SOME BIOLOGICAL ASPECTS OF THE FPISH FAMILIES, SCHILBEIDAE AND MALAPTERURIDAE (OSTEICHTHYES : SlLURIFORMES) IN ZARIA AREA

BY

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THESIS SUBMITTED IN PARTIAL FUFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER *OF* SCIENCE IN FISHERIES

DEPARTMENT OF BIOLOGICAL SCIENCES

FACULTY OF SCIENCE

AHMADU BELLO UNIVERSITY

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DECLARATION

I declare that this work is wholly that of the author and has not formed part of any presentation for any other qualification.

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DEDICATION

This work is dedicated to my late brother,

MR MATTHEW OGBE.

ACKNOWLEDGEMENT

I am greatly indebted to Dr A. A. Olatunde who supervised the research and offered many useful suggestions.

Grateful to my parents, Mr G. J. Ogbe and Mrs Asana Ogbe for their moral and financial support.

Thankful to Benue State Government for partly financing this programme.

Thankful to Dr J. O. D Adegboye, Head of Biological Science, Ahmadu Bello University, Zaria, Nigeria for providing the facilities for the research.

Mr. J. Auta is thankfully acknowledged for making his car and office available for use in this project.

I wish to thank F. Y Abuh, I. Ejiga and S. A. Onoja who helped me in different ways.

My thanks also go to Dr. A. A. Oladimeji for his assistance.

ABSTRACT

A total of 873 specimens were observed in Zaria. 390 were Schilbe mystus. 366 Eutropius niloticus and 117 Malapterurus electricus. Schilbe mystus was the most abundant followed by Eutropius niloticus and the least abundant was Malapterurus electricus.

Pattern of growth in Schilbe mystus was allometric while both Eutropius niloticus and Malapterurus electricus were isometric All the species were in good condition throughout the study. Omnivorous habit was observed in all the species, In Schilbe mystus the main food item was fish during the rainy season, in the dry season they fed slightly more on insects than on fish. Piscivorous habit was also noticed in Malapterurus electricus while Eutropius niloticus fed more on insects. The sex ratio for Schilbe mystus, Eutropius niloticus and Malapterurus electricus were 1:5 females; 1:2 females and 1:1 females respectively. The three species bred during the rainy season. The fecundity of Schilbe mystus was 10,676 while that of Eutropius niloticus was 10, 530 and 2,331 for Maiaptor lrus electricus.

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CHAPTER ONE

I N T R O D U C T I O N

Nigeria's steadily increasing Gross National Product (G.N.P) since the oil boom of the 1970's has resulted in higher Private Consumption Expenditure (P.C.E) in the country. This is clearly manifested in bigger demand for animal protein in the diet of a wide spectrum of Nigerian population. Fish which has been a traditional source of protein for riverine and coastal people can now be enjoyed by both rural and urban population in all the corners of the country because of availability of marine frozen fish and the nationwide distribution network which enterpreneurs have organised.

Nigeria is the largest consumer of fish and fisheries product in Africa, yet only 70 percent of the total demand is met by domestic production (Dada and Gnanadoss, 1983). Reports from Federal Department of Fisheries (1985) indicated that the domestic fish production in 1983 was 522,403 metric tonnes while that of 1984 was 349,396 metric tonnes. The short fall in the production was supplimented by importation of more than 238,854 tonnes and 137,777 tonnes in 1983 and 1984 respectively (this figures do not include sardines, canned fish and stock fish imports). The source of information also reported that fish production was poorest in 1984 since the past 10 years, and it was in 1984 that the least importation of the fish was recorded.

Adesimi et al (1983) in his studies of domestic fish production in Nigeria by sources (1971-1980) indicated that as

much as 42.3 percent of the total fish production came from inland rivers, lakes and ponds. This sources could contribute considerably more to the domestic supply of fish if more investment could be made to this subsector (Okpanife, 1976).

Olayide et al (1969) showed that the per capita consumption of fish per day was 29.1 grams yeilding 2.6 grams of animal protein and representing 35 percent of the per capita consumption of livestock product and 30.8 percent of the ingested protein.

It is in the recognisance of the unique roles played by fisheries resources in the national economy and the need to encourage local production, that Nigerian Government did not only limit the importation of stock fish, sardines and canned fish, but projected some well desired plans to achieve self sufficiency in fish production. Such plans include, increased exploration of Nigerian fisheries resources to meet the rapidly increasing demand for fish and encouragement of the development of fisheries based industries. Others include, provision of employment opportunity for young school leavers in the coastal riverine areas of the country and lastly, increase generation of foreign exchange through shrimps exports. To achieve these plans, the sectoral allocation to fisheries sectors rose from ₦11.6 million in the second National Development Plan (1970-1974) to ₦101.55 million in the third plan. The allocation to fisheries in the Fourth National Development Plan (1981-1985) increased to ₦170.99 million which was 68.4 per cent above that of the third plan.

Another programme aimed at boosting fish production in the third and fourth National Development plans, is the National

Accelerated Fish Production Project (NAFPP). It was designed to bring the benefits of modern fishing technology to artisnal fishermen along the country's coastline, lagoons and the inland waters. It also involves organising small scale fishermen into Fisheries Cooperatives, the provision of credit facilities and the supply of fishing inputs at subsidized rates.

For fisheries development plans to be realistic therefore, it is important that they are based on a clear understanding and appraisal of the nature and availability of resources. It is on this ground that studies on some biological aspects of the families Schilbeidae and Malapteruridae were undertaken in Zaria area. The area of concentration in the study were the food habit, length/weight relationship, condition factor, reproductive cycle and fecundity.

Similar biological studies have been carried out elsewhere. Such works include that of Arawomo, (1976) who investigated the food and feeding habit of the three Citharinus sp in lake Kainji. Here he found their main food items to be planktonic and epipetic blue green algae. Reynolds (1974) studied the biology of the small pelagic fishes in the new volta lake in Ghana. His findings on the sex and reproduction indicated that reproductive patterns of five species from the three families of small pelagic fishes in the new Volta lake in Ghana showed several similar features. These include size differences, males maturing and reaching final sizes smaller than females, heterogenous sex ratio in four species, being mostly markedly unequal usually at peak breeding times, dermesal eggs, and extended spawning patterns.

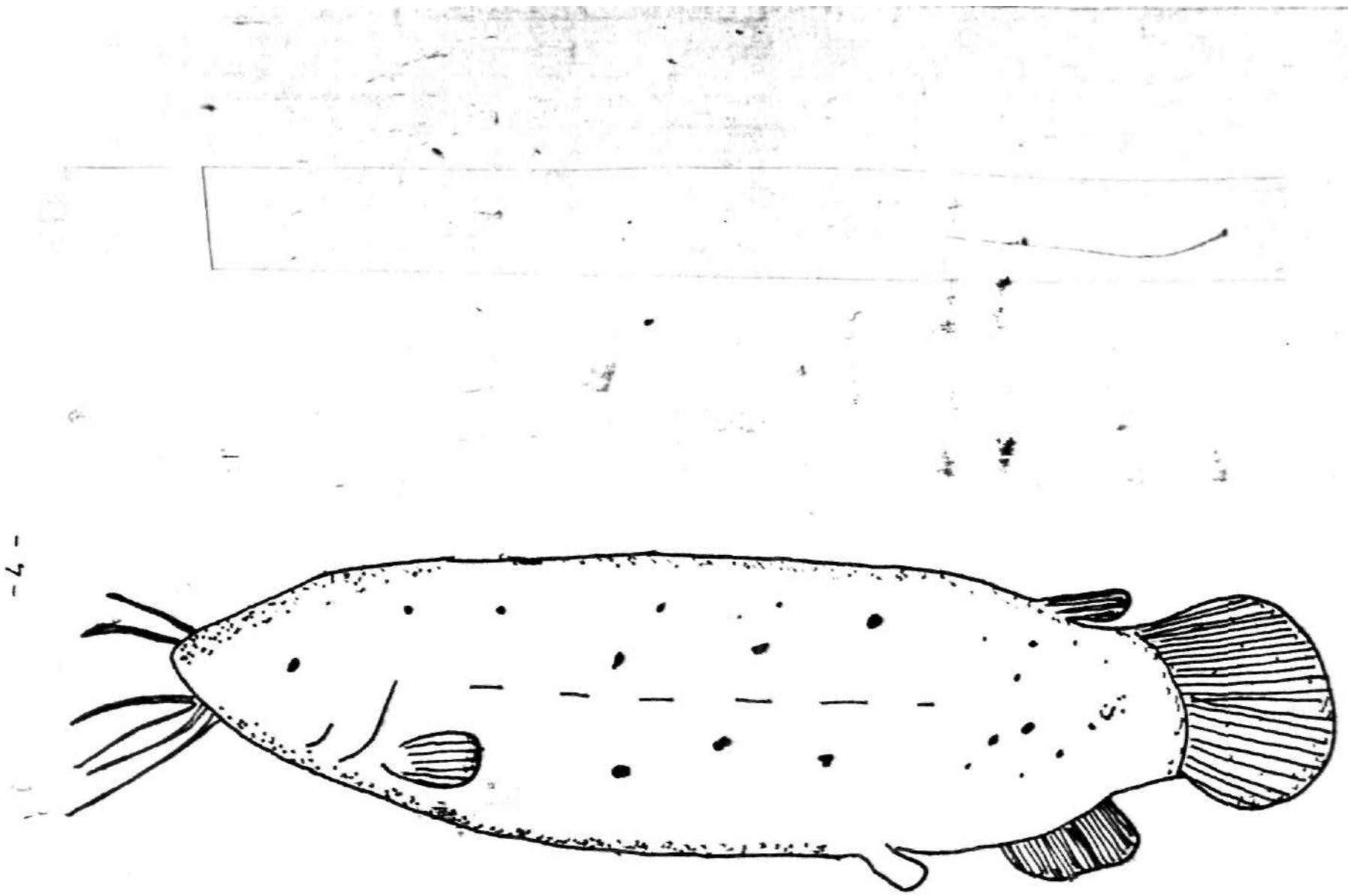


Fig 1: Malapterurus electricus (Gmelin) life-size

In his biological studies of clupeids in Lake Kainji, Otobo, (1978) indicated Eutropius niloticus, Schilbe mystus and Malapterurus electricus, as some of the fishes contributing to clupeid mortality, stating that the degree varies from species to species.

FAMILY MALAPTERURIDAE

The family Malapteruridae, is represented by one species, Malapterurus electricus (GMELIN) in Zaria area (Fig 1). Full description of this species has been given by Boulenger (1909) and Alwyne (1975). The electric catfish is immediately distinguished by its heavy built, scaless, and rather bloated appearance which is moderately elongate or little depressed. It possess no rayed dorsal fin, but adipose fin is present. Anal fin is short and pectoral fin without spinous rays. They have three pairs of barbels, maxillary and two mandibular. The eye is centrally located without free border and the nostril are widely seperated from each other. Each jaw posess a band of villiform teeth and a toothless plate. An electric organ extends over the adipose and anal fins Boulenger (1909).

It lives mostly in swamps, occassionally in rivers and then around the reed beds flanking the flowing water (Alwyne, 1975).

Although rarely seen in large number Malapterurus electricus is commonly seen and widely distributed throughout the whole of Nile System to River Zaire, Tropical Africa (except Lake Victoria' and rivers of the East Africa north of Zambesi (Boulenger, 1909). In River Niger, they are found mainly in shallow littoral areas and swamps (Sagua, 1975).

Daget and Illis (1965), recorded a specimen caught in the Niger Republic with a standard length of 122 cm and weight of 27 kilograms. In the River Niger near Kainji, Nigeria, Sagua (1979) recorded the largest specimen to be 19.5kg for a standard length of 95cm and that they occur relatively abundant in the hook and line catches.

Malapterurus electricus is surrounded by great mystique; for the electrical properties are clearly special (Alwyne, 1975). He also stated that from the number of representations of the fish in an ancient Egyptian pictographs, it was obviously of high regard and that in the Northern part of Nigeria today, it is used by some fishermen for making magic.

Despite the use of the specimen in educational institution and its ready availability in all the inland rivers and lakes of African countries, comprehensive investigation into the food habit, reproductive biology and length-weight relationship are still lacking particularly in Zaria area.

Earlier studies on this species in Zaria area by Bello (1981) have been limited by method of analysis and inadequate consideration of size and seasonal effects.

Extensive studies have been carried out on Malapterurus electricus (Gmelin) elsewhere and have been documented in its natural range, such work include Sagua, (1976) who studied the biology and ecology of M. electricus in River Niger and Lake Kainji. He also determined the proximate composition of fresh and smoked Malapterurus electricus contents of crude protein, ash, fats and water of the flesh and skin of the electric catfishes. Sagua (1979) also expressed surprise that despite the fact that the electric catfish has few natural predators, (e.g Hydrocynus

brevis) which occasionally attacks Malapterurs electricus, it is not very abundant in fresh waters of Africa.

Other workers are Cleland (1854) who carried out studies on the Skeleton, muscles and viscera of the electric catfish obtained from Calabar Nigeria. He also pointed out that, the fish appeared to have been feeding entirely on crustacean.

Bauer (1968), Belbenoit Moller, Serrier and Push (1979) related the function of the electric organs to defensive and offensive predatory behaviours, while Coates and Atz (1962), who commented on the paucity of knowledge on the mode of life of the electric catfish stated that, it was reported as eating algae, worms and fish.

FAMILY SCHILBEIDAE

This is a family of catfish found in the freshwater of Africa and Asia. It is distributed over nearly all the areas of the two continents with the exception of the arid region (Alwyne, 1975). There are six genera in this family, namely Eutropiella, Eutropius, Schilbe, Siluronadon, Physailia and Parailia. In Lake Kainji, Nigeria, the family is represented by four species. These are Eutropius niloticus, Schilbe mystus, Physailia pellucida and Siluranodon auritus (Lewis, 1974). Eutropius niloticus and Schilbe mystus are the species of this family seen in Zaria. Generally this fish family have 4 pairs of barbels. They are Scaless, moderately elongated and compressed.

Previous work on this family include their food and feeding habits as reported by Irvine (1914), Pekkola (1919) Sandon and Tayib (1953), Verbeke (1959) and Imevbore (1970).

Imevbore, (1970) carried out some preliminary observations on the sex ratios and fecundity of the fishes of River Niger while Otobo (1975) carried out biological studies on some fish families including Schilbeidae. Other workers included Blake (1977) who summarized the changes within the fish population since the impoundment of the Niger in 1968. He noted that the family Schilbeidae were found to be one of the most numerous families in the Lake, but are commercially under-exploited. He also observed that the Schilbeidae particularly Eutropius niloticus (Ruppel), were abundant in the Lake during 1974 and 1975, but were rarely represented in the market. Commenting further, and citing Otobo (1975), who obsered similar trend in his work on clupeids, Blake (1977), remarked that a large population of Schilbeidae in Kainji are yet to be exploited. He further emphasized that the value of this resources is more likely to be in the production of organic fertilizers rather than direct consumption. Olatunde (1980) analysed the biochemical composition and nutritional value of Eutropius niloticus, Schilbe mystus and Physailia pellucida in the Lake Kainji, Nigeria and found the fish to be rich in lipids, protein and essential mineral element. He suggested that the Schilbeidae should be harvested for direct consumption rather than use as fertilizers as suggested by Blake (1977).

In Zaria area, Aromire (1981) studied the biology of Eutropius niloticus, she focused her attention on their food habit during the five months of study (November 1980 to March 1981), as well as the length-weight relationship of this fish. Her studies does not cover a whole year to observe a seasonal variations in dietary pattern. The studies also lacked information on the reproductive biology of the fish. The present study is

therefore designed to cover the reproductive biology, food habit, length-weight relation and condition of the fish.

Eutropius niloticus (Ruppel) Fig. 2.

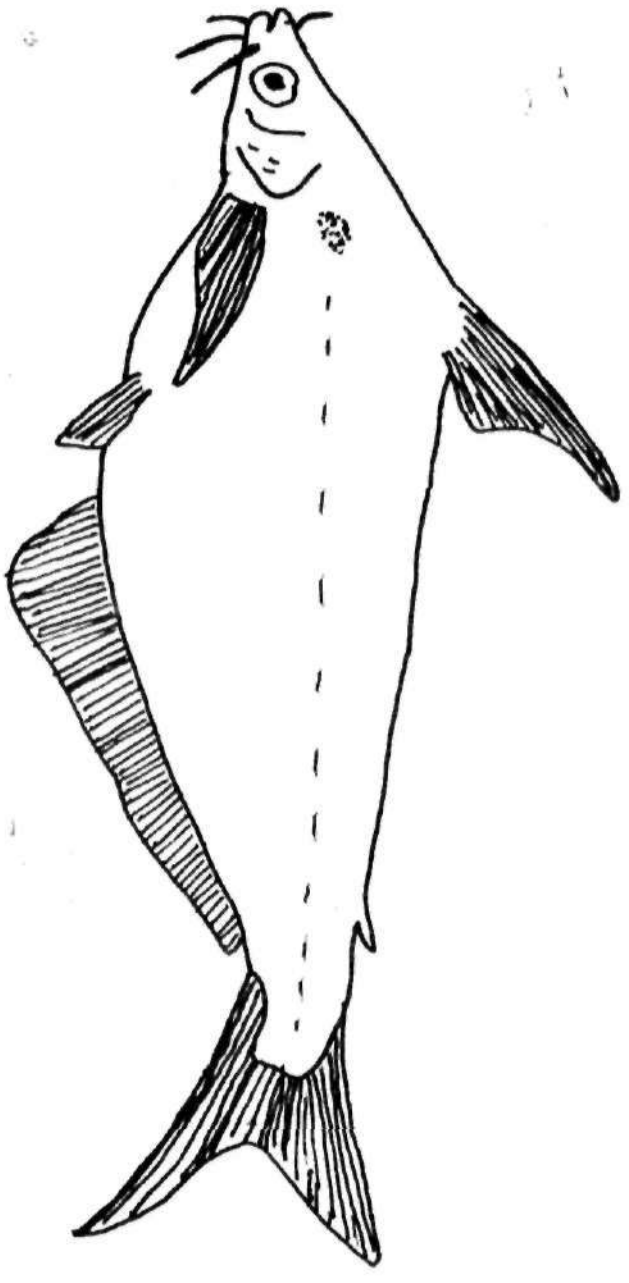
Full discription of this fish has been given elsewhere by Boulenger (1909) and Lewis (1974). The body of this fish is compressed laterally and lack scales. A long anal fin is present. They posess a short-based dorsal fin. The pectoral spine is sharp and can inflict a painful wound, and there is a tiny adipose fin. The caudal fin is forked and bent down at angle to the body. There are four pairs of barbels. The fins are clear. The flesh is soft and of excellent flavour especially suitable for frying.

Schilbe mystus (Linnaeus) (fig. 3) has the body similar in appearance to Eutropius niloticus but an adipose fin is present. The large rounded snout has the lower jaw projecting slightly.

The colour of adult is silver on the sides, greenish on the back, white on the belly, and the fins are clear. There is a large dark spot above the base of the pectoral fin. Juveniles have three dark longitudinal bands. The upper and lower of which continue along the caudal lobes (Reed, et al (1967)

This species is widely distributed in African rivers including the Nile, the rivers of West Africa, the Congo and Zambesi and the lakes of Africa. It is found in the open shallow water and is an active gregarious species (Alwyne, 1975).

This fish has a lot of market value in Zaria particularly during their breeding season, probably because of the large amounts of eggs they produce (oral communication from fish mongers). It is also a common aquarium species (Alwyne, 1975).



Frg. 2 Eutroplus niloticus (Puppel) life-size

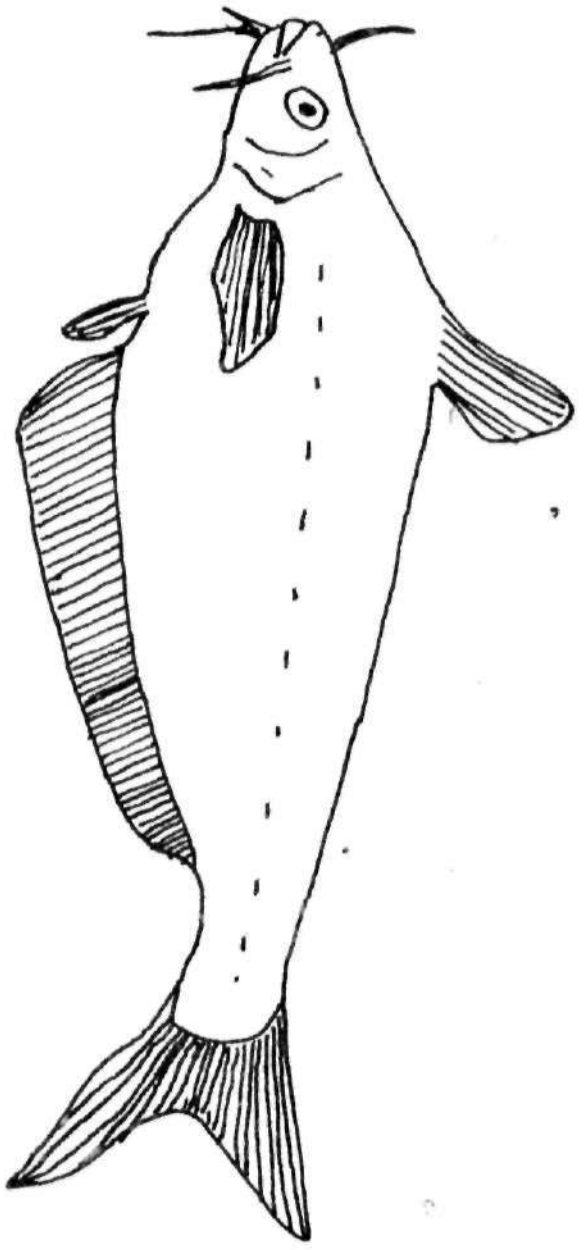
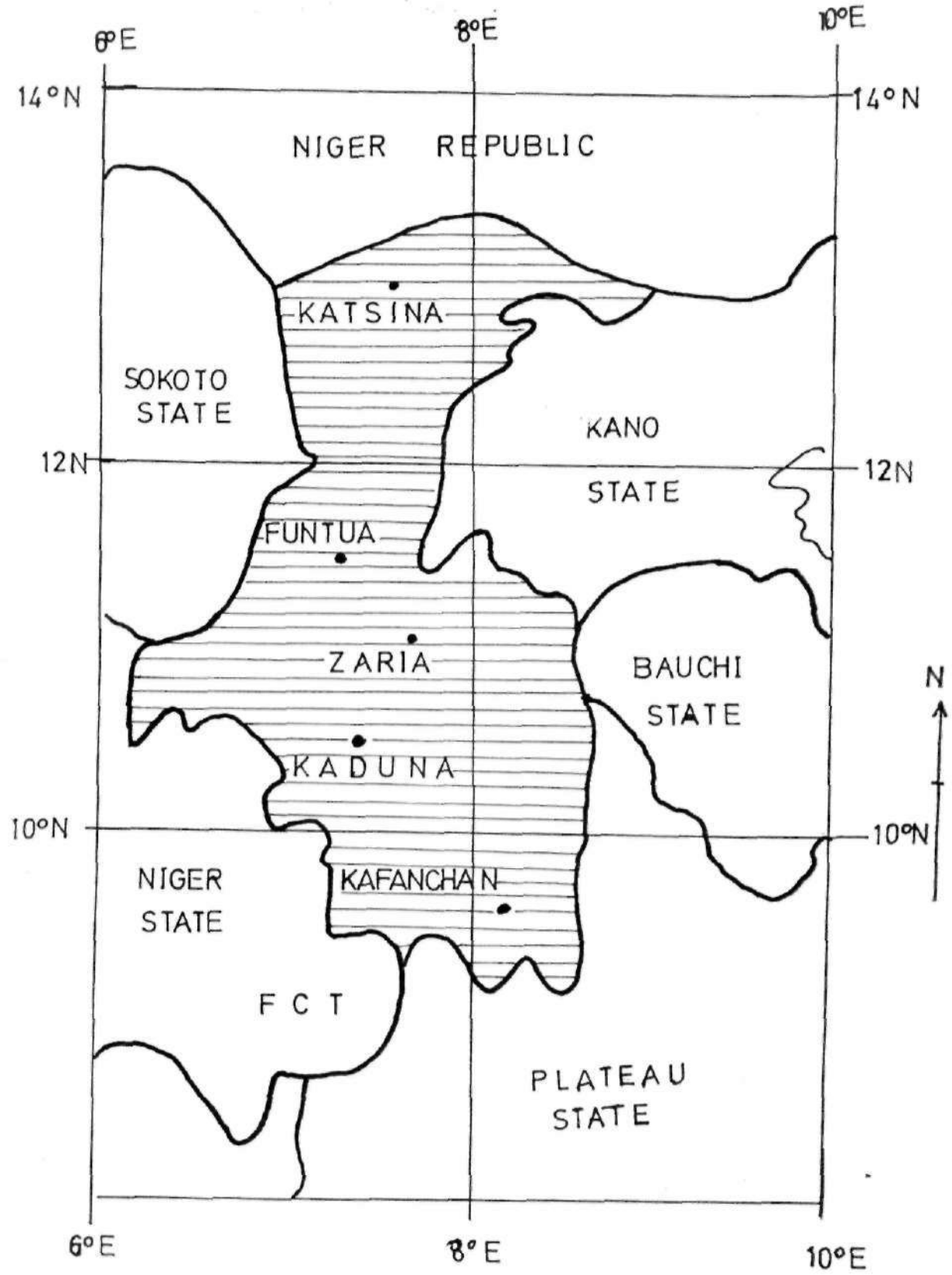


Fig. 3 Schilbe mystus (Linneus) Life size

Biological knowledge of Schilbe mystus and Eutropius niloticus was considered essential in view of their commercial importance. The project was carried out in Zaria, Kaduna State, Nigeria. The geographical location of Zaria is longitude 7° 42'E and latitude 11° 03'N (fig. 4a). It is 540 meters above the sea level. The vegetation is Northern Guinea Savanna. The climate was described by Hore (1970) as tropical continental. Zaria has two distinct seasons, rainy seasons which last from (late April or to early May to September or early October) which is usually characterized by strong wind (Walter, 1970) and the dry season (October to March). The rainfall recorded during the year of the study was 888.0mm and the average rainfall in Zaria for the past 56 years is 1050.1mm (Titwit, Dec. 1984).



SCALE: 1 : 60

FIGURE 4A: MAP OF KADUNA STATE SHOWING STATE BOUNDARIES.

SOURCE KADUNA STATE MIN. OF WORKS & LAND SURVEY

CHAPTER TWO

MATERIALS AND METHOD

Method of Collection

Fish specimens were bought from the fish mongers at Zaria Sabon-gari market. Information from the fish mongers revealed that their supplies come from fishes obtained from rivers, lakes and dams around Zaria, notably, River Galma around the Zaria Dam (fig. 4b). Other rivers included Rivers Makwaiye and Kubani.

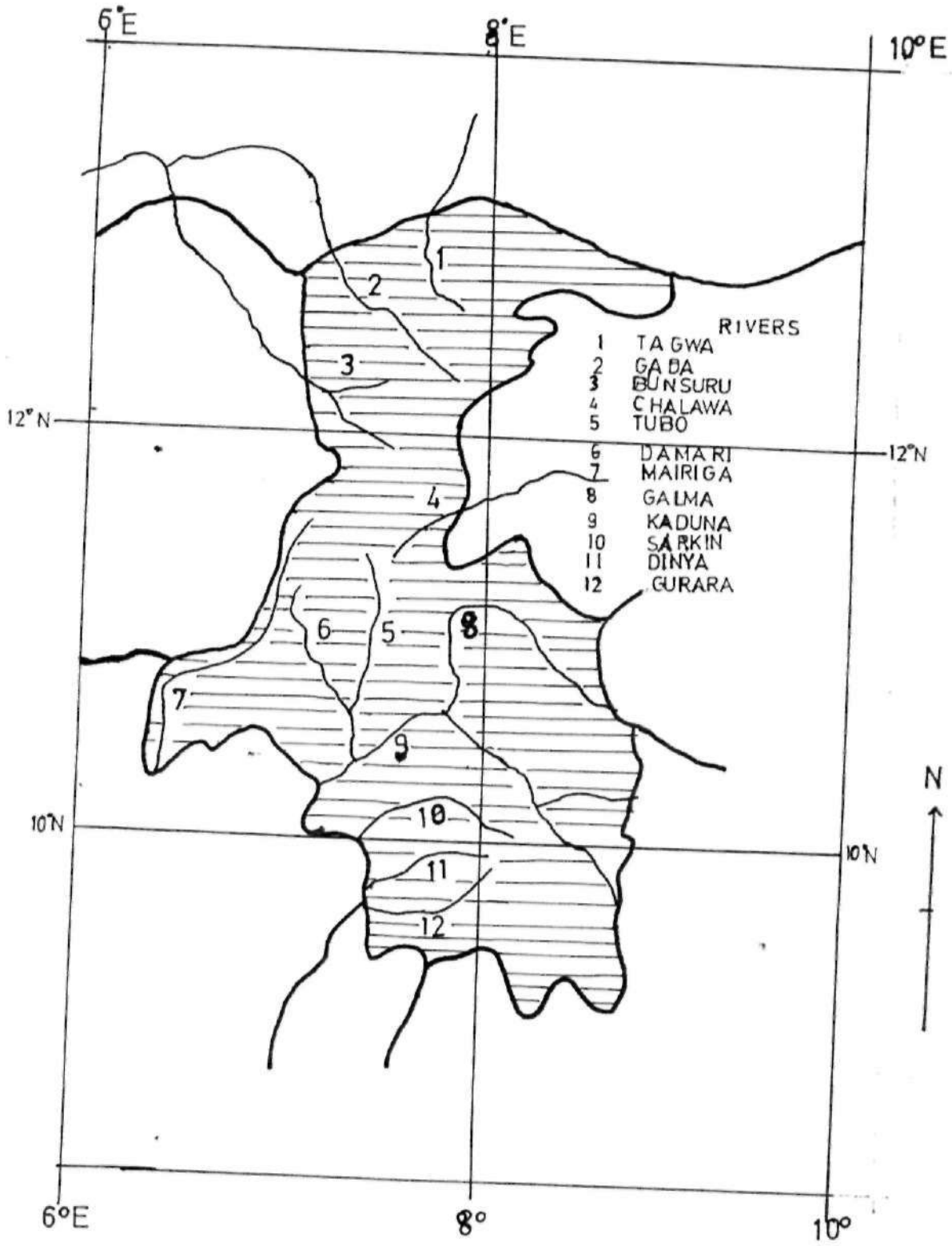
The fish mongers also revealed that, the fish were mostly caught by the use of gill nets of various mesh sizes and cast nets.

The period of study was from January to December, 1984.

Samples were bought once or twice monthly, and usually in the mornings between 9.00 a.m. - 11.00 a.m. and in the evenings between 4.30 p.m. to 6.00 p.m. The fish were transported in an ice-box containing some ice pellets (to reduce posthumous digestion to the minimum) to the laboratory. The fishes were identified using the key prepared by Lewis (1974). The identification were later confirmed by Dr. A. A. Olatunde.

LABORATORY ANALYSIS

In the laboratory, total and standard lengths were measured to the nearest millimeter using the measuring board. Standard length is the greatest length of a fish from its most anterior extremity with the mouth closed to the hidden base of the median



SCALE: 1 : 60

FIGURE 4 B: RIVER COURSES OF KADUNA STATE

SOURCE: KADUNA STATE MIN. OF WORKS & LAND SURVEY

tail fins rays (where these meet the hypural plate). Total length is the greatest length of a fish from its anterior most extremity to the end of the tail. In fish with forked tail like Eutropius niloticus and Schilbe mystus, the two lobes were pressed together to give the maximum length measurement.

Fish were weighed to the nearest 0.1g using electronic Mettler balance.

Length frequency distribution

The standrad lengths were grouped in 2 centimeters for Eutropius niloticus, Schilbe mystus and these were used to construct length frequency distribution for males and females. For Malapterurus electricus, the standard length were grouped into 5 centimeters groups. Then the frequency distribution was constructed graphically.

Length-Weight relationship and condition factor

The length-weight relationship was expressed graphically by plotting the observed standard lengths with weights on the double logarithmic graph paper and calculated using the formula described by LE CREN (1951):

$$W = aL^b \quad - - - - - (1)$$

Equation (1) can be represented as

$$\text{Log } W = \text{Log } a + b \text{ Log } L \quad - - - - (2)$$

Where W = Weight of fish (g)

L = Standard length of fish (cm)

a = Constant

and b = an exponent

for males, females and both males and females combined by

least square regression method.

Condition factor, K was calculated using the formula

$$K = \frac{W100}{L^3}$$ (Worthington and Richardo, (1930) - - (3)

Where K = the condition factor

W = weight of fish in grams

L = standard length of fish in centimeters

Since condition is related to both sex and size (Le Cren, 1951), it was considered for each sex separately and groups of fish of standard lengths 5 - 10 cm; 11 - 15 cm; 16 - 20cm for Schilbe mystus and Eutropius niloticus, and 1 - 20 cm and 21 - 40 cm for Malapterurus electricus. Monthly variation of the K-value for the three species was also considered.

SEX DETERMINATION

The gonads were inspected to determine the sex of the specimen. In matured females, eggs were readily discernable in the ovary. In matured males, the testis are typically smooth, whitish and non-granular in appearance.

DETERMINATION OF MATURITY STAGES

Maturity stages were determined using the scale modified after Nikolsky (1963) as in Table 1

Table 1: Gonad Maturity stages

Stage	Description
I. IMMATURE	Young individuals which have not yet engaged in reproduction, gonads of very small size
II. RESTING STAGE	Sexual products have not yet begun to develop: gonads of very small size; eggs not distinguishable to the naked eye.
III. MATURATION	Eggs distinguishable to the naked eye; a very rapid increase in weight of the gonad is in progress, testis changes from transparent to a pale rose colour.
IV. MATURITY	Sexual product ripe, gonads have achieved the maximum weight but the sexual products are still not extruded when light pressure is applied.
V. REPRODUCTION	Sexual products are extruded in response to a very light pressure on the belly, weight of gonad decrease rapidly from the starts of spawning to its completion.
VI. SPENT CONDITION	The sexual products have been discharged. Genital aperture inflamed; gonads have the appearance of deflated sacs, the ovaries usually containing a few left-over eggs, and the testis some residual sperm.
II. RESTING STAGE	Sexual product have been discharged, inflammation around the genital aperture has subsided, gonads of very small size, eggs not distinguishable to the naked eye.

GONADO SOMATIC INDEX ESTIMATION

Gonads of maturity stagesI,II, III, IV, V,VI were removed from the body cavity and weighed to give the weight ± 0.1mg using a mettler H15 electronic balance. Gonado somatic index, (Gs 1) was calculated by expressing the ratio of gonad weight to total weight as a percentage. A chi-square goodness of fit was performed on the sex ratio.

PRESERVATION OF MATURED GONADS

The ovary of stage IV were preserved in Gilson fluid (Simpson, 1951), for at least three months. Gilson fluid was prepared by a mixture of 100ml 60% alcohol

40 ml 80% acetic acid

18 ml glacial acetic acid

20g mercuric chloride

880ml Distilled water

Ovary removed from the fish were split longitudinally and turned inside out to assist penetration by preservative. The preserved ovary was shakened hourly for 24 hours and later, weekly.

After three months, the preserved eggs were washed with water. The eggs were separated by shaking the container vigorously. Later the eggs were further separated manually.

FECUNDITY ESTIMATION

Relative fecundity Nikolsky (1963) was determined by the subsampling dry weight method Simpson (1959). This is the number of eggs per females as observed in individuals of gonad

stage IV. The preserved and washed eggs were poured into a filter paper in a funnel. When the liquid had drained away the paper and eggs were spread on a blotting paper to remove excess moisture. After about 20 minutes the eggs were spread on a filter paper tray made from 30 x 45 cm sheets, with the edges turned up. They were then left to dry until the eggs could be moved freely without raising the surface of the paper. They were left to air dry under room temperature of 25°C and moved about with the fingers to prevent clumps forming. When they were thoroughly dried, that is when a constant weight was got after repeated weighing, they were stored in labelled specimen tube.

The fecundity estimate was obtained by weighing all the eggs in a sample, then three random subsamples of 200 eggs were weighed and their mean weight calculated.

The toal weight of the eggs was divided by the mean weight of the subsamples. The quotient was multiplied by 200 (subsample number of eggs) to give fecundity estimate. The formula for describing the estimated fecundity is given below:

$$F = \frac{Sn}{S_{wt}} \times Wt_t.$$

F = Fecundity estimate

Where Sn = Subsample number of the eggs.

S_{wt} = subsample weight of the eggs.

Wt_t = Total weight of the eggs.

A microbalance was used to weigh the eggs. Mean value were then calculated to estimate the total number of eggs per female. Regression analysis was performed to determine fecundity relative to both standard length and weight of the fish.

LABORATORY ANALYSIS OF DIET

It is usual in feeding studies to employ more than one method of analysis in order to account for limitation of some method (Hyslop, 1980).

The food habit of these species were studied by examination of stomach contents of individual fish. Frequency of occurence and points methods were used to analyse the stomach contents.

The Point Method

Here stomachs that were not empty were removed by opening the body cavity and severing the gut at the Oesophagus and behind the pyloric constriction. Food remains contained in the cardiac portion were squeezed into a petri-dish. The degree of fullness (volume) of the stomach was estimated as in table 2 . Those stomach that did not fall exactly on these points were awarded points accordingly. The graded stomach was then dissected lengthwise and the contents washed into a petri-dish containing little water. The food items that could not be seen with the naked eye were then observed and identified to the nearest taxonomic unit with the aid of binocular microscope. Food items were then awarded points according to the volume they were judged to have occupied in relation to the total volume of the food in the stomach. In this way the sum of the points awarded to individual food items equalled to the points awarded for the stomach size. The points gained by individual food items in each fish examined were summed and the percentage contribution made by each was determined for rainy and dry seasons. The figure obtained gave the relative volume of the food items consumed expressed as percentage. This method is

Table II: Classification of stomach size

Stomach size	Description	point
Full stomach	The stomach bulges considerably with food, stomach wall very thin and transparent	100
¾full stomach	The stomach is almost full, does not bulge	75
½Full stomach	Food occupied about 50% of the stomach	50
¼Full stomach	The stomach was very flabby, sometimes looked as if emptied.	25
Empty stomach	No visible food in the stomach when dissected and examined under the microscope	0

(Olatunde, 1978)

essentially a volumetric method and was used to show the importance of each food item in the diet.

This method was proposed by Swynnerton and Worthinton (1940), modified by Frost (1943) and again slightly modified and recommended by Hynes (1950).

Hynes (1950) noted that it is rapid and easy, requires no special apparatus for measurement, is not influenced by frequent occurance of small organism in small numbers, nor of heavy bodies, and does not involve trying to count large numbers of small and broken organisms. It also does not give the spurious impression of accuracy which is given by some other methods. Despite the good points, there are weakness of this method. First, it is subjective, and the investigator may be influenced by prejudice in his allotment of points, but where large samples are analysed over a period of months this difficulty is to some extent over come.

The second criticism is that the results given by the points method cannot be used for comparison with counts of organisms in the habitat. Such comparisons have in the past been used to give numerical expression to the availability of food organism (Allen, 1941, 1942; and Hess and Swartz, 1941). It is suggested that this would be better accomplished by using an arbititrary method of allocation of points on the basis of estimated volume of each food item present (a) in the fish guts and (b) in general faunal collection from the habitat. The number of points, expressed as a percentage of the total, gained by any food item in fish guts and in the general collections could then be compeared.

Frequency of occurence

Here the number of stomachs in which different food items occured were recorded and expressed as percentage of the total stomach examined (e.g Allen, 1935; Frost, 1939; Frost and Went, 1940; Hartley, 1940; Frost, 1946; Hartley, 1947, 1948 and many others. The method was used becaused it shows the number of individual fish in the sample that ate the food items, but it gives no information on quantities or numbers and does not take into consideration the accumulation of food organism resistant to digestion.

CHAPTER THREE

RESULT

3.1.1 Abundance

The number of fish examined is as shown in table 3. There were 390 Schilbe mystus , 366 Eutropius niloticus and 117 Malapterurus electricus. Market observation of the abundance of the three species showed that Schilbe mystus was the most common followed by Eutropius niloticus and Malapterurus electricus. All the three species had a seasonal trend in abundance. They were more abundant during the rainy season than in the dry season. This pattern of distribution was most prominent in Malapterurus electricus.

3.1.2 SIZE DISTRIBUTION

3.1.2.1 Schilbe mystus

The minimum standard length encountered in male Schilbe mystus was 7.5 cm while the maximum was 11.5cm. That of the females was 7.5 cm and 19.8 cm respectively. The mean standard length of the males was 9.39 cm and females, 11.78cm. The weight of the males ranged from 6.0g to 18.4 g, while that of the females was 5.1 g to 141.7 g. The mean weight of the males was 10.27g while the corresponding value for females was 23.94g (table 4). Table 5 showed that the mean standard lengths and mean weights of the males were statistically smaller than the mean standard length and mean weight of the females.

Length frequency histograms were drawn for male and females(Fig.5). Fig 5 showed that most of the males were between 8 cm to 10 cm with a mode of 9.2 cm.

Table 3. The number of fish examined each month

Month	Schilbe mystus	Eutropius niloticus	Malapterurus electricus
JANUARY	60	28	4
FEBRUARY	15	44	8
MARCH	55	21	16
APRIL	33	55	7
MAY	61	15	18
JUNE	12	18	6
JULY	12	27	5
AUGUST	20	29	24
SEPTEMBER	30	23	6
OCTOBER	32	29	1
NOVEMBER	22	26	14
DECEMBER	39	31	8
TOTAL	390	366	117

Table 4 Length and weight measurement

Fish species	Physical Parameter	Sex	Number examined	minimum	maximum	mean	standard error
Schilbe mystus	Total length (cm)	M	66	8.1	13.7	11.36	0.25
		F	323	8.2	21.7	14.27	0.20
	Standard length(cm)	M	66	7.5	11.5	9.39	0.21
		F	323	7.5	19.8	11.78	0.17
	Weight (g)	M	66	6.0	18.4	10.27	0.62
		F	323	5.1	141.7	23.94	1.23
Eutropius niloticus	Total length (cm)	M	128	12.6	19.7	15.54	0.27
		F	238	11.9	23.1	17.9	0.21
	Standard length(cm)	M	128	10.1	17.4	12.4	0.22
		F	238	9.4	19.6	14.2	0.22
	Weight (g)	M	128	9.4	57.8	21.1	1.26
		F	238	8.0	95.7	31.4	1.49
Malapterurus electricus	Total length (cm)	M	50	11.7	37.4	22.7	1.71
		F	67	12.1	29.4	19.9	1.02
	Standard length(cm)	M	50	10.2	34.9	18.9	1.49
		F	67	10.9	26.8	17.8	0.43
	Weight (g)	M	50	24.0	804.6	195.7	50.4
		F	67	28.9	442	130.1	21.7

Table 5 STATISTICAL ANALYSIS FOR SIGNIFICANT DIFFERENCE BETWEEN TOTAL AND STANDARD LENGTHS AND WEIGHTS OF MALES AND FEMALES OF *Schilbe mystus*

Physical parameter	Sex	Numuber of fish examined	Range	Mean ± SE	't'	Mean Significantly different?	'p' values
Total length (cm)	Male	66	8.1-13.7	11.36±0.25			
	Female	324	8.2-21.7	14.27±0.2	9.09	YES	< 0.001
Standard length (cm)	Male	66	7.5-11.5	9.39±0.21			
	Female	324	7.5-19.8	11.78±0.17	8.85	YES	< 0.001
Weight (g)	Male	66	6.0-18.4	10.27±0.62			
	Female	324	5.1-141.7	23.94±1.23	9.91	YES	< 0.001

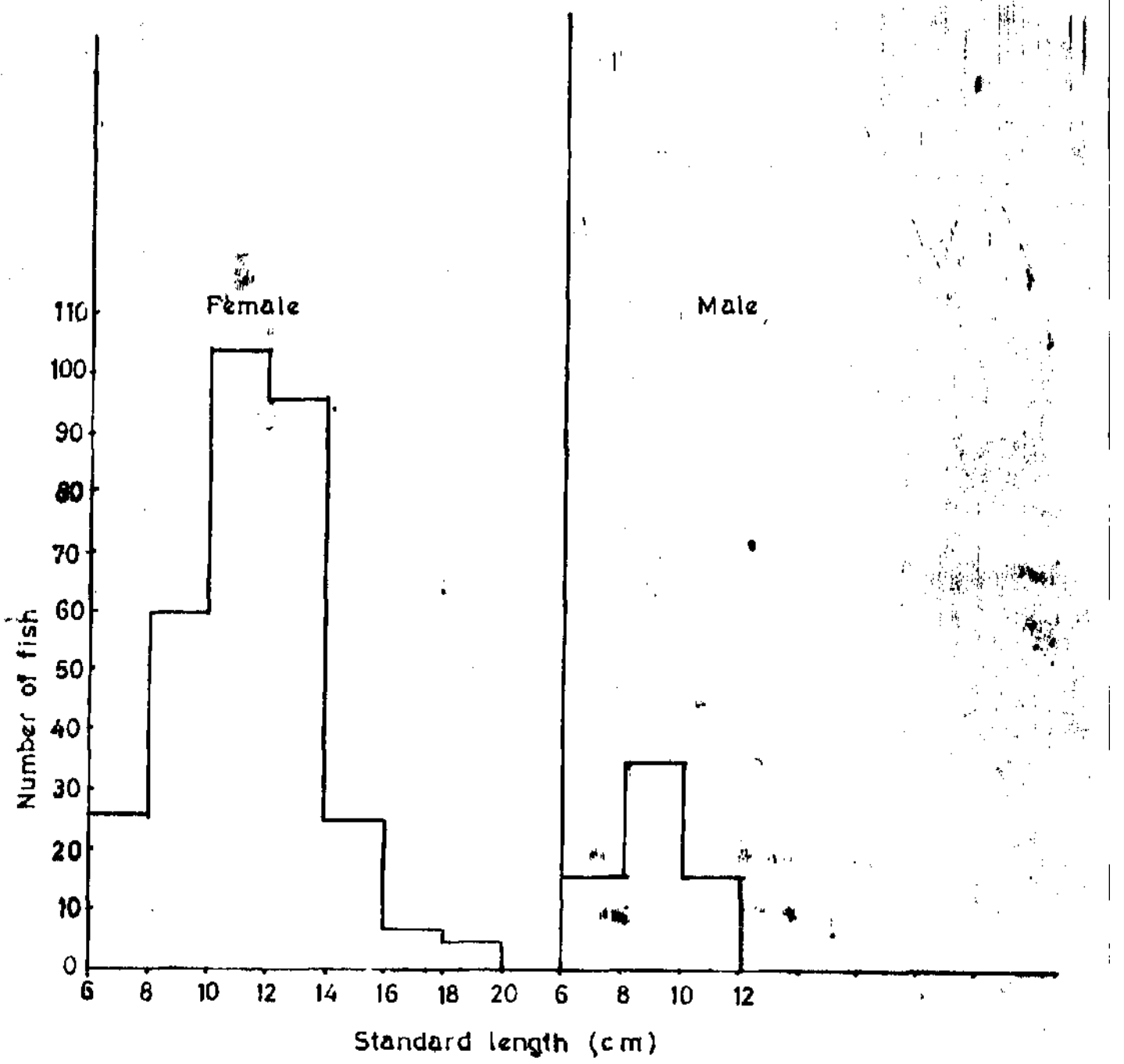


FIG.5 Standard length distribution of Schilbe mystus.

In the females, it was between 8cm and 14cm, and a mode of 11.3

3.1.2.2 Eutropius niloticus

Table 4 shows that the standard length of males ranged from 10.1cm to 17.4, while that of the females ranged from 9.4 cm to 19.6 cm. The mean standard length of males was 12.4 cm and the corresponding value for females was 14.2 cm. The weight of males varied from 9.4g to 57.8g, while that of the females was between 8.0g and 87.7g. The mean weight was 21.1g for males and 31.4g for females (table 4). Statistical test at 1% level of significance showed that the mean standard length and the mean weight of the females were larger than those of the males (table 6).

Length frequency histogram for males and females (fig 6) showed that most of the males were between 12cm and 16cm while most of the females were between 14cm and 18cm. The mode was 12.1cm and 15.1cm for males and females respectively.

3.1.2.3 Malapterurus electricus

The smallest standard length of males observed was 10.2cm and the largest was 34.9cm. The standard length of females ranged from 10.9 cm to 26.8 cm. The mean standard length of males was 18.9cm while that of the females was 17.8 cm. The weight of the males ranged from 24.0g to 804.6 g and that of the females 28.9g to 442g. The mean weight for the males and females were 195.7 and 130.1 respectively.

Table 6 STATISTICAL ANALYSIS FOR SIGNIFICANT DIFFERENCE BETWEEN TOTAL AND STANDARD LENGTHS AND WEIGHTS OF MALES AND FEMALES OF Eutropius niloticus

Physical parameter	Sex	Number of fish examined	Range	Mean ± SE	't'	Mean Significantly different?	'p' Value
Total length (cm)	Male	128	12.6-19.7	15.54±0.27			
	Female	238	11.9-23.1	17.9±0.22	6.94	YES	< 0.001
Standard length (cm)	Male	128	10.1-17.4	12.4±0.22			
	Female	238	9.4-19.6	14.2±0.22	5.81	YES	< 0.001
Weight (g)	Male	128	9.4-57.8	12.1±1.26			
	Female	238	8.0-95.7	31.37±1.99	4.35	YES	< 0.001

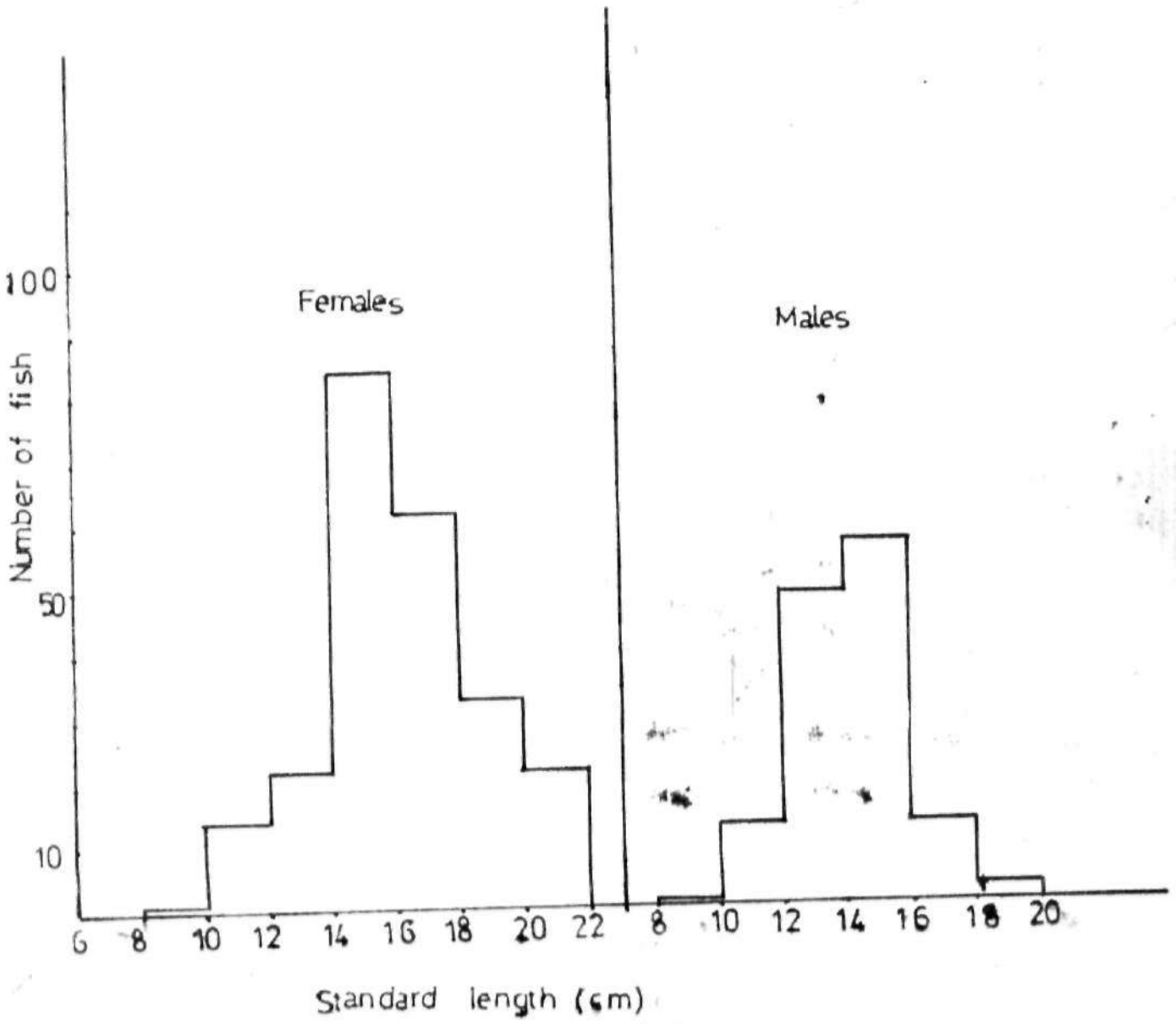


Fig. 6 Standard length distribution of Eutropius nilotic~~i~~cus

Statistical analysis showed that there were no significant differences between the standard lengths and weights of males and females at 5% level of significance (table 7).

Length frequency histograms for males and females (Fig 7) indicated that males were between 18 cm and 20cm while females had a modal class at 16cm and 18cm. The mode for the males and females were 18.6cm and 17.4 cm respectively.

3.2.1 STANDARD LENGTH - TOTAL LENGTH RELATIONSHIP

Appendix 1 gives the regression equations describing the relationship between the standard length and total length of Schilbe mystus, Eutropius niloticus and Malapterurus electricus. In all the three species the proportion of total length to standard length increased slightly with increase in size. The corrolation coefficient was highly significant in the three species. The graphical representation as seen in appendices 2, 3, 4, 5, 6, and 7.

3.3.0 LENGTH - WEIGHT RELATIONSHIP AND CONDITION FACTOR

The analysis of length-weight data has usually been directed towards two objectives. First to describe, mathematically the relationship between length and weight, to enable conversion of one to the other and secondly, to measure the variation from the expected weight for length of individual fish or relevant groups of individuals as indicator of fatness or general 'well being' of the fish. The term 'Length-Weight' relationship was applied to the first category, while the term

Table 7 STATISTICAL ANALYSIS FOR SIGNIFICANT DIFFERENCE BETWEEN TOTAL AND STANDARD LENGTHS AND WEIGHTS OF MALES AND FEMALES OF *Malapterurus electricus*.

Physical parameter	Sex	Number of fish examined	Range	Mean± SE	't'	Mean Significantly different?	'p' Value
Total length (cm)	Male	50	11.7-37.4	22.2±1.71			
	Female	67	12.1-29.4	19.9±1.02	1.16	No	>0.1
Standard length (cm)	Male	50	10.2-34.9	18.9±1.49			
	Female	67	10.9-26.8	17.8±0.43	0.71	No	>0.1
Weight (g)	Male	50	24.0-804.6	195.7±50.4			
	Female	67	28.9-442	130.1±21.7	1.21	No	>0.1

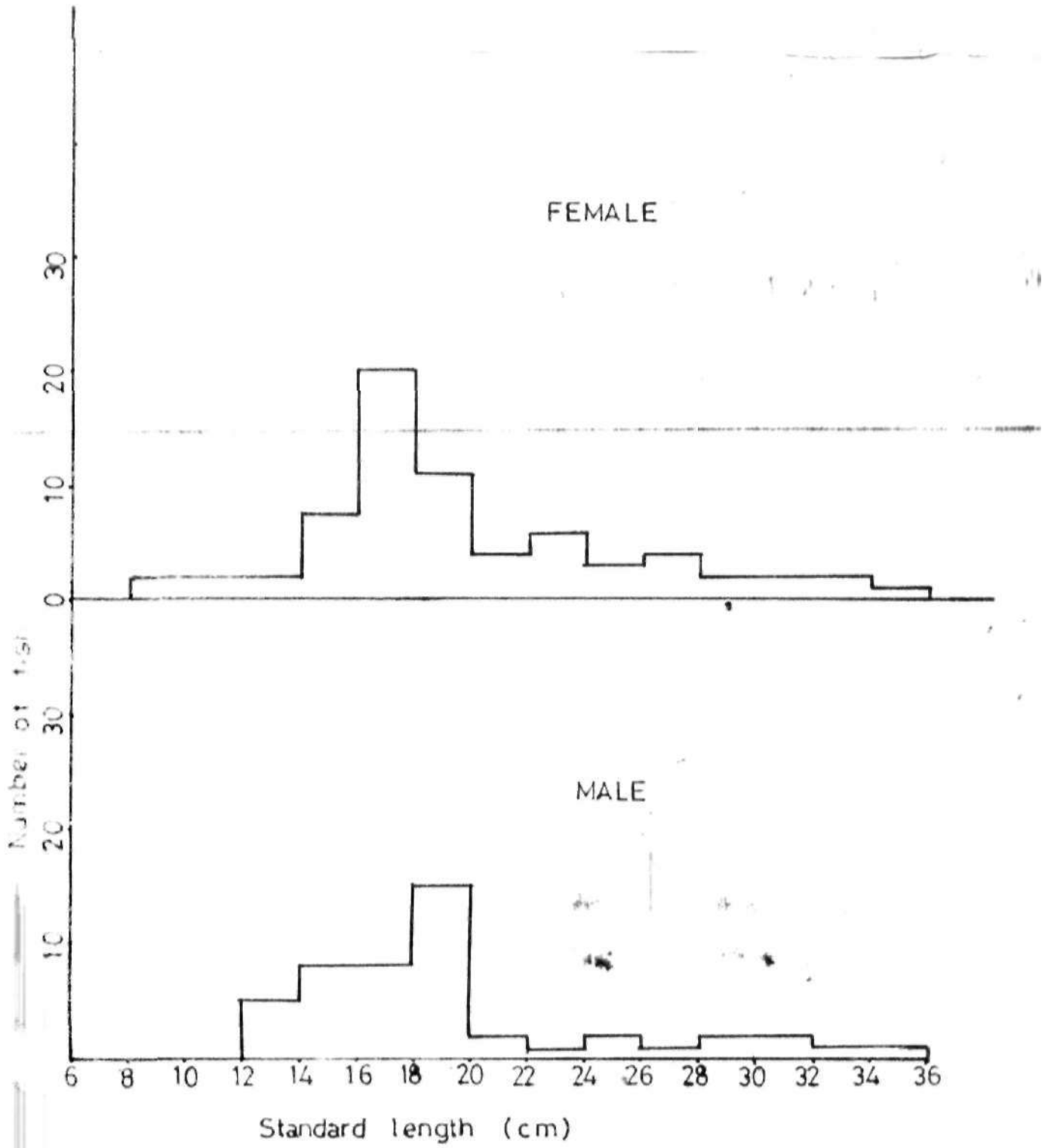


Fig. 7 Standard length distribution of Malapterurus electricus

'condition' was applied to the second category (Le Cren, 1951). The formula for calculating the two terms were as described previously under materials and methods.

3.3.1 Schilbe mystus

Regression equations for males, females and males and females combined are as given on(table 8). The graphs showing these relationship are seen in figures 8, 9 and 10 respectively. The regression coefficient 'b' of males (2.30) and females (3.71) suggested that the growth pattern of males was negatively allometric, while that of the females was positively allometric. From the regression formular, males weighed more than females of the same length at a standard length less than 9,9 cm and more above it. The relationship between the length and weight were all highly correlated.

3.3.2 Eutropius niloticus

The regression equations for males, females and both males and females combined are shown on table 9. The exponent 'b' in all the three cases were very close to 3. This shows that the growth pattern was isometric. From the regression formular females weighed more than the males of the same length at a standard length above 16.1cm, while the males weighed more below this length. The graphical representations of the regression equations are given in figures 11, 12, and 13. The relationship between the lengths and the weights are all highly corrolated.

Table 8 Log Standard length-weight regression analysis of females, males and females & males combined of Schilbe mystus

	Number of fish examined	Intercept 'a'	Exponent 'b'	Corrolation coefficient 'r'	Signi-ficance of r
Females	324	-2.64	3.71	1.00	<0.001
Males	66	-1.24	2.30	0.83	<0.001
Females and Males combined	390	-1.96	2.99	0.91	<0.001

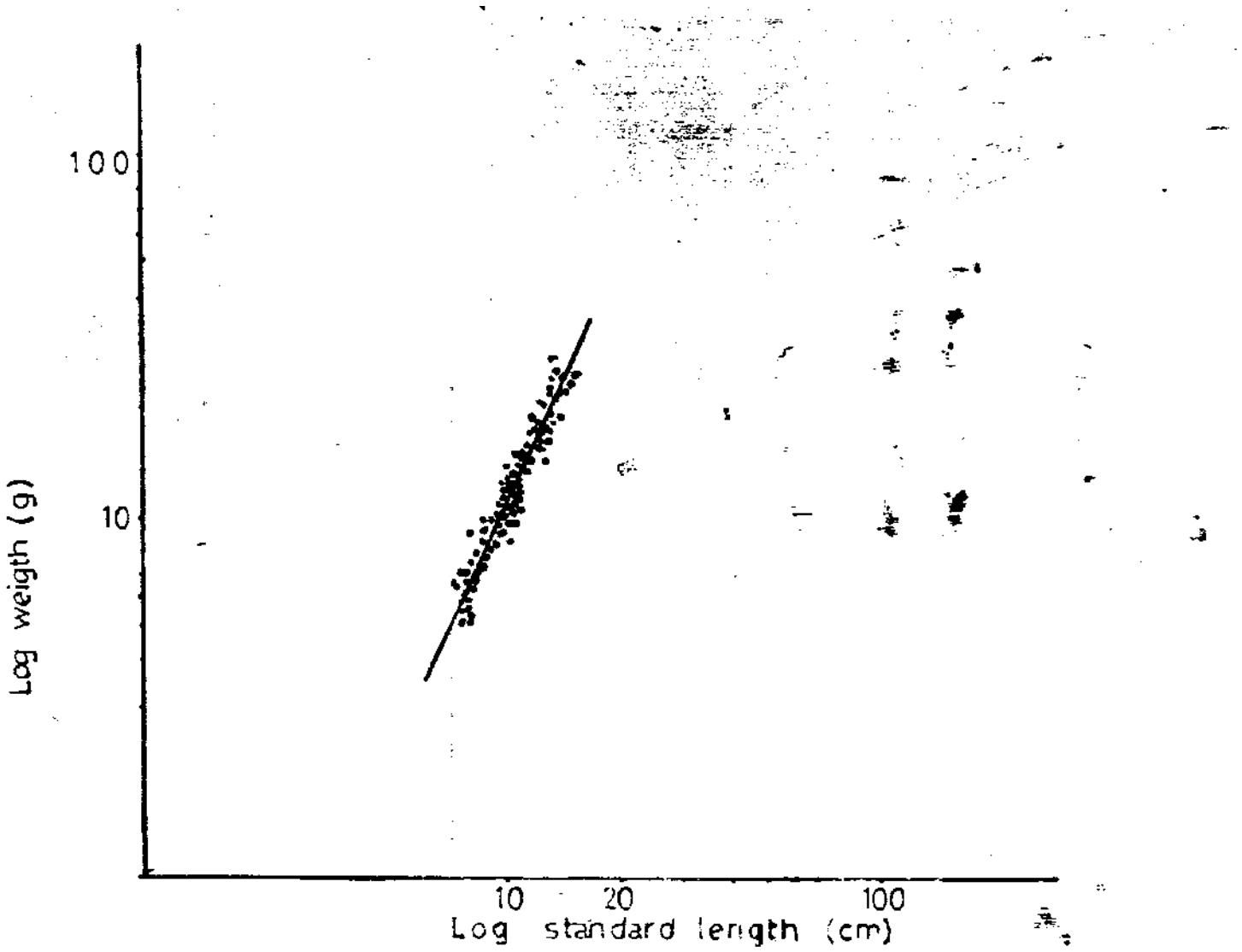


Fig 8 Length-weigth relationship (log-log) of Scrilbe [illegible] (males)

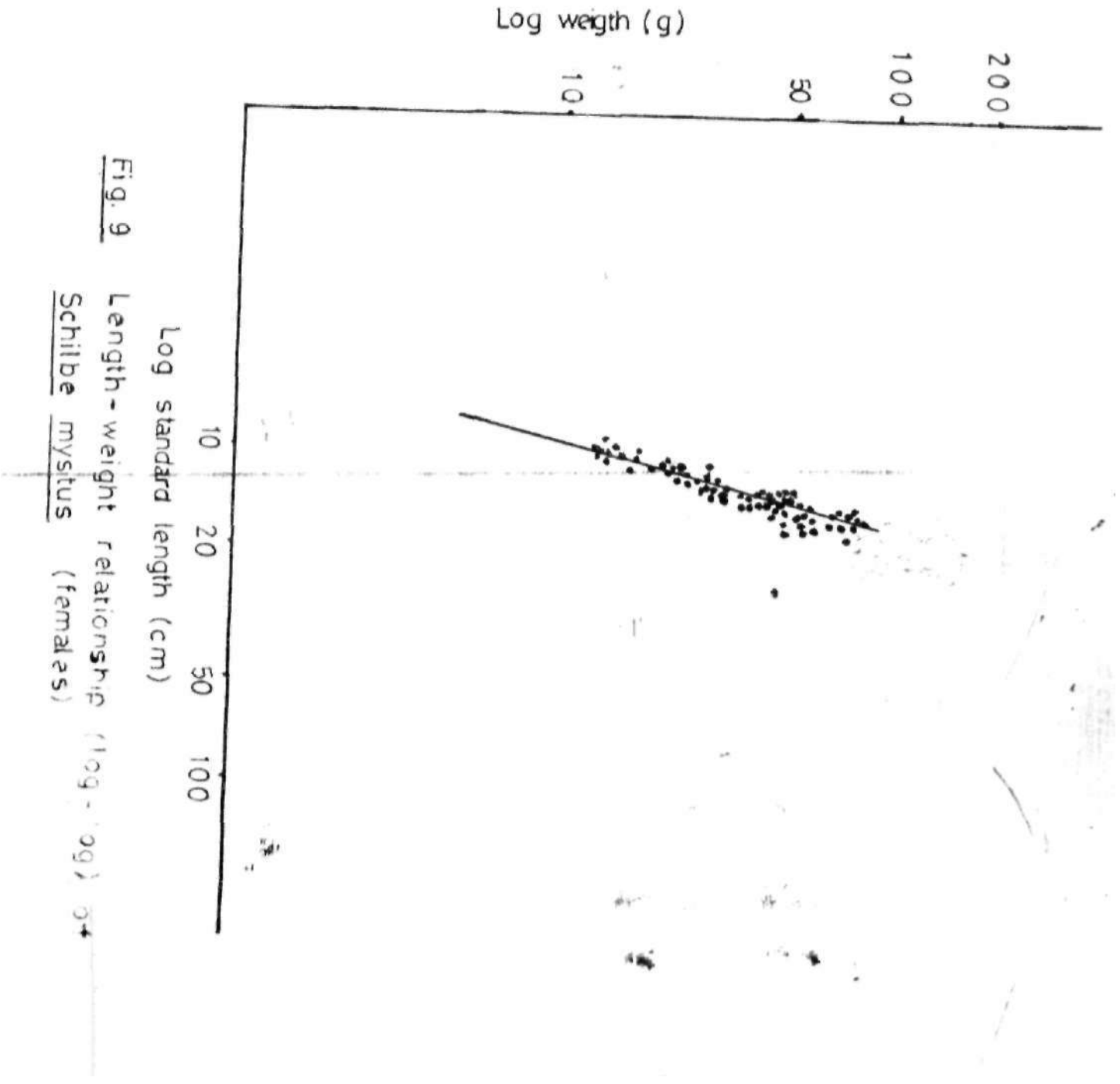


Fig. 9 Length-weight relationship (Schilbe mystus (females)

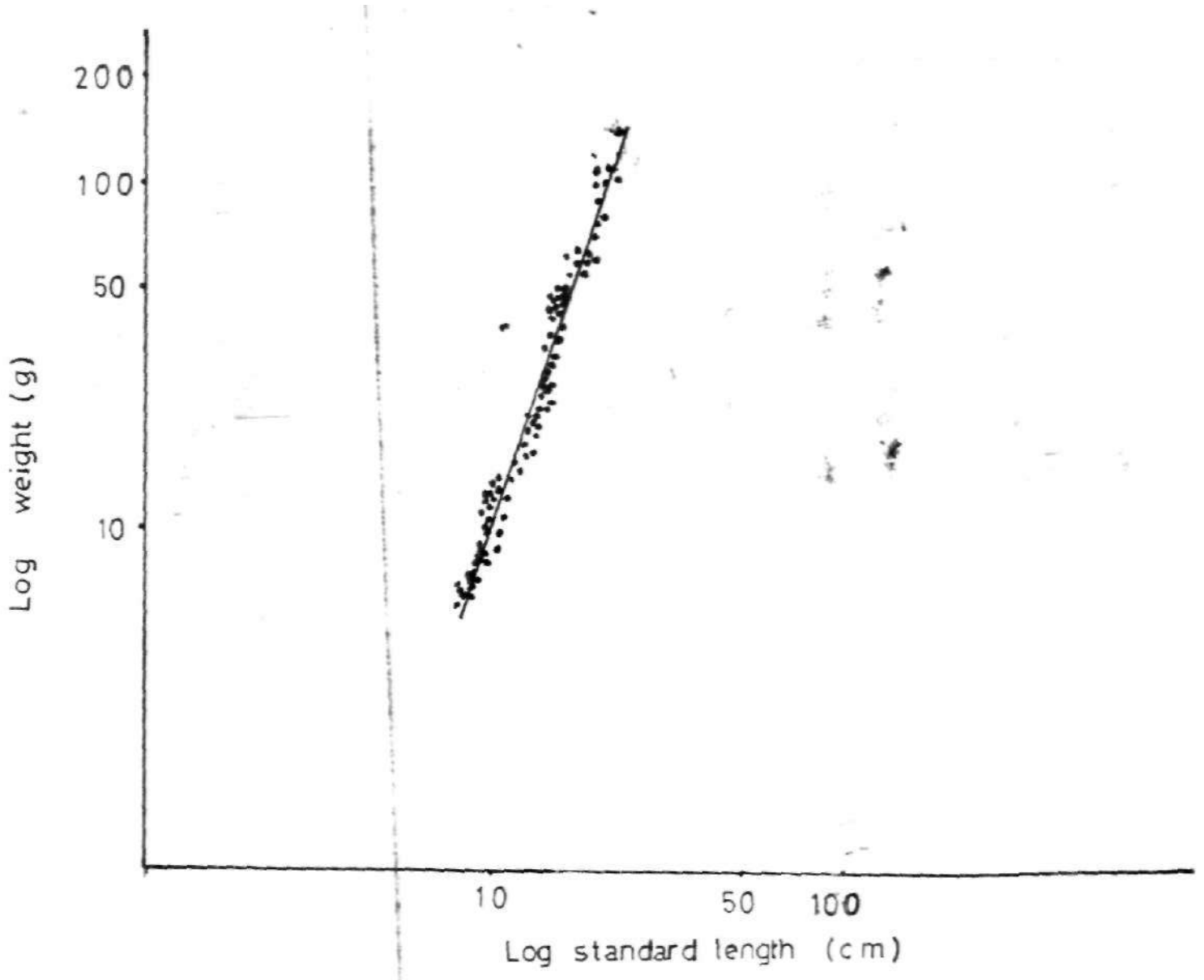


Fig. 10 Length - weight relationship (log-log) of Schilbe mystus (males & females)

Table 9

Log standard length-weight regression analysis of females, males and males & females combined of *Eutropius niloticus*

	Number of fish examined	Intercept 'a'	Exponent 'b'	Corrolation coefficient 'r'	Significance of r
Females	238	-2.13	3.11	0.97	<0.001
Males	128	-1.78	2.82	0.94	<0.001
Females and Males combined	366	-1.96	2.97	0.96	<0.001

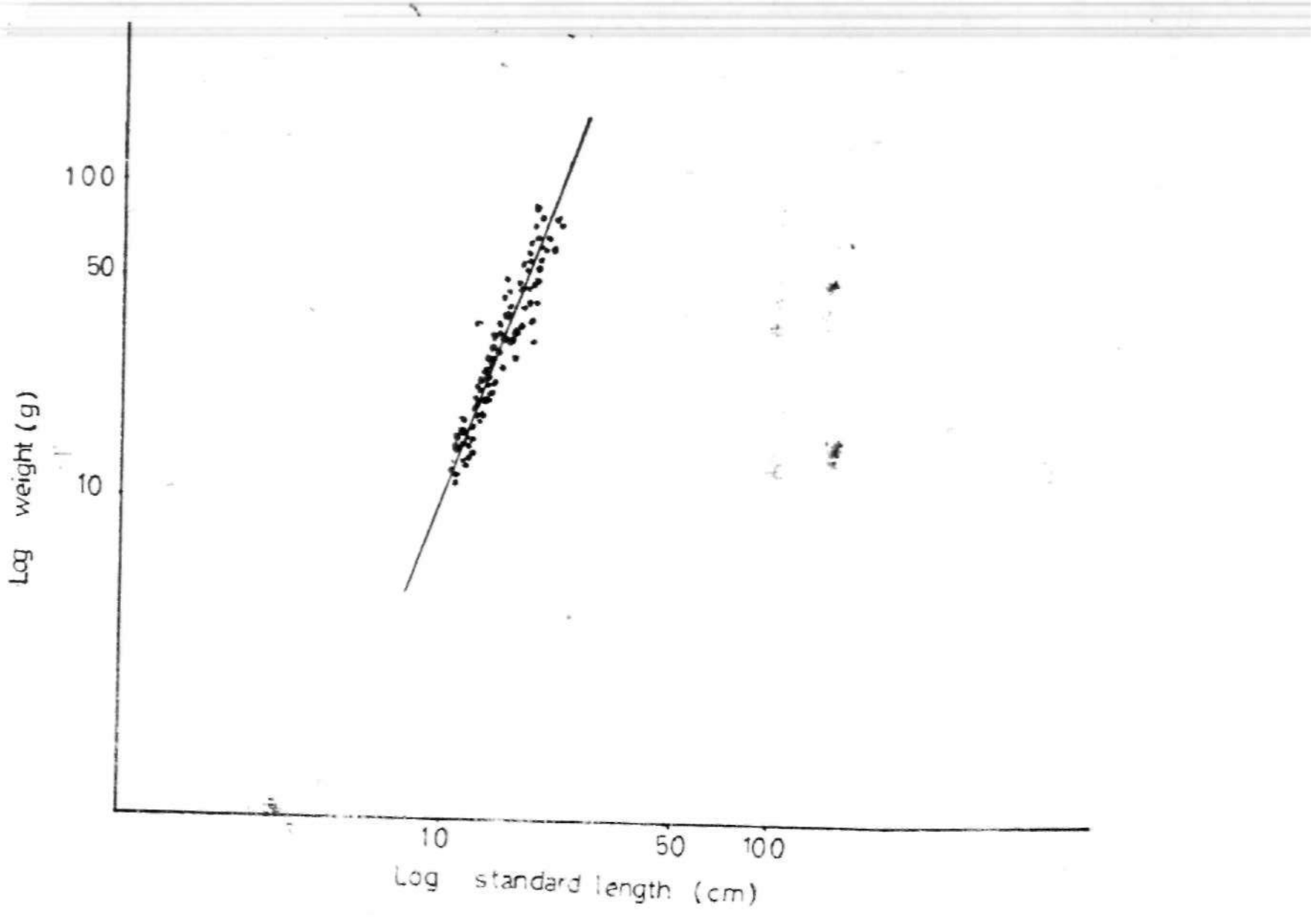
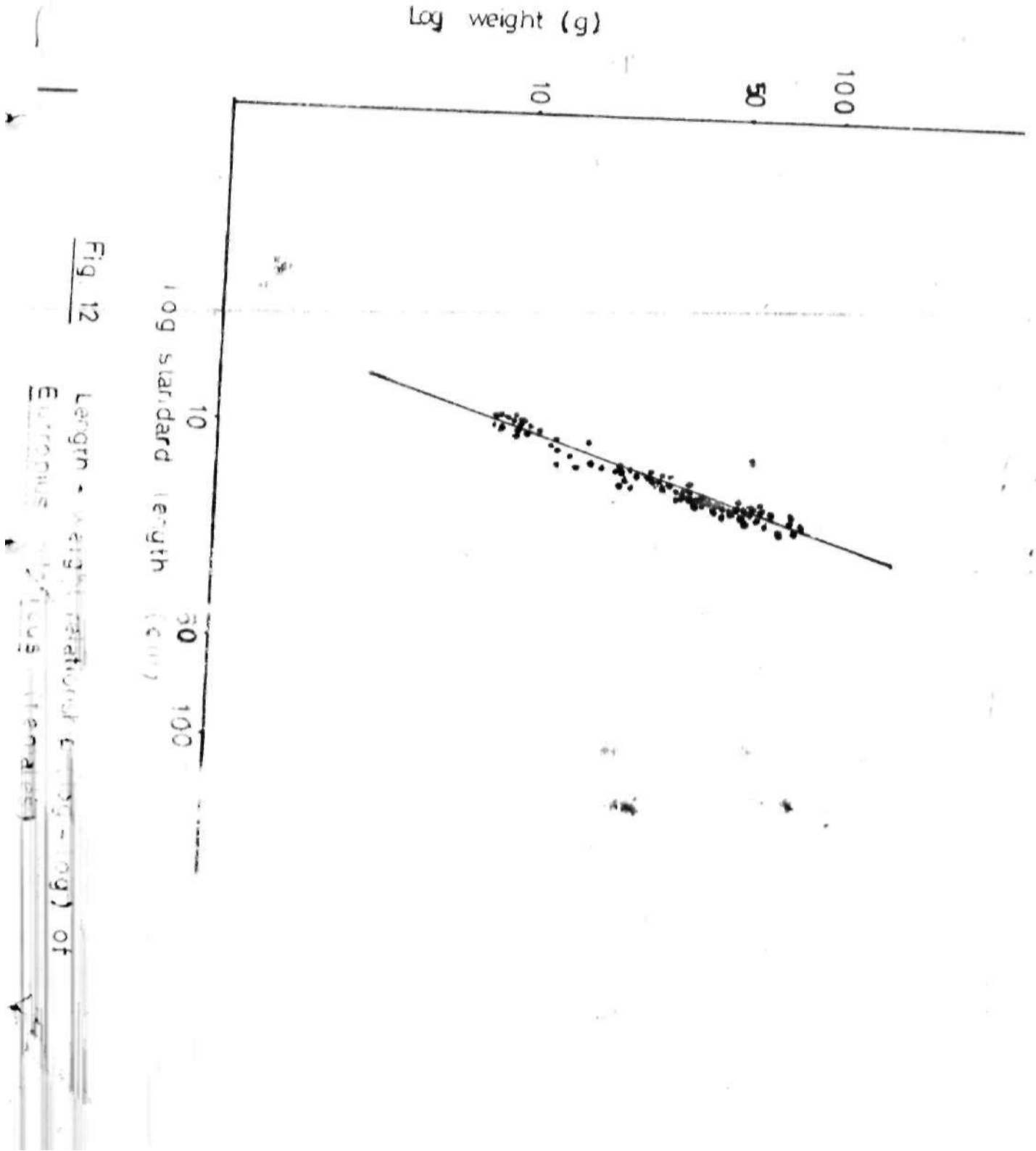


Fig 11 Length - weight relationship (log - log) of


Log weight (g)
10
50
100
10
Fig 12

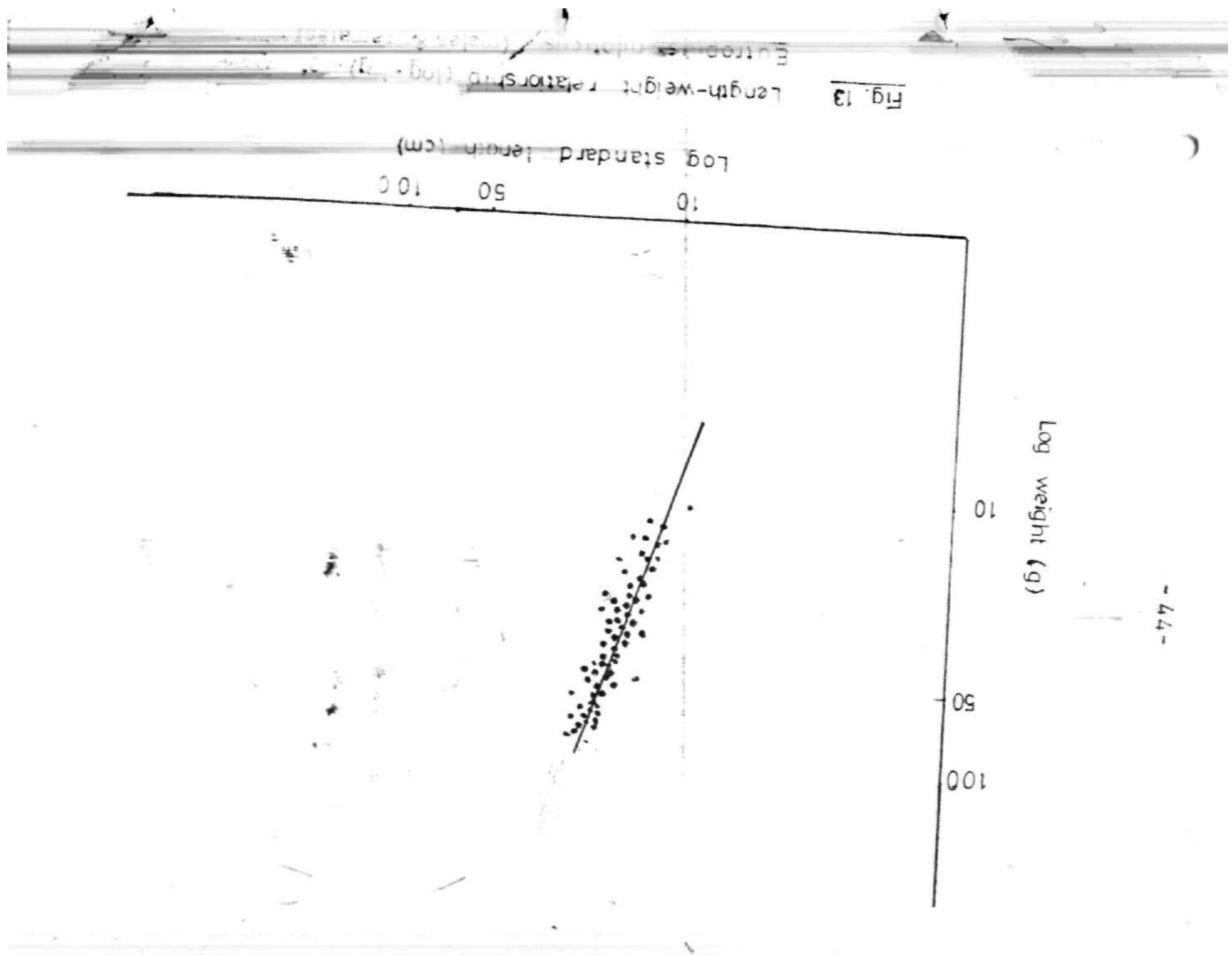


Fig. 13 Length-weight relationship

3.3.3 Malapterurus electricus

Table 10 shows the regression coefficient of males, females and males and females combined were 2.86, 3.04 and 2.95 respectively. All the exponents, 'b' were very close to 3; that means the growth was isometric. The relationship between standard lengths and weights in all the three cases were highly correlated. The graphical representation are as seen in figures 14, 15 and 16 respectively. The males weighed more than females of the same length at a standard length less than 16.0 cm and less than the females below this value.

3.3.4 CONDITION FACTOR

The condition factor 'k' was calculated for individual fish of all the species for each month. The relationship between standard length and condition factor was analysed and can be seen on tables 11, 12 and 13 for Schilbe mystus, Eutropius niloticus and Malapterurus electricus respectively. Table 11 shows that the mean condition factor of females Schilbe mystus increased with increasing standard length, while that of the males decreased slightly with increase in standard length. In the case of Eutropius niloticus, the mean condition factor increased with increasing standard length in both males and females. Increased in standard length had no effect on the condition factor of both males and females of Malapterurus electricus (Table 13).

Table 10

Log Standard length-weight regression (Log-log) analysis of females, males and females & males combined of *Malapterurus electricus*

	Number of fish examined	Intercept 'a'	Exponent 'b'	Corrolation coefficient 'r'	Significance of r
Females	67	-1.69	3.04	1.00	0.001
Males	50	-1.47	2.86	1.00	<0.001
Females and Males combined	117	-1.58	2.95	1.00	<0.001

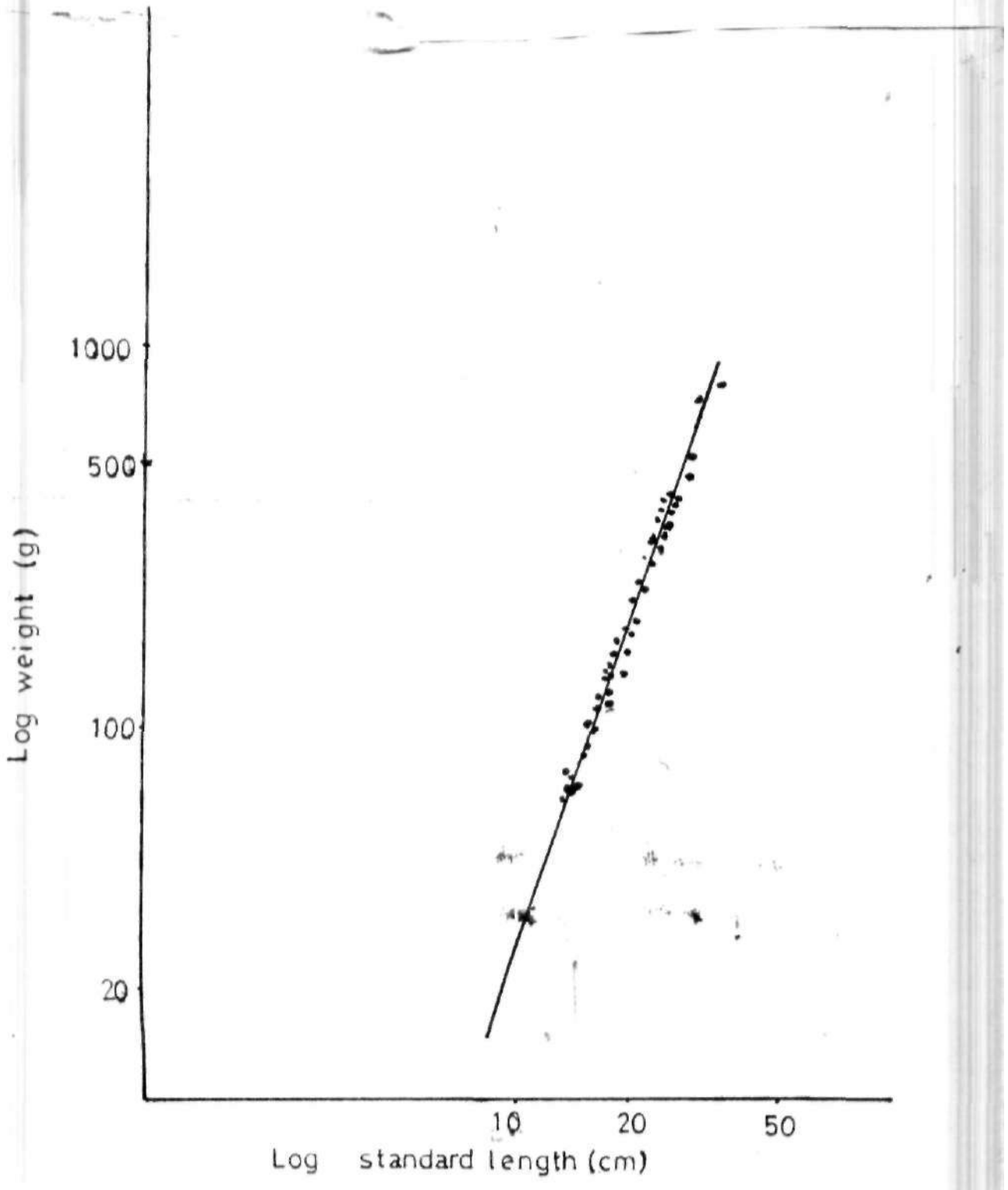


Fig. 14 Length - weight relationship (log - log) of Malapterurus electricus (males)

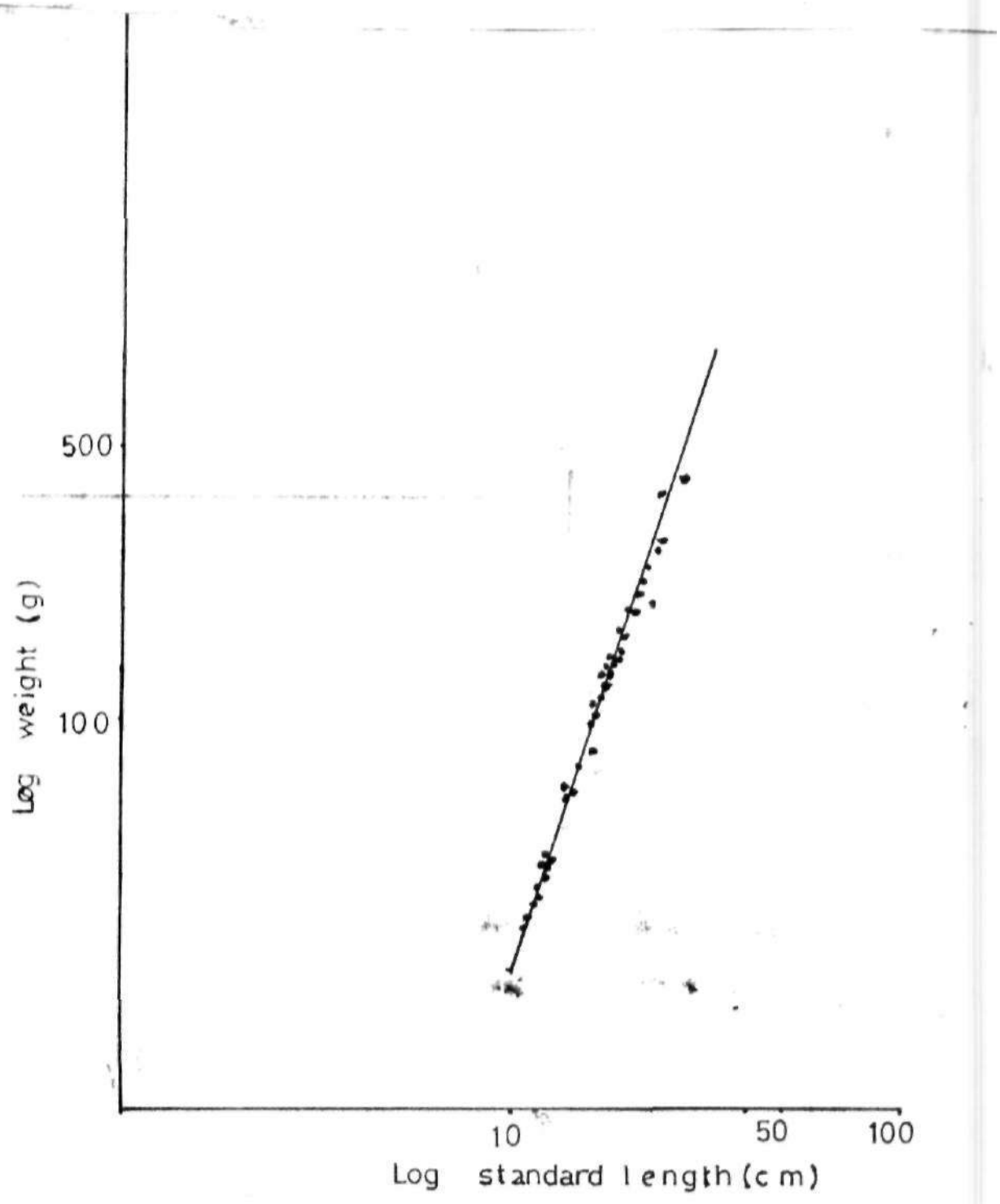


Fig. 15 Length-weight relationship(log-log) of Malapterurus electricus (females)

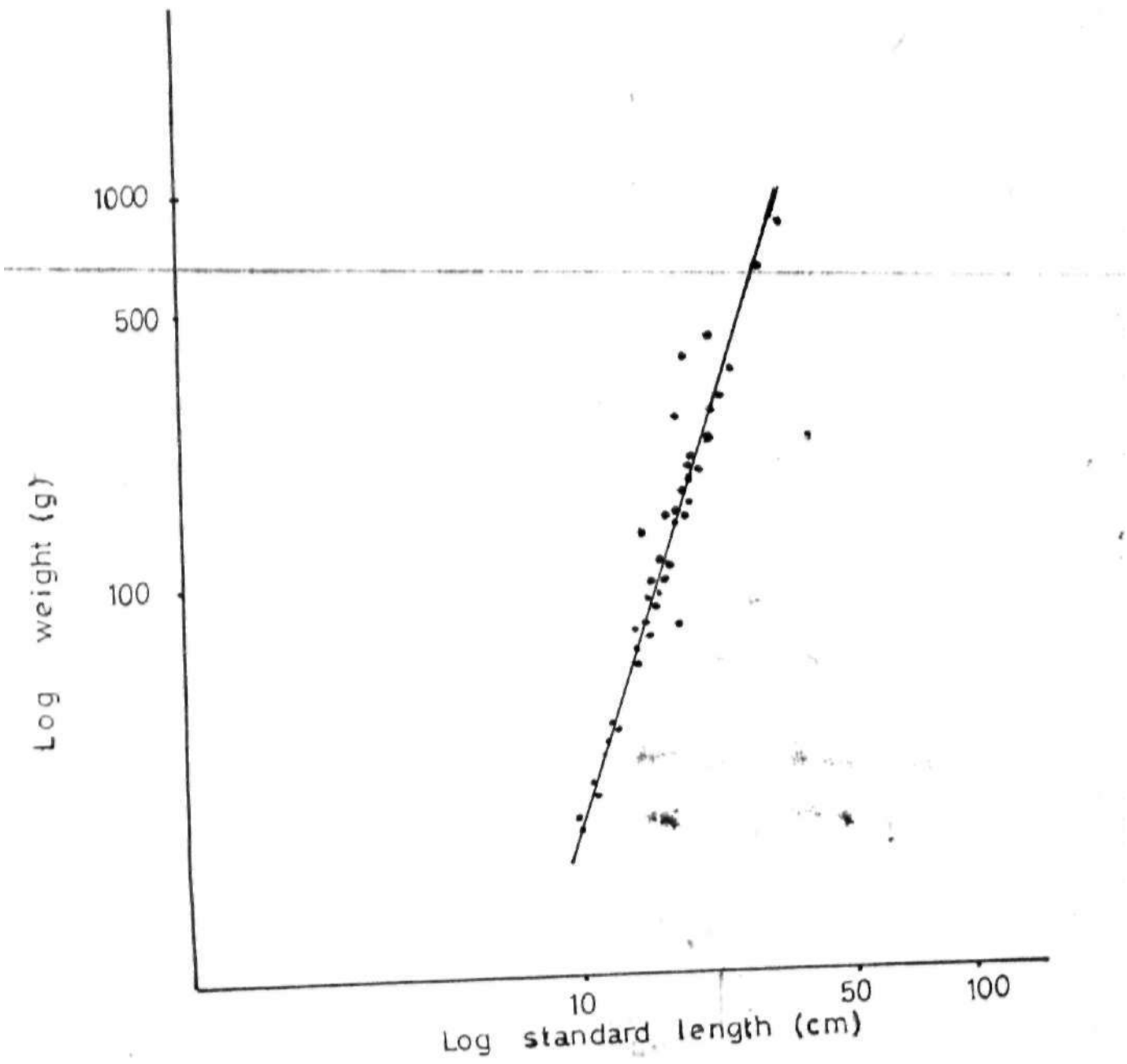


Fig. 16 Length-weight relationship (log-log) of Malapterurus electricus (males & females)

Table 11

Relationship between standard length and Mean condition factor (K) of Schilbe mystus

Sex	Number of fish examined	standard length groups(cm)	condition factor range	mean	standard error
Males	51	5 - 10	1.02-1.39	1.17	0.0020
	16	11 - 15	1.01-1.48	1.08	0.0041
	-	-	-	-	-
Females	86	5 - 10	1.0-1.30	1.20	0.0009
	215	11 - 15	1.03-2.05	1.27	0.0034
	23	16 - 20	1.02-1.81	1.47	0.02

Table 12

Relationship between standard length and mean condition factor (k) of Cutropius niloticus

Sex	Number of fish examined	Standard length groups(cm)	condition factor range	Mean	Standard error
Males	14	5 - 10	0.85-1.12	1.06	0.01
	106	11 - 15	0.87-1.24	1.08	0.007
	8	16 - 20	0.95-1.29	1.12	0.003
Females	15	5 - 10	0.74-1.13	1.01	0.008
	138	11 - 15	0.77-1.28	1.03	0.015
	85	16 - 20	0.90-1.32	1.13	0.006

Table 13

Relationship between standard length and mean condition factor (k) of *Malapterurus electricus*

Sex	Number of fish examined	Standard length group(cm)	condition factor range	Mean	Standard error
Males	35	10 - 20	1.9-2.7	2.5	0.11
	15	21 - 40	2.0-2.7	2.5	0.07
Females	46	10 - 20	2.1-2.5	2.4	0.09
	19	21 - 40	2.3-2.6	2.46	0.10

Monthly condition factors for males and females of Schilbe mystus, Eutropius niloticus and Malapterurus electricus are seen on tables 14, 15, 16, 17, 18 and 19 respectively. The average 'k' values for male Schilbe mystus was 1.16 while that of the females was 1.21. Male Eutropius niloticus had an average condition factor of 1.04 while that of the females was 1.01.

In Malapterurus electricus, the average 'k' value for males was 2.30, while that of the females was 2.28. The mean 'k' values of all the males in the three species were statistically the same with the females and were all in good condition. When the 'k' values during the dry season (November to April) of all the species were compared with that of the rainy season (May to October), the male 'k' value for Schilbe mystus and Malapterurus electricus were slightly higher in the dry season than in the rainy season, the opposite was true for the females. The differences however were not statistically significant. In Eutropius niloticus, the 'k' values in the wet season were slightly higher than in the dry season in both males and females but statistically the same.

The graphical representations of the monthly variation in 'k' values for males and females of the three species are as shown in figures 17, 18 and 19 for Schilbe mystus, Eutropius niloticus and Malapterurus electricus respectively.

Table 14

Monthly condition factor for Schilbe mystus (Males)

Month	Number of fish examined	Range	Mean	Standard error
JANUARY	24	1.03-1.48	1.21	0.17
FEBRUARY	1	-	1.3	-
MARCH	7	1.06-1.16	1.09	0.04
APRIL	2	1.05-1.2	1.18	0.16
MAY	6	1.07-1.39	1.18	0.04
JUNE	0	-	-	-
JULY	0	-	-	-
AUGUST	1	-	1.16	-
SEPTEMBER	6	1.02-1.05	1.17	0.03
OCTOBER	3	1.01-1.03	1.07	0.14
NOVEMBER	3	1.05-1.08	1.09	0.26
DECEMBER	13	1.07-1.10	1.17	0.02
DRY SEASON (NOV-APRIL)	50	1.01-1.48	1.17	0.03
WET SEASON (MAY-OCT.)	16	1.10-1.39	1.15	0.03
TOTAL	66	1.02-1.48	1.16	0.004

Table 15

Monthly condition factor for Schilbe mystus (females)

Months	Number of fish examined	Range	Mean	Standard error
JANUARY	36	1.03-1.6	1.23	0.02
FEBRUARY	14	1.08-1.43	1.30	0.02
MARCH	48	1.0-1.41	1.20	0.02
APRIL	30	1.1-1.3	1.21	0.02
MAY	54	1.02-1.70	1.29	0.02
JUNE	12	1.02-2.05	1.33	0.06
JULY	12	1.1-1.81	1.46	0,07
AUGUST	19	1.03-1.6	1.30	0.05
SEPTEMBER	24	1.04-1.4	1.24	0.03
OCTOBER	29	1.12-1.14	1.18	0.02
NOVEMBER	19	1.10-1.20	1.12	0.009
DECEMBER	26	1.13-1.23	1.21	0.02
DRY SEASON (Nov-APRIL)	173	1.03-1.6	1.21	0.024
WET SEASON (MAY-OCT.)	150	1.0-2.05	1.324	0.03
TOTAL	323	1.0-2.05	1.21	0.02

Table 16

Monthly condition factor for Sutropius niloticus (Males)

Months	Number of fish examined	Range	Mean	Standard error
JANUARY	11	0.87-1.10	0.99	0.04
FEBRUARY	12	0.81-1.1	0.93	0.02
MARCH	1	-	0.85	-
APRIL	15	0.89-1.2	1.03	0.04
MAY	5	1.01-1.29	1.15	0.07
JUNE	15	0.88-1.28	1.11	0.03
JULY	12	0.9-1.24	1.10	0.02
AUGUST	15	1.04-1.23	1.10	0.02
SEPTEMBER	13	0.97-1.23	1.09	0.02
OCTOBER	13	0.95-1.2	1.04	0.008
NOVEMBER	10	0.85-1.07	1.04	0.02
DECEMBER	6	0.87-1.04	1.05	0.02
DRY SEASON (NOV-APRIL)	55	0.85-1.2	0.98	0.03
WET SEASON (MAY-OCT.)	73	0.88-1.29	1.10	0.02
TOTAL	128	0.85-1.29	1.04	0.02

Table 17

Monthly condition factor for Eutropius niloticus (Females)

Months	Number of fish examined	Range	Mean	Standard error
JANUARY	17	0.9-1.13	1.00	0.02
FEBRUARY	32	0.74-1.07	0.89	0.02
MARCH	20	0.77-1.08	0.93	0.02
APRIL	40	0.9-1.10	1.00	0.02
MAY	10	1.02-1.29	1.11	0.03
JUNE	23	1.00-1.32	1.11	0.02
JULY	15	0.98-1.30	1.15	0.03
AUGUST	14	0.98-1.28	1.15	0.03
SEPTEMBER	10	0.91-1.12	1.08	0.05
OCTOBER	16	0.94-1.12	0.98	0.03
NOVEMBER	16	0.90-0.99	0.87	0.02
DECEMBER	25	1.00-1.05	0.91	0.01
DRY SEASON (NOV-APRIL)	150	0.74-1.13	0.93	0.02
WET SEASON (MAY-OCT.)	88	0.90-1.32	1.09	0.03
TOTAL	238	0.74-1.32	1.01	0.03

Table 18

Monthly condition factor for Malapterurus electricus (Males)

Month	Number of fish examined	Range	Mean	Standard error
JANUARY	1	-	2.0	-
FEBRUARY	2	1.9-2.0	2.05	0.03
MARCH	6	1.9-2.3	2.20	0.04
APRIL	2	-	2.70	0
MAY	6	2.10-2.4	2.22	.006
JUNE	2	2.5-2.7	2.6	.04
JULY	2	2.1-2.20	2.15	0.015
AUGUST	12	2.01-2.47	2.37	0.008
SEPTEMBER	3	2.21-2.7	2.47	0.018
OCTOBER	1	-	2.1	-
NOVEMBER	8	2.2-2.4	2.34	0.024
DECEMBER	5	2.4-2.7	2.64	0.034
DRY SEASON (NOV-APRIL)	24	1.9-2.7	2.22	0.025
WET SEASON (MAY-OCT.)	26	2.0-2.7	2.32	0.008
TOTAL	50	1.9-2.7	2.30	0.019

Table 19

Monthly condition factor for Malapterurus electricus (Females)

Moths	Number of fish examined	Range	Mean	Standard error
JANUARY	3	2.2-2.6	2.4	0.015
FEBRUARY	6	2.1-2.6	2.41	0.028
MARCH	10	2.1-2.41	2.33	0.018
APRIL	5	2.12-2.31	2.21	0.007
MAY	12	2.2-2.60	2.39	0.005
JUNE	4	2.2-2.42	2.23	0.009
JULY	3	2.4-2.6	2.43	0.004
AUGUST	12	2.1-2.42	2.33	0.017
SEPTEMBER	3	2.11-2.3	2.21	0.005
OCTOBER	0	-	-	-
NOVEMBER	6	2.1-2.4	2.20	0.015
DECEMBER	3	2.1-2.21	2.13	0.015
DRY SEASON (NOV-APRIL)	33	2.1-2.6	2.38	0.013
WET SEASON (MAY-OCT.)	34	2.2-2.6	2.23	0.12
TOTAL	67	2.1-2.6	2.28	0.01

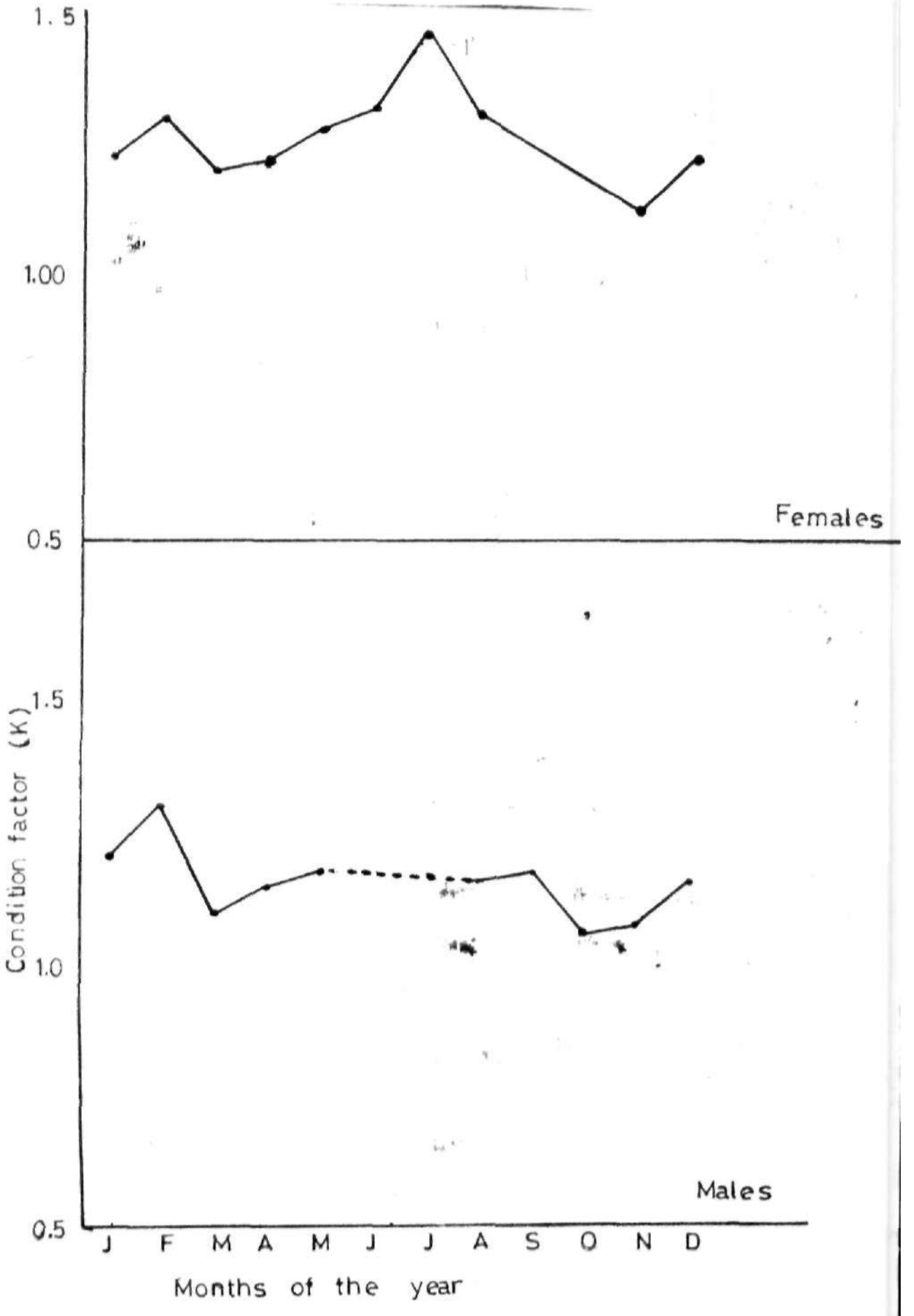


Fig. 17 Monthly variation in the condition factor (K) of Schilbe mystus

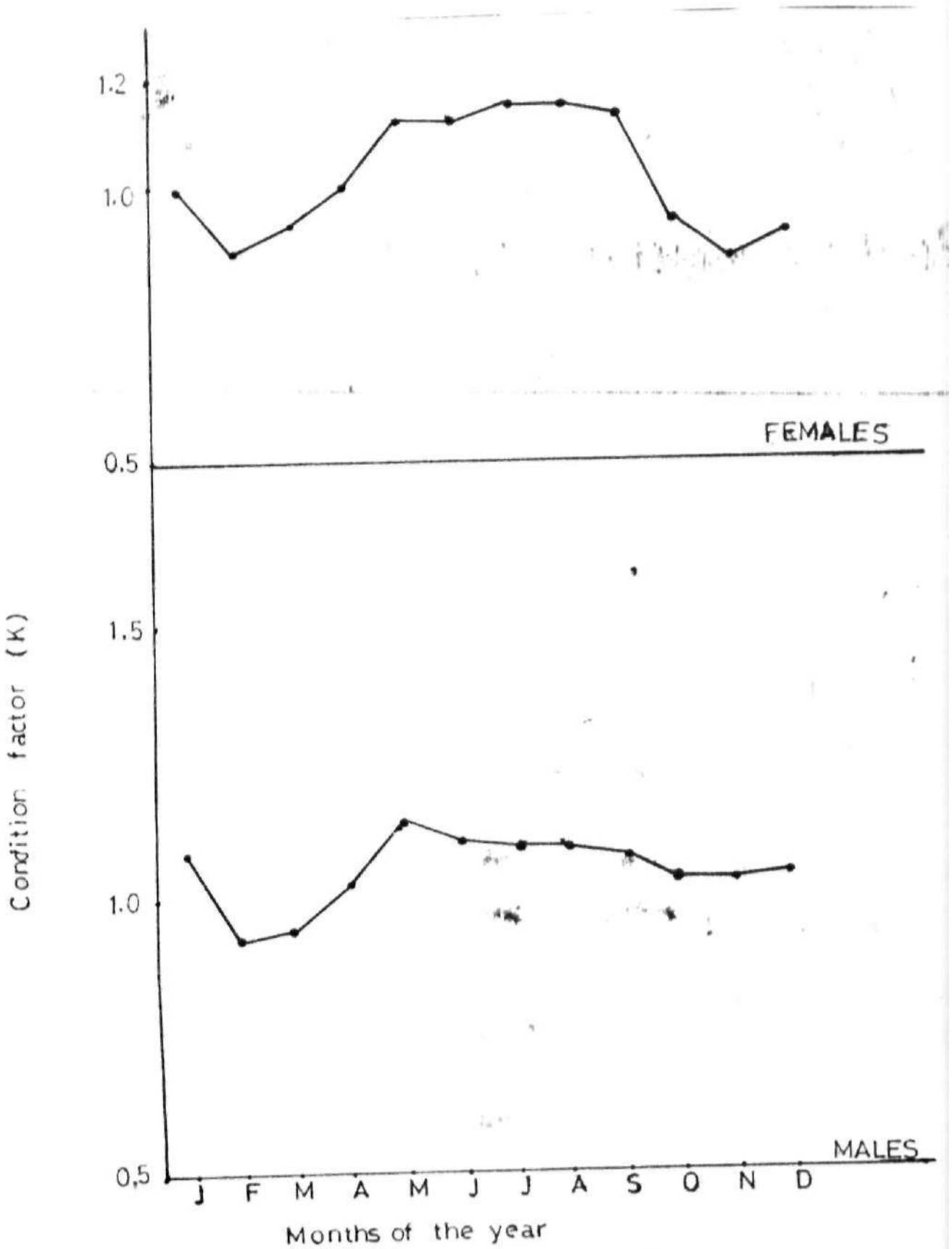


Fig. 18 Monthly variation in the condition factor (K) of Eutropius niloticus

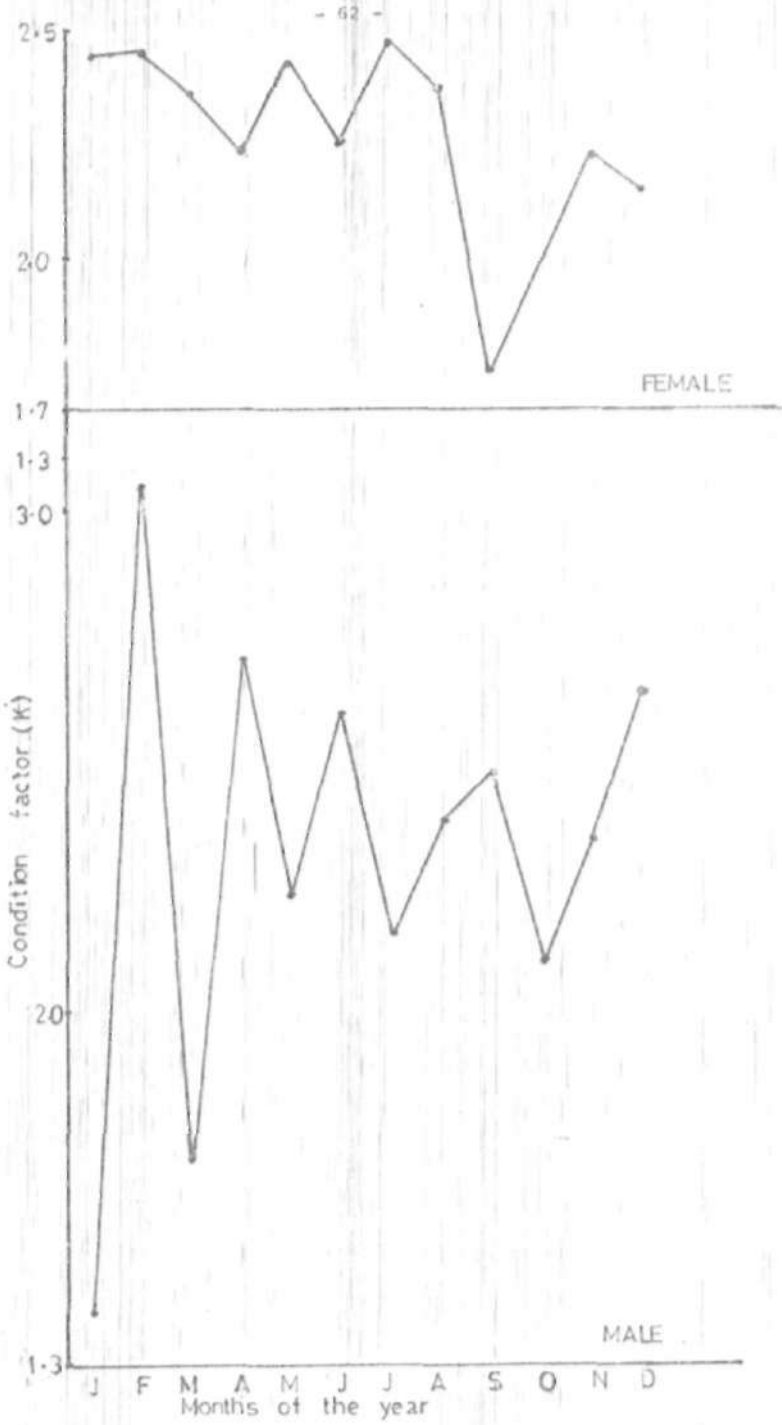


Fig. 19 Monthly variation in the condition of Malapterurus electricus

3.4.0 FOOD AND FEEDING HABITS

3.4.1 Schilbe mystus

390 stomachs were examined, out of which 135 were found to contain food (table 20). Fish formed the main contents of the food with total points of 45.0% and a frequency of occurence of 37.7%. Insects was secondary in importance with a total point of 36.3% and frequency of occurence of 50.6%. The rest of the food items collectively formed less than 13% of the food items and therefore are of minor importance. These food items are crustacea (3.8%), mollusc (1.1%) amphibian remains (2.0%) bird remains (1.5%) and annelids (1.0%),(Table 20).

Closer examination of individual food items showed that hemiptera, coleoptera and insect larva, family syrphidae were the insect food items that occured most regularly. Insects remains contributed immensely to the food items seen in the stomachs (13.0%). Whole fish and fish remains were often encountered in the stomachs. The food items suggested that Schilbe mystus was an omnivore, although fish and insects predominated in its food.

3.4.1.1 SEASONAL VARIATIONS IN THE DIETARY COMPOSITION OF Schilbe mystus

Seasonal variation in diet was investigated by comparing the food items found in the stomachs of the fish for the wet season period (May to October) and dry season (November to April) (Table 21).

Table 20 : Relative importance and frequency of occurence of dietary items in the stomachs of Schilbe mystus in Zaria area.

No. of stomachs examined = 390

No. of stomechs with food = 135

% of stomechs with food = 34.6%

Dietary items	% frequency of occurence	% of total point gained
Fish remains (including) whole fish	37.7	45.0
ADULT INSECTS:		
Hemiptera	13.0	7.5
Coleoptera	10.6	3.6
Orthoptera	3.6	3.6
Diptera	6.0	2.1
Ephenoptera	2.4	1.2
Siphonapter	1.2	0.9
IMMATURE INSECTS:		
Syrphidae larva	8.2	7.0
Coleoptera larva	1.2	0.6
Helius sp larvae	2.4	1.0
Liriope sp larva	3.6	1.6
Trichoptera larva	1.2	0.1
Orthoptera larva	1.2	0.1
Unidentified larva	2.4	0.1
Diptera pupae	1.2	0.9
Dragon fly numph	1.2	0.1
Unidentified insect remain	13.0	6.2
Unidentified pupae	1.2	0.3
TOTAL INSECT	36.3	50.6
Annelids	3.6	1.0
Bird remain	1.2	1.5
Amphibean remain	2.3	2.0
Crustacean	5.9	3.8
Mollusc	2.4	1.1
Plant debris	2.1	0.6
Digested material	5.9	7.6
Undientified material	1.2	1.5
TOTAL		100.5

Table 21: Relative importance and frequency of occurence of dietary items in the stomachs of Schilbe mystus in Zaria area during the rainy and dry seasons

Dietary item	% total points gained		% frequence of occurence	
	Rainy season	Dry season	Rainy season	Dry season
Fish remains including whole fish	51.9	34.5	55.9	25.5
ADULT INSECTS				
Hemiptera	4.3	11.6	11.8	15.7
Coleoptera	2.4	4.8	11.8	9.9
Orthoptera	3.6	4.6	5.9	3.9
Diptera	0.2	3.7	2.9	7.8
Siphonaptera	1.8	-	2.9	-
Ephenoptera	-	2.3	-	3.9
IMMATURE INSECTS				
Syrphidae larvae	11.3	-	20.6	-
Coleoptera larvae	1.2	-	3.0	-
Helius sp larva	2.0	-	5.9	-
Liriope sp larva	1.3	-	8.9	-
Trichoptera larva	0.1	-	3.0	-
Orthoptera larva	0.2	-	3.0	-
Undientified insect larva	0.4	-	3.0	-
Diptera pupae	0.4	-	3.0	-
Unidentified pupae	1.5	-	3.0	-
Dragon fly numph	0.1	-	3.0	-
Unidentified insect remains	4.4	9.5	14.7	17.7
TOTAL INSECTS	35.2	36.5	61.8	51.0
Annelids	0.3	1.6	3.0	5.9
Bird remains	3.0		3.0	
Amphibian remains	4.4		5.9	
Crustacea	3.8	4.8	5.9	9.8
Mollusc	0.2	1.9	3.0	3.9
Plant debris	0.8	0.6	3.0	2.0
Digested materials	0.2	17.2	3.0	21.6
Unidentified material	-	2.9	-	2.0
TOTAL	99.8	99.9		

Figure 20 shows the histogram of dietary variations in both wet and dry season.

During the dry season, insects contributed most to the diet of the fish both in the total points gained (36.5%) and the number of stomachs they were found (51.0%). This was closely followed by fish which gained a total point of 34.5% and frequency of occurence of 25.5%. Immature stages of insects were not important during this period (2.3%). Digested materials contributed substancially to total food items seen forming 17.2% by points and having frequency of occurence of 21.6%.

In the rainy season, fish was the most importance food item seen forming 51.9% by point and 55.9% by frequency of occurence. Contribution by insect was second with total points of 35.2% and frequency of occurence of 61.8%. Most of the stomachs in this season contained insects. The contribution by digested materials was not much compared with the dry months.

3.4.1.2 CHANGES IN COMPOSITION OF DIET WITH SIZE

The fish were grouped into 6cm to 10cm, 11cm-15cm and 16cm - 20 cm range of standard length for the purpose of the analysis (fig.21). Fish below or 10cm were mostly insectivorous, while fish between 11cm and 15cm fed almost equally on fish and insects. Other food items like amphibia remains, crustacea, plant debris were found but were not of importnace. The largest in size (16cm - 20 cm) were mostly piscivorous.

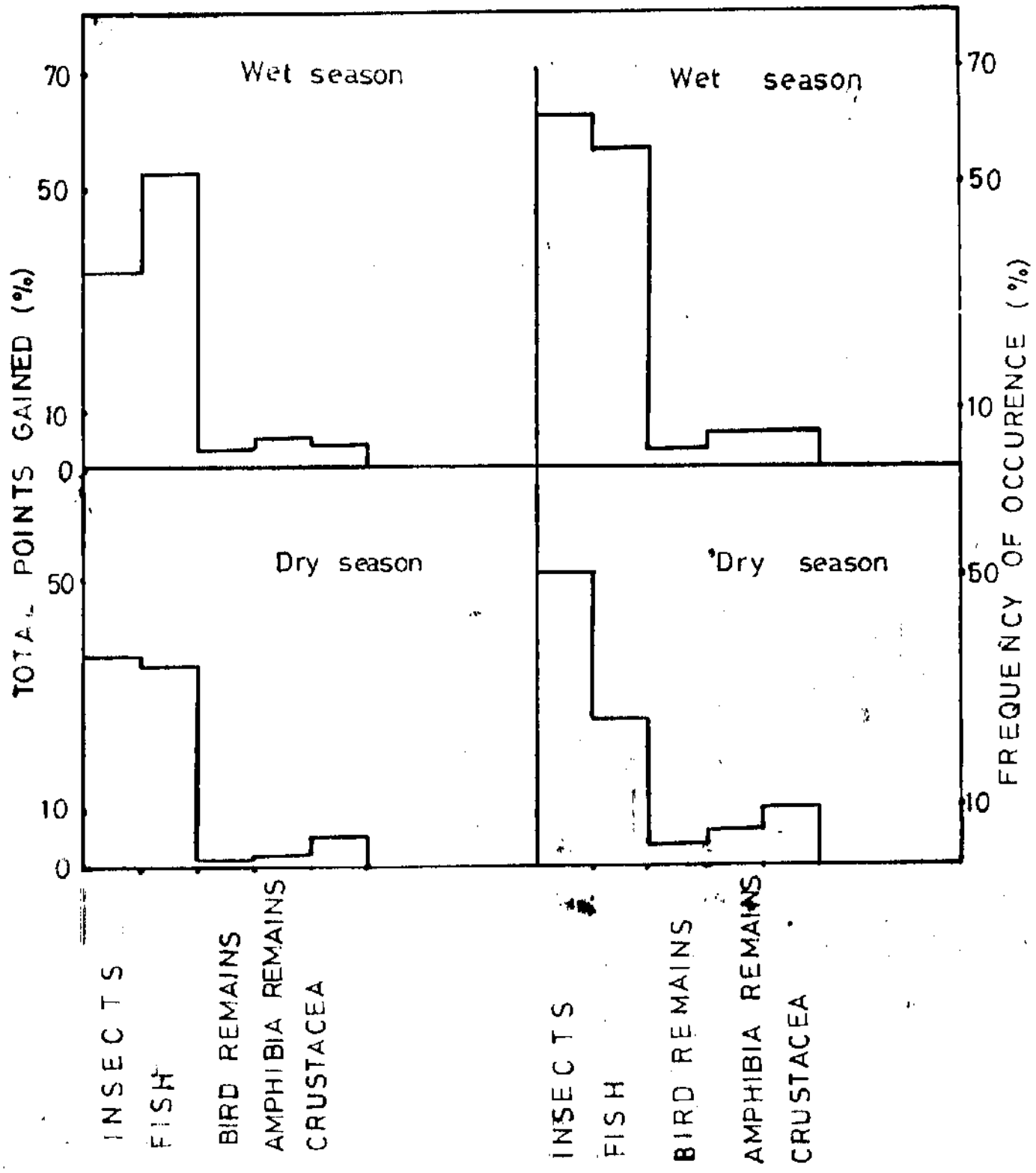


Fig. 20 Seasonal variation in the dietary composition of *Schilbe mystus*

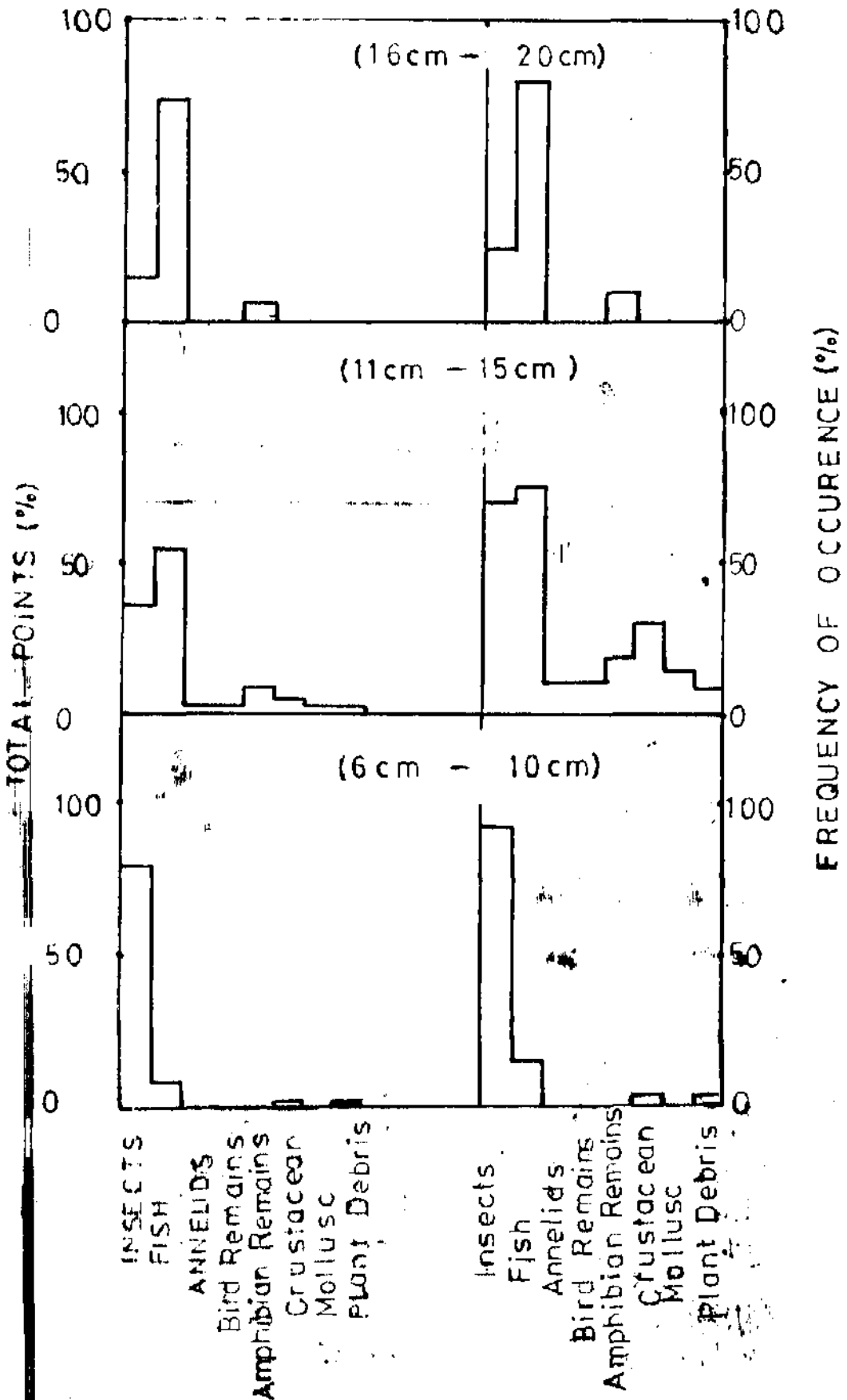


Fig. 21 Changes in the dietary composition with standard length of Schilbe mystus

Amphibian remains was seen in their diet. The general trend observed was a change from insectivorous habit to piscivorous habit as the fish grows.

3.4.1.3 MONTHLY FEEDING INDEX

The percentage of the fish with food in their stomachs and those without is shown in fig. 22. In February and August over 50% of the fish were feeding whereas in the other months most of the fish feeding were below 40%

3.4.2 Eutropius niloticus

Out of the 366 stomachs examined, 194 contained food(Table 22). Insects formed the dorminant food items of the fish with a total point of 33.4 % and a frequency of occurence of 50.8 %. Fish was secondary in importance with a total point of 14.8 % and frequency of occurence of 20.9 %.

Other food itmas found in the stomachs included crustacea (2.1%), plant debris (1.3 %), zooplankton (0.1 %) organic materials (2.1%) and soil materials (1.2 %), all of which are of minor importance. Digested materials contributed 40.2 % of the total point and occured in 55.5% of the stomachs. Detailed analysis of the result revealed that insect remains contributed substancially to the total food items seen (15.6 %) and occured in 25.7% of the stomachs. Hemipteran insects were found to be the most important insect food seen forming 8.0% by points and a frequency of occurence of 13.9%.

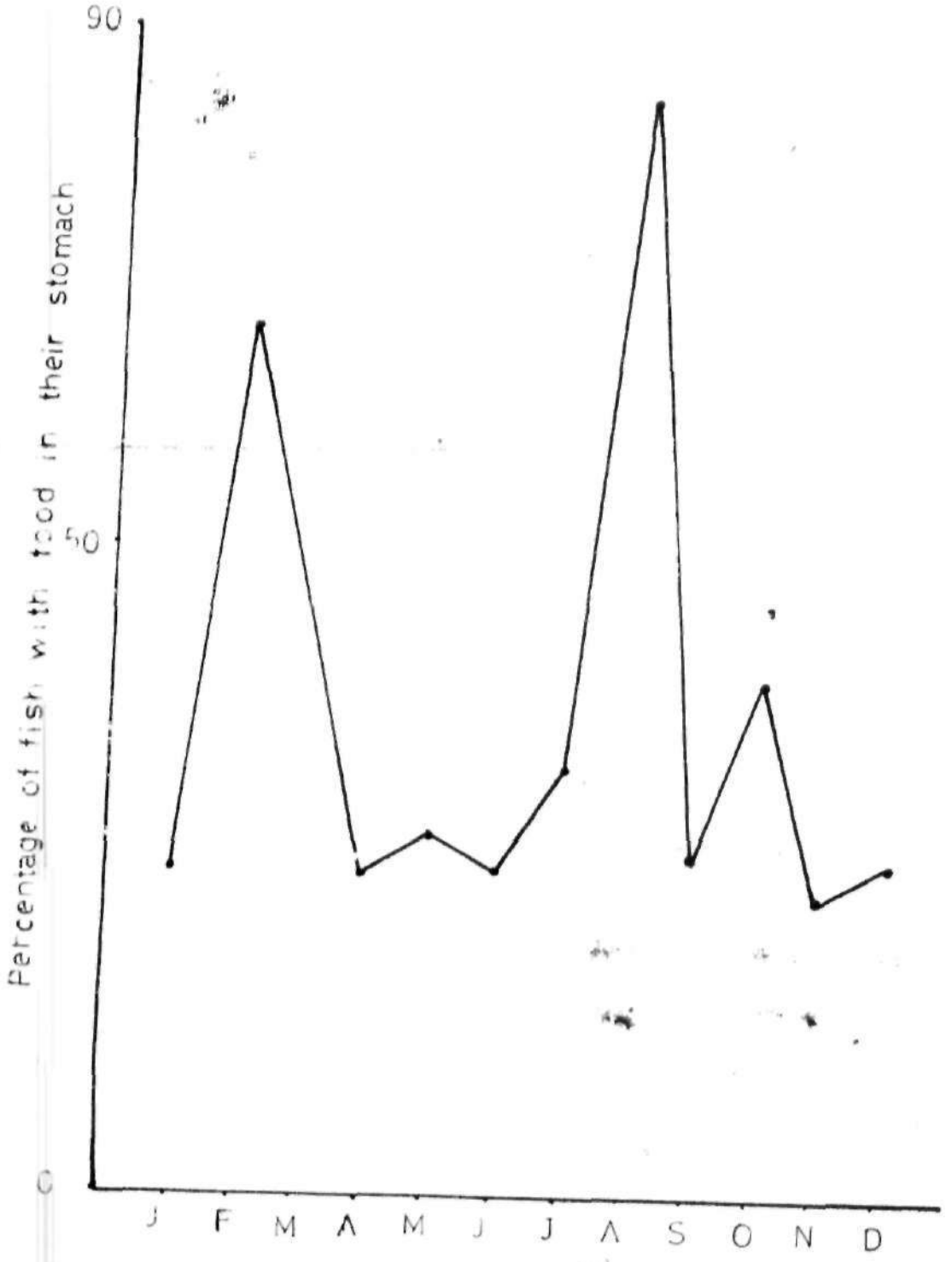


Fig. 22 Monthly feeding index of Schilbe mystus

Table 22: Relative importance and frequency of occurence of dietary items in the stomachs of Eutropius niloticus in zaria area.

No. of stomachs examined = 366
No. of stomachs with food = 191
% of stomachs with food = 53%

Dietary item	% of total point gained	% of frequency of occurance.
ADULT INSECTS:		
Hemiptera	7.9	13.9
Coleoptera	3.1	8.0
Orthoptera	0.4	1.0
Diptera	0.1	1.0
Hymenoptera	0.4	1.0
IMMATURE INSECTS:		
Chironomid larva	0.1	1.0
Trichoptera larvae	0.9	1.0
Diptera larvae	0.5	2.0
Dragon fly numph	0.7	2.0
Hemiptera numph	0.8	1.0
insect eggs	0.2	1.0
Larva remain	2.6	10.9
insect remain	15.6	25.7
TOTAL INSECTS	33.4	50.8
FISH:		
fish scales	5.1	7.9
fish remain	4.8	11.0
whole fish	4.9	8.0
TOTAL FISH	14.9	20.6
Crustacern		
water slater	0.1	1.00
chrirocephellus grubei	0.3	1.0
unidentified crustacean	1.8	4.0
TOTAL CRUSTACEA	2.1	6.0
PLANT:		
seed of his plants	1.8	3.0
plant debris	1.3	6.0
Diatom (Algae)	0.5	1.0
TOTAL PLANT	3.7	6.0
Zooplakton	0.1	1.0
Organic material	2.1	9.0
Digested material	40.2	55.5
unidentified material	1.7	4.0
soil material	1.2	1.0
TOTAL	100.1	

The result indicated that Eutropius niloticus is an omnivore but had a tendency to predate more on insects

3.4.2.1 SEASONAL VARIATION IN THE DIETS OF Eutropius niloticus

Comparison of the dietary items in the wet season with the dry season (table 23) and figure 23 showed that there was no seasonal variation in the items selected. Insects was the major food item during the rainy and dry seasons. Fish was secondary in importance in both seasons.

3.4.2.2 CHANGES IN THE COMPOSITION OF DIET WITH SIZE

Figure 24 shows variation of diet with standard length groups. All the three groups of fish (6cm - 10cm; 11cm - 15cm and 16cm - 20cm) fed more on insects than any other food item. However, the quantity of fish consumed was found to increase with increasing standard length.

3.4.2.3 MONTHLY FEEDING INDEX

The percentage of fish feeding each month is given in figure 25, More than 50% of the fish were feeding in most of the months, particularly between May and July. In December, only 23% of the fish were feeding.

3.4.3 Malapterurus electricus

38 stomachs contained food out of the total number of 117 stomachs examined.

Fish was found to be the dorminant food item with a total point of 32.8 % and frequency of occurence of 43.8 %

Table 23 Relative importance and frequency of occurence of dietary items in the stomachs of Eutropius niloticus in Zaria area during the rainy and dry seasons.

Dietary items	% of total points gained		% frequency of occurence	
	Rainy season	Dry season	Rainy season	Dry season
ADULT INSECTS				
Hemiptera	6.5	5.1	17.5	9.1
Coleoptera	0.9	3.8	10.5	9.1
Orthoptera	-	1.1	-	2.3
Diptera	0.2	-	1.8	-
Hymenoptera	0.7	-	1.8	-
Immature insects				
Chironomid larvae	0.2	-	1.8	-
Trichoptera larvae	1.5	-	1.8	-
Diptera larvae	0.9	-	3.5	-
Hemiptera larva		1.9		2.3
Dragon fly numph	1.3	-	1.8	-
Insect eggs	0.3	-	1.8	-
Immature insect larva	4.1	0.4	15.8	2.3
Insect remains	11.4	22.3	28.1	34.1
Total insects	28.3	39.4	58.5	54.6
Total fish	10.8	19.0	44.5	20.5
Crustacea		4.3		4.6
Water slater	0.2	-	1.8	-
Chirolepallus sp	0.4	-	1.8	-
Plant materials	2.1	5.7	8.8	12
Organic materials	2.5	1.5	14.0	2.3
Digested materials	56.2	24.3	77.2	27.3
Soil materials	-	3.0	-	2.3
Unidentified material	-	4.0	-	9.1
TOTAL	100.5	100.2		

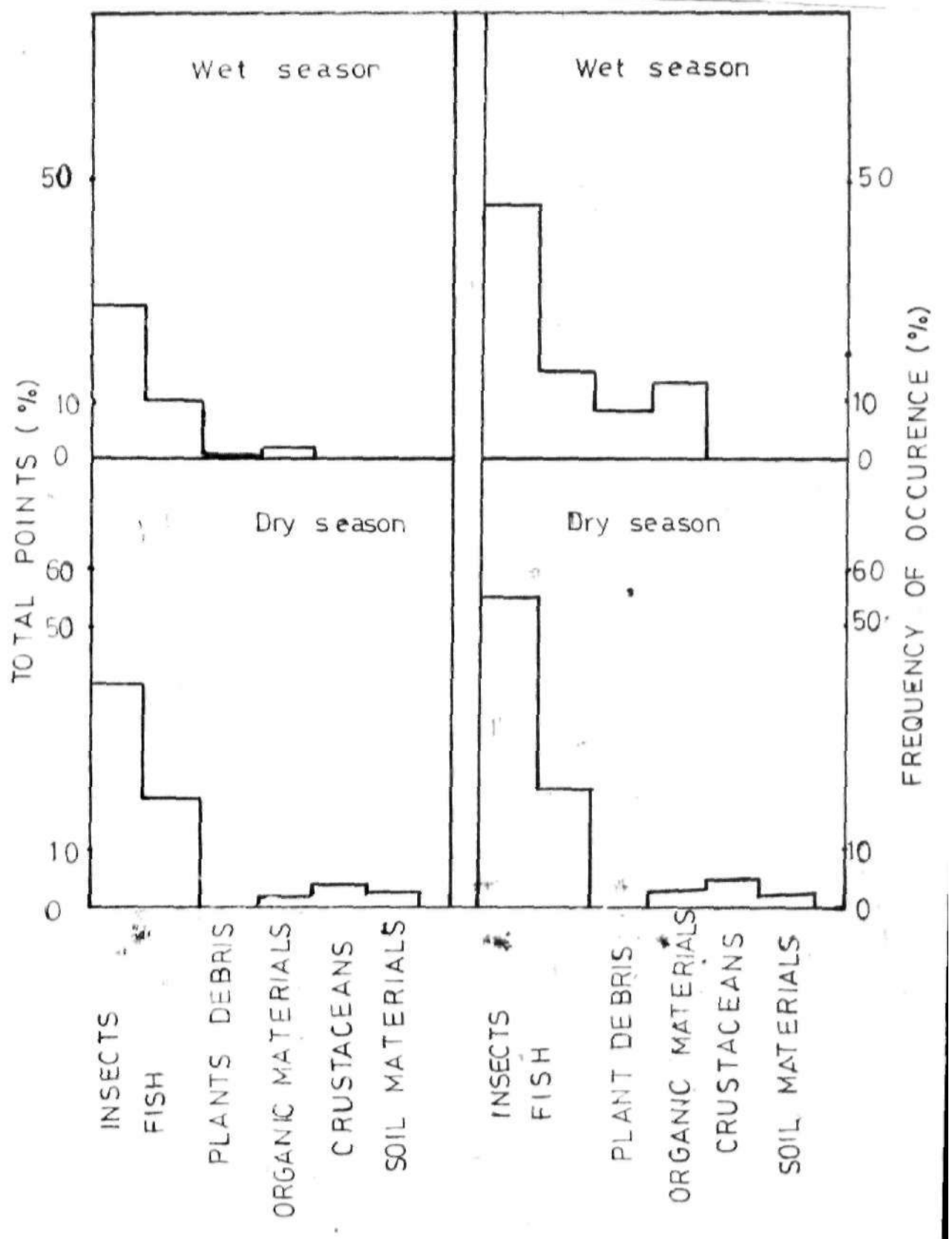


Fig. 23 Seasonal changes in the dietary composition of Eutropius niloticus

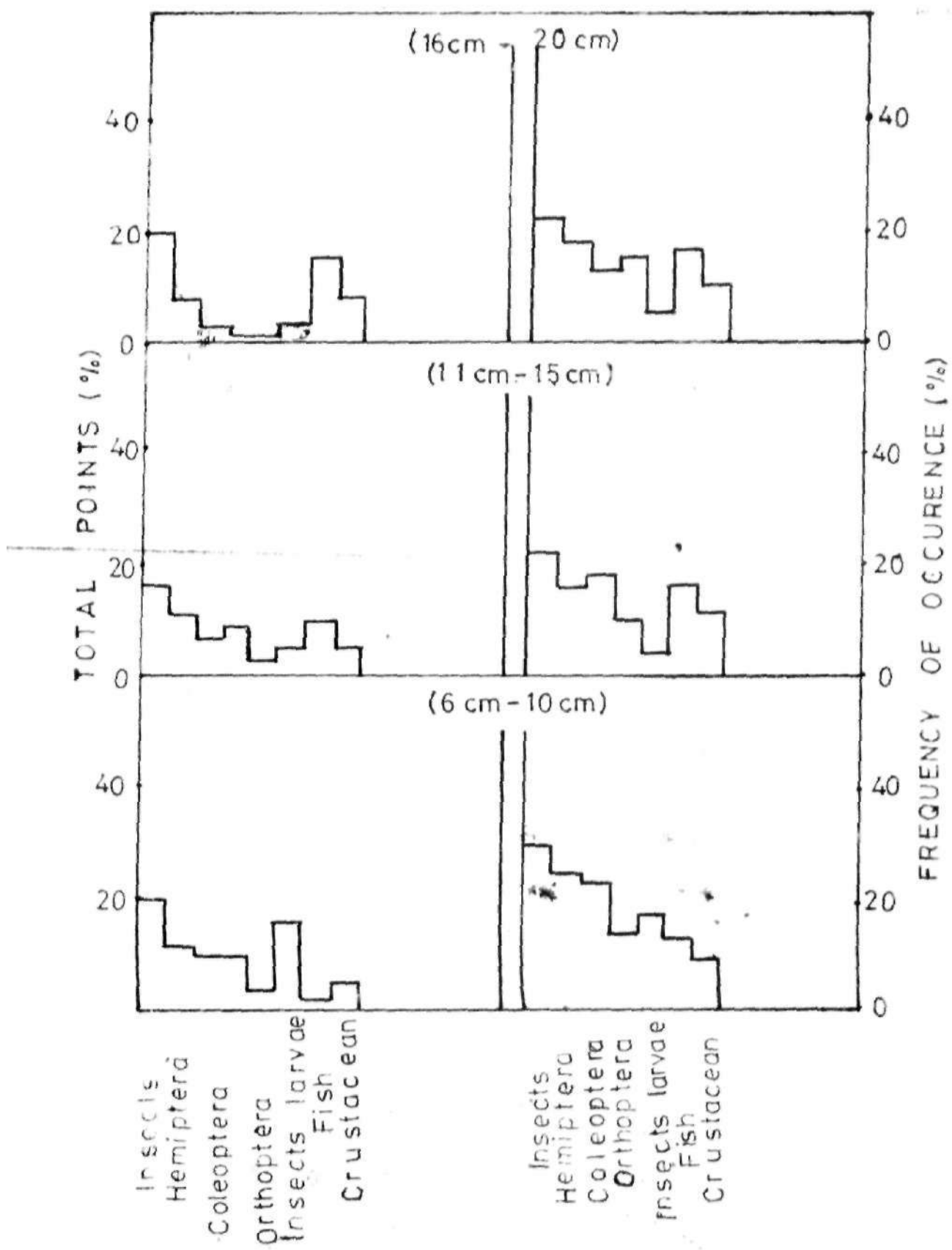


Fig. 24 Changes in the dietary compositions with standard length of Eutropius niloticus

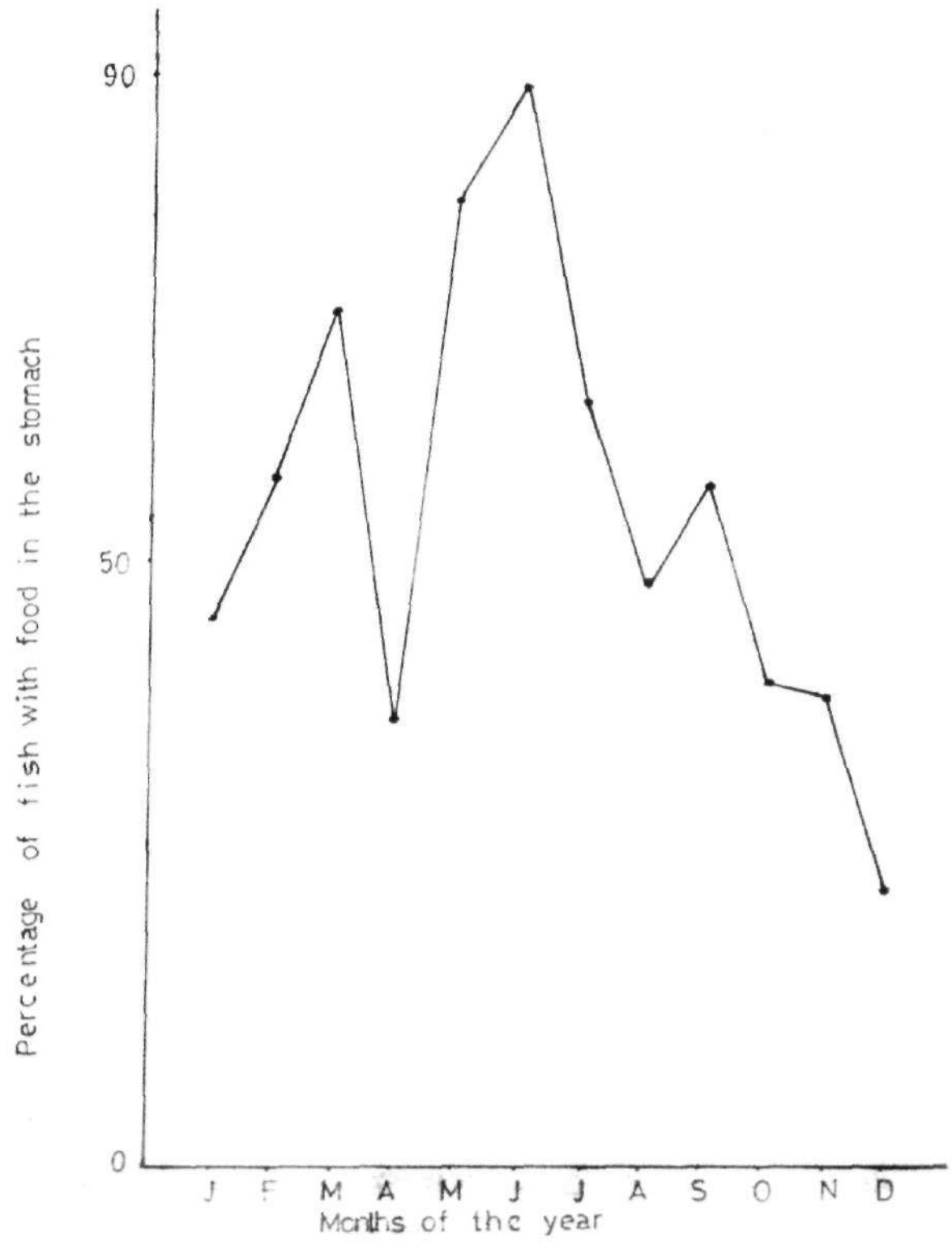


Fig. 25 Monthly feeding index of Eutropius niloticus

while insects were of secondary importance, 24.3 % by points and frequency of occurence of 68.1 %. Plant debris (11.1 %) organic materials like household food remain (9.6 %) and crustacean (7.4 %) were also consumed with less intensity, A close look of the insect food items showed that hemiptera (5.0%) coleoptera (4.2%) and orthoptera (4.5%) were consumed more than any other insects (Table 24).

3.4.3.1 SEASONAL VARIATION IN THE DIET

Food items consumed during the rainy and dry seasons are as given on table 25. Fish was the major food item during wet and dry seasons. However the contribution by fish food item in the dry season is more than that of the wet season. Another food item found to be of importance was insect during wet and dry seasons. Organic materials (e.g. household food remains) and plant debris were also of some importance during the dry and wet seasons. However, there were more plant debris found in the stomachs during the dry season (12.0%) than in the wet season (10.6%). Organic materials gained more points in the wet season (12.9%) than the dry season (7.8%). Histograms of seasonal variations in diet is given in figure 26.

3.4.3.2 CHANGES IN THE DIETARY COMPOSITION WITH SIZE

The fish were grouped into 10cm-15cm, 16cm - 25cm; and 26cm - 40cm ranges of standard length. Figure 27 shows that the proportion of organic materials, adult insects and plant debris decreased with increase in standard length. The importance of fish and crustaceans increased with increase in standard length.

Table 24: Relative importance and frequency of occurence of the dietary items in the stomachs of Malapterurus electricus in Laria area.

No of stomachs examined = 117
No of stomachs with food = 38
% of stomachs with food = 32.5%

Dietary items	% of total points gained	% frequency of occurence
Fish remains	19.0	27.4
Fish scales	13.9	25.3
Total fish	32.8	43.8
ADULT INSECTS		
Hemiptera	5.0	12.5
Coleoptera	4.1	12.5
Orthoptera	4.5	25.0
Hymenoptera	3.1	6.3
IMMATURE INSECTS		
Chironomid larva	3.9	18.8
Diptera larvae	1.2	6.3
Insect remains	3.0	12.5
TOTAL INSECTS	24.8	68.8
Decapodes	5.5	12.5
copepodes	1.5	12.5
TOTAL CRUSTACEA	7.4	12.5
Plant debris	11.1	43.8
Green algae	0.3	6.3
TOTAL PLANTS	11.4	43.3
Soil Materials	2.3	18.8
Organic Materials	9.6	37.3
Digested Materials	8.0	25.0
Unidentified Materials	2.1	6.3
TOTAL	99.5	

Table 25 Relative importance and frequency of occurence of dietary items in the stomach of Malapterurus electricus in Zaria area during the rainy and dry seasons.

Dietary items	% of total points gained		% frequency of occurence	
	Dry season	Wet season	Dry season	Wet season
Fish remains	35.2	35.2	50.0	50.0
Fish scales	10.6	4.2	37.5	12.5
TOTAL FISH	45.8	39.4	50.0	62.5
ADULT INSECTS				
Hemiptera	5.8	4.2	6.3	37.5
Coleoptera	6.6	2.8	6.3	12.5
Orthoptera	3.3	3.5	3.1	6.3
Hymenoptera	-	2.6	-	6.3
IMMATURE INSECTS				
Chironomid larvae	0.7	5.0	1.6	10.0
Diptera larvae	-	2.2	-	3.1
Insect remains	2.0	4.0	3.1	6.3
TOTAL INSECTS	19.4	23.3	25.0	62.5
Decapode crustacea	8.6	6.0	3.1	12.5
Copepode crustacea.	1.5	-	6.3	-
plant debris	12.0	10.6	37.5	37.5
Diatom	0.7	-	1.6	-
Organic materials	7.8	12.9	25.0	37.5
Digested materials	2.0	6.8	3.1	12.5
Soil materials	3.3	-	6.3	-
Unidentified materials	-	1.6	-	3.12
TOTAL	100.0	100.0		

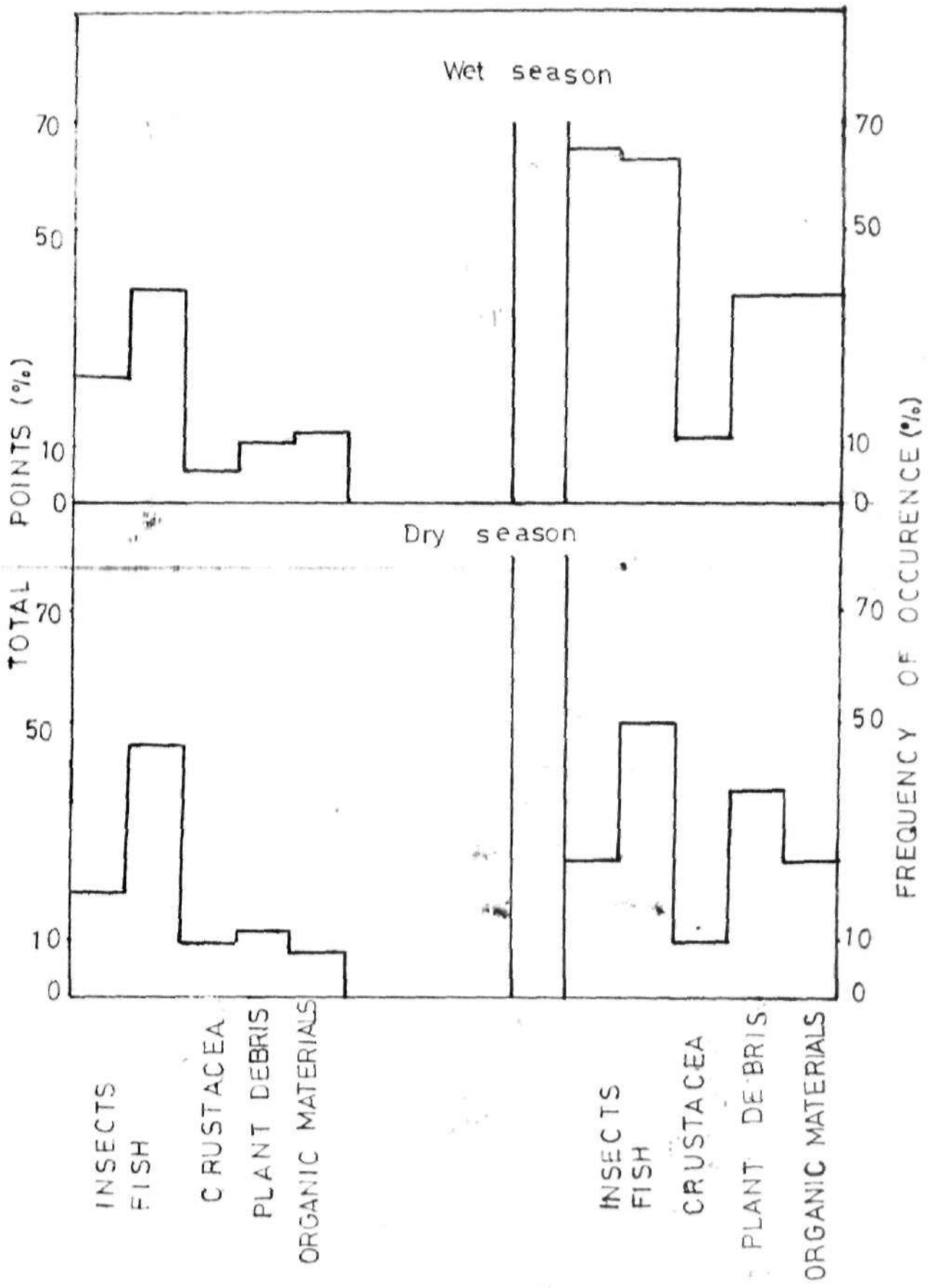


Fig. 26 SEASONAL VARIATION IN THE DIETARY COMPOSITION OF *Malapterurus electricus*

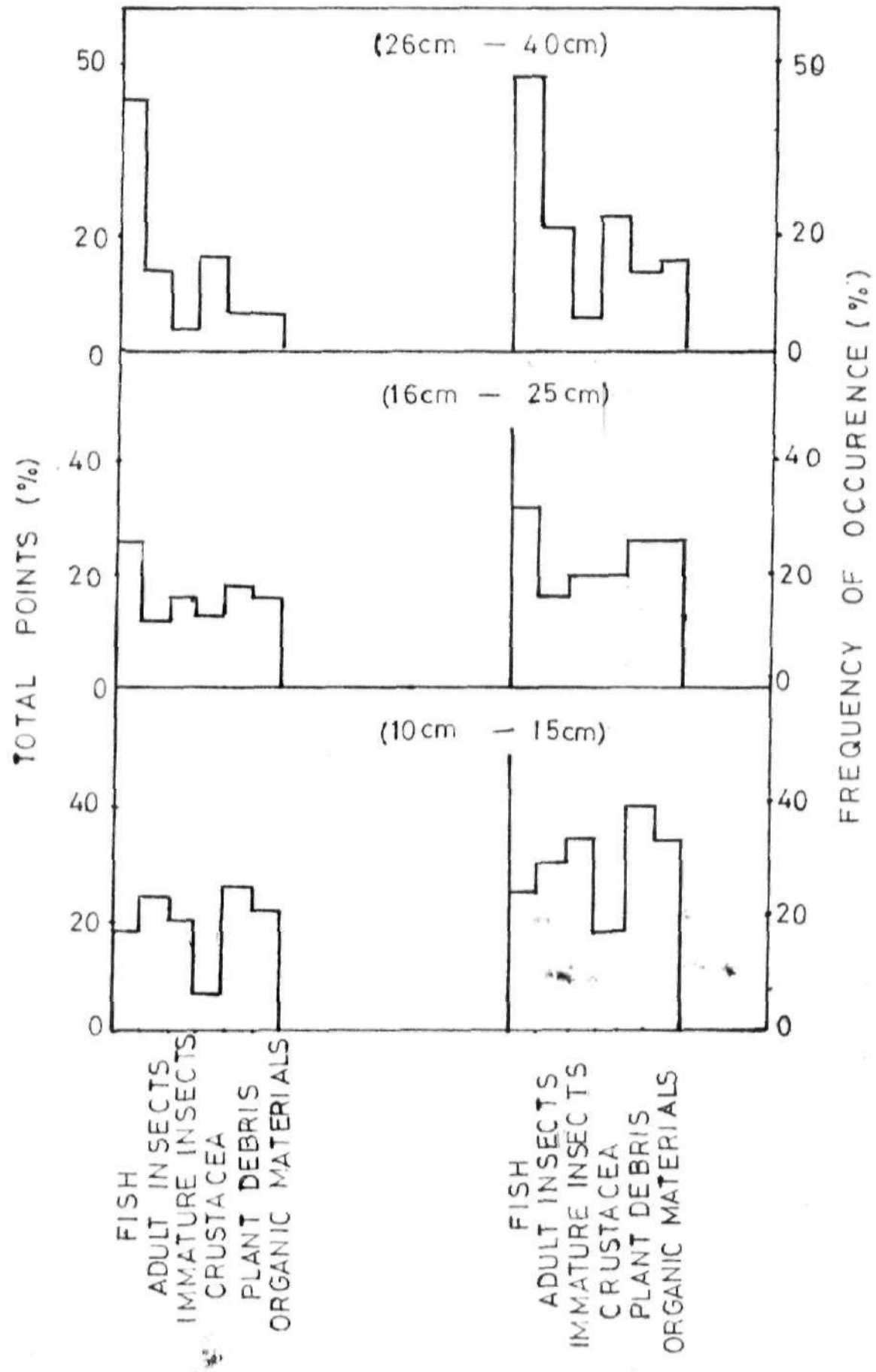


Fig. 27- Changes in the dietary composition with standard length of Malapterurus electricus

3.4.3.3 MONTHLY FEEDING INDEX

It was only in January, February and September that about 50% and above of the fish were seen with food in their stomachs. The number of the fish feeding were low during the other months particularly during the breeding months (April - August) Figure 28.

3.5.0 SEX RATIO, REPRODUCTIVE CYCLE AND FECUNDITY

3.5.1 SEX RATIO.

The sex ratios of Schilbe mystus, Eutropius niloticus and Malapterurus electricus are shown on table 26

In Schilbe mystus, there were 66 males to 324 females giving a sex ratio of 1 male to 4.9 (1:5) females. Out of the 366 specimens of Eutropius niloticus studied, 124 were males while 238 were females. This gave a sex ratio of 1:1.86 (1:2) females. In Malapterurus electricus, there were 50 males to 67 females. This gave a sex ratio of 1:1.34 (1:1) females.

Monthly variation in the sex ratio of Schilbe mystus, Eutropius niloticus and Malapterurus electricus are shown in tables 27, 28 and 29 respectively. Females of Schilbe mystus were more numerous than the males throughout the year. This trend was also true for Eutropius niloticus, except in the months of August and September. In Malapterurus electricus, the proportion of males to females was equal in August and September. The males were slightly fewer than the females from January to July and from October to December, the males were more than females.

3.5.1.1 RELATIONSHIP BETWEEN STANDARD LENGTH AND SEX RATIO

The relationship between the standard length and sex ratio was studied for the three species and the result is as seen on table 30.

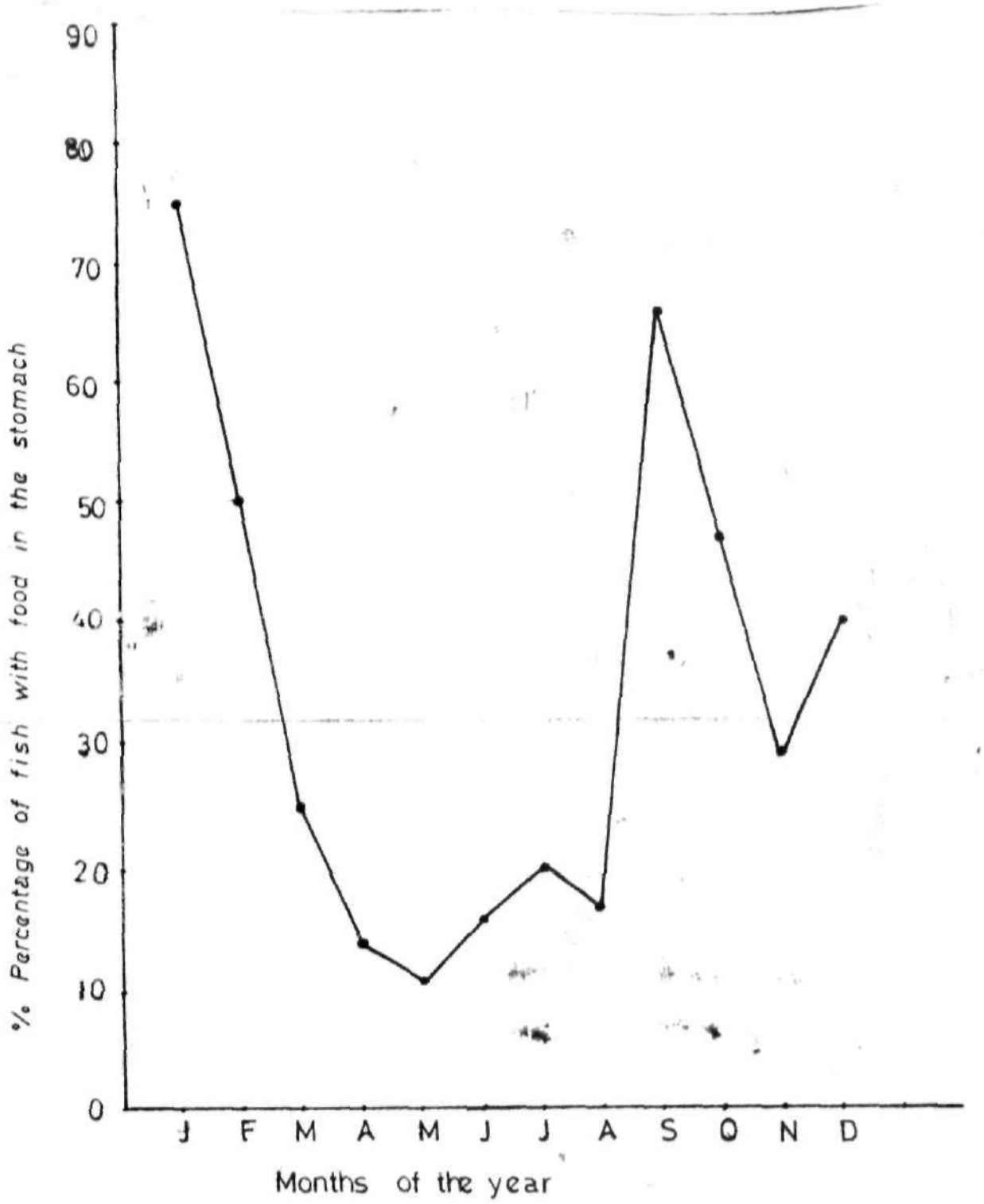


Fig. 28 Monthly feeding index of Malapterurus electricus

Table 26

SEX RATIO OF Schilbe mystus, Eutropius niloticus and Malapterurus electricus IN ZARIA ARCA

Species	Total number with recognisable gonads	Number of males	Number of females	Sex ratio M F
Schilbe mystus	390	66	324	1 : 5
Eutropius niloticus	366	128	238	1 : 2
Malapterurus electricus	117	50	67	1 : 1

Table 27 SEASONAL VARIATIONS IN THE SEX RATIO OF

Schilbe mystus

Month	Males	Females	Total number of fish examined	Sex ratio M : F
JANUARY	24	36	60	1 : 1.5 (1:2)
FEBRUARY	1	14	15	1 : 14
MARCH	7	48	55	1 : 6.9 (1:7)
APRIL	2	30	32	1 : 15
MAY	6	54	61	1 : 9.2(1:9)
JUNE	0	12	12	0 : 12
JULY	0	12	12	0 : 12
AUGUST	1	19	20	1 : 19
SEPTEMBER	6	24	30	1 : 4
OCTOBER	3	29	32	1 : 9.7(1:10)
NOVEMBER	3	19	32	1 : 6.3(1:6)
DECEMBER	13	26	39	1 : 2
TOTAL	66	323	390	1 : 4.9(1:5)

Table 28

SEASONAL VARIATIONS IN THE SEX RATIO OF

Eutropius niloticus

Month	Males	Females	Total number of fish examined	Sex ratio M : F
JANUARY	11	17	28	1 : 1.55(1:2)
FEBRUARY	12	32	44	1 : 2.67(1:3)
MARCH	1	20	21	1 : 20
APRIL	15	40	55	1 : 2.7(1:3)
MAY	5	10	15	1 : 2
JUNE	15	23	38	1 : 1.5(1:2)
JULY	12	15	27	1 : 1.2(1:1)
AUGUST	15	14	29	1.07 : 1 (1:1)
SEPTEMBER	13	10	23	1.3 : 1 (1:1)
OCTOBER	13	16	29	1.0 : 1.23(1:1)
NOVEMBER	10	16	26	1 : 1.6(1:2)
DECEMBER	6	25	31	1 : 4.2(1:4)
TOTAL	128	238	36	1 : 1.86(1:2)

Table 29

SEASONAL VARIATIONS IN THE SEX RATIO OF

Malapterurus electricus

Month	Males	Females	Total number of fish examined	Sex ratio M : F
JANUARY	1	3	4	1 : 3
FEBRUARY	2	6	8	1 : 3
MARCH	6	10	16	1 : 1.6(1:2)
APRIL	3	5	7	1 : 2.5(1:3)
MAY	6	12	18	1 : 2.0
JUNE	2	4	6	1 : 2.0
JULY	2	3	5	1 : 1.5(1:2)
AUGUST	12	12	24	1 : 1.0
SEPTEMBER	3	3	6	1 : 1
OCTOBER	1	0	1	1 : 0
NOVEMBER	8	6	14	1.33 : 1 (1:1)
DECEMBER	5	3	8	1.67 : 1 (2:1)
TOTAL	50	67	117	1.38 : 1 (1:1)

SPECIES	Standard length groups (cm) 5 - 10	11 - 15	16 - 20	10 - 20	21 - 30
Schilbe mystus	Males = 51 Females = 86 Sex ratio = 1:1.69 (1:2)	Males = 16 Females = 215 Sex ratio = 1:13.4 (1:13)	Males = 0 Females = 23 Sex ratio=0:23		
Eutropius niloticus	Males = 14 Females = 15 Sex ratio = (1:1)	Males = 106 Females = 138 Sex ratio = 1:1.3 (1:1)	Males = 8 Females = 85 Sex ratio =1:10.6 (1:11)		
Malapterurus electricus				Males = 35 Females = 46 Sex ration =1:3 (1:1)	Males = 15 Females = 19 Sex ratio =1:27 (1:1)

Table 30 Relationship between standard length and sex ratios of Schilbe mystus, Eutropius niloticus and Malapterurus electricus.

In Schilbe mystus and Eutropius niloticus, the sex ratio increased with increasing standard length in favour of the females while the sex ratio of Malapterurus electricus decreased slightly with increase in standard length.

3.5.2 SIZES AT MATURITY

Sizes of individuals at maturity is given on table 31. The minimum standard length of Schilbe mystus at which maturity was achieved by females was 10.1 cm while the maximum standard length observed was 19.8cm. The males had a minimum standard length of 10.1 cm and a maximum standard length of 12.3 cm at maturity. Figure 29 shows a maturation ogive indicating the average standard length of 10.8cm and 10.4 cm at which at least 50% of the females and males Schilbe mystus showed breeding activities respectively.

Female Eutropius niloticus had a minimum standard length of 12.2cm and a maximum standard length of 19.6 cm, while the males had a minimum standard length of 11.6 cm and a maximum standard length of 14.2 cm at maturity. Maturation ogive (fig. 30) showed that 13.0 cm was the average standard length at which at least 50% of the males showed breeding activities, while that of the females was at a mean standard length of 13.6 cm.

In Malapterurus electricus, the minimum standard length at which the females were observed to achieve maturity was 16.1 cm while the maximum standard length was 24.1 cm. The females matured at a minimum standard length

Table 31

SIZE AT MATURITY OF Schilbe mystus, Eutropius niloticus, and Malapterurus electricus IN ZARIA

Species	Sex	Number examined	Size ranges of matured specimen standard length (cm)	
			Minimum	Maximum
Schilbe mystus	M	5	10.1	12.3
	F	73	10.1	19.8
Eutropius niloticus	M	25	11.6	14.2
	F	42	12.2	19.6
Malapterurus electricus	M	6	15.6	23.0
	F	19	16.1	24.1

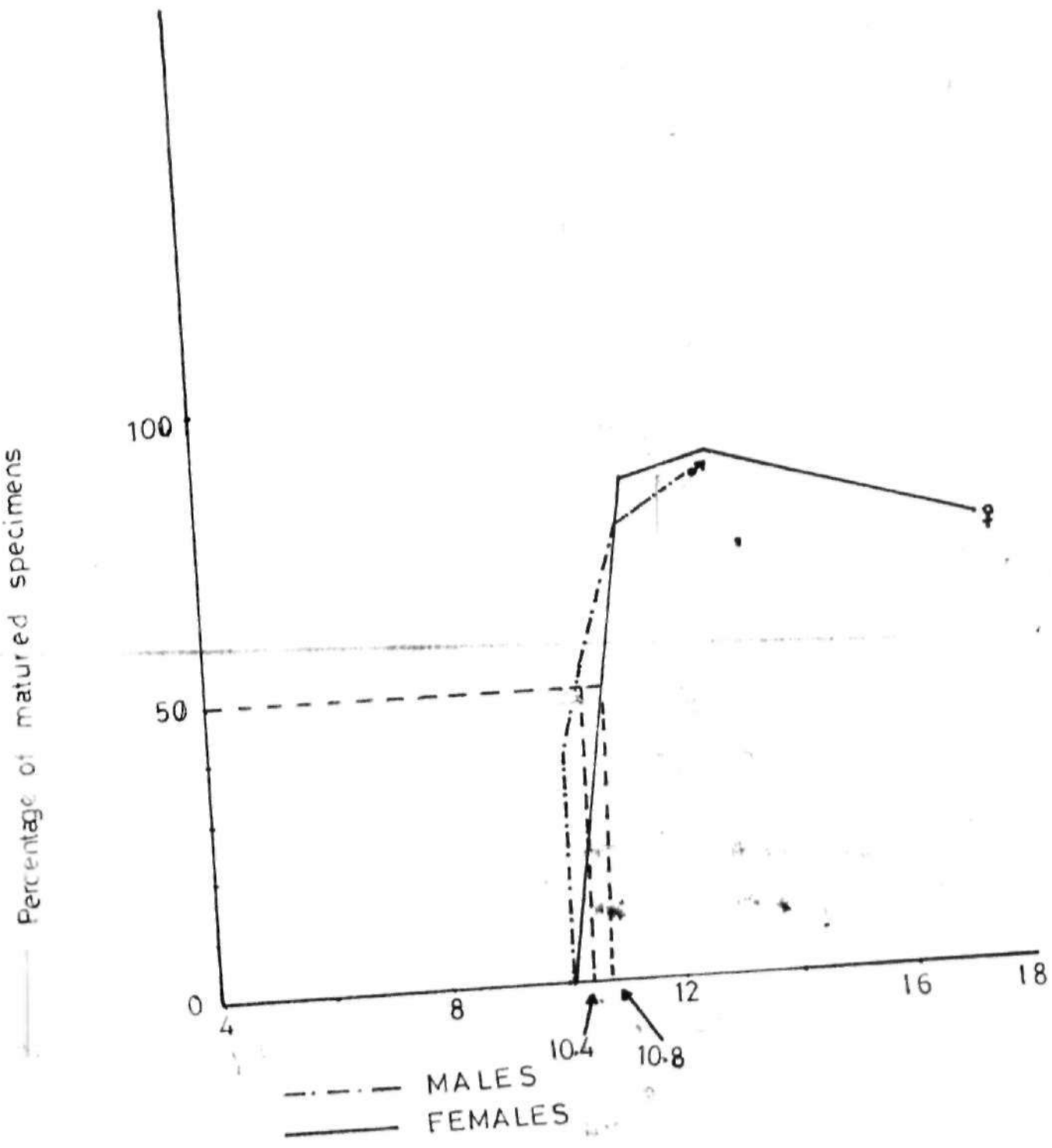


Fig. 29 Percentage of matured (stage V) of males and females *Schilbe mystus* in 2 cm length group.

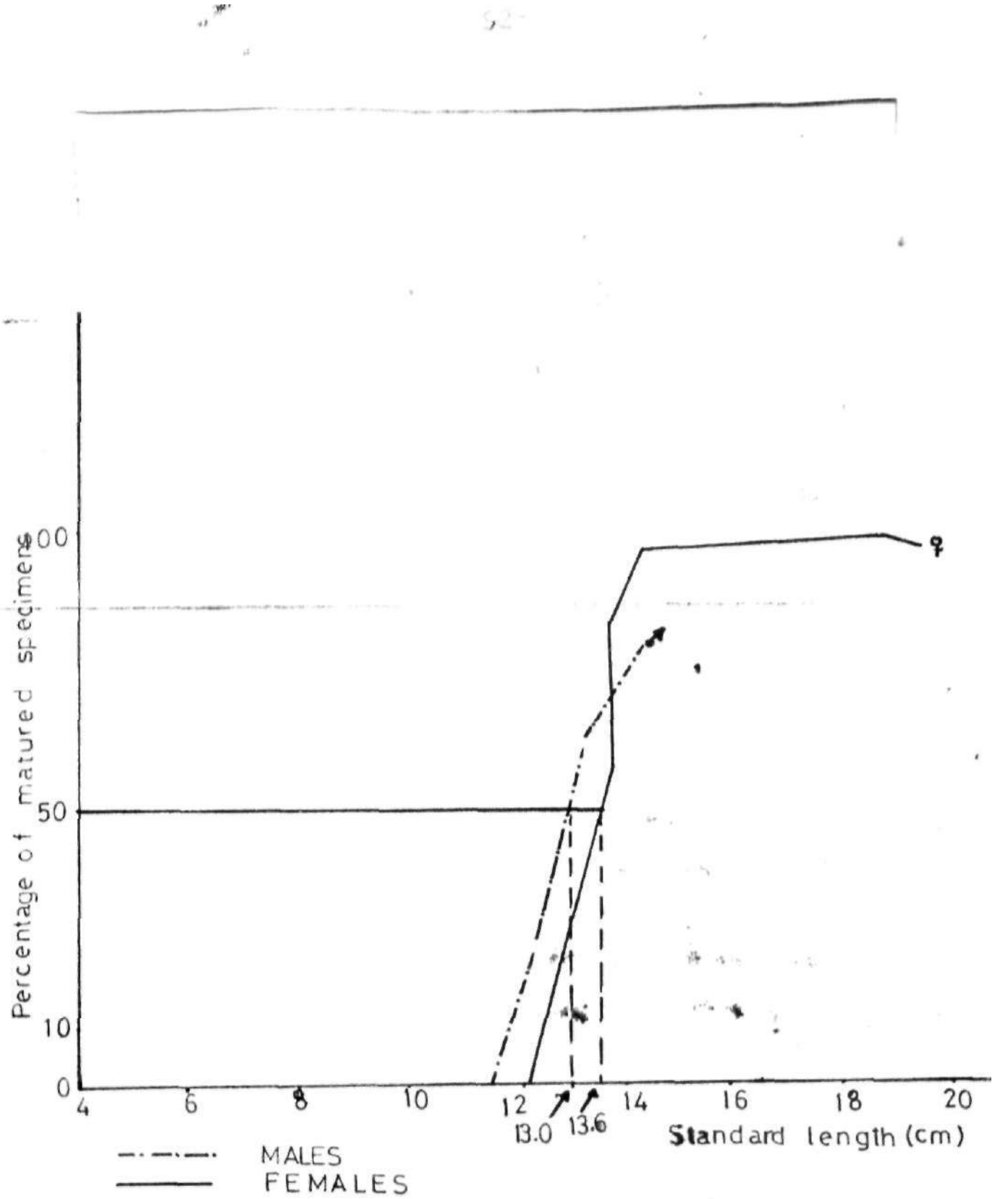


Fig. 30 Percentage of matured (stage IV) males and females Eutropius niloticus in each 2 cm standard length group

of 15.6 cm and at a maximum standard length of 23.0 cm. Figure 31 showed that the average standard length at which 50% of the males achieved maturity was 16.7cm, while that of the females was 17.4cm.

3. 5. 3. REPRODUCTIVE CYCLE

Details of monthly occurences of different stages of gonad maturity and number of Schilbe mystus in the various stages is given on table 32. Fully matured females were seen from May to September while one spawning female was seen in August and two in September. Spent females were seen between September and November while developing females (maturation) were seen from December to May. Resting stages of the female gonad were seen throughout the year except in June. Immature females were seen in all the months. Fully matured males were very few and seen in the month of May and August. One spawning male was seen only in September, while spent males were seen in September and October and Maturation stages seen in May. Most of the males were immature, and seen between January and March and then September to December. Figure 32 shows the proportion of fully matured female Schilbe mystus to the rest of the females population. The figure showed that about 10% and above of the females were gravid between May and September and could be suggested that this fish breed during these months.

Table 33 shows the occurences of different stages of gonad maturity in Eutropius niloticus. Fully matured females

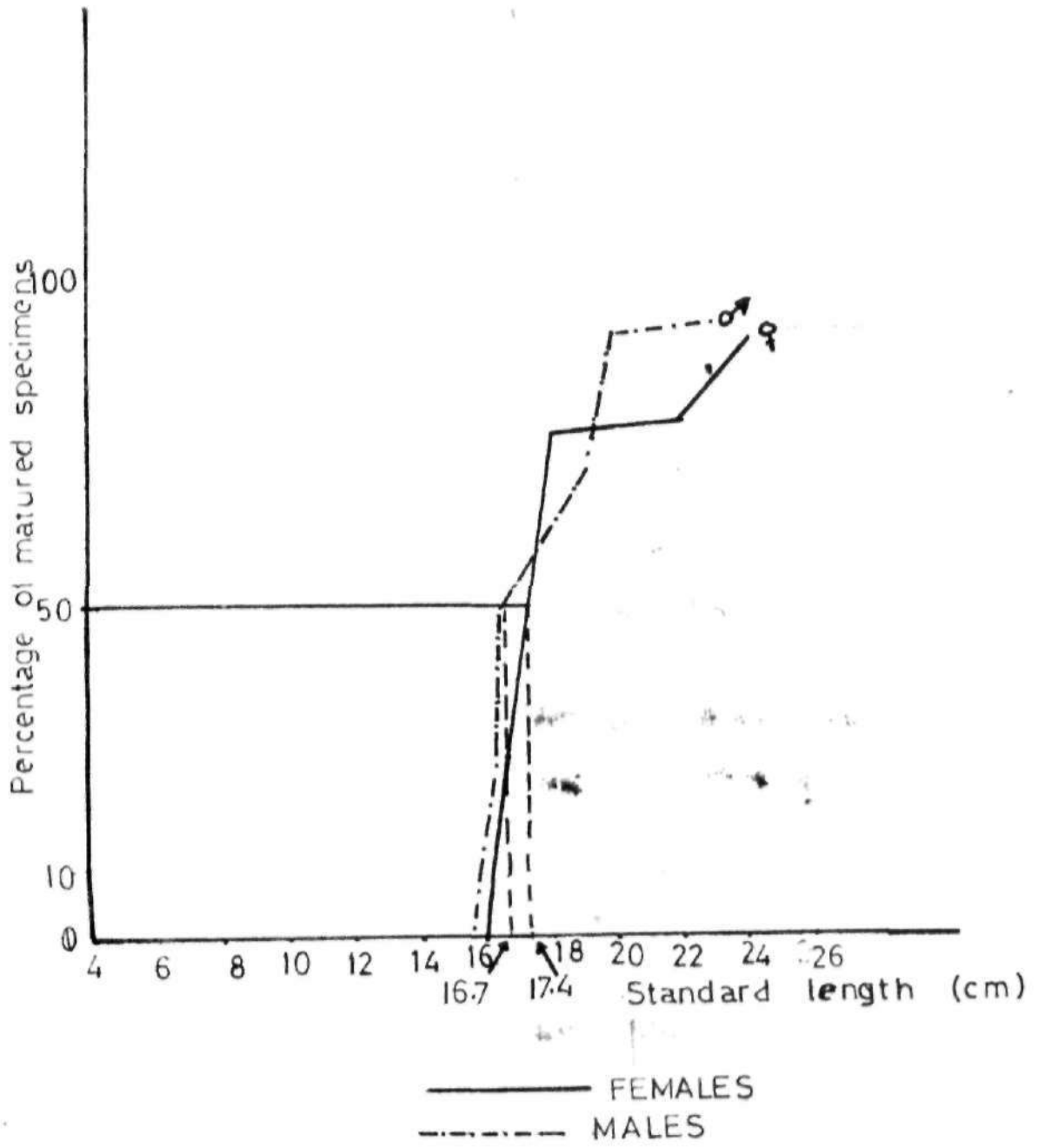


Fig. 31 Percentage of matured (stage IV) males and females Malapterurus electricus in each 2cm standard length group

Table 32 MONTHLY OCCURRENCES OF DIFFERENT STAGES OF GONAD MATURITY IN SPECIMEN OF *Schilbe mystus*

Months	Sex	Stages of gonad maturity						Total number examined
		I	II	III	IV	V	VI	
JANUARY	M	9	15	0	0	0	0	24
	F	4	25	7	0	0	0	36
FEBRUARY	M	1	0	0	0	0	0	1
	F	1	12	1	0	0	0	14
MARCH	M	6	1	0	0	0	0	7
	F	14	30	4	0	0	0	48
APRIL	M	0	1	1	0	0	0	2
	F	2	10	13	0	0	0	30
MAY	M	0	4	0	2	0	0	6
	F	2	8	10	35	0	0	55
JUNE	M	0	0	0	0	0	0	0
	F	1	0	0	1	0	0	12
JULY	M	0	0	0	0	0	0	0
	F	1	1	0	10	0	0	12
AUGUST	M	0	0	0	1	0	0	1
	F	0	2	0	16	1	0	19
SEPTEMBER	M	1	0	0	0	1	4	6
	F	2	3	0	1	2	13	24
OCTOBER	M	1	0	0	0	0	2	3
	F	4	17	0	0	0	9	29
NOVEMBER	M	2	1	0	0	0	0	3
	F	5	13	0	0	0	1	19
DECEMBER	M	5	7	1	0	0	0	13
	F	2	18	6	0	0	0	26

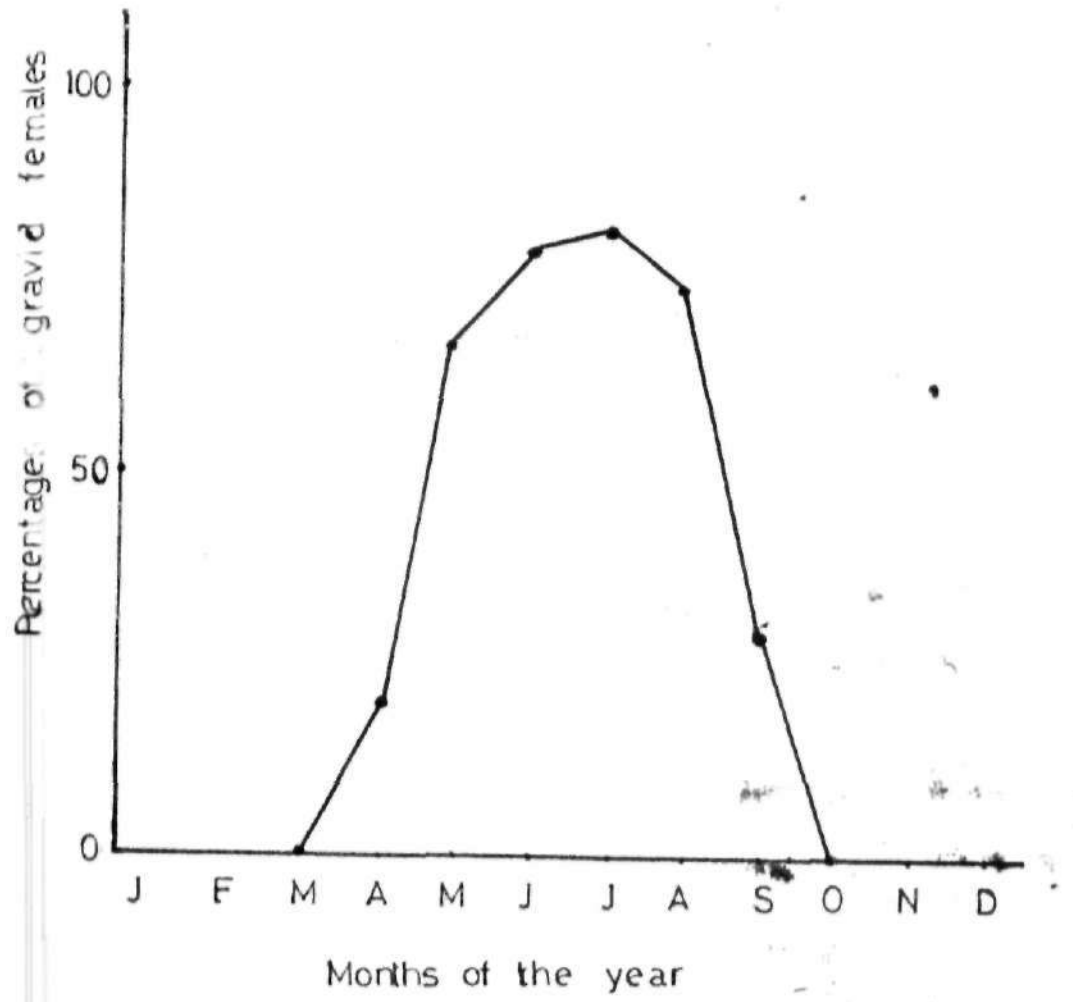


Fig 32 Seasonal changes in the proportion of gravid females of Schilbe mystus

Table 33: MONTHLY OCCURENCES OF DIFFERENT STAGES OF GONAD MATURITY IN SPECIMEN OF *Eutropius niloticus*.

Months	Sex	Stages of gonad maturity						Total number examined
		I	II	III	IV	V	VI	
JANUARY	M	0	11	0	0	0	0	11
	F	3	24	0	0	0	0	17
FEBRUARY	M	2	9	0	0	0	0	12
	F	9	22	1	0	0	0	32
MARCH	M	0	1	0	0	0	0	1
	F	1	20	0	0	0	0	21
APRIL	M	6	7	1	0	0	0	15
	F	2	18	20	0	0	0	40
MAY	M	0	3	0	2	0	0	5
	F	2	1	1	6	0	0	10
JUNE	M	5	3	3	1	0	0	15
	F	2	5	7	9	0	0	23
JULY	M	1	2	5	4	0	0	12
	F	1	2	5	7	0	0	15
AUGUST	M	1	0	0	11	0	3	15
	F	1	1	0	11	1	0	14
SEPTEMBER	M	1	0	0	8	0	4	13
	F	1	0	0	7	0	2	10
OCTOBER	M	2	0	0	0	1	10	13
	F	4	0	0	0	0	10	16
NOVEMBER	M	1	2	0	0	0	7	10
	F	1	8	0	0	0	7	16
DECEMBER	M	2	4	0	0	0	1	7
	F	4	21	0	0	0	0	25

were seen from May to September. Only one spawning female was found in August, while spent individual females were seen from September to November. Virgin (immature) females were found throughout the year, while maturation stages of female gonad were found in February and April to July. Resting stages of female gonad were seen between January and August and October to December. Fully matured males were seen from May to September and one spawning male in October. Maturation stages of male gonad were seen in April, June and July, while spent males were found from August to December. Immature males were seen throughout the year except in January, March and May while resting stage of males were seen from January to July and November to December. Figure 33 shows the proportion of fully matured female Eutropius niloticus in the population examined. It could be seen that a high percentage of the females were involved in breeding activities during the breeding months (May to September).

In Malapterurus electricus, fully matured females were seen from April to August (table 34) while no spawning female was seen in any of the months. Spent individuals were seen in August and September while maturation stages of females were seen from February to August. Resting stages of female gonad were seen from January to May, August and November to December. Immature females were found from January to April, August to September and November to December. Fully matured males were seen in May, June and August while no spawning male was seen. Spent males were only found in August and September. Figure 34 show that gravid female Malapterurus electricus were seen from April to August and over 50% of the

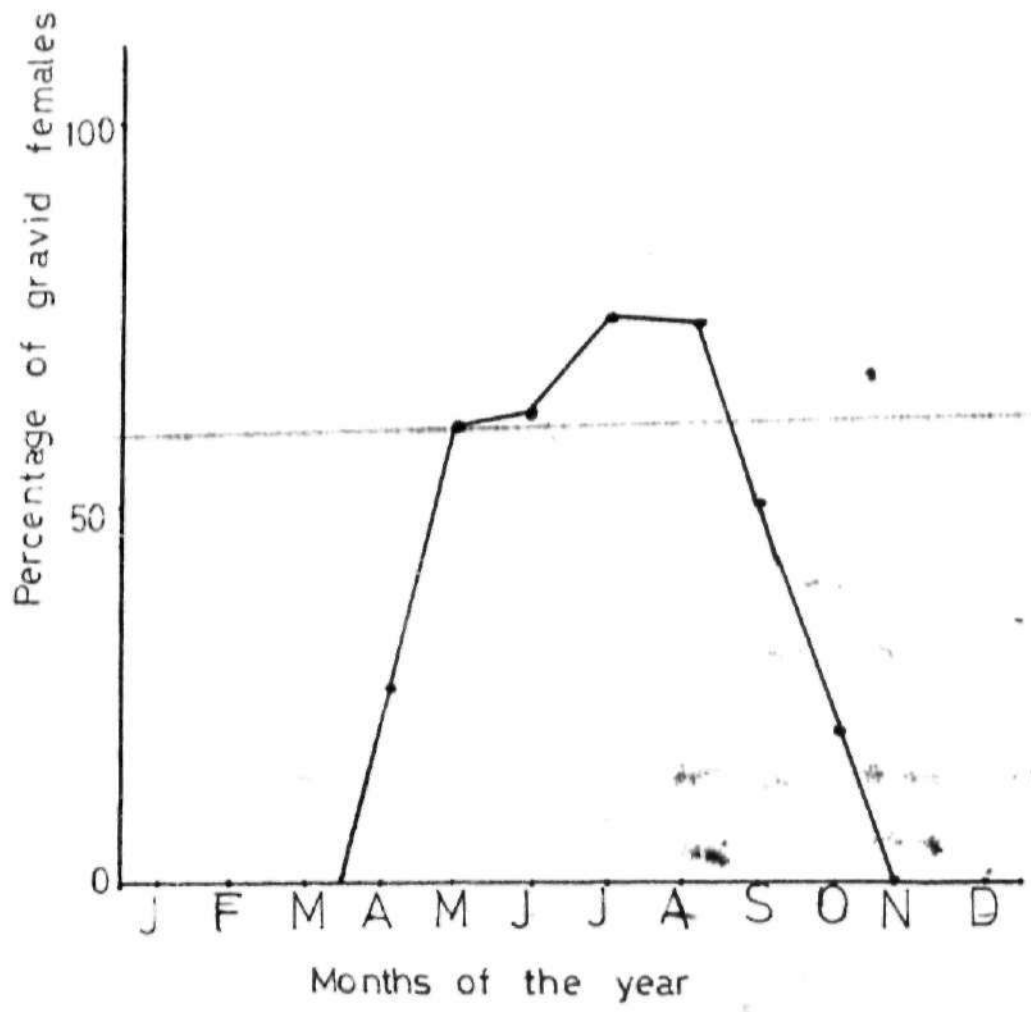


Fig 33 Seasonal changes in the proportion of gravid females of Eutropius niloticus

Table 34 MONTHLY OCCURRENCES OF DIFFERENT STAGES OF GONAD MATURITY IN SPECIMEN OF *Malapterurus electricus*

Months	Sex	Stages of gonad maturity						Total number examined
		I	II	III	IV	V	VI	
JANUARY	M	0	1	0	0	0	0	1
	F	2	1	0	0	0	0	3
FEBRUARY	M	2	0	0	0	0	0	2
	F	1	4	1	0	0	0	6
MARCH	M	1	2	3	0	0	0	6
	F	1	1	7	0	0	0	10
APRIL	M	0	1	1	0	0	0	2
	F	1	1	2	1	0	0	5
MAY	M	1	0	2	3	0	0	6
	F	0	1	1	10	0	0	12
JUNE	M	0	0	1	1	0	0	2
	F	0	0	1	3	0	0	4
JULY	M	0	0	2	0	0	0	2
	F	0	0	0	3	0	0	3
AUGUST	M	4	2	1	2	0	3	12
	F	5	2	0	2	0	3	12
SEPTEMBER	M	0	1	0	0	0	2	3
	F	1	0	0	0	0	2	3
OCTOBER	M	1	0	0	0	0	0	1
	F	0	0	0	0	0	0	0
NOVEMBER	M	1	5	0	0	0	0	6
	F	1	7	0	0	0	0	8
DECEMBER	M	2	3	0	0	0	0	5
	F	1	2	0	0	0	0	3

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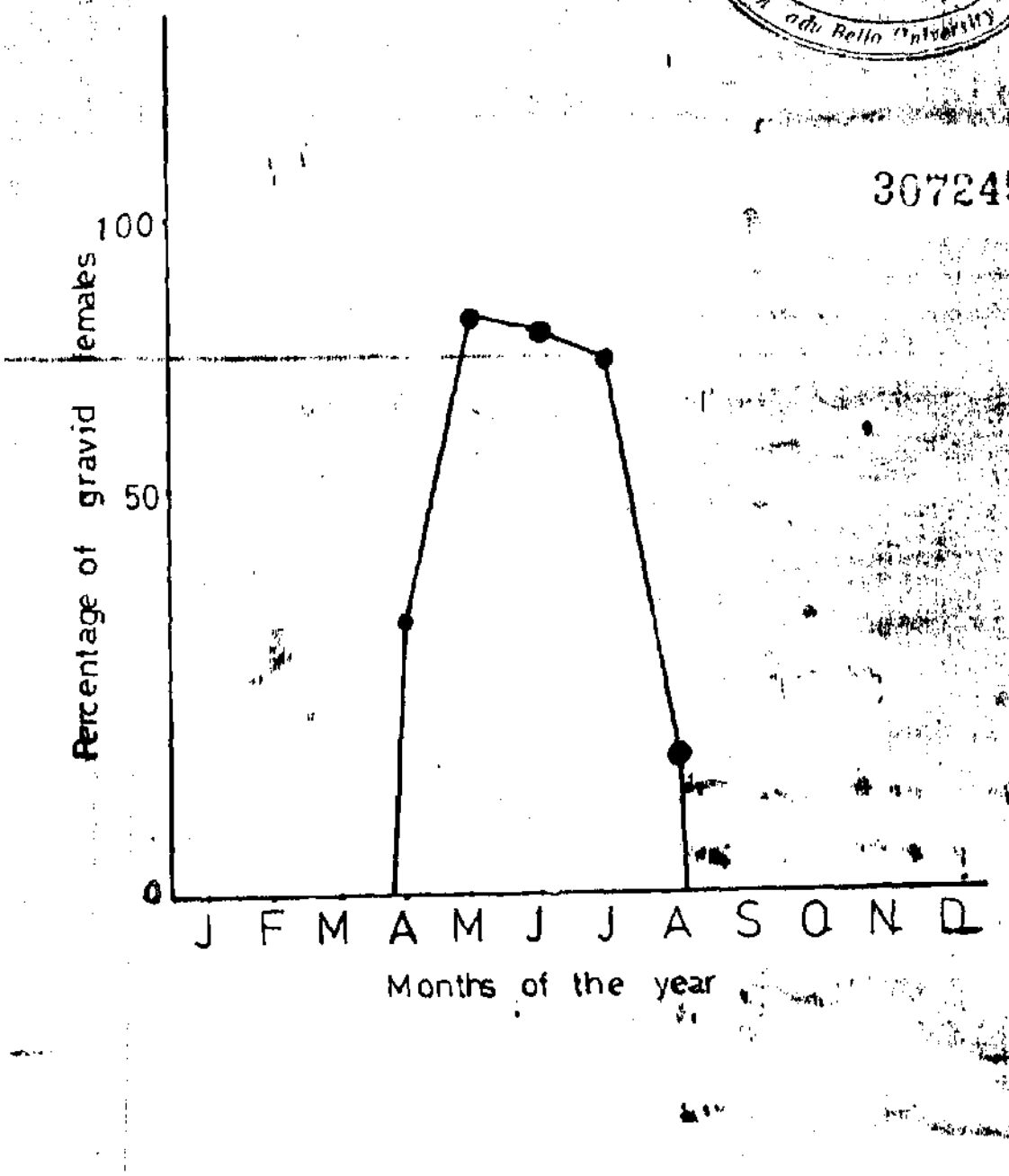


Fig. 34 Seasonal changes in the proportion of gravid females of Malapterurus electricus

females were fully matured between May and July.

3.5.4 FECUNDITY

Fecundity of Schilbe mystus, Eutropius niloticus and Malapterurus electricus are given in appendices 8, 9 and 10 respectively.

Table 35 gives the summary of fecundity of Schilbe mystus, Eutropius niloticus and Malapterurus electricus. The estimated fecundity in Schilbe mystus ranged from 315 to 60,203 with a mean total number of 10,676 (SE ± 1550). In Eutropius niloticus, the minimum fecundity recorded was 3,328 while the maximum was 31,183 and a mean of 10,530 (SE ± 2542). In Malapterurus electricus, the fecundity ranged from 902 to 4,003 with a mean of 2,331 (SE ± 970).

FECUNDITY AND INDIVIDUAL SIZE

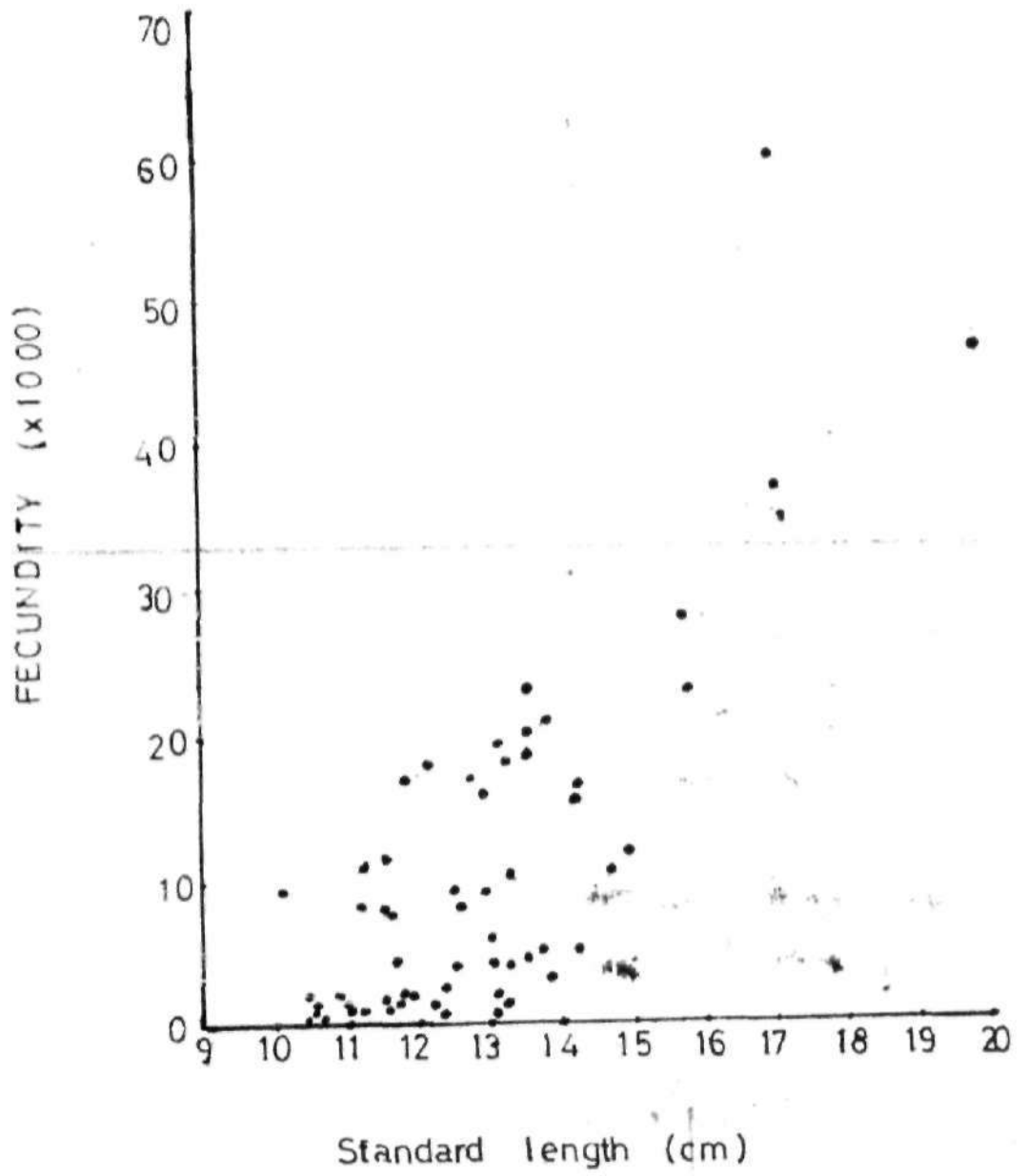
Table 35 gives the details of the regression equation co-efficient describing the relationship between log fecundity, log standard length and log weight of Schilbe mystus, Eutropius niloticus and Malapterurus electricus respectively. The corrolation coefficient 'r' in all the three species were not significant. This indicated that prediction of fecundity based on either length or weight is not reliable. Graph of fecundity against standard length and weight of Schilbe mystus, Eutropius niloticus and Malapterurus electricus are given in figures 35, 36, 37, 38, 39 and 40 respectively. From these figures it could not be established whether fecundity increased with increase or decrease in standard length or weight.

Table 35 FECUNDITY OF Schilbe mystus, Eutropius niloticus and Malapterurus electricus IN ZARIA

Species	Number of fish examined	Standard length range	Mean standard length	weight range	Mean weight	fecundity range	mean fecundity	Standard error
Schilbe mystus	59	10.1-19.8	12.8	14.3-141.7	31.5	315-60,203	10,676	1,550
Eutropius niloticus	11	13.4-19.4	15.84	26.8-90.8	48.2	3,328-31,183	10,530	2542
Malapterurus electricus		16.1-24.1	19.3	125.9-369.5	183.7	902-4,003	2,331	970

Table 36 REGRESSION EQUATION DESCRIBING RELATIONSHIP BETWEEN LOG FECUNDITY (F) STANDARD LENGTH AND WEIGHT OF Schilbe mystus, Eutropius niloticus and Malapterurus electricus

Species	Variables	No. of fish	Log a	'b'	SE of 'b'	'r'	Significance of 'r'
Schilbe mystus	SL(cm)	59	37.9	13.00	3.01	0.08	NS
	WT(g)	59	20.5	4.82	0.92	0.12	NS
Eutropius niloticus	SL(cm)	11	38.3	10.86	3.80	0.06	NS
	WT(g)	11	24.2	4.36	1.15	0.11	NS
Malapterurus electricus	SL(cm)	8	58.7	19.26	7.33	0.25	NS
	WT (g)	8	35.9	6.70	2.35	0.28	NS



Frg 35 Relationship between standard length and fecundity of Schilbe mystus

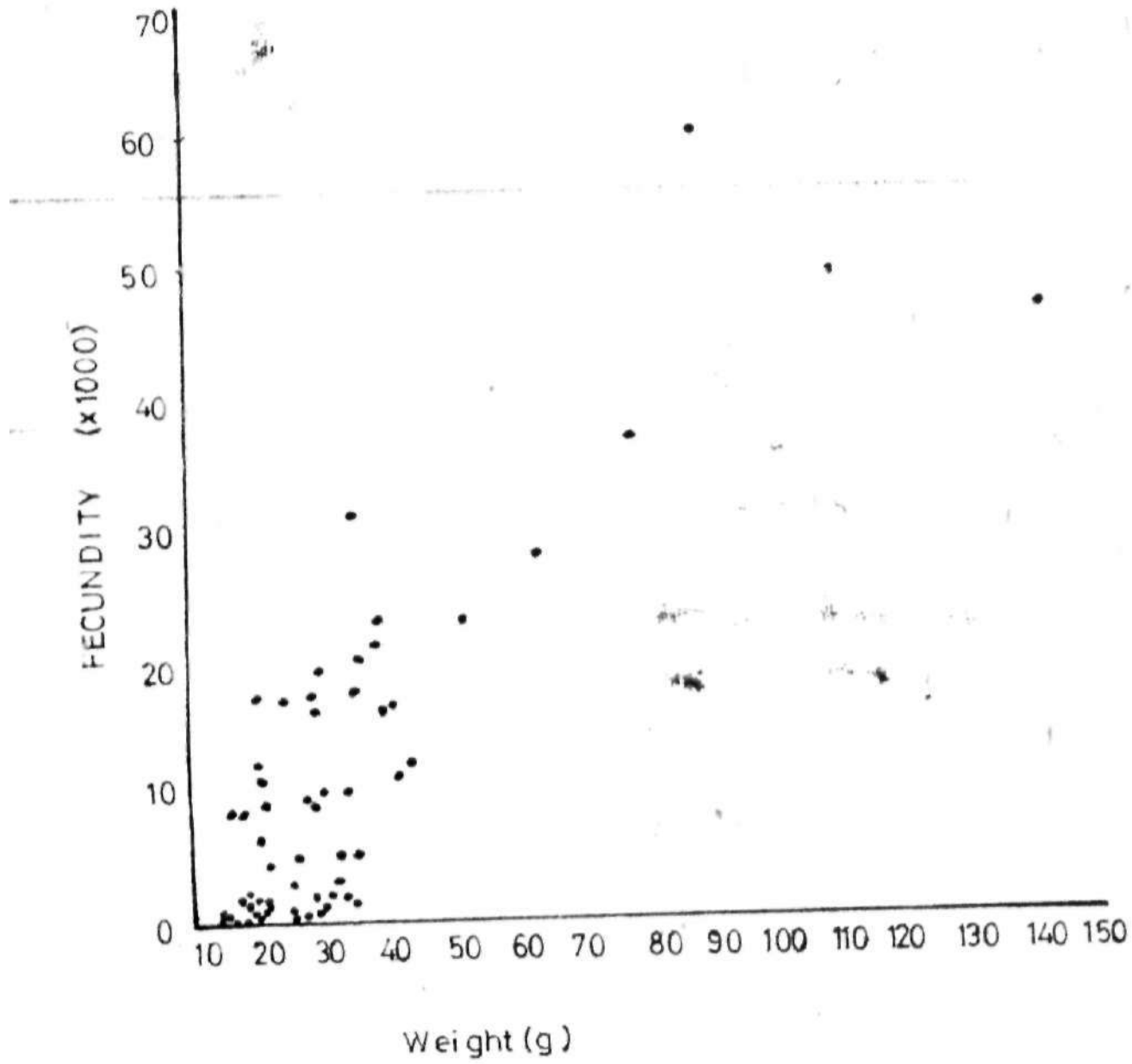


Fig. 36 Relationship between weight and fecundity of Schilbe mystus

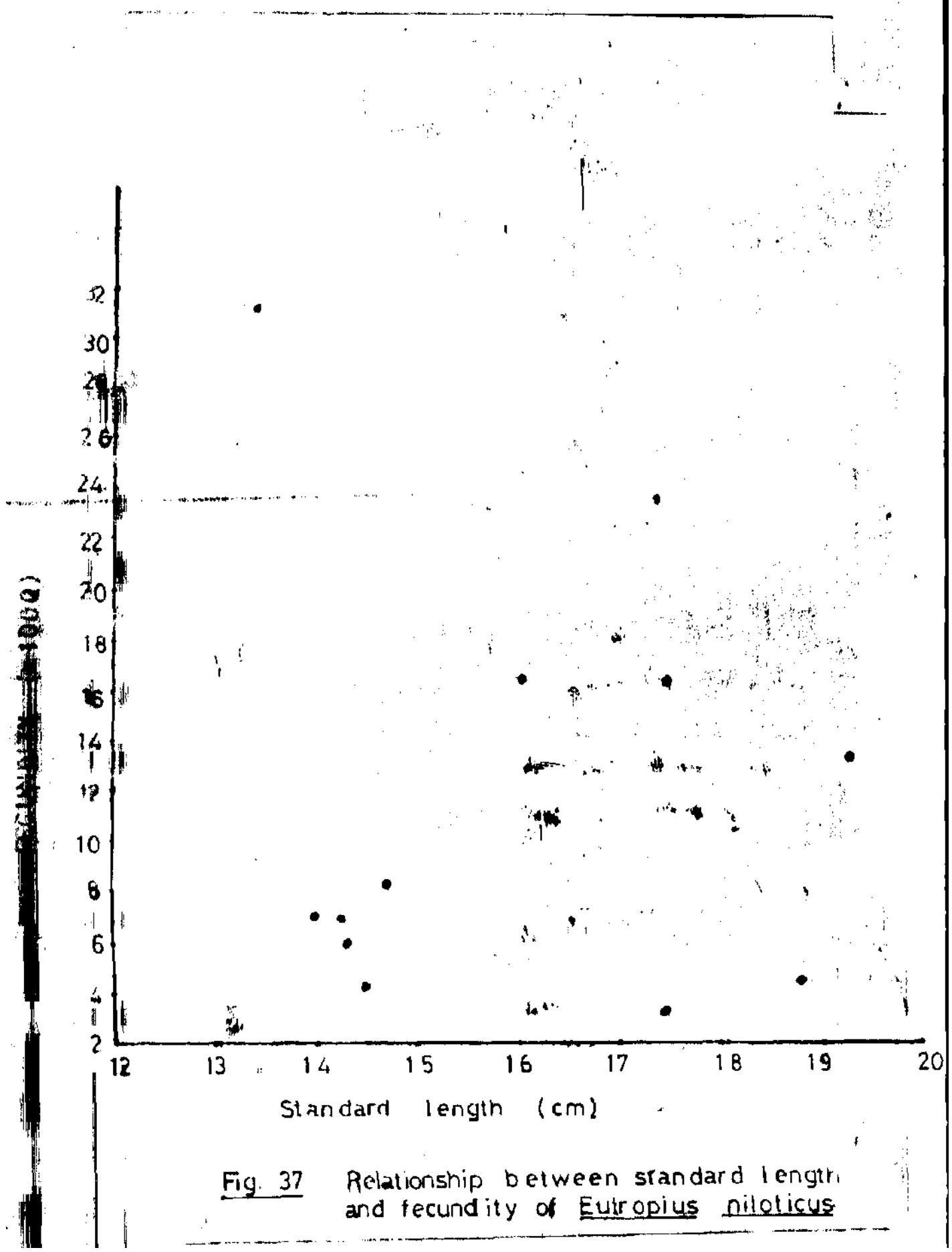


Fig. 37 Relationship between standard length and fecundity of Eutropius niloticus

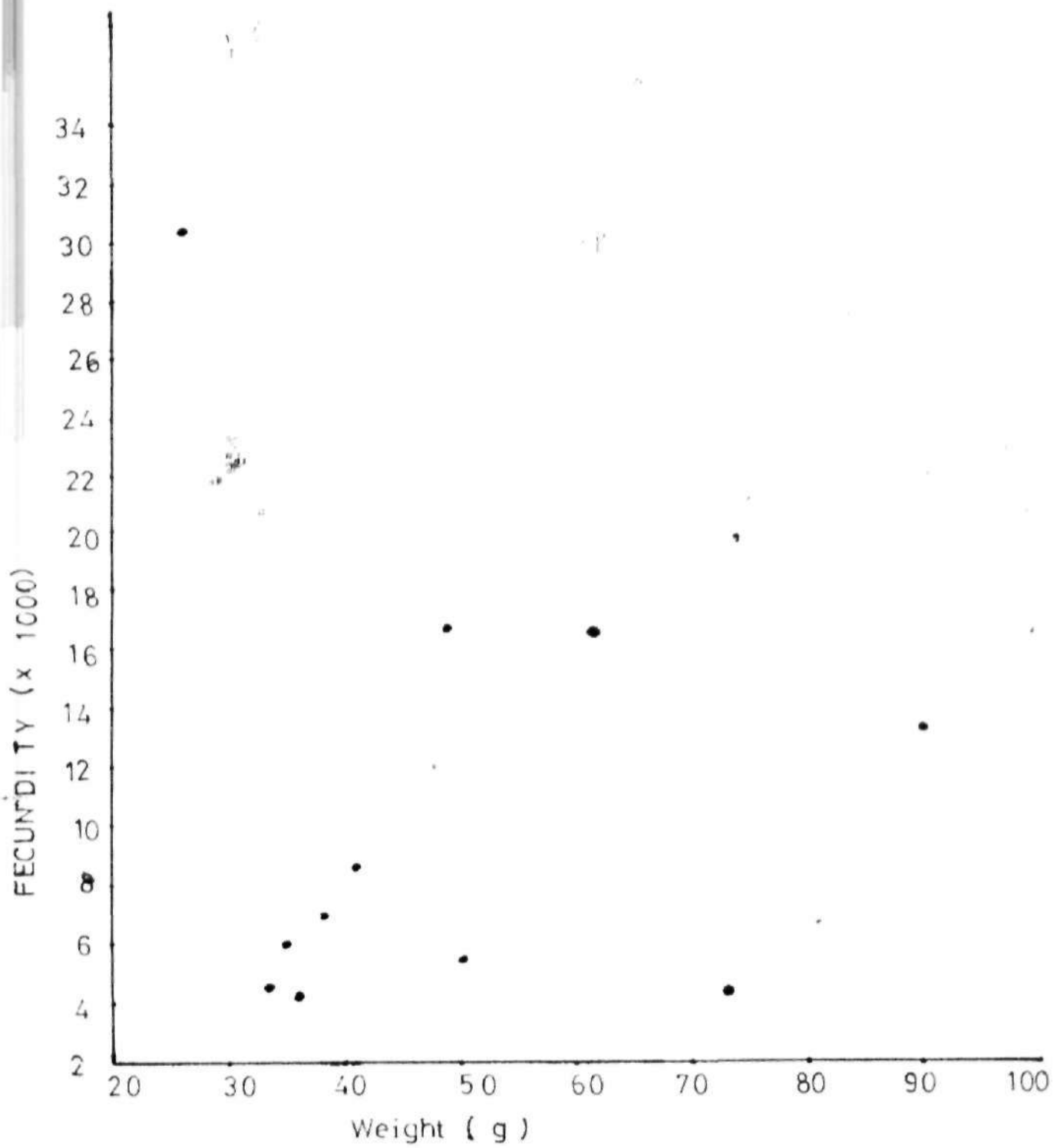


Fig. 38 Relationship between weight and fecundity of Eutropius niloticus

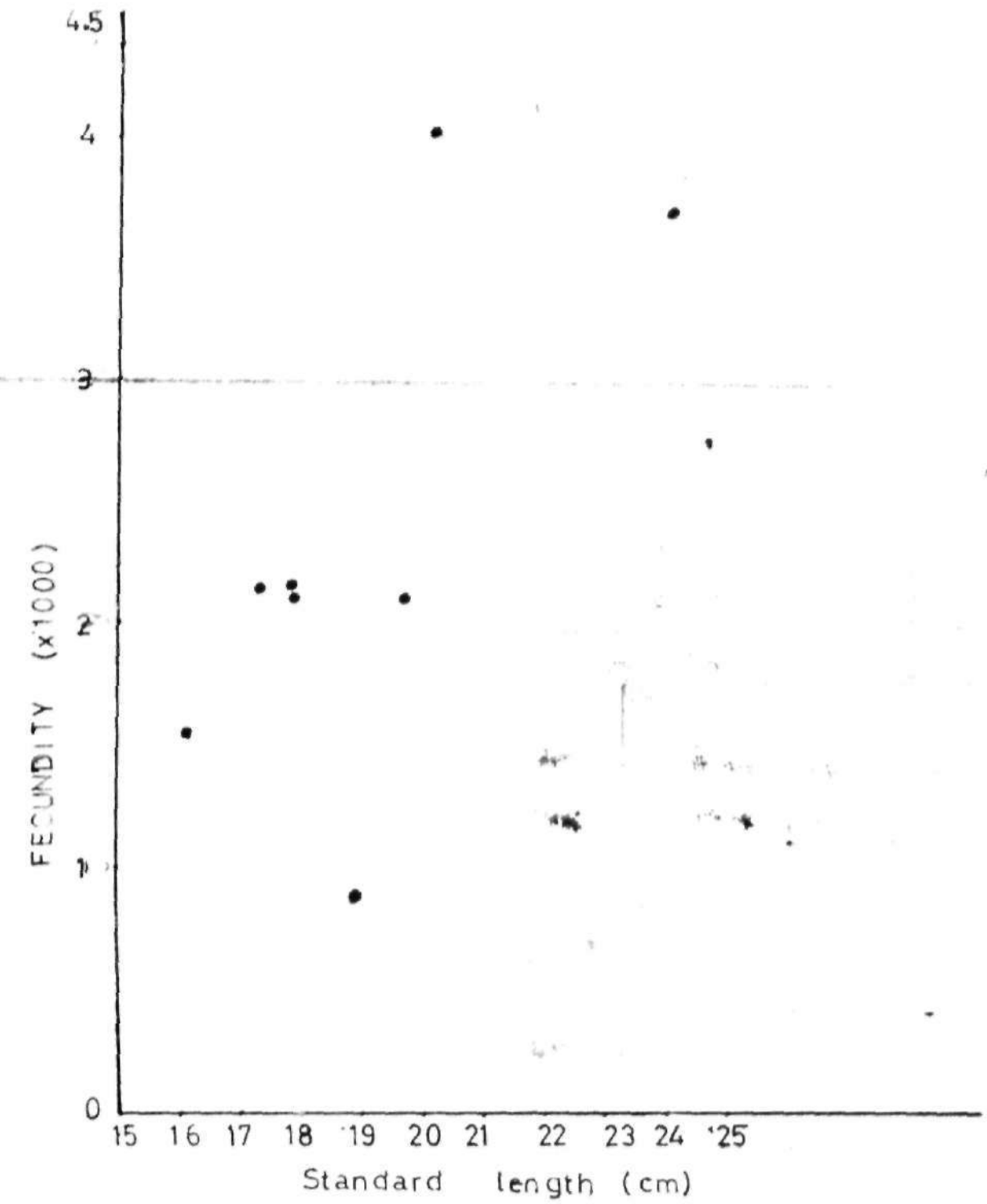


Fig. 39 Relationship between stahdard length and fecundity of Malapterurus electricus

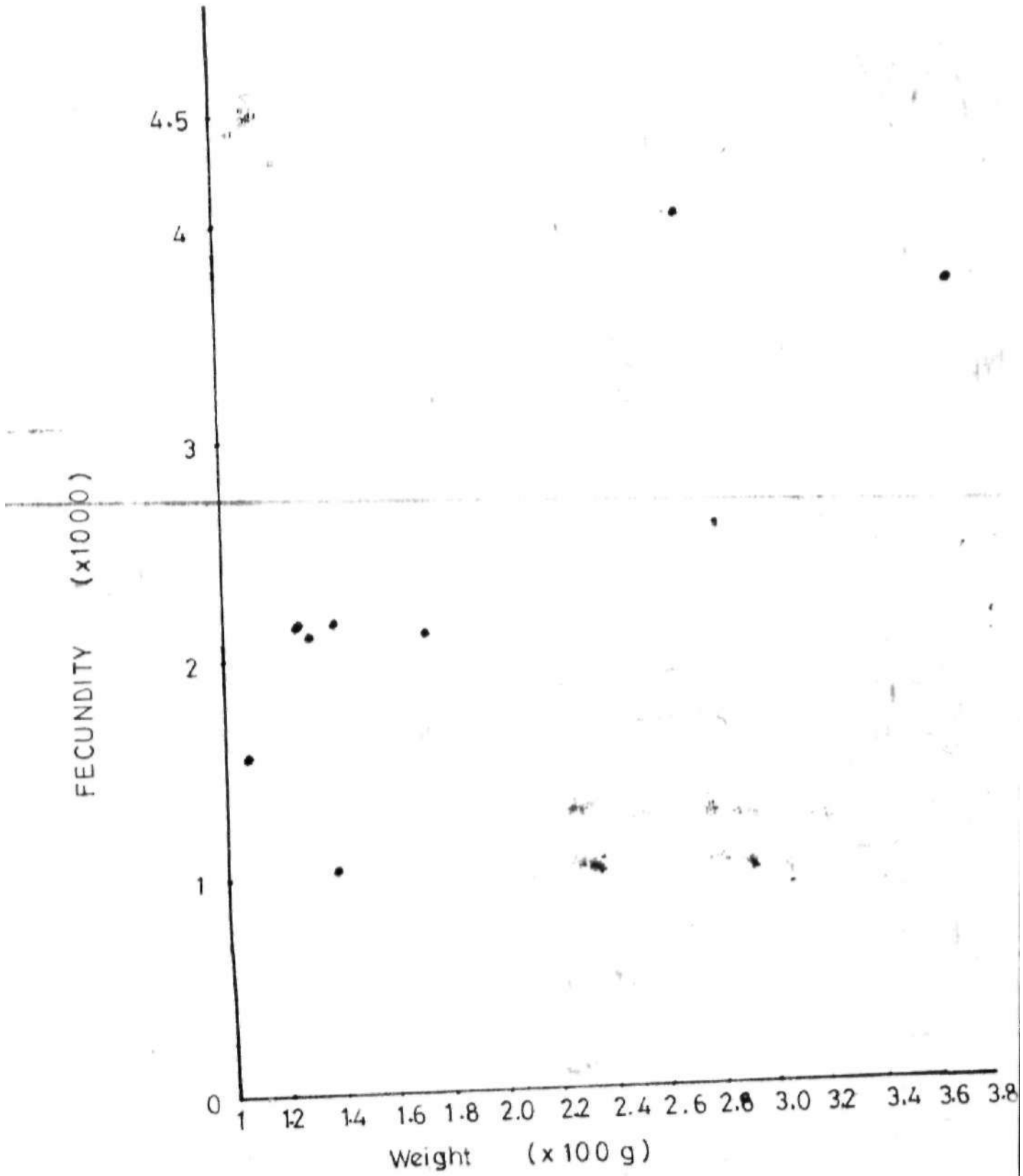


Fig. 40 Relationship between weight and fecundity of Malapterurus electricus

3.5.5 GONADO-SOMATIC INDEX AND INDIVIDUAL SIZE

The relationship between gonad-somatic index and standard length of the three species are given on table 37. The low values of correlation coefficient indicates that gonado-somatic index have no linear relationship with standard length. Appendices 8, 9 and 10 also showed that gonado-somatic index does not necessirily increase as the standard length increases.

Gonado-somatic index of various stages of gonad maturity of females of Schilbe mystus, Eutropius niloticus and Malapterurus electricus is given in table 38. The table showed a progressive increase in the mean gonado-somatic ratio from gonad maturity stage (1) to stage (IV) after which it started to decrease drastically to stage VI. The table also showed that, when gonads are fully matured, Schilbe mystus used the biggest proportion of its body weight in gonad development than any of the three species studied. Eutropius niloticus had the least gonado-somatic index.

Table 37

REGRESSION EQUATION DESCRIBING RELATIONSHIP BETWEEN LOG GONADO-SOMATIC INDEX AND STANDARD LENGTH OF FEMALE Schilbe mystus, Eutropius niloticus and Malapterurus electricus

Species	Number of fish	log a	'b'	coefficient of corrolation	Significance of 'r'
Schilbe mystus	324	31.39	11.10	0.12	NS
Eutropius niloticus	238	20.89	6.00	0.02	NS
Malapterurus electricus	67	12.67	2.27	0.12	NS

Table 38 Mean Gonado-somatic index (GSI) of the different stages of gonad development in females of Schilbe mystus, Eutropius niloticus and Malapterurus electricus.

Species	Mean gonado-somatic index ± SE of various Gonad Maturity stages						Total
	I	II	III	IV	V	VI	
Schilbe mystus	0.08±0.005	0.70±0.24	2.13±0.25	8.80±0.73	1.26±0.04	0.21±0.015	324
Eutropius niloticus	0.02±0.001	0.55±0.05	1.66±0.39	6.41±0.48	1.66±0.06	0.17±0.012	238
Malapterurus electricus	0.08±0.003	0.12±0.12	3.71±0.42	8.04±0.24	1.61±0.02	0.2±0.034	67

CHAPTER FOUR

DISCUSSION

In Zaria females of Schilbe mystus and Eutropius niloticus were larger than the males . In Malapterurus electricus, there was no statistical differences in size between males and females.

Females of some fish species usually grow larger than the males for instance, Qasim and Qayyum (1964) found such differences in Barbus, in siluroids such as Eutropius (Greoneward, 1964) and O latunde (1978) on Schilbeids of Lake Kainji.

Schilbe mystus was the most common of the three species studied in Zaria follwed by Eutropius niloticus. This contrasts with findings of Lewis (1974) and Blake (1977) in Lake Kainji, who recorded that Eutropius niloticus was more common than Schilbe mystus. Reed et al (1967) found that Schilbe mystus was more common than Eutropius niloticus. in the Northern part of Nigeria. The least common of the three species was Malapterurus electricus, which was recorded to be less common in Lake Kainji (Sagua, 1978). However as the analysis in this study was based on Market samples, the findings might not reflect exactly the true picture of a wild population because of reasons discussed elsewhere by Olatunde (1983). Such reasons may include:-

a) Type of fishing gears used for capture

b) Seasons of the year and time of the day of capture

c) Size selection with tendency of selecting larger or smaller sizes and

d) Structural and physiological adaptation which makes one fish more vulnerable to capture than others.

Length frequency histogram for the males and females of the three species were unimodal and showed normal distribution curves. This means that the fish worked on were of the same population or had one strong year class or age group. Sizes of Schilbe mystus worked on were smaller than Eutropius niloticus, this findings disagree with Olatunde (1979) who found that sizes of Schilbe mystus were larger than Eutropius niloticus in Lake Kainji.

The length-weight relationship for Schilbe mystus showed allometric growth pattern for both males and females. The low 'b' value for males showed that they had a smaller weight for their length. Contrary to case with the males, the females had a higher 'b' value. This could partly be explained by the fact that most of the females were large and some were already gravid. Gonad maturity stages have been found to influence the value of 'b' (Le Cren, 1951) and consequently might make some fish apprently heavier for their length. The pattern of growth in both Eutropius niloticus and Malapterurus electricus were isometric. Olatunde (1979) recorded isometretic growth in both Schilbe mystus and Eutropius niloticus in Lake Kainji. The result for Malapterurus electricus differed from Bello (1981) who reported allometric growth pattern for Zaria species. Aromire (1981) also noticed isometric growth for Eutropius niloticus of Zaria.

Condition factors for males and females of Eutropius niloticus and Schilbe mystus increased with increase in length. The reason for the increased could be

associated with the change of diet as the fish grows.

The objective of dietary studies are to understand how animal lived and grow, what food may influence their abundance and distribution and the relative quality of feeding condition. Food relationship also serve as a partial basis for determining the status of various predatory or competing animals.

Study of the food habit of three catfishes of Zaria, Schilbe mystus, Eutropius niloticus and Malapterurus electricus revealed that the three species were omnivorous in habit, but Schilbe mystus and Malapterurus electricus preyed more on fish than any other food item. In Eutropius niloticus, insects formed the major part of the food item studied. Irvine (1947) reported that the food of Schilbe mystus in East Africa consisted mainly of Cichlidae, whereas Bandon and Tayib (1953) stated that Upper Nile species were bottom feeders living on green mud, chironomid larvae, water bettle, cladoceran and rotifer. Other prevous account revealed that in Lake Albert, Schilbe mystus fed on a mixture of vegetables, young fish and insect larvae (Verbeke, 1959) while Corbet (1961) showed that Schilbe mystus (13cm-34cm) long in Lake Victoria were primarily piscivorous, although insects were also of some importance. These results compare favourably with that obtained for Schilbe mystus in Zaria. Corbet (1961) also reported that the important food item of Schilbe mystus in Rivers Kagera and Nzora (East Africa) were terrestrial insects, mainly Hymenoptera and fish. Imevbore and Bakare (1970)

and Olatunde (1979) observed that they were mostly piscivorous, and that insects were supplimentary food items. Studies on the seasonal variation of their food in Zaria revealed that they fed more on insects than on fish in the dry season. In the rainy season, the opposite was true when fish food item dominated the diet. This could mean that the most dominant food item in each season were the most vulnerable of the prey species or could as well mean that they were relatively more common at that particular time. When the diet was related to standard length of Schilbe mystus, the importance of fish in the diet increased with size, while contribution by insects decreased with increase in size. This could be explained by increased ability to consume larger prey as a result of increase in mouth gape and stronger jaws (Olatunde, 1979).

Pekkola (1919) reported that Eutropius niloticus was insectivorous in habit while Sandon and Tayib (1953) recorded small fish, insect larvae and crustacean as their main food. He also observed that young Eutropius niloticus (90mm - 180mm) fed mainly on fish such as Labeo Petrocephalus, Alestes as well as chironomid larvae, cladocerans and grasses. Olatunde (1978) revealed that in Lake Kainji, Eutropius niloticus had omnivorous habit, but fed more on insects than any other food item. The result of the last Author agreed with those of Eutropius niloticus in Zaria. The high percentage of digested material encountered in Eutropius niloticus might result from the fact that the food taken were soft and were easily digested. Arawowo (1976) also explained that fishes differed in their reactions to capture

in gill nets, that some species captured early in the evening digested a considerable part of their food before being removed from the gill net in the following morning. Digested materials were most encountered in Eutropius niloticus during the rainy season.

Coates and Atz (1962) commenting on the food of the electric catfish, Malapterurus electricus stated that it was reported as eating algae and fish while Segua (1979) reported that the fish was a voracious piscivore, feeding on Schilbeids, clupeids, cichlids and other available fish species. In Zaria, although fish was found to be the major food, insects, plant debris and organic materials contributed substancially to the total food items consumed. Organic materials contributed much to food seen in the stomach during the rainy season. This house hold food remains might have either been wash-off by rains into the river or as a result of the habit of people throwing their wastes into running stream and rivers during rains. Food items probably used as baits could as well be a reason for their presence in the stomach.

The percentage of Schilbe mystus and Malapterurus electricus with food in their stomachs were low. The reason for high percentage of empty stomachs might be that the fish were kept long enough in the gill net before being removed for examination. This was the view of Munro (1967) in East Africa and Arawomo (1976) in Lake Kainji, who observed that fishes captured early in the evening digested a considerable part of their food before being removed from

the gill net the following morning. This explanation preclude the fact that a high percentage of the fish were starving since these fish species were in good condition during the period of study. Another reason advanced for empty stomachs is reguigitation of food after capture by Olatunde (1979). Some of the fish with empty stomachs showed evidence of reguigitation, that is, everted stomachs and food remains in the mouth. Lagler (1962) reported that many predatory fishes appear to reguigitate the food in their stomach with ease because of the straited muscles, extending from Oesophagus to the stomach. Moreover, carnivores generally digest their food faster than the herbivores. Sagua (1979) also recorded that average of 35.8% of the specimen of Malapterurus electricus he examined had empty stomach.

The fact that most West African Freshwater Fishes breed during the local rains had been documented by Daget (1954); Reynolds (1974); Olatunde (1978), Otobo (1978) and a host of other workers. In Volta Lake, Reynolds (1974) reported that reproductive patterns of five species from three families of small pelagic fishes in the Volta Lake in Ghana showed several similar features. These included size difference, males maturing and reaching final stages smaller than the females, heterogenous sex ratio in four species, being most markedly unequal usually at the peak of breeding seasons and extended spawning patterns. Rinne and Wanjala (1983) in Lake Victoria reported that all the five species of catfish studied showed reproductive pause either prior to or following the long and short rains. Emere (1984) also reported that characids in Zaria breed

during the rainy seadon. In Zaria fully matured Schilbe mystus, Eutropius niloticus and Malapterurus electricus were either seen from April or May to September or October, which are the rainy months. The reproductive strategies for breeding during the rainy season could be synchronized with increase in food and protection for the young during this period (Imevbore and Baker, 1974) and enough spawning ground (Bank et al 1965; Blache 1964; Imevbore 1970; Motwani and Kanwai,1970). In Zaria the males of Schilbe mystus, Eutropius niloticus and Malapterurus electricus matured and grow to a final size smaller than females. Males maturing at a smaller size than females are seen frequently, for instance, Bhatt (1971) found such differences in Schilbe. Olatunde (1978) also noticed this trend among Lake Kainji Schilbeids. However, Matthes (1964) found no such size differences in Pellonuline clupeids of Lake Tumbar. Males grow slower and matured at a smaller size than females. Sex size difference usually reflect sexual differences in growth rate (Reynold, 1974). In Zaria, Schilbe mystus and Eutropius niloticus has a sex ratio favouring the females while in Malapterurus electricus, there was no sex ratio difference. The sex ratio of Schilbe mystus increased with increase in standard length usually in favour of the females. Males therefore have slower growth rate and, or shorter life span. Disparity in sex ratio of Schilbe mystus was most noticeable during the breeding season. Some of the samples collected at the peak of their breeding activities consisted of females alone. In Eutropius niloticus, sex ratio was more homogenous during the breeding season than any other time of the year. The drastic decrease in the number

of males during the breeding season could be as a result of differential mortality of the sexes due to the excessive energy lost by males during breeding. It could as well be due to increased predation of the smaller forms, predominantly males. Olatunde (1978) associated with the high sex ratio in Eutropius niloticus between August and November with breeding activities and explained that during the breeding season more females were expected to associate with males, particularly in a situation where there are few males in the population. He however found high sex ratio in Schilbe mystus during the non-breeding season. He reasoned that it might be associated with sampling variations or with behavioural pattern of the fish which might be different from Eutropius niloticus.

Fecundity study of the three species indicated that Schilbe mystus was the most fecund compared to Eutropius niloticus and Malapterurus electricus. Comparison of the fecundity of some fish species studied in Zaria with Schilbe mystus, Eutropius niloticus and Malapterurus electricus showed that Schilbe mystus and Eutropius niloticus were more fecund than any other five species recorded in Zaria (table 39). When the fecundity of Zaria Schiblbeids were compared with those of Lake Kainji Schilbeids, Eutropius niloticus in Zaria were less fecund, while Schilbe mystus in Zaria carried more eggs than Kainji species. Comparison of Malapterurus electricus of Zaria with those of other water bodies was not possible because records of their fecundity were not known. Sagua (1976) however estimated the fecundity of two specimens from Lake Kainji and obtained a fecundity range of 16,000 to 30,000 for a specimen of 57cm total length, 22kg and 80cm, 7.8 kg respectively. Fecundity of other fish species outside Zaria are also given on table 39 for comparison.

Table 39 FECUNDITY OF Schilbe mystus, Eutropius niloticus and Malapterurus electricus IN ZARIA AND SOME OTHER FISH SPECIES

Species	number examined	standard length range (cm)	Range of fecundity estimate	Mean fecundity	sources
Schilbe mystus	59	10.1-19.8	315-60,203	10,676	In this study
Eutropius niloticus	11	13.4-19.4	3,328-31,183	10,530	"
Malapterurus electricus	8	16.1-24.1	902-4,003	2,331	"
Schilbe mystus	2	27.0-28.4+	41,530-53,750	47,640	River Niger(Imervbore, 1970)
Synodontis batensoda	5	15.0-18.2	6,850-20,400	-	Lake Kainji(Willoughby, 1974)
Synodontis schall	99	15.0-26.0	7,130-73,000	-	"
Synodontis nigrita	35	10 - 13.5	952-11,400	-	"
Synodontis membraraceous	8	29-31.9	33,700-179,000	-	"
Siluranodon auritus	14	9.0-11.2	1,249-1,655	-	Lake Kainji(Olatunde, 1978)
Physailia pellucida	15	6.2-11.6	1,204-3,923	-	"

cont'd on p123

Table 39 cont'd

Species	number examined	standard length range (cm)	Range of fecundity estimate	Mean fecundity	Sources
Eutropius niloticus	9	17.0-21.1	13,905-21,841	-	Lake Kainji(Olatunde, 1978)
Schilbe mystus	2	16.5-16.6	9,037-9,088	9,063	"
Pellonula afzeliusi	185	2.8-6.5	140-4,900	871	Lake Kainji(Otoba,1978)
Sierrathrisa leonensis	139	1.8-2.8	94-2,595	313	"
Sarotherodon niloticus			426-824	569	Zaria(Elakhame,1983)
Hemichromis faciatus	1	-	-	1,382	"
Sarotherodon galli			2,180-6,225	4,031	"
Alestes nurse	21	10.5-13.5	914-16,667	6,835	Zaria(Emere,1984)
Alestes macrolepidotus	10	12.5-17.0	1,138-8,923	5,981	"

SUMMARY AND Conclusion

A total of 873 specimens were studied in Zaria between January, 1984 to December, 1984. 390 were Schilbe mystus, 366 Eutropius niloticus and 117 Malapterurus electricus. Species abundance and size distribution studies based on market samples revealed that Schilbe mystus was the most abundant of the three species, followed by Eutropius niloticus and Malapterurus electricus. All the species were relatively more common during the rainy season than in the dry season..

Length distribution of all the species showed a unimodal normal distribution. Both Eutropius niloticus and Malapterurus electricus had isometric pattern of growth, while Schilbe mystus grew allometrically.

All the species were in good condition throughout the study period. The differences between the males and females in the condition factor in all the species were not significant.

In Schilbe mystus, the main food item was fish. Piscivorous habit was also noticed in Malapterurus electricus, whiel Eutropius niloticus fed more on insects than any other food item. Fish became more important in diet as all the three species increased in size.

Heterogenous sex ratio was observed in Schilbe mystus 1:5 females and Eutropius niloticus 1:2 females. Malapterurus electricus had even sex ratio 1:1 female. The males matured at a smaller size than the females, Males of Schilbe mystus, Eutropius niloticus and Malapterurus electricus matured at a minimum size of 10.1cm, 11.6cm and

15.6 cm respectively while the corresponding values for the females were 10.1cm, 12,2 cm and 16.1cm respectively.

Schilbe mystus was the most fecund (10,676) followed by Eutropius niloticus (10,530) and Malapterurus electricus (2,331) in that order.

This work could be built upon by future Researchers. Some of the areas that need further Scientific information are listed below:-

1) The intensity and possible uses of electric current generated by Malapterurus electricus as well as isolation, seperation extraction and indentification of their medicinal chemical components which are believed to be of importance in traditional medicine, and;

2) the suitability of the three species for aquaculture and ways of improving on their negative aquacultural qualities, for instance, small sizes of Schilbeidae and their slow growth rate. The possibility of using Malapterurus electricus and Schilbe mystus to control Tilapia in over crowed ponds could also be looked into. Future workers should as well try to collect their samples directly from the wild by using various fishing gears and mesh sizes to reduce error that might result from market samples.

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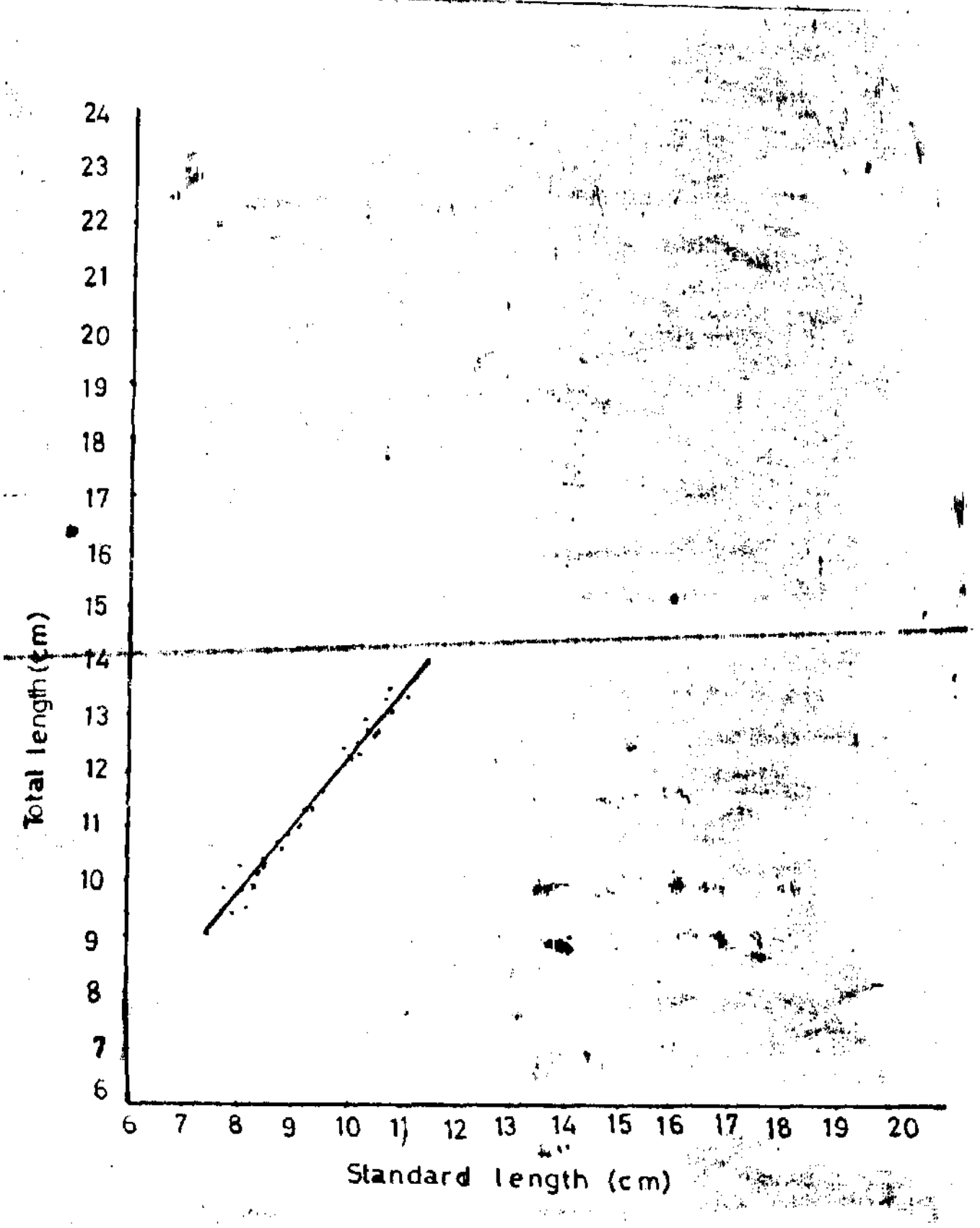
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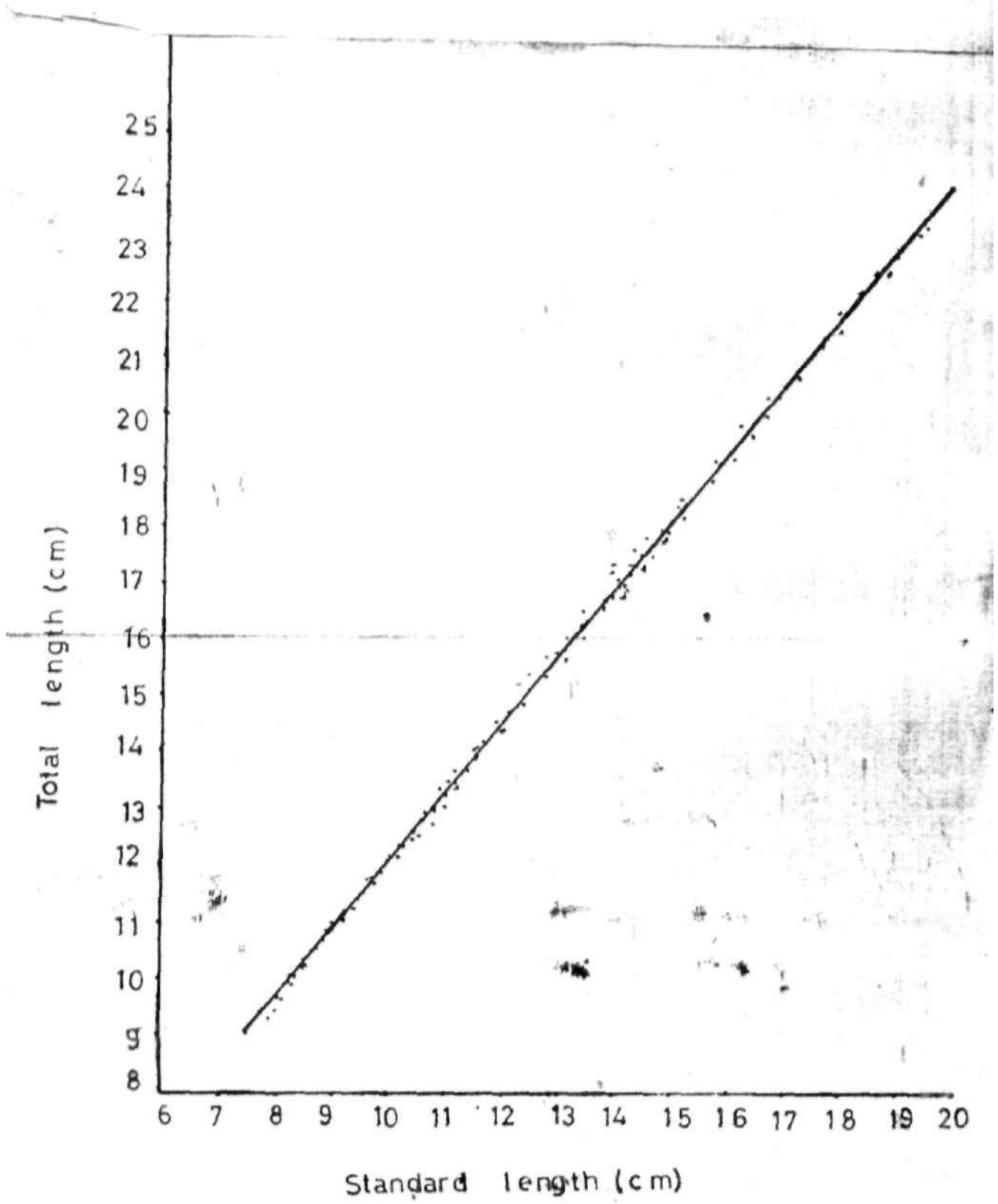
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Appendix 1: Standard length - Total length regression analysis of males and females of Schilbe mystus, Eutropius niloticus and Malaptururus electricus

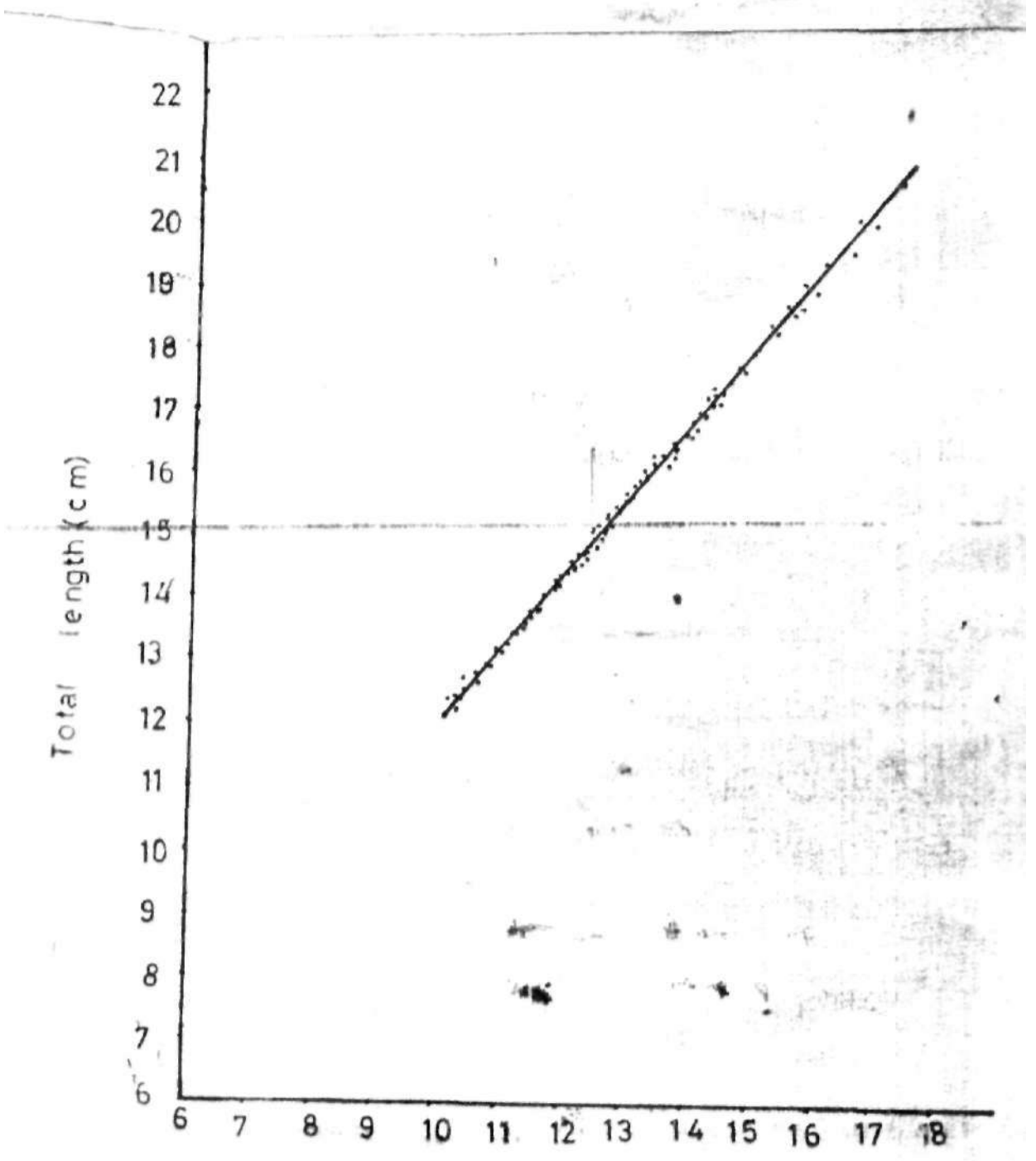
Species	No of fish examined	Intercept 'a'	Exponent 'b'	Corrolation coefficient 'r'	Significance of 'r'
Schilbe mystus					
Males	66	-0.1 *	1.226	0.99	<.001
Females	324	0.2	1.23	1.00	<.001
Eutropius niloticus					
Males	128	0.5	1.2	0.96	<.001
Females	238	0.37	1.27	0.98	<.001
Malapterurus electricus					
Males	50	0.5	1.15	1.0	<.001
Females	67	0.4	1.21	0.85	<.001



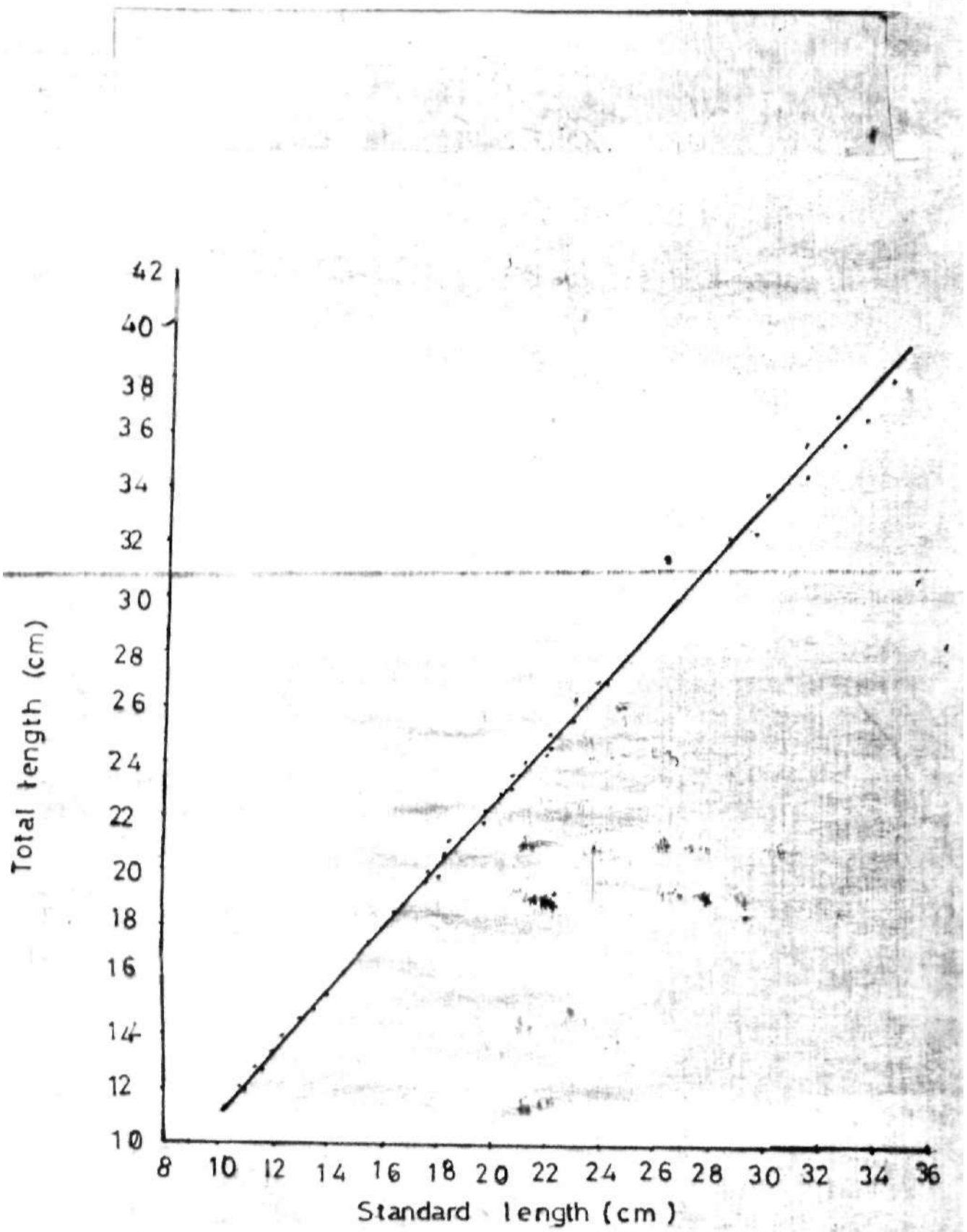
Appendix 2: Standard length-total length relation of males Schilbe mystus



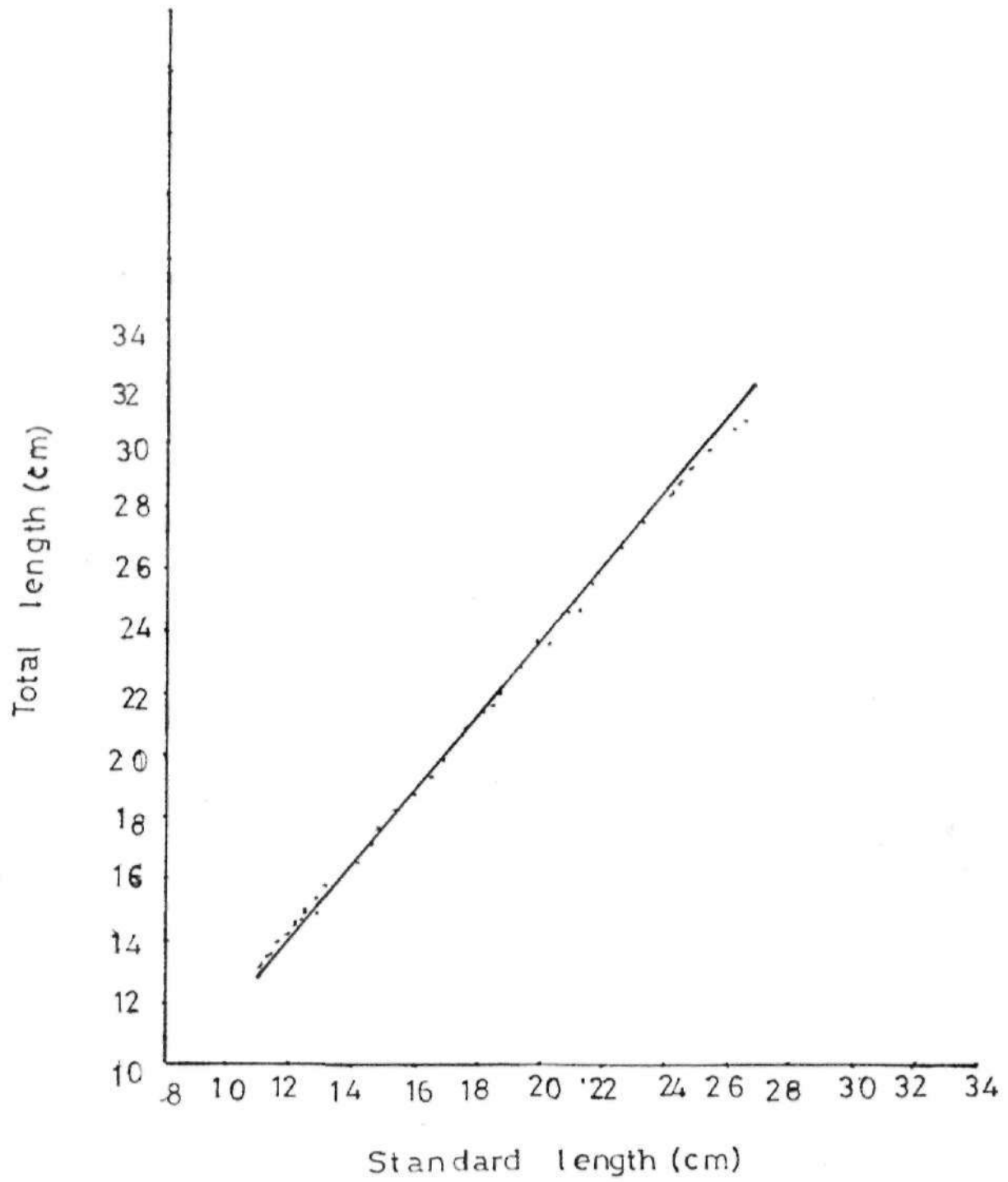
Appendix 3: Standard length- total length relation of female Schilbe mystus



Appendix 4 Standard length- total length relationship of male Eutropius niloticus



Appendix 6: Standard length-total length relationship of male Malapterurus electricus



Appendix 7: Standard length-total length relationship of female Malapterurus electricus

Appendix 8 : Fecundity of Schilbe mystus in Lurin.

Standard length (cm)	Fish weight (g)	Gonado-somatic index	Total dried egg weight (g)	Fecundity
10.1	21.1	14.7	0.929	9,150
10.4	15.9	7.2	0.168	2,616
10.5	15.3	1.9	0.091	367
10.6	16.7	6.7	0.100	878
10.6	14.5	2.4	0.050	1,235
10.7	14.3	1.6	0.027	315
10.9	19.1	2.9	0.115	2,012
11.0	15.5	4.4	0.078	1,200
11.1	16.4	3.7	1.67	832
11.2	19.7	17.9	1.064	8,870
11.2	20.4	16.6	1.152	11,998
11.4	19.5	2.1	0.083	235
11.5	21.2	2.5	0.085	1,307
11.5	21.9	5.6	0.325	11,811
11.5	15.5	4.5	0.817	8,208
11.6	19.8	9.5	0.578	6,804
11.6	22.7	6.7	0.417	4,547
11.6	18.7	4.9	0.199	1,560
11.7	20.1	3.5	0.138	1,758
11.8	18.7	6.2	0.286	2,115
11.8	20.3	15.0	1.095	17,512
11.9	20.7	4.3	0.223	2,364
12.1	23.8	9.5	0.585	18,558
12.2	26.9	2.7	0.085	946
12.3	26.39	1.4	0.015	452
12.3	29.3	4.1	0.286	2,828
12.4	28.9	4.8	0.298	3,721
12.4	27.1	9.6	0.814	9,386
12.7	27.7	6.5	0.402	17,295
12.7	29.1	9.9	0.917	8,221
12.8	29.4	19.8	1.909	16,526
12.9	27.7	12.8	0.965	9,062
13.0	26.2	8.6	0.594	6,818
13.1	28.3	9.0	0.166	1,314

Appendix Table. Fecundity of Schilbe mystus in Zaria.

Standard length (cm)	Fish weight (g)	Gonado-somatic index	Total dried egg weight (g)	Fecundity
13.1	31.9	6.0	0.382	4,311
13.1	28.8	3.0	0.138	2,147
13.2	30.9	19.4	1.889	19,175
13.2	28.9	2.8	0.154	1,776
13.3	31.1	4.2	0.281	3,969
13.3	30.3	7.8	1.166	10,700
13.4	34.0	11.3	1.646	10,512
13.5	35.2	12.8	1.282	17,923
13.5	33.1	7.0	0.586	4,307
13.5	38.3	22.1	2.674	23,252
13.5	32.5	17.3	1.808	20,091
13.7	33.6	4.8	0.428	4,918
13.8	34.8	4.1	0.296	3,534
13.8	37.5	20.0	2.525	21,580
14.1	34.9	9.5	1.023	30.978
14.2	34.7	7.2	0.713	5,093
14.2	39.0	12.1	1.417	16,199
14.4	41.1	11.7	1.369	16,852
14.7	41.7	4.0	0.365	11,058
14.9	44.5	10.0	1,273	12,604
15.6	64.6	12.1	2.615	28,119
15.8	51.6	15.0	2.382	23,818
16.9	87.3	24.1	7.074	60,203
17.0	78.0	16.0	3.701	37,382
19.8	141.7	10.1	4.661	46,839
Number of fish 59	59	59	59	59
Range 10.1-19.8	14.3-141.7	1.4-24.1	0.015-7.074	315-60,203
Mean 13.8	31.8	8.19	0.965	10,676
Standard error 0.62	0.61	0.61	0.163	1,550

Appendix 9: Fecundity of Lutropius niloticus in Zaria.

Standard length (cm)	Fish weight (g)	Gonado-somatic index	Total dried egg weight (g)	Fecundity
13.4	26.8	0.86	3.578	31,183
13.9	33.3	7.42	0.717	4,525
14.3	37.6	7.92	0.886	6,935
14.3	34.8	7.48	0.758	5,993
14.5	35.97	5.12	0.605	4,259
14.7	**38.5**	**6.41**	**0.722**	**8,394**
16.2	46.9	15.4	2.271	16,579
17.3	50.2	3.19	0.284	3,328
17.5	62.0	10.3	2.178	16,534
18.7	73.0	2.58	0.421	4,436
19.4	90.8	1.391	1.391	13,668
Number of fish	"	"	"	"
Range 13.4-19.4	26.8-90.8	0.86-15.4	0.284-3.578	3,328-31,183
Mean 15.84	48.17	5.12	1.258	10,530
Standard error 0.63	5.91	0.86	0.306	2,542

Table 6: Fecundity of Malapterurus electricus in Zaria

Standard length (cm)	Fish weight (g)	Gonado-somatic index	Total dried egg weight (g)	Fecundity
16.1	108.2	13.13	2.914	1,548
17.3	125.9	0.55	1.208	2,148
17.8	138.3	11.95	1.922	2,135
17.9	132.6	12.14	2.43	2,100
18.9	141	0.32	1.25	902
19.7	184.9	9.19	2.533	2,101
22.7	269.0	10.12	7.843	4,003
24.1	369.5	6.9	6.767	3,710
Number of fish 8	8	8	8	8
Range 16.1-24.1	108.2-369.5	0.55-13.13	1.25-7.843	902-4,003
Mean 19.3	163.68	8.04	3.370	2,331
Standard error 0.98	32.0	2.07	0.889	970.2