963) record T.~galilaea. T. nilctica. T. monodi. T. zillii and T. melanopleura from the Cameroun section of the Benue River. Among these identifications, Thys van den Audenaerde (1968a) verifies those of T. galilaea. T. nilotica and T. zillii but indicates that T. monodi and T. heudelotii are mistaken for T. aurea. and that T. Melanopleura is la several cases an unspecified Tilapia and in some oases may be this or T. sillii. Holden (1963) records T. galilaea. T. nilotica. T. sillii and an unidentified Tilapia from the Sokoto River, tributary to the Niger River in northern Nigeria. Leger and Leger (1914) as recorded in Thys van den Audenaerde (1968a) report T. lata from the Niger, probably Mistaken for T. Zillii.

3.2 LOWER NIGER

Boeseman (1963) identified two Tilapia spp. collected from the Niger River delta mouth as T. melanopleura and T. heudelotii. Thys van den Audenaerde (1968a) corrects these to be T. guineensis and T. selanotheron respectively. Boulenger (1902a, 1902b) as reported in Thys van den Audenserde (1968a) records T. mariae. T. lata. T. nilotica and T. galilaca from the Niger River delta; Thys van den Audenaerde indicates the idsntity of T. Tata reported to be T. guineensis. Burchard (1967) reports T. mariae as occurring in clear water streams tributary to the Niger at least as far upstream as Lokoja.

3.3 KAINJI LAKE AREA

Various preimpoundment surveys connected with the proposed Kainji Dam (Daget, 1961b; Banks, Holden and McConnell, 1966; FAO, 1970a; Motwani and Kanwai. 1970) report T. galilae, T. nilotica, T. zillii, T. monodi and T. melanopleura as present in the Niger River. McConnell (1966) indicates that these are the species likely to occur in the proposed impoundment. Thys van den Audenaerde (1968a) corrects the identification by Daget (1961b) of T. monodi as T. aurea and T. melanopleura as an unnamed Tilapia.

Investigations of Tilapia in Kainjii Lake since filling (FAO, 1970b; FAO, 1972; Ita, 1972) have reported the presence of four species only: T. galilaea, T. nilotica, T. zillii, and T, melanopleura.

Trewavas (1966) describes the differences between T. aurea and T. nilotica, and concludes that T. aurea "... was recognized in the Middle Niger by Daget as T.monodi in 1954 ..." T, aurea to date has not been positively recorded in Kainji Lake since its filling, although Dr. D. Lewis (personal communication) tentatively identified a T. monodi in 1970 which may have been T. aurea.

The four Tilapias presently recognized in Kainji Lake include T. galilaea, T. nilotica, T. zillii, and T. dageti. Two specimens of the latter have been identified by Dr. E, Trewavas (personal communication). T. dageti has hitherto been referred to as T. melanopleura in the papers of Daget; the type specimen of T. melanopleura is apparently T. zillii and the name is no longer valid (Thys van den Audenaerde, 1968b). T." dageti is now the unnamed Tilapia noted noted by Thys van den Audenaerde (1968a) as being confused as T. melanopleura in the Niger drainage..

3.4 SUMMARY

A tiotal of 12 species of tilapiahave been reported from the river drainge by variousauthors (and one personal communication). Of these eight appear to be valid records, including T. guineesis, T. melanotheron,T. mariae, T. aurea, T. gailaea, T. nilotica, T. zillii, and T. dageti. The last four have been recored from kainji Lake.

4. TAXONOMIC OBSERVATIONS

4.1 USEFUL LITERATURE DESCRIPTIONSOF TILAPIA

Trewavas (1966) describes the differences between T. nilotioa and T. aurea. and Daget and Iltis (1965) the differences between T. zillii and T. dageti. Welcome (1964) defines differences in juvenile specimens of T. zillii and T. nilotica. McConnell (1966) and Burchard (1967) are general references for Kainji Lake Tilapia. taking due note of species name changes as outlined.

4.2 NOMENCLATURE OF KAINJI LAKE TILAPIA

Dr. Trewavas (personal communication) has a paper in press proposing the separation of Tilapia at generic level into mouthbrooders (Serotherodon) and substrate brooders (Tilapia). Thus T. galilaea and T. nilotica become Serotherodon galilaeus and S. niloticus; T. aurea will also join this genus. T. zillii and T. dageti remain as Tilapia.

4.3 FIN COUNTS OF T. galilaea AND T. nilotica

Dorsal and anal fin counts were made on a substantial number of T. galilaea and a few T. nilotica. with the following results:

Species	Standard length range, cm	Dorsal fin formula			Anal fin formula
T. galilaea	12.8 - 32.5	XV	- 13	(1)	III - 11 (14)
		XV	- 14	(6)	III - 12 (26)
		XV	- 15	(1)	
		XVI	- 13	(15)	
		XVI	- 14	(16)	
		XVI	-15	(1)	
T. nilotica	26.2 - 32.8	XVII	-13	(3)	III - 11 (5)
		XVII	-14	(2)	

Note: Number of samples in brackets

The five Kainji Lake specimens of T. nilotica all had 17 dorsal spines, while the T. galilaea have either 15 or 16 spines. This appears to be one method of separating these two species, a method supported by counts of dorsal spines in small specimens- However, caution should be employed in using this criterion as in the Sudan area, Sandon (1950) found dorsal spines of T. nilotica to range from 15-18 and of T. galilaea from 15-17. Trewavas (1966) gives the range for T. nilotica as 16-18, presumably a composite of fish from the Jordan Valley, coastal Palestine, and the Nile and Niger Rivers. Burchard (1967) gives the dorsal spine count (presumably Nigerian specimens) of T. galilaea as 15—17 and of T. nilotica as 17-18.

4.4 SEPARATING SMALL T. nilotica AND T. galilaea

A problem was encountered in separating small T. nilotica from T. galilaea in dipnet samples. A number of characters were tested for differences between specimens 32 mm total length (T.L.) or larger which could be easily identified, including:

(a) Dark pignent bars on the tail of T. nilotica. These can be used for separation from T. galilaea. down to a size of 25 mm standard length (S.L), (32 mm T.L.). Among a large number of fish below this size sampled, either there were no T. nilotica (considered unlikely), or bars on the tail are not formed until a length of 32 mm T.L. is reached (probable). The bare on the tail could be accentuated in live specimens by placing them in a clear dish over a black background.

(b) Bars on flanks. T. nilotica was found to have from 8-11 bars and T. galilaea from 7-10. This is too great an overlap to be useful in separating~the species.

(c) Tilapia mark. This tends to be more rounded and lies anterodorsal on the dorsal fin of T. nilotica and more elongate tending to lie in a posterodorsal inclination in T. galilaea. However, the overlap was too great to be of much assistance as a separation character.

(d) Bars on the dorsal fin behind the Tilapia mark. In T. nilotica these number two or three, are well-pigmented on the posterior tip, and tend to lie anterodorsal. In T. galilaea these generally number three, have less pigment at the dorsel end, and Tend to lie vertically or posterodorsal. Again, however, there was too much similarity to allow positive separation.

(e) Pectoral fin length differences as indicated by Sandon (195O). The pectoral fin reaches between the anus and anal fin insertion in both species and was found to be useless for identification of snail specimens.

(f) The lower pharyngeal teeth can be used to separate T. nilotica and T. galilaea down to a size of 25 mm S.L. In smaller fish, however, this structure has not assumed a typical shape and so cannot be used as a separation characteristic (the shape and orientation of the teeth themselves were not examined in the smaller specimens - this may possibly be a distinguishing feature).

(g) Number of dorsal spines. In a sample of 43 T. nilotica between 32 and 52 mm T.L. with definite pigment bars on the tail, the manber of dorsal spines was 17 in all cases. Among 87 T. galilaea of a size range between 32 and 90 mm T.L. the dorsal spine count was 16 in all fish. A dorsal spine count of 79 Tilapia less than 32 mm T.L. included 76 fish with 16 spines and three fish with 17 spines, indicating that T nilotica was rare but not recognized by visual appearance in the sample.

4.5 LENGTH-WEIGHT RELATIONSHIP OP T. galilaea

The standard length-weight relationship of 506 T. galilaea from Kainji Lake is recorded in Table 1. No tendency for a difference between males and females was noted in the limited sample available. A curve is fitted to the data for combined sexes in Figure 3, in which is also plotted the points for this relationship of T. galilaea from Volta Lake (Reynolds, Adetunji and Ankrah, 1969). The length-weight relationship is similar in Kainji and Volta Lakes to a size of about 230 mm S.L.; above this size the Volta Lake fish tend to weigh less.

4.6 STANDARD LENGTH-TOTAL LENGTH RELATIONSHIP OF T. galiaea AND T. nilotica

The standard length total length of 416 T. galilaea is recorded in Table 2 by millimetre length groups. The data when plotted (Figure 4) suggests a slight curve, which was not tested mathematically; it has been used, however, in converting these two measurements in the present study where necessary. Table 3 and Figure 5 present the standard length-total length relationships for 95 T. nilotica.

4.7 MERISTICS OF T. zillii AND T. dageti

Dr. E. Trewavas (personal communication) examined two T. zillii and two T. dageti from Kainji Lake and forwarded the following observations:

	T. zillii	T. dageti
Soft dorsal rays	12 or 13	14
Body depth	Shallower, 41.5 and 41 % S.L.	Deeper, 49.6 and 48.8% S.L.
Pectoral fin	Shorter, 35.8 and 32.8 S.L.	Larger, 39.5 and 37.9% S.L.
Mouth as measured by	Larger, 37.8 and 40% of	Smaller, 33.7 and 34.9% of
length of lower jaw	head length	head length
Pharyngeal bone	Narrower, 32% of head length (1 specimen)	Wider, 38.8% of head length (1 specimen)

Differences between these two species are given by Daget and Iltis (1965, not seen). Dr. Trewavas has summarized these as follows: "In T. dageti the soft rays of the dorsal fin number 11-16, in T. zillii 10-13, the soft anal rays in T. dageti 8-11, in T. zillii 7-10. T. zillii generally has two longitudinal dark bands on the body as well as The vertical. In T. .dageti the vertical predominate. The anal fin and lower half of the caudal are generally coloured red in W. African T. zillii; T. dageti is without this colour, the vertical fins being usually pale, the caudal sometimes bluish. Both species may have pink or red colour at the sides of the chest and lower flanks.

The bluish cast of the tail is the character by which the Kainji Lake Research Projeot workers have, to date, separated T. zillii from the former T. melanopleura (now T. dageti).

5. LIFT HISTORY NOTES

5.1 DISTRIBUTION

The four species of Tilapia recorded in the lake are all widely distributed around the entire shore length, although there are major differences in relative abundance among species. The Warra region with its widespread area of emergent grass is notably rich in T. galilaea. and the intensive castnet fishery here harvests large numbers. The Yelwa and Papiri areas also support major castnet fisheries which harvest Tilapia among other species. Host of the

T.L. = Total length

S.L. = Standard length

shallow grassy bays harbour good populations of T. galilaea with lesser amounts of T. nilotica and T. zillii. Lelek (FAO, 1972) notes that Cichlids (including Tilapia) were abundant on shorelines with aquatic vegetation, but were scarce or absent where little vegetation occurred.

5.2 HABITAT OF FRY (T. galilaea AND T. nilotica)

Abundant samples of fry (T. galilaea with fewer T. nilotica) were obtained by dipnet near Shagunu; at a village on the north shore of the Swashi Bay mouth; at Warra beach, at Monai beach; and near the Kainji Dam looks. The favoured habitat has a gently-sloping (less than 5 percent) mud and organic debris bottom of 1 to 6 inches deep, protected on the lakeward side by emergent weeds. Here the fry receive maximum protection from aquatic predators, the benefit of the warmest water, and nearby weeds in which to hide from non-aquatic predators.

When the survey fishermen were asked to collect fry, they generally went to an area such as described, near a village where women were washing clothes at the beach. Presumably nutrients in the detergent used for washing encouraged the growth of food upon which the fry feed, or perhaps the agitation of the water by humans made food easy to collect.

Only T. galilaea and T. nilotica were found in this habitat, never accompanied by T. zillii or T. dageti in The periods of dipnet sampling (November and February).

5.3 REPRODUCTION OF T. galilaea AND T. Nilotica

Both T. galilaea and T. nilotica are known to be mouthbrooders. Direct evidence of the reproductive season by observations of fish with eggs or fry in their mouths has not been obtained in the lake, although many hundreds of fish (particularly T. galilaea) haw ben examined by the Shagunu resarch. workers and others. Banks, Holden, and McConnell (1966) report the capture of two T. galilsea carrying eggs in the river near Shagunu before the lake formation, but give no date. In a nearby drainage (the lower Yobe River flowing into Lake Chad) Tobor (1970) reports that large female T. galilaea captured in late February were carrying eggs in their mouths.

Hatching of T. galilaea takes place in the mouth and the young are retained to a length of 12 mm T.L. (9-T0 mm S.L.)at the age of 10-15 days, depending on the temperature (Fryer and Iles, 1972). T. nilotica releases fry at about the same size. Indirect evidence of spawning is available from the length-frequency distribution of fry collected by electro fishing and dipnets, Tables 4 and 5.

Fry of T. galilaea of a size indicating release from the parental mouth within a week or two (up to 14 mm S.L.), were found in catches each month from August to March, Table 4. The only month samples when only larger fry were found was June. The actual spawning would have taken place a month previous to the catches. More intensive sampling might well have shown some reproduction through the year; the present data suggest greatest spawning activity in October, November and February, the period of filling and full supply level of the lake. Spawning of T. galilaea here seems related to rising water levels and recently-flooded shorelines. This~agrees with Lelek's (FAO, 1972) observation that female ovaries of this species were ripening from August to January and February coinciding with a rise in water level until the months of high water level.

Indirect evidence or reproduction for T. nilotica (Table 5) suggests recent spawning in September and November. The difficulty of separating the smaller fry of these from T. galilaea may have masked better evidence of reproduction of T. nilotica. This problem merits further study utilizing the criterion of spine counts to differentiate between very small T. nilotica and T. galilaea.

5.4 PREDATION ON Tilapia

Turner (FAO, 1970b) records that of 138 Hydrocynus spp. stomachs which contained food, in only four were Tilapia identified (species not given). Tilapia were not identified in stomach examinations of Chrysichthys spp., Schiibe mystus, Eutropius niloticus. Synodontis membranaceous or Lates niloticus.

Mr. N. Willoughby (personal communication) while studying Syndontis spp. in Kainji Lake, reports that these are basically detritus feeders and not serious predators on Tilapia. On rare occasions S. schall and *S.* ocellifer were found to have eaten Tilapia fry about 13 mm in length. Mr. R.Sellick (personal communication) while working on Alestes spp. here found no predation on Tilapia fry. Dr. D.S. Lewis (personal communication) notes that most predaceous fishes in the lake occasionally eat Tilapia up to 150 ran, but that Tilapia are not major prey species for piscivores, at least after the fingerling stage. The expert haB seen two T. galilaea in apparently healthy condition but with the caudal peduncle missing, and received reports of others. This is attributed by the fishermen to attacks by Hydrocynus brevis.

5.5 FOOD OF T. galilaea

An observation of piscivorous feeding by T. galilaea was made at the village of Faku (1/4 mile downstream from Kainji Dam) on 8 December 1972. Two boys were angling with small hooks baited with Sierrathrissa leonensis 30-35 mm long, successfully catching (at the time of visit) 29 T. galilaea ranging in length from 120-200 mm S.L. Faku is the centre of a thriving 'atalla' net fishery which captures small clupeids, and many of these are washed out of the fishermen canoes each day. The small T. galilaea were conditioned to eating these, and were seen doing so as one canoe was washed out. While T. galilaea is essentially a plankto-nophage, these fish (in common with many other species) are opportunistic feeders in specialized situations. This observation suggests the possibility of developing a sport fishery for T. galilaea in Kainji Lake.

6. RELATIVE POPULATIONS

6.1 COMMERCIAL CATCH

The importance of Tilapia in the commercial catch is indicated by a subjective estimate of groups of fish seen at the Shagunu fish market, provided through the kindness of Mr. N. Willoughby (Table 6). For this purpose a tour of the fish available for sale was made on most market days from the end of November 1971 to mid-October 1972 between 12.00 hours and 13.00 hours. Three later observations (November 1972 and February 1973) were made by the expert.

The observations indicate a progressive increase in the proportion of Tilapia in the market fish from late 1971 to a place of prominence in late 1972, with no suggestion of a a decline in importance. A count of individual Tilapia seen by species in February 1973 showed that T.' galilaea was about ten times more abundant than T. nilotica and 18 times more abundant than T. zillii.

The increased importance of Tilapia in the commercial catches has been noted by personal observations of survey fishermen and the catch assessment survey crew on Kainji Lake.

6.2 GILLNET SAMPLING

Stationary survey gillnets set throughout the lake between 1969 and 1972 did not catch large numbers of Tilapia and generally do not show any trend in the Tilapia populations. The catch in a conservatively estimated 200 000 metres of gillnet set in this period was as follows:

	No.	%
T. galilaea	429	86
T. nilotica	55	11
T. zillii	15	3
T. dageti	2	+

Thus T. galilaea was nearly eight times as abundant as T. niloiica and 29 times as abundant as T. zillii in the catches.

6.3 SHORELINE SAMPLING

6.3.1 Electrofishing

The relative importance of species of Tilapia in the electrofishing rounds is recorded below:

Year	Month	T. galilaea	T. nilotica	T. zillii	T. dageti	Total
1970	October	113	2	6	-	121
1971	March-April	41	19	19	4	83
	June	232	108	91	30	461
	Sept-Oct	340	21	17	-	378
	Nov-Dec	779	54	47	9	889
1972	August	602	30	84	-	716
1973	January	525	177	81	2	785
	Total	2 632	411	345	45	3 433
	%	77	12	10	1	100

Although electrcfishing is a very subjective method of sampling and depends largely on the skill of the sampling crew, the increase in numbers of Tilapia per fishing round indicates an increase in the Tilapia population from late 1970 to late 1972.

The proportion of each species in the catch corroborates other information on the dominance of T. galilaea among the Tilapias. These were 6.5 tines more abundant than T. nilotica and 7.5 times as abundant as T. zillii. Among these samples T. zillii closely approached the abundance of T. nilotica, and relatively large numbers of*"*T. dageti were captured. The January 1973 catch of T. nilotica suggests that these may be increasing in relative abundance.

6.3.2 Castnet samples

Castnet catches (½ to 3-inch stretched mesh) by research crews and commercial fishermen from September 1972 to February 1973 resulted in the following:

	No.	%
T. galilaea	316	97
T. nilotica	6	3
T. zillii	2	+

Again the dominance of T. galilaea is notable in the catch.

6.3.3 Dipnet samples

Dipnet samples taken in November 1972 and February 1973 (Tables 4 and 5) showed the following composition:

	T. galilaea4	T. nilotica
November 1972	459	77
February 1973	147	7
Total	606	84
%	86	14

As noted previously no T. zillii or T. dageti were captured in shallow water with young T. galilaea and T. nilotica."

6.4 SUMMARY OR RELATIVE ABUNDANCE

A review of the percent composition of Tilapia spp. by the various sampling methods is as follows:

	T. galilaea	T. nilotioa	T. zillli	T. dageti	Total
Commercial (Feb., Shagunu market)	87	8	5		100
Survey gillnet catch	86	11	3	+	100
Electrofishing catch	77	12	10	1	100
Castnet survey	97	3	+	-	100
Dipnet samples	86	14	-	-	100

The dominance of T. galilaea among the Tilapia in Kainji Lake is very marked at present. Banks, Holden and McConnell (1966) predicted that T. nilotica would become the dominant species of fish in Kainji Lake, basing this on the assumption that the shallow flooded Foge Island area would provide ideal habitat for this species; the prediction of Tilapia dominance has been questioned (FAO, 1970a p. 45; Imevbore, 1969). The final position of Tilapia among the fish populations in the lake may not be fully revealed for some years.

7. GEAR SELECTIVITY FOR T. galilaea

7.1 GILLNETS

The length-frequency distribution of 428 T. galilaea captured from August 1960 to October 1972 in nine different mesh sizes is recorded in Table 7. Modal lengths of fish for each mesh are as follows:

Stretched mesh size, inches	Modal midpoint, S.L., mm
1½	70
2	100
2½	130
3.	140-150
3½	170
4	200, 270
5	220, 270
6	270
7	310, 270

The modal distribution shows a reasonably regular increase from fish 70 mm long in the 11/2-inch mesh to fish 310 mm in the 7-inch mesh. A secondary mode of fish at about 270 mm is present in the 4, 5, and 7-inch mesh. The origin of this group is not clear, but in the 4 and 5 inch mesh represents fish caught in 1972 while in the 7-inch mesh they were mainly caught in 1971.

Mesh selectivity for T. galilaea in Kainji Lake is essentially similar to that in Volta Lake (Figure 6).

7.2 CASTNETS

The lengths of 314 T. galilaea measured from castnet catches of four different mesh sizes from September 1972 to February 1973 are found in Table 7. Modal lengths for each mesh are:

Stretched mesh size, inches	Modal midpoint, S.L., mm
1½	90
2½	120
3	150
5	300, 240

The sizes of fish caught in castnet meshes are similar to but not exactly the same as corresponding meshes of gillnet. While oastnet fishing is selective in that the fishermen often actively pursue their prey the data indicates that control of castnet meah size used could certainly influence the size of T. galilaea harvested.

8. COMMERCIAL FISHERY ASPECTS

8.1 FISHING METHODS

Gillnets and castnets are the major gear used to harvest Tilapia commercially in Kainji Lake. The gillnets are used in two ways, passive and active netting. Aspects of these three methods of fishing are discussed below. Illicit poisoning is a problem in the lake.

8.1.1 Passive gillnetting

The gillnets are set late in the day and picked up early in the morning. The catch of Tilapia in passive gillnets is incidental to the catch of other species, and probably relatively few are taken this way. As noted previously many thousands of yards of survey gillnet were set between 1969-1972 and only about 500 Tilapia were captured.

The survey gillnets and most of the commercial nets used in the lake are multifilament nylon. Taylor and Denyoh (n.d.) found that experimental monofilament nylon nets caught 4.5 times as many T. galilaea in Volta Lake as did the same mesh size of multifilament nylon nets. They note that commercial fishermen who observed the comparative catches subsequently converted from multifilament to monofilament nets. Monofilament nets were found to disentangle from trees more easily than multifilament nets. Counterbalancing this is the greater initial cost of monofilament, and the greater rapidity with which these disintegrate when left in the sun.

8.1.2 Active gillnetting

Shallow nets of 5 to 7-inch stretched mesh without a leadline and with floats about 15 feet apart are quietly set after dark near known Tilapia habitat. The nets are set in 3 to 6 foot deep water about 15 to 45 feet offshore, and parallel to the shoreline. Then the boat proceeds with much splashing and noise between the shoreline and the net, and the fish are frightened into the net. The net is then picked up, leaving the fish little opportunity to work itself free of the meshes. One attempt to fish this way, observed by the expert near Monai, caught two T. galilaea (200 and 240 mm S.L) in a 6-inch mesh net. The fisherman reported that when active gillnetting was first taking place in the lake two years previously much larger T. galilaea were caught and the use of 7-inch mesh nets was profitable, but that fewer and smaller fish were now available.

8.1.3 Castnetting

Castnets of stretched mesh size from 1 to 6-inch are used at various times of the year. Smaller mesh nets are used during highwater levels among flooded vegetation and aquatic weeds. The reaction of Tilapia to castnets is to dive into aquatic vegetation and so escape the fishermen as the net rests on top of the grass. Larger mesh and indeed castnetting generally, is most profitable when the water level is down, the fish are more concentrated in the reservoir, and there is less brush and vegetation to impede the net.

Two fishermen comprise a boat crew, one for propulsion in the stern, the other standing in the bow to spot fish by water movements and to cast the net. The largest number of Tilapia observed by the expert to be caught in one cast consisted of eight small T. galilaea (about 180 mm S.L.) in a 3 inch stretched mesh castnet

8.2 EDIBILITY

Tilapia are not a favourite fish among local Nigerians, as most of their fish for market are smoked and Tilapia dries out too much. An oilier fish such as Citharinus or catfish is preferred. Shagunu-based fishermen claim that both T. galilaea and T. nilotica are good when fried, but that T. nilotica is 'sweeter' (better flavoured) when used~in soup.

A poll of European taste preferences at the Shagunu research station indicated that, among the Kainji Lake fish, the Nile perch Lates niloticus was first choice followed closely by T. galilaea and T. nilotica. They noted that Tilapia develop a marked 'muddy' taste when Microcystus algae became noticeable in the lake; this taste could be partly removed by over— night soaking in water or milk*

9. MANAGEMENT

9.1 POISONING

Jenness (1967) describes a variety of plant poisons used within the Kainji Lake basin. The use of poisoning to harvest fish by local fishermen has been noted by Fishery Biologists F.O. Otobo and E.O. Ita (personal communications). Literally thousands of small Tilapia and many small fish of other species are uselessly destroyed by this procedure, being too small to be collected by the fishermen. While poisoning is illegal and should be vigorously combatted, there is at present no effective agency to control this activity on the lake.

9.2 NET MESH-SIZE REGULATION

Lelek (FAO, 1972) examined 90 T. galilaea of mixed sex from Kainji Lake and found the smallest mature individual to be a 7emale in the 110-150 mm S.L. group; in the 160-200 mm group, 31.4 percent of the fish were mature; and of fish 210 mm and larger 69.8 percent were mature. He comments that the onset of maturity (fish over 150 mm S.L. in Kainji Lake) corresponds to that in Volta Lake, where Lelek and Wuddah (1968) found 5O percent of the females maturing at about 155 mm S.L. and that first spawning took place in 24 fish at an average size of 155 mm S.L. (range 135-195 mm). Applying these data to Kainji Lake, from Figure 6 and Table 7, it is noted that to allow this species to mature before harvesting would necessitate a gillnet and castnet stretched mesh size larger than 3-inches. This may be unrealistic for the entire lake since it would limit the harvest of several other species of fish which do not reach a size to be taken in nets larger than 3—inch. However, in certain Tilapia-rich areas such as Warra, Yelwa and selected bays young Tilapia might well be protected by such mesh-size regulation. Identification and complete protection of particularly important spawning and nursery areas might also be considered, although the need for this should first be established.

At present the trend in Kainji Lake is to an ever-decreasing mesh size (Bazigos, 1972;Smart and Sagua, 1972) and the use of gillnets and castnets down to 1-inch stretched mesh is common. It will be very difficult to reverse this trend. Indeed, experience in Lake Victoria in enforcing a 5-inch minimum mesh size was found to be impossible, with subsequent illegaldecreases in mesh to 21/2—inch and catastrophic results in a population of T. esculenta (Fryer and Iles, 1972 p. 436-43).

9.3 NUMBERS OF FISHERMEN

At present the fishing industry on Kainji Lake provides a borderline economy for an estimated 6 000 fishermen (Bazigos, 1972). He estimates that even though the price of fish has increased on Kainji Lake between 1970-71 and 1972, the average revenue has decreased by 30 percent due to lower catches. One of the major considerations of fisheries management must be to somehow limit the number of fishermen to enable the development of viable economic units. When the fish populations have reached relative stability and the long-term expected annual production is known, an economic study will be necessary to determine the number of fishermen units the lake will support. Meanwhile relocation of fishermen to other areas or industries should be encouraged.

9.4 PROPOSED ADMINISTRATIVE AGENCY

At present there is no agency concerned primarily with management of the Kainji Lake fishery. The need for activation of such an agency is obviously a priority for fisheries management. Experience in enforcing fishing regulations on Lake Victoria (and other countries) suggests that this agency should be strongly oriented towards fishermen education, but with able police facilities.

10. SUMMARY OF REC0MMENDATIONS

(a) The possibility of developing a sport fishery for T. galilaea using clupeids as bait should be investigated.

(b) Before management recommendations can be implemented an agency primarily concerned with fisheries matters must be organized to deal with Kainji Lake. This agency should be strongly oriented to fishermen education but with effective police capabilities.

(c) Methods of management should be employed to allow development of viable economic units on the lake.

(d) To prevent the harvest of T. galilaea before they attain a mature reproductive size (155 mm S.L.) gillnets and castnets should be larger than 3-inch stretched mesh.

(e) While a lakewide ban on use of gillnets and castnets of 3-inch stretched mesh or less may not be desirable, the feasibility of restricting mesh size in certain Tilapia-rich areas may be considered as a protective measure.

(f) The illegal practice of using plant poisons to harvest fish with the attendant destruction of small fish should be stopped insofar as possible.

Appendix 1

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Table 1

STANDARD LENGHTH-WEIGHT RELATIONSHIP OF 506 T. galilaea FROM KAINJI LAKE, 1969-1973

Midpoint S.L.mm	Average weight, grammes (number of samples in brackets)							
	Males		Females		Sex not recorded		All samples	
50					7	(1)	7	(1)
60					8	(1)	8	(1)
70	14	(1)			15	(32)	15	(33)
80	25	(1)			20	(1)	23	(2)
90	32	(1)			34	(7)	33	(8)
100	38	(3)	54	(1)	41	(15)	41	(19)
110	58	(3)	54	(3)	65	(3)	59	(9)
120	90	(2)	73	(4)	79	(35)	78	(9)
130	110	(1)	106	(4)	98	(10)	101	(15)
140	117	(13)	116	(10)	118	(4)	117	(27)
150	167	(6)	147	(13)	151	(14)	152	(33)
160	168	(1)	193	(2)	190	(17)	189	(10)
170	209	(4)	239	(6)	214	(7)	221	(17)
180	260	(1)	280	(4)	268	(7)	271	(12)
190	280	(1)	315	(4)	317	(6)	313	(11)
200	450	(1)	422	(3)	366	(16)	378	(20)
210	442	(3)	457	(3)	417	(13)	427	(19)
220	515	(3)	535	(3)	476	(16)	490	(22)
230	609	(5)	564	(5)	527	(3)	573	(13)
240	690	(1)	653	(8)	668	(10)	663	(19)
250	777	(6)	772	(6)	779	(7)	776	(19)
260	809	(5)	840	(12)	823	(13)	828	(30)
270	967	(10)	973	(14)	956	(23)	963	(47)
280	1 039	(14)	1 021	(12)	1 035	(11)	1 032	(37)
290	1 124	(11)	1 091	(10)	1 105	(14)	1 107	(35)
300	1 273	(9)	1 309	(8)	1 302	(12)	1 295	(29)
310	1 347	(6)	1 397	(7)	1 424	(8)	1 393	(2)
320	1 400	(3)	1 290	(1)	1 500	(1)	1 398	(5)
330	1 700	(1)	1 550	(1)	-		1 625	(2)

<u>Table 2</u>

STANDARD LENGTH, AVERAGE TOTAL LENGTH OF 416 <u>T. galilaea</u> FROM KAINJI LAKE, 1970-1973

S.L. mm	Aver. T.L.mm	No. fish	S.L.mm	Aver. T.L. mm	No. fish	S.L. mm	Aver. T.L.	No. fish	S.L. mm	Aver. T.L. mm	No. fish	S.L. mm	Aver. T.L. mm	No.fish
25	52	18	115	157	1	167	225	1	242	315	2	285	369	2
26	35	73	117	156	1	170	221	1	244	315	1	286	362	4
27	35	16	118	147	1	172	223	2	247	321	2	287	369	3
28	36	5	119	1 57	1	174	225	2	248	316	1	288'	368	3
29	37	5	120	155	2	175	227	1	250	332	1	289	376	2
30	36	2	124	163	2	177	237	1	251	326	1	290	372	9
31	39	1	126	169	1	179	237	1	252	317	1	291	368	2
32	41	2	127	167	3	180	235	1	253	333	2	292	377	2
33	43	2	128	170	1	181	230	1	254	331	2	293	379	3
34	44	1	130	174	2	182	239	1	256	334	3	294	371	1
42	52	1	133	179	2	185	24.3	1	257	333	2	295	377	1
47	60	2	134	178	2	186	236	2	258	330	1	296	378	1
65	89	1	135	174	4	187	255	1	259	338	2	297	378	1
69	91	3	136	168	1	190	251	1	260	334	6	298	384	1
70	93	2	137	173	2	199	267	1	261	341	1	299	384	8
71	95	7	138	179	3	200	265	1	262	337	2	300	377	4
72	96	4	140	183	8	203	266	1	263	334	1	301	388	1
73	9b	3	143	189	3	205	275	3	264	343	1	302	390	2
71	94	1	144	185	1	208	276	1	265	342	5	303	382	1
88	115	1	145	190	5	209	270	1	266	348	1	304	389	2
89	113	1	146	187	2	212	278	1	267	348	1	305	390	0
90	122	1	147	187	4	218	291	1	268	347	6	307	394	3
92	124	1	148	190	2	219	281	1	269	353	1	309	401	1
93	124	1	149	197	2	220	296	2	270	347	5	310	390	2
94	126	1	150	199	5	222	293	2	271	351	2	31l	397	1
95	125	2	152	207	1	223	295	1	272	353	5	312	389	2
96	123	3	153	201	3	224,	293	1	273	354	4	313	400	1
97	133	2	154.	198	1	225	288	3	274	354'	5	314	395	3
98	134	1	155	196	1	227	296	1	275	356	8	315	405	2
99	132	1	156	207	1	228	286	1	276	356	2	317	404	1
100	132	2	158	210	1	232	301	1	277	357	3	318	407	2
102	131	2	159	212	1	233	302	3	378	361	4	320	398	1
109	138	2	160	205	2	235	305	2	279	368	1	325	419	1
110	146	1	162	219	1	236	299	1	280	362	5	331	416	1
111	140	1	163	218	1	237	306.	2	282	359	1			
1 12	146	2	165	213	2	239	307	3	263	363	3			
114	153	1	166	221	2	241	315	2	284	367	1			

Table 3

STANDARD LENGTH, AVERAGE TOTAL LENGTH OF 95 T. Nilotica from Kainji Lake 1970-1973

S.L. mm	Aver.T.L.mm	No. fish	S.L. mm	Aver. T.L. mm	No. fish	S.L. mm	Aver. T.L. mm	No. fish
19	24	1	78	103	1	280	356	3
24	32	1	79	104.	2	286	364	2
25	32	4	169	216	1	291	365	1
2b	33	2	178	225	1	292	365	1
27	36	6	205	267	1	294	370	1
28	37	4	212	270	1	295	370	1
29	36	5	220	288	1	297	370	1
30	38	9	224	288	1	298	370	1
31	40	6	227	289	1	302	375	1
32	42	2	230	295	1	304	382	1
33	42	1	232	296	2	309	396	1
34	49	1	240	305	2	310	398	1
36	47	1	250	318	1	317	403	1
38	46	1	255	326	1	320	405	1
40	51	1	262	337	1	322	410	1
71	95	1	265	336	1	326	412	1
74	93	1	270	338	1	330	425	1
75	100	2	275	353	1	334	424	1
77	102	1	279	340	1	342	435	1
						345	434	1

Table 4

LENGTH-FREQUECY DISTRIBUTION OF T. galilaea IN ELECTROFISHING

and dipnet samples from Kainji Lake, 1970-1973

S.L. range, mm	Number of fish in cach length range									
	Electroflsing								Dipnet	
	1970	1971					1972	1973	1972	1973
	Oct.	March	June	Sept	Oct	Nov.	Dec.	Aug.	Jan.	Nov.	Febr.
5- 9	2	-	-	-	-	-	-	-	-	1	6
10-14	7	2	-	7	3	18	1	14	1	74	53
15-19	15	3	13	54	19	81	18	22	19	178	60
20-24	25	1	13	32	18	101	71	29	57	107	19
25-29	31	7	16	30	7	82	54	73	80	71	
30-34	9	a	6	24	14	63	25	30	81	18	3
35-39	2	4	13	13	6	52	16	21	60	3	5
40-44	4	-	23	17	.7	41	10	34	64	5	1
45-49	'2	3	14	15	3	29	. 3	35	43	1	
50-54	6	1	19	0	2	37	4	52	39	-	
55-59	5	2	30	3	1	14	2	41	19	-	
60-64	-	2	16	6	2	19	2	53	13	-	
65-69	1	1	13	4	3	10	-	27	11	-	

70-74	-	2	10	6	3	14		42	10	1	
75-79	1	2	2	4		4	-	24	2		
80-84	-	1	11	10	-	2	-	27	2		
85-89	-	1	8	2	1	1		22	2		
90-94	-	-	4	2	-	2	-	14	3		
95-99	1	-	7	2	-	1	-	11	1		
100-149	2	1	14	11	1	1	1	31	18		
Total	113	41	232	250	90	572	207	602	525	459	147

Table 5

LENGTH-FREQUECY DISTRIBUTION OP *T. nilotica* IN ELECTROFISHING AMD DIPNET SAMPLES FROM KAINJI LAKE, 1970-1973

S.L. range mm	Numberof fish in each length range									
	Electrofishing								Dipnet	
	1970	1971					1972	1973	1972	1973
	Oct.	March	April	June	Sept.	Nov.	Aug.	Jan.	Nov.	Feb.
10-44					1				1	
15-19		1			3				2	1
20-24					1			1	4	
25-29								1	29	1
30-34					3	4		7	34	2
35-39		2		9	1	1		38	4	3
40-44	1	3		8	2	9		20	2	
45-49	1			12	3	4		29	1	
50-54			2	15		4		18		
55-59		1		10	1	3		15		
60-64		3		11		2	1	10		
65-69		1		21	1	3		6		
70-74		1		12		7		9		
75-79		1		2		2	4	8		
80-84		2		3	1	3	2	5		
85-89						1	1	2		
90-94						5	6	1		
95-99		1			1		3	1		
100-149		1		3	3	6	13	6		
Total	2	17	2	108	21	54	30	177	77	7

<u>Table 6</u>

ESTIMATED ABUNDANCE OF FISH APPEARING IN COMMERCIAL CATCHES ON SALE AT SHAGUNU ONMARKET DATS, 1971-1973

			1971																		1972
	Nov.	Dec				Jan.			Feb.				Mar.			April				May	
Group	25	2	9	16	30	6	15	20	3	10	17	24	1	8	30	6	13	20	26	4	11
Tilapia	1	3	1	1	5		2	3	3	3	3	3	2	3	2	1		2	2	2	4
Polypterus		1			1				1	1					1	1	1				
Glupisudis		1			1	1				1 1	1	1		1	2				1		
Morayaids	1		1	1	1	1		1		1			1	1	1					1	
Hydrocymns	1	3	2	1	3	2	4.	4		2	3	3	2	2	2	2	1	2	1	1	2
Alestes	4	5	5	4	3	4	5	5		1	3	4	4	3	4	3	3	4	3	4	4
Distichodus					1		2		1	1	1	1	1	1	1	1		1	1	1	1
Citherinus	3	1	2	2	1	1	2	2	2	2	3	3	2	2	3	3	3	2	1	3	
Labeo	2	1	4	3	3	3	3	3	2	2	3		4	3	4	1	2	2	2	2 2	
Eutropius	1	2	2	2	2	3	2	1	1	2	2	1	1	1	2	3	2	2	1	2	
Clarias					1		2	2		2	2	1	2	2	2		2	1		3	
Meterobranchus							2						3								
Bagrus		1			1	1	2	3	1	2	1	1			4	3	3	3		31	2
Chrysichthys	1	2	2	1	2	2	2	1	2	2	1	2	1	3	3	4	3	4		3	3
Aucherglanis	2	1	2		1	2	2	2	2	1	2	3	3	3	3	2	2	2	3	2	
Sypodontis	2	3	3	3	2	2	3	3	5	3	2	3	4	4	5	5	3	4	5	3	5
Lates	1	1	1		2	1	1	5	3	2	2	2	2	3	1	1	1	2	1	2	
No.of baskets*	30	40	50	40	40	50	50	50	50	40	50	60	60	60	90	47	35	58	64	35	60

			Jun.				July			Aug					Sept.				Oct.		Nov.		Feb
Group	18	25	1	8	15	22	29	6	13	20	3	10	17	24	31	7	14	21	28	5	19	9	18	1
Tilapia	4	3	4	4	4	3	5	5	5	4		5	5	4	5	5	5	5	4	5	4	4	4	4
Polypterus		1		2	2	1	1	1	1	1				2	2	1	1	2	1	1			1	1
Glupisudis			3	3	1	2	2		1	2		2	2				1	2						
Morayaids		1	1	2	1	1	1	1	1		1	1	1	2	1			1						
Hydrocymns	2	1	2	1	2	2	1	2	2	1	2	2	3	3	2	3	3	4	1	3	2	3	2	4
Alestes	3	2	2	3	4	3	5	5	5	5	5	4	5	5	5	5	3	4	4	2	3	4	5	5
Distichodus	2	1		1	1			1		1	1	1		1	1	2	1		1	1	1	1		1
Citherinus	4	3	2	4	4	3	4	3	4			3	4	3	2	3	3	3	2	3	3	5		2
Labeo	3	2	3	2	2	2	2	3	2	3		5	3	1	2	3	3	5	4	3	2	2	2	3
Eutropius					2	1	1		1	3	3	3	2	2	3	1	1	2	2	3				
Clarias	2	2		1	1		1	2	1	1	1	2	1	1			1	1	1	2			1	
Meterobranchus	2		1		2	1		2	1	1	1	1					1							1
Bagrus	2	1			3	1	1	3	2	1	2	2	2	2	2	2	2	2	1		1	3	4	1
Chrysichthys	3	1		1	2	3	3			2	1	4	3	3	3	2	3	2	2	2	2	3	5	
Aucherglanis	3	1		1			1	2	2	2	1		2			2	)	3	1	1	1	2	1	1
Sypodontis	5	5	4	4	4	3	3	3	3	3	3	4	4	4	3	4	4	3	4	4	4	4	3	3
Lates	1	2	3	1	3	3	2	2	3	2	2	2	2	2	3	2	3	2	3	3	3	2	2	2
No.of baskets*	90	50	48	38	50	46	85	86	60	70	76	92	106	92	87	100	130	136	76	80	70	28	70	45

* Cylindrical fish basket 3 fect loong by 11/2 feet diameter, representing about 60 Kg fresh weight.

1 Rare
2 Occassional
3 Common
4 Very common
5 Abundant

<u>Table 7</u>

LENGTH- FREQUENCYdistribution of <u>T. galilaea IN</u> gillnet AND CABINET CATCHES IN KAINJI LAKE

Midpoint S.L., mm	Gillnet sise, inches									Castnet size, inches (stretched nesh)			
	1½	2	2½	3	3½	4	5	6	7	1½	2½	3	5
60	1												
70	35				1					1			
80	1									1		1	
90	1	6		1						7			
100	2	11	1	1						1	3		
110		1	2	1						1	26		
120	1		5							2	47	4	
130			8	3			1			1	23	6	
140		1	2	9						3	19	30	
150		2	2	9	6					1	14	35	
160			1	4	3						9	15	
170				2	7	5					1	6	
180				1	2	6	2					3	
190				1	5	3						1	
200				1	3	1.1	6						2
210				1	1	2	10						1
220						5	17						4
230				1	1		7	1					4
240						4	7	3	1				5
250						3	8	6	1				1
260					1	2	8	15	2				2
270				1	1	5	13	19	7				3
280				2	1	2	3	17	7				
290					1	1	7	13	6				8
300						1	3	6	6				10
310				1		1	1	2	8				7
320				1			2		2				
330													1
340							1						
Total	41	21		40	33				40	18	142	101	

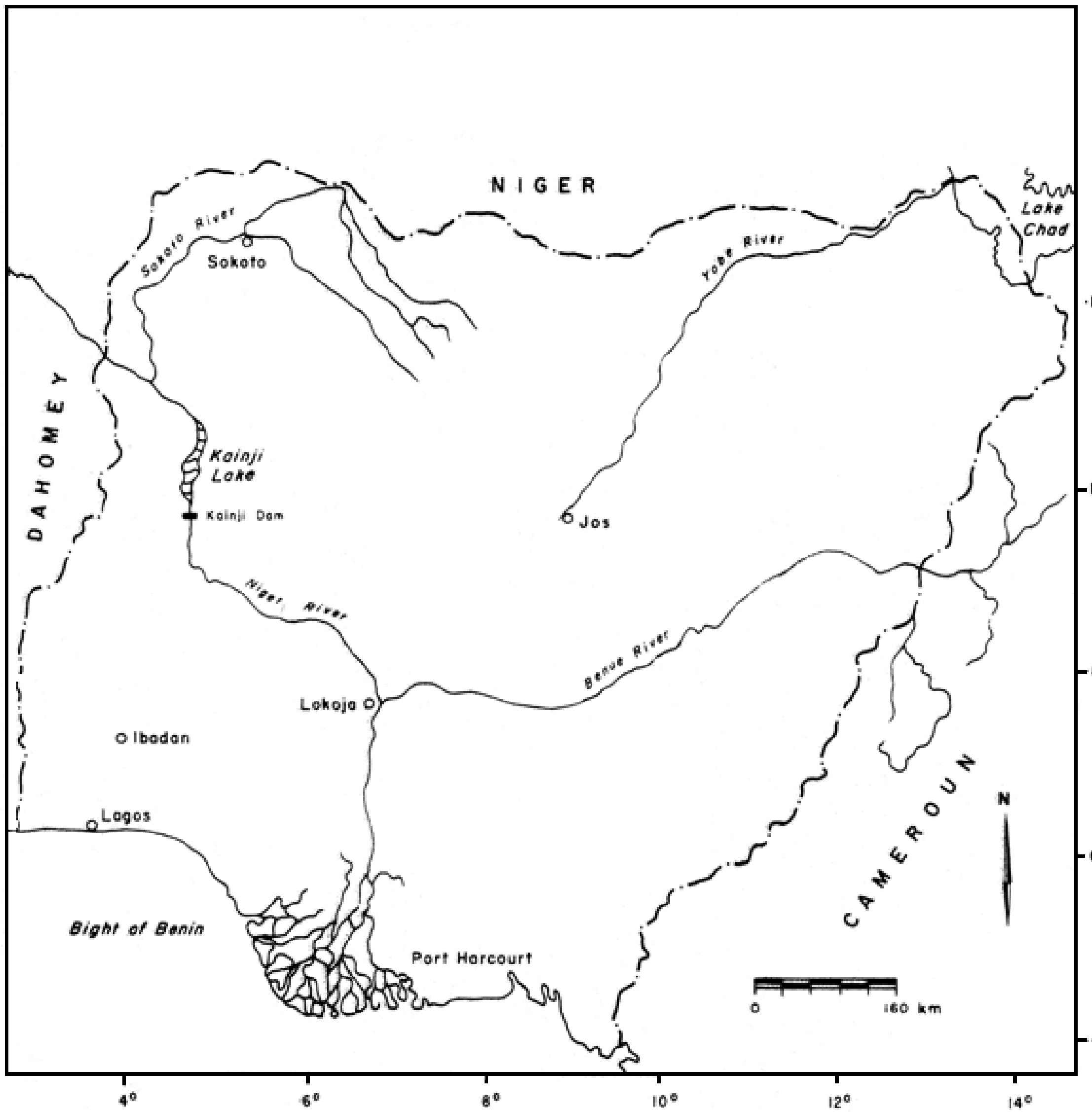

Fig. 1 - LOCATION MAP OF NIGER AND BENUE RIVERS AND KAINJI LAKE IN NIGERIA

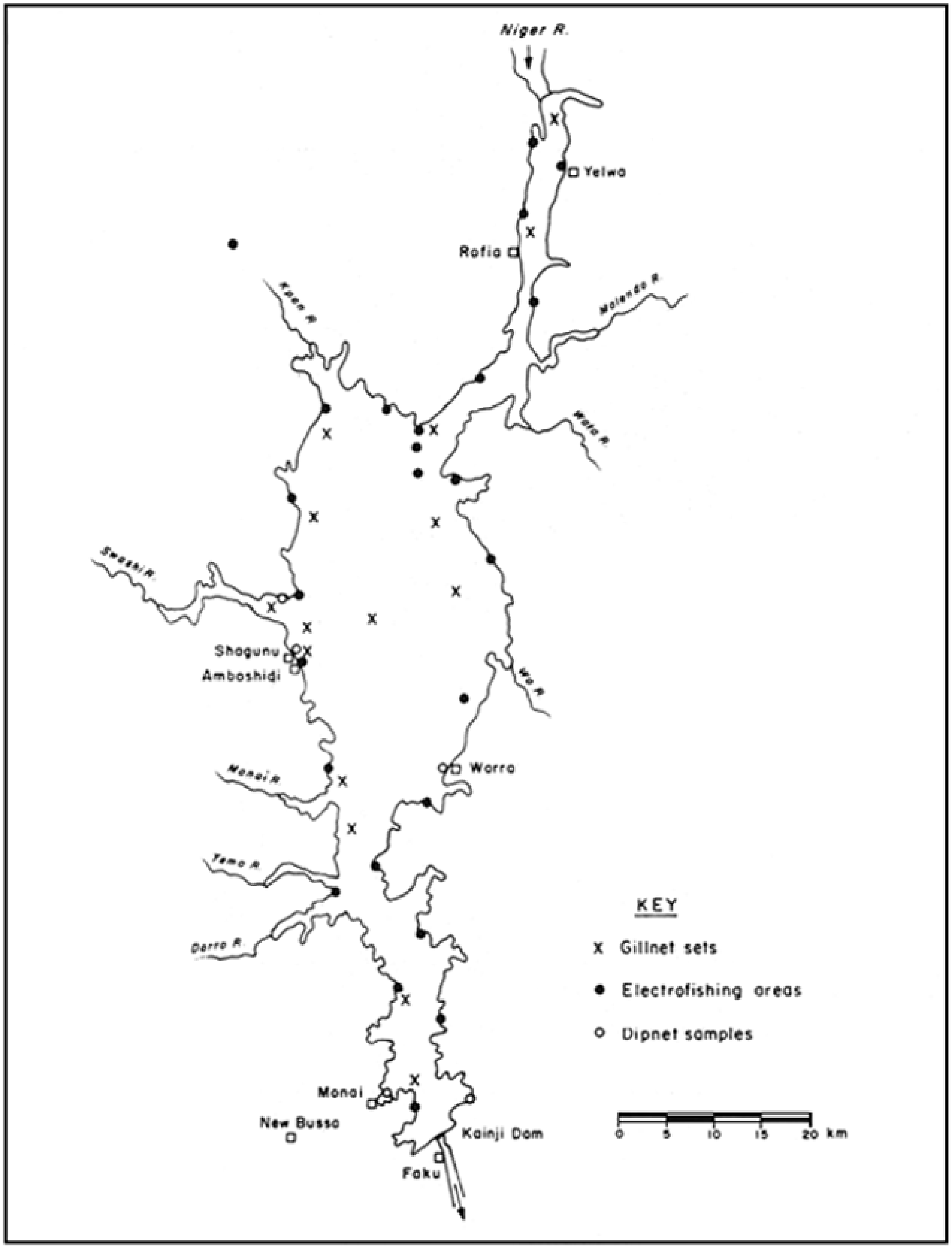

Fig. 2 - MAP OF KAINJI LAKE SHOWING SAMPLING LOCATIONS

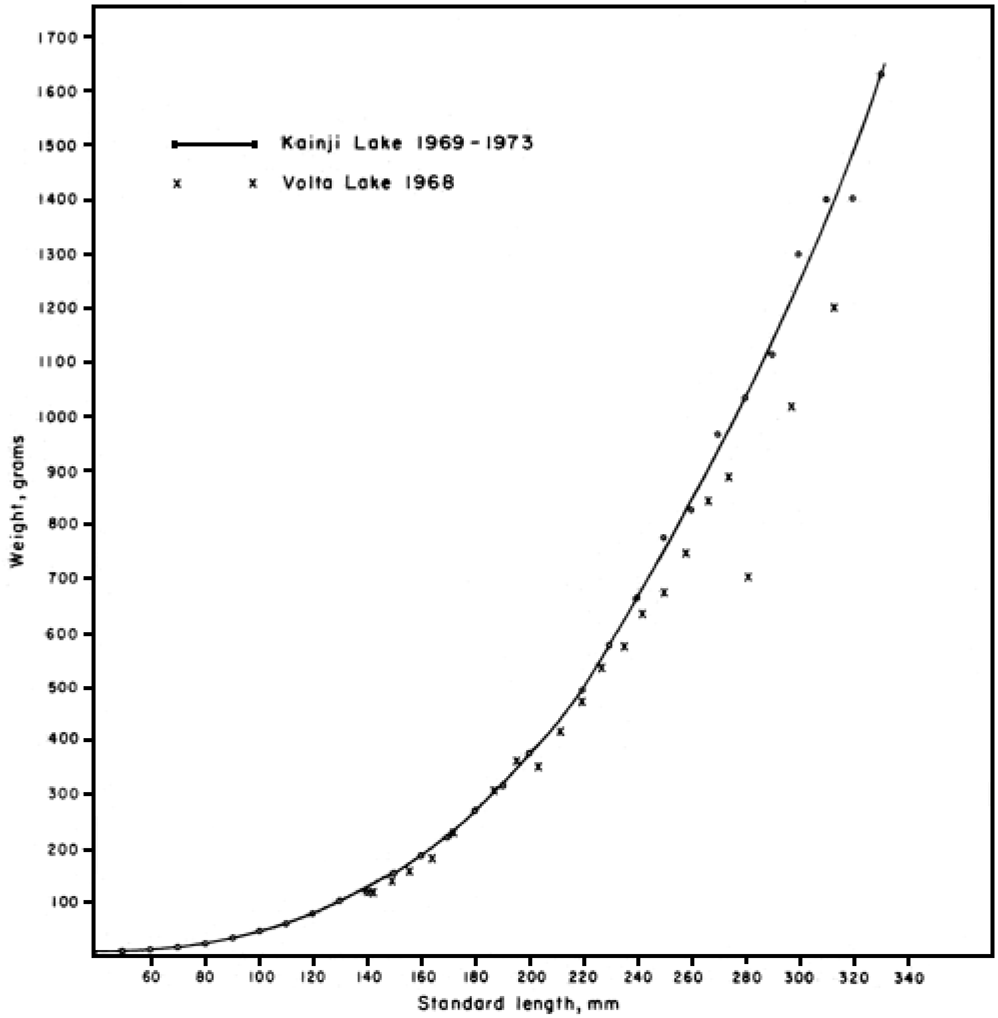

Fig. 3 - STANDARD LENGTH: WEIGHT RELATIONSHIP OF T. galilaea IN KAINJI LAKE AND VOLTA LAKE (curve drawn by eye)

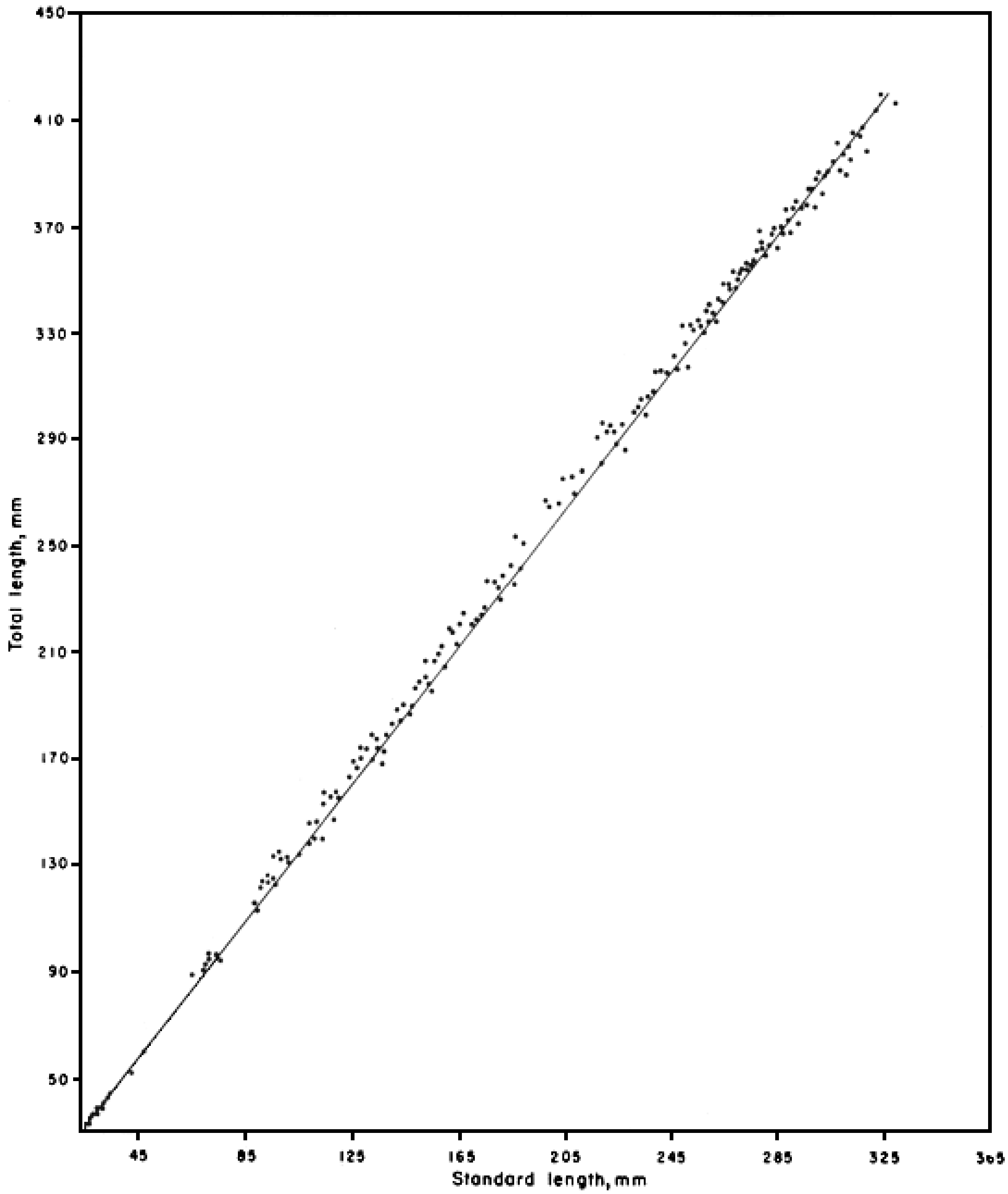

Fig. 4 - STANDARD LENGTH: TOTAL LENGTH RELATIONSHIP OF T.galilaea IN KAINJI LAKE (curve drawn by eye)

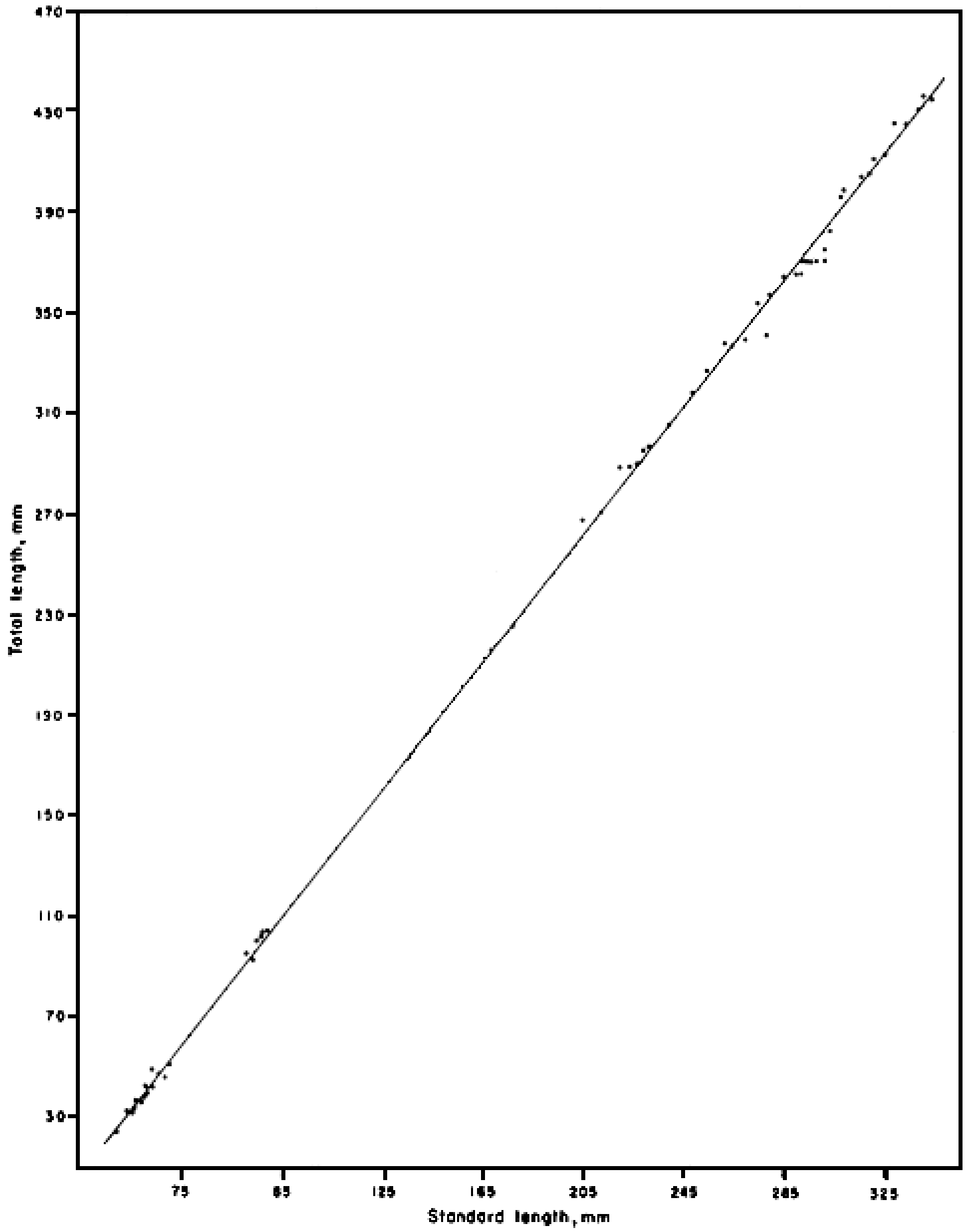

Fig. 5 - STANDARD LENGTH: TOTAL LENGTH RELATIONSHIP OF T. nilotica IN KAINJI LAKE (curve drawn by eye)

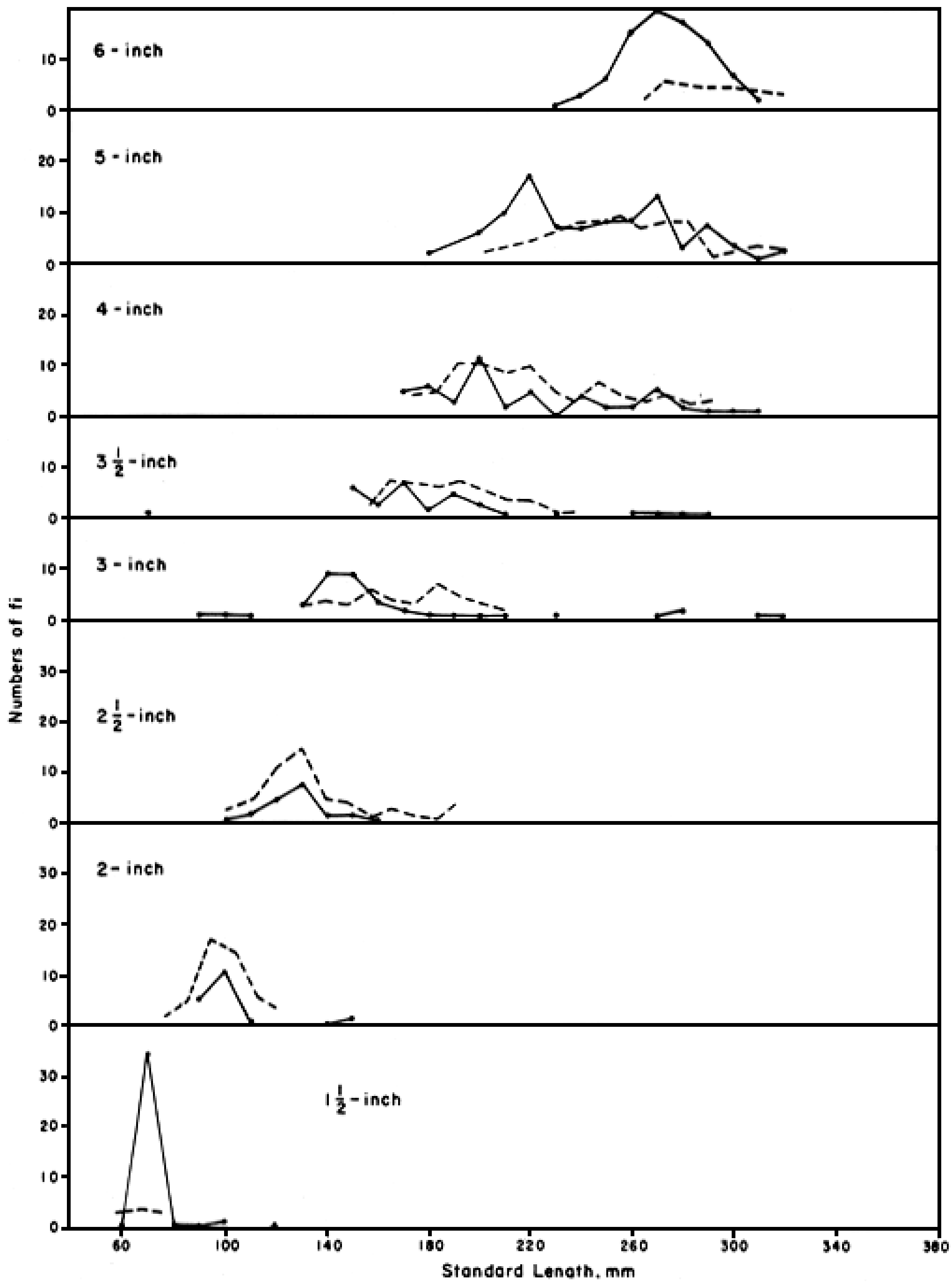

Fig. 6 - LENGTH FREQUENCY DISTRIBUTION OF T. galilaea CAUGHT IN VARIOUS MESH SIZES OF GILLNETS IN KAINJI LAKE (1969 TO 1972) (the dotted line compares similar data for Volta Lake, adapted from Evans, 1971)