SOME ASPECTS OF THE BIOLOGY OF THE FAMILY CHARACIDAE IK ZARIA

BY

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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.

Signed by the author



M. C. AMERE
(AUTHOR)

DEDICATION

To my parents Chief and Mrs Emere
who have spurred me on in life.

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I owe profound gratitude to my supervisor, Dr. A.A. Olatunde for supervising the work from the beginning to the end and also for his immense help and guidance.

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A B S T R A C T

Some aspects of the biology of the family Characidae in

s studied between the months of March and December,

3. Commercial fish landings in the market were the main source of the fish samples which were collected once or twice weekly. Only two genera of the family Characidae were found in the samples. The genus Hydrocynus (the Tigerfish) was represented by the species Hydrocynus vittatus Castelnau while the genus Alestes was made up of two species namely Alestes nurse Ruppell and Alestes macrolepidotus Cuvier and Valenciennes.

Alestes nurse was the most abundant species of the family Characidae in Zaria followed by Alestes macrolepidotus. The rarest was Hydrocynus vittatus.

The size distribution showed some marked differences

ween the males and females of the same species. The mean condition factor was determined for the various species and was found to be high throughout the period of investigation, The fishes exhibited some diversity in their feeding habits and also fed on a variety of food items. They were all pelagic feeders. Hydrocynus vittatus was principally a piscivore. Alestes macrolepidotus and Alestes nurse were omnivores feeding principally on plants, insects and detritus.

The length-weight regression analysis showed isometric growth for all the species except for Alestes nurse.

The sex ratio showed that there were more females than males in all the species. The fecundity of the species was found to be high. The maximum number of eggs recorded for Alestes nurse was 16,667 while that of Alestes macrolepidotus was 8,923.

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CHAPTER ONE

INTRODUCTION

The estimated world production of fish has more than doubled in the last two decades from less than twenty million metric tons in 1948 to over fifty million tons in 1965 (F.A.O. 1966). In the early 1950's the total world catch of fish was around twenty million metric tons, followed by forty million tons in 1960 and reached more than 60 million in 1970. This increase means that fish are making an increasingly important contribution to the world's food supply; particularly of animal protein.

In the world as a whole fish contribute about ten percent of the total animal intake but considerably more in some areas such as the far East. Fishes have been important as human food from the time of the Paleolithic man, who left fish bones in his "kitchen middens", to the present day.

Fish is of major importance to man not only because of man's mere preference but also because of its excellent food constituents essential for human health compared to land livestock foods which contain highly saturated fatty acid composition and a large amount of cholesterol. An increasing proportion of the total catch is not used directly for human consumption, rather it is converted to fish meal which is used for a variety

of livestock feeds and fertilizers.

The flesh of most fishes contain 13 to 20 percent (Benton,1973) of protein and also has a food value of 300 to 1,600 calories per kilogramme depending on the oil content. Crude fish oils are used in paints and insecticides. Refined oils from livers of cod and other species comprise a concentrated source of vitamin D. Liquid glues are rendered from heads and trimmings of fishes. Sports fishing is an outdoor recreation for thousands of persons and also a source of food. Some fish such as the Top minnow (Gambusia affinis) has been propagated and distributed widely to aid in control of malaria.

The fisheries industry in Nigeria is still at the traditional level. Nigeria is the largest consumer of fish and fish products in Africa. (Iyamabo, 1980). The domestic production of fish was only about 50 percent of our national demand. With an animal population growth of about 2.5 percent per annum the demand for fish is definitely going to rise (Adegboye,1982). Only about 167,000 metric tons of fish are produced annually by the thirteen inland states in Nigeria.

Protein deficiency is the major form of malnutrition in Nigeria and this results in "Kwashiokor".

Recent surveys have indicated that over 40 percent of the proteins consumed by Nigerians originate from fish and fish products. While Nigerians consume a million metric tonnes of fish per annum they produce only half of that amount, Fish imports make up for the remaining half a million metric tonnes of fish that is consumed.(Adegboye and Oniye 1982). The annual consumption value of fish in Nigeria is estimated to be about ₦2.1 billion (Fed. Dept. of Fisheries 1984) The rational exploitation of our fisheries could go a long way to offset the foreign exchange costs and could also lead our many fishermen to a more prosperous life and a respected place in society. Fish is a highly nutritious food and a larger local production of it at cheaper prices could also benefit the health of many of our people.

The increased catches due both to increased local fishing and especially the rapidly increasing vessels have intensified the problems of overfishing and the possible need for regulation and management to make the best use of the resources. A very good biological knowledge of the species of fish is therefore necessary in order to evolve good management practices.

The importance of fish in Nigeria has been shown by the different studies carried out by different scholars. Webb and Hill (1958) had studied the ecology

of the Lagos Lagoon while Williams (1962) studied the seasonal distribution of the teleost fish fauna in the Lagos harbour, creek and Lagoon in relation to salt tolerance. Reed et al (1967) had studied the fish and fisheries of Northern Nigeria while Bakare (1968) studied the food and feeding habits of the non-cichlid fishes of the middle-Niger with particular reference to the Kainji Reservoir basin. Fagade (1969) studied the biology of some fishes of the Lagos Lagoon, while Imevbore (1970) made some preliminary observations on the sex ratios and fecundity of the fish in River Niger. Fagade and Olaniyan (1972) studied the food and feeding interrelationship of the fishes of the Lagos Lagoon. Tobor (1972) studied the food and feeding habits of some Lake Chad commercial fishes. Lewis (1973) studied the effects of the formation of Lake Kainji upon the indegenous fish population while Johnson (1973) made observations on Tilapia galilaea in lake Kainji. Otobo (1974) studied the potential for clupeid fishery in Lake Kainji while Arawomo (1976) studied the food and feeding of three Citharinus species in Lake Kainji. Akintunde (1976) studied the biology of Tilapia and Sarotherodon species in Lake Kainji while Adebisi (1978) studied the ecology, growth and reproduction of the fishes of upper Ogun River. Olatunde (1978b) studied

sex, reproductive cycle and variations in the fecundity of the family Schilbeidae in Lake Kainji. Olatunde (1979a) studied the age determination and growth of Eutropius niloticus and Schilbe mystus in Lake Kainji. Also Olatunde (1979b) studied the food and feeding habits of Physalia pellucida and Schilbe mystus in Lake Kainji.

The characins compose the large freshwater family of several hundreds of species (Lagler 1952). They are widely distributed in South America and a few dozen species occur North of the Isthmus of Panama. Only one, the banded tetra is found in Texas and New Mexico. (Lagler 1952).

The Characins have elongated fusiform bodies usually silvery in colour and covered with cycloid scales but there are no scales on the head. The jaws have well developed teeth especially in Hydrocynus species all of which have large mouths, with the single row of large pointed teeth in each jaw being razor-sharp on both edges.

These teeth which can be seen even when the mouth is closed has earned them the appropriate common name, Tigerfish. This feature distinguishes them from all other African fresh water fishes. Their flesh is white and tasty but the numerous fine and sharp bones make them bothersome to eat. Their flesh also is dry,

not oily and has excellent keeping qualities for smoking.

The family Characidae is numerous in Zaria and make up an important part of the commercial catch (Reed et al 1967).

In Tropical Africa the genus Alestes is widely distributed and is found in countries like Cameroon, Senegal and Nigeria. They also occur in large Rivers and Lakes such as the Nile and Lake Victoria respectively (Irvine 1947, Reed et al 1967). Hydrocynus is found in Nile systems and from Ghana to Congo.

Apart from the brief mention of the physiology, quality of food consumed and their location in terms of habitat (Reed et al, 1967 and Irvine 1947) little or no report has been written on the biology of Family Characidae in West Africa.

Reed et al (1967) working on the fishes of Northern Nigeria has recorded that the family Characidae is represented by three genera and fifteen species. The genera include Hydrocynus, Micralestes and Alestes. Graham (1929) had studied the food of Alestes jacksoni Boulenger in Lake Victoria. Worthington (1929) has made a survey of the fishes including Alestes macrolepidotus Cuvier and Valencinnes of Lakes Albert and Kioga. McCormick (1949) has studied Hydrocynus vittatus as one of the game fishes of the world. Jubb (1952) studied the

distribution of Hydrocynus vittatus Castelnau, the well known tigerfish of the Zambesi and Limpopo Rivers. Greenwood (1959) worked on the Characin fishes of Lakes Victoria and Kyoga. Bellcross(1960) stuidied the migr tion of Hydrocynus vittatus Castelnau upstream during the Rains in a Northern Rhodesian River. Corbet (1961) worked on the food of Alestes jacksoni in Lake Victoria. Jackson (1961) studied the impact of predation especially by the tigerfish Hydrocynus vittatus Castelnau on African freshwater fishes. Lagler et al (1962) studied the digestive processes of Hydrocynus vittatus Castelnau while Matthes(1968) studied the food and feeding habits of the tigerfish Hydrocynus vittatus Castelnau in Lake Kariba. Whitehead (1969) studied the food of Alestes nurse Ruppell. Holden (1970) studied the feeding habits of Alestes baremose and Hydrocynus forskahlii in Lake Albert, East Africa. Graigher (1970) stuided the ecology of the tigerfish, Hydrocynus vittatus Castelnau and the feeding habits of the various species of Hydrocynus in the Incomati River System. Balon (1971a) has studied the replacement of Alestes imberi Peters by Alestes lateralis Boulenger in Lake Kariba. Also Balon (1971b) stuided the age and growth of Hydrocynus vittatus Castelnau in Lake Kariba.

Reynolds (1973a) worked on the biology [illegible] of four species of Alestes (Characidae) in the New Volta Lake in Ghana. Petr (1974) studied the distribution,

abundance and food of the family Characidae in the Black Volta and the Volta Man-made Lake in Ghana during the filling up period.

In the Northern part of Nigeria of which Zaria is included there are about nine species of the genus Alestes (Reed et al 1967) These are:-

Alestes longipinis Gunther

Alestes baremose Joannis

Alestes chaperi Sauvage

Alestes dentex senthente Cuvier and Valenciennes

Alestes brevis Boulenger

Alestes leuciscus Gunther

Alestes imberi Boulenger

Alestesmacrolepidotus Cuvier and Valenciennes and

Alestes nurse Rupnell

The genus Hydrocynus is represented by four species These are:

Hydrocynus brevis Gunther

Hydrocynus somonorum Daget

Hydrocynus vittatus Castelnau and

Hydrocynus forskahlii Cuvier

In Nigeria, Afinowi (1973) studied the pattern of fat deposit in Alestes dentex Cuvier and Valencienues and Alestes baremose Joannis. Lewis (1973) studied the food and feeding habits of

Hydrocynus forskahlii Cuvier and Hydrocynus brevis Gunther in Lake Kainji. Talabi (1973) has studied the chemistry of Alestes species while Adegboye et al (1983) has recorded Alestes species as one of the commonest species in the catch of the local fishermen of the Niger -Benue River system.

The aim of this study is to investigate some aspects of the biology of the family Characidae in Zaria, Nigeria. Since little or no previous work had been done on this family in Zaria, it is hoped that this study will help in throwing light to the biology of this species in Zaria.

The following areas were investigated.

(a) The length-weight relationship

(b) The food and feeding habits

(c) Sex, fecundity and reproductive cycle

(d) Condition factor

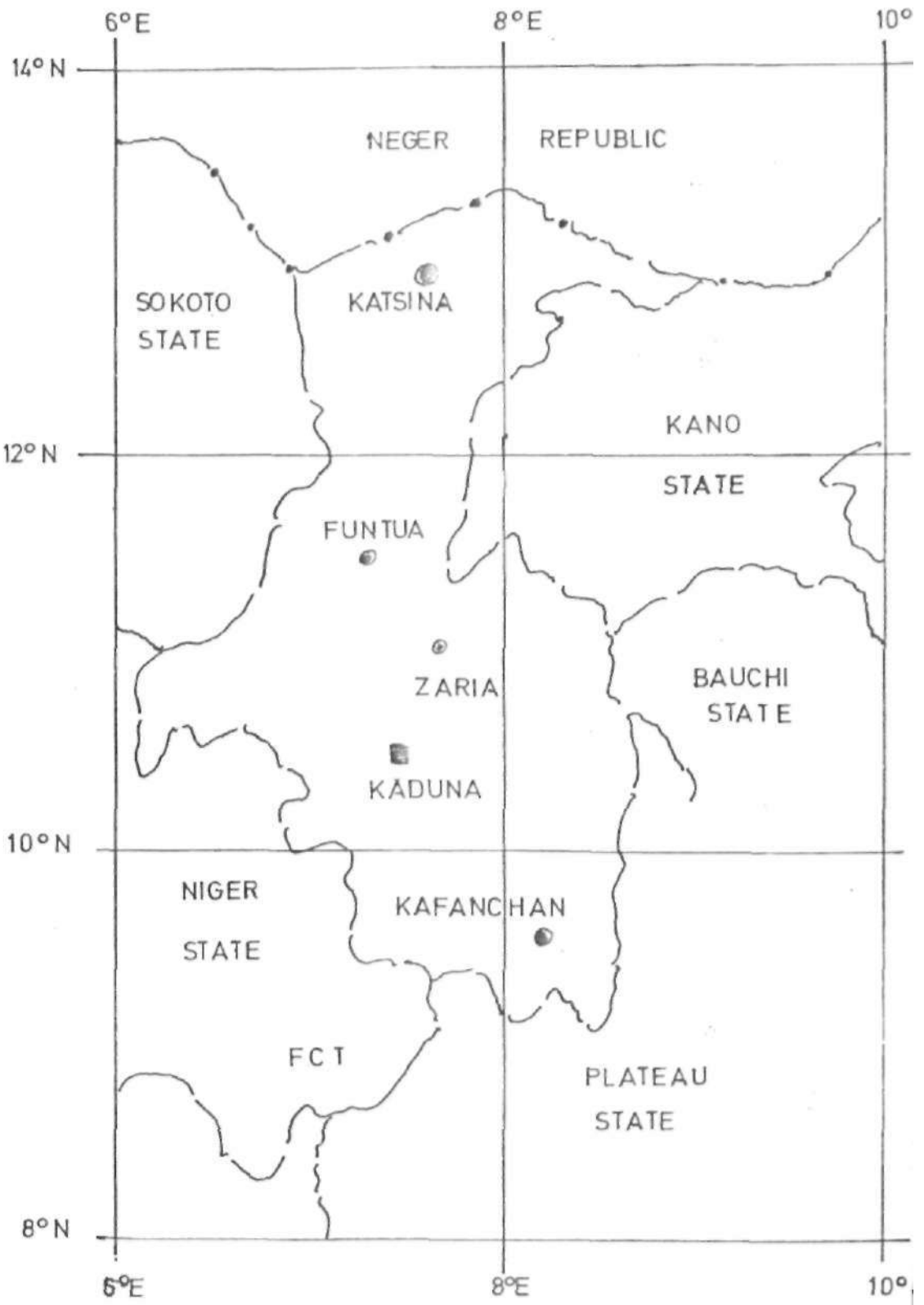


FIG. 1 SCALE: 1 : 64·37 KM

MAP OF KADUNA STATE SHOWING STATE BOUNDARIES.
Nigeria – Political (1967) Fed. Surveys
Information Macmillan Education Ltd.

CHAPTER TWO

MATERIALS AND METHOD

2.1. STUDY AREA

Zaria town, a city in Kaduna State of Nigeria is located on longitude 7^{o} 42'E and latitude 11^{o} 03'N. In Zaria there are two major seasons namely the dry and rainy (wet) seasons. The rainy season starts in May and lasts up to September or early October. The dry season is from October to March or early April.

2.2. SUBJECT OF STUDY

Fresh fish samples were bought from the Sabon Gari market in Zaria from March 1983 to December 1983 once weekly. The number of the different fish species bought depended on the number available in the market at the time of the visit. Information collected from the fish mongers and the fishermen showed that the fish specimens were caught from River Galma (Figure 2). It was also gathered from the local fishermen during the course of several interviews that the gears they used included Hook and line clap nets, gill nets, cast nets, pots and seine nets. They had stretched mesh sizes which varied from 20mm to 45mm or 50mm. Fish samples were carried in polythene bags to the laboratory for analysis.

2.3. LABORATORY MEASUREMENTS

Using the key prepared by Holden and Reed (1972) and Lewis (1974) the fish species were identified. Different measurements were made on each specimen as followes:-

(a) LENGTH:

Total length was meansured from the snout to the end of the caudal fin. The standard-length was

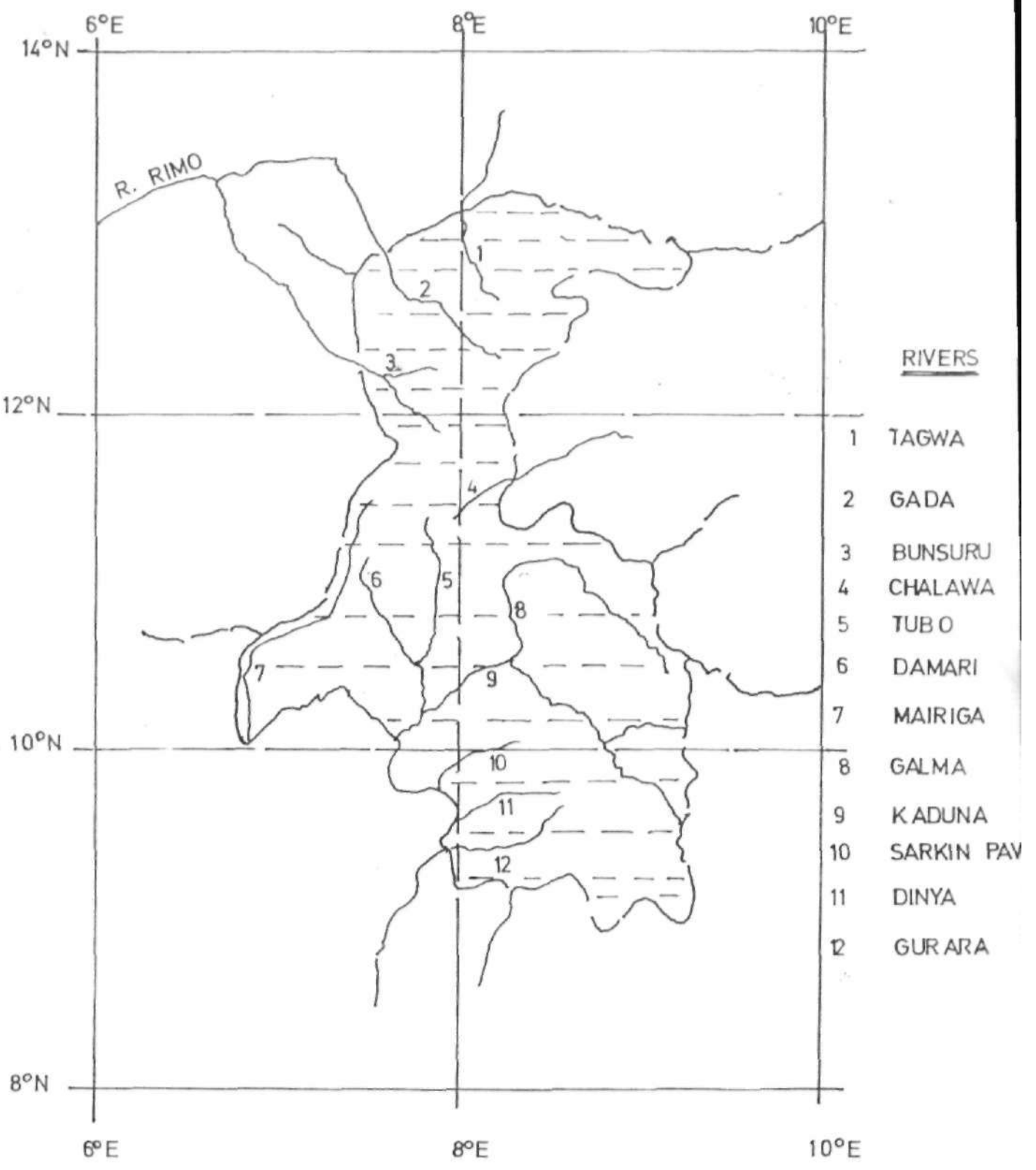


FIG. 2 SCALE 1 : 64·37 KM

RIVER COURSES OF KADUNA STATE.

measured from the tip of the snout to the tip of the hypural bone. Both total and standard length measurement were made to the nearest millimetre.

(b) WEIGHT:

Water and other substances on the fish were removed with filter papers and the fresh weight of the whole fish was determined using electronic mettler balance. The weight was measured to the nearest gram.

2.4. SEX DETERMINATION AND GONAD CLASSIFICATION

The sex and maturity of the gonads of Hydrocynus species was determined by internal examination of the fish without the aid of lenses. In Alestes species the sexes were determined by the shape of the anal fins (Figure 6). The anal fin of the females is either straight or concave while that of the males is convex (Holden and Reed 1972). Male and female gonads were classified according to a maturity scale modified after Nikolsky (1963) and Olatunde (1978b) as shown in Table 1.

Fully matured ovaries in stage IV were removed, weighed and kept in labelled specimen bottles containing Gilson's fluid (Simpson 1951). The Gilson's fluid as well as hardening and liberating the egg; also helps to liberate the ovarian tissues (Olatunde 1978b). Bagenal (1968) strongly recommended Gilson's fluid as the best preservative for fish eggs.

2.5. STOMACH ANALYSIS

A major objective of the food analysis studies

is to determine the diet of the species concerned. This usually includes a quantitative and qualitative analysis of the kinds and amounts of food consumed. The stomach therefore is the best unit to choose for qualitative purposes being easily defined and containing the least digested food.

The stomach of each specimen was removed and kept in labelled specimen bottles containing 5 percent formalin solution until needed for further analysis. Initial trials of the other methods of stomach analysis revealed that the Points and Occurence methods were most suitable for this work.

2.3a. POINTS METHOD:

The stomachs for examination were removed from the fish and the fullness of each stomach was estimated to the nearest quarter. After the stomach had been graded it was slit lengthwise and the contents washed into petridishes containing a little water. The food items were separated into watch glasses. The food items in each stomach were listed as common, frequent et ce tera on the basis of rough counts and judgement by the eye due regard being taken of the size of the organism as well as their abundance (i.e. one large organism counted as much as a large number of small ones). The contents of each stomach were alloted a number of points. The points were then divided among the food items on a visual estimate of the relative volumes of these items. In this way

TABLE 1 GONAD MATURITY STAGES IN FAMILY CHARACIDAE

MATURITY STAGE	CONDITION OF GONAD	DESCRIPTION OF GONADS	
		FEMALE	MALE
i	Virgin	Ovary very small. Usually colourless. Accumulation of fat in the abdomen.	Testes very small. Not easily identifiable
ii	Immature or Developing	Left and right ovaries visible to the naked eyes. Developing eggs cannot be seen with the naked eye.	Testes are clearly visible to the naked eye. But usually very thin.
iii	Matured or Developing	Eggs visible to the naked eye. The ovarian colour is yellowish.	Testes are white and slightly swollen. When abdomen is pressed, no milt comes out
iv	Fully Matured	Abdominal fat decreases greatly. Ovaries large.	Testes white and fully swollen.
v	Running or Spawning	As in IV but eggs discharge when abdomen is pressed slightly. The genital opening is swollen.	As in IV but discharge when abdomen is is slightly pressed.
vi	Spent and Recovering	Eggs shed. Ovaries like empty sacs.	No spent testis seen.

- -

the sum of the points awarded to individual food items was equal to the point awarded for the stomach size. The points gained by each food item were summed and scaled down to percentages to give the percentage composition of the food of all the fish examined. This technique has been recommended by Hynes (1950) as a rapid volumetric estimate of the diet which yields results similar to those obtained by weighing or measuring volume displacement.

The merits and demerits of the methods of food analysis are discussed in Chapter 4. Hynes (1950) Munro (1967) and Ball (1961) also reviewed these methods.

2.3b OCCURENCE METHOD:

In this method the stomachs were slit open and the number of fish in which each food item occured was listed. The number of occurences of all items was summed up for each fish and scaled down to a percentage to show the occurence of the diet.

2.4 FECUNDITY ESTIMATION:

Bagenal (1968) has defined fecundity as the number of ripening eggs in the female prior to the next spawning period. Using Simpson's (1959) dry gravimetric method fecundity was estimated.

The ovaries were kept in numbered jars or bottles containing Gilson's fluid (Simpson 1951) for at least three months. The numbered jars were

- -

periodically shaken to assist the penetration of the preservative and the liberation of the eggs from the ovarian tissue (Olatunde 1978b). The Gilson's fluid was decanted off and the eggs were washed as many times as possible until both the ovarian tissue and all the other unwanted materials have been decanted off. After washing, the eggs were poured into a funnel containing a filter paper and the remaining water was drained off. The eggs were later poured into two filter papers to dry them further and help separate the clumps of eggs. The eggs were then spread on filter papers and left for at least twenty four hours to dry at room temperature. After drying the eggs were weighed and two or three random subsamples of 200 eggs each were weighed individually and the mean weight of the three aliquot weights or subsamples was calculated. The total weight of the eggs was divided by the mean weight of the aliquot weights. The quotient was multiplied by 200 to give an estimate of the fecundity of the fish.

The eggs were weighed in the same room using the metler electronic microbalance (Type H_4 Cap-160). This was done to make the moisture content to be in equilibrium with the ambient temperature.

CHAPTER THREE

R E S U L T S

3.1• DESCRIPTION - THE FISH SPECIES IN ZARIA

3,1a. *Alestes nurse* Ruppel

This is silvery or golden in colour. It is greenish grey above with a black spot behind the gill opening and another in front of the caudal fin. The snout is short, the mouth small and inferior with small bicuspid teeth Figure 7. It has two conical teeth inside the outer series of the pleuricuspid ones near the jaw symphsis. The inner teeth of the upper jaw have thick bases. The scales are moderately small and ciliated. The adipose fin is rather large. The s< ire often seen with red or' orange markings. All tin ire characteristically reddish including the tail fin which has a black tinge Figure 3. The mean dorsal spiny fin ray count was found to be II while the mean for soft rays was 8. The mean for the gill rakers count was 11+.

3.1b. *Alestes macrolepidotus* Cuvier and Valenciennes

This is the largest species in the genus *Alestes*. They have a straight dorsal profile flattened on top of the head. The body is greenish-olive on the back, lighter on the sides, becoming white or silvery on the lower sides and belly. There is a prominent snout, big eyes and the characteristic large strong scales Figure U. The maxillary and mandibular teeth appear

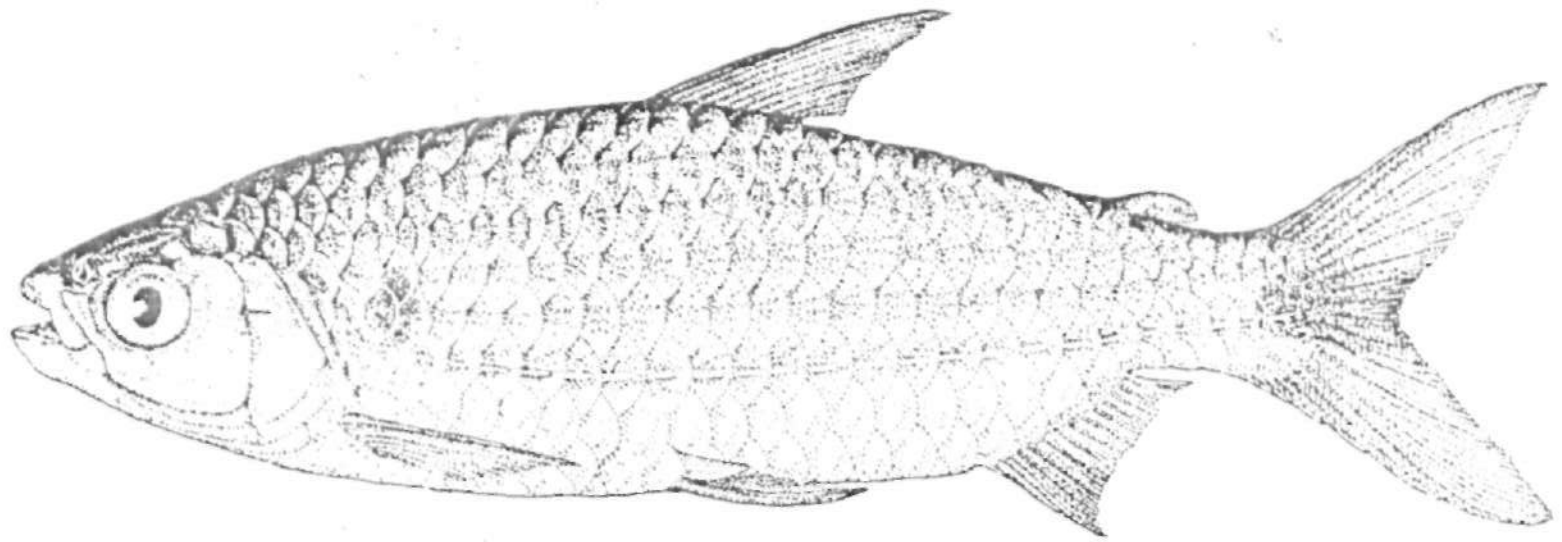
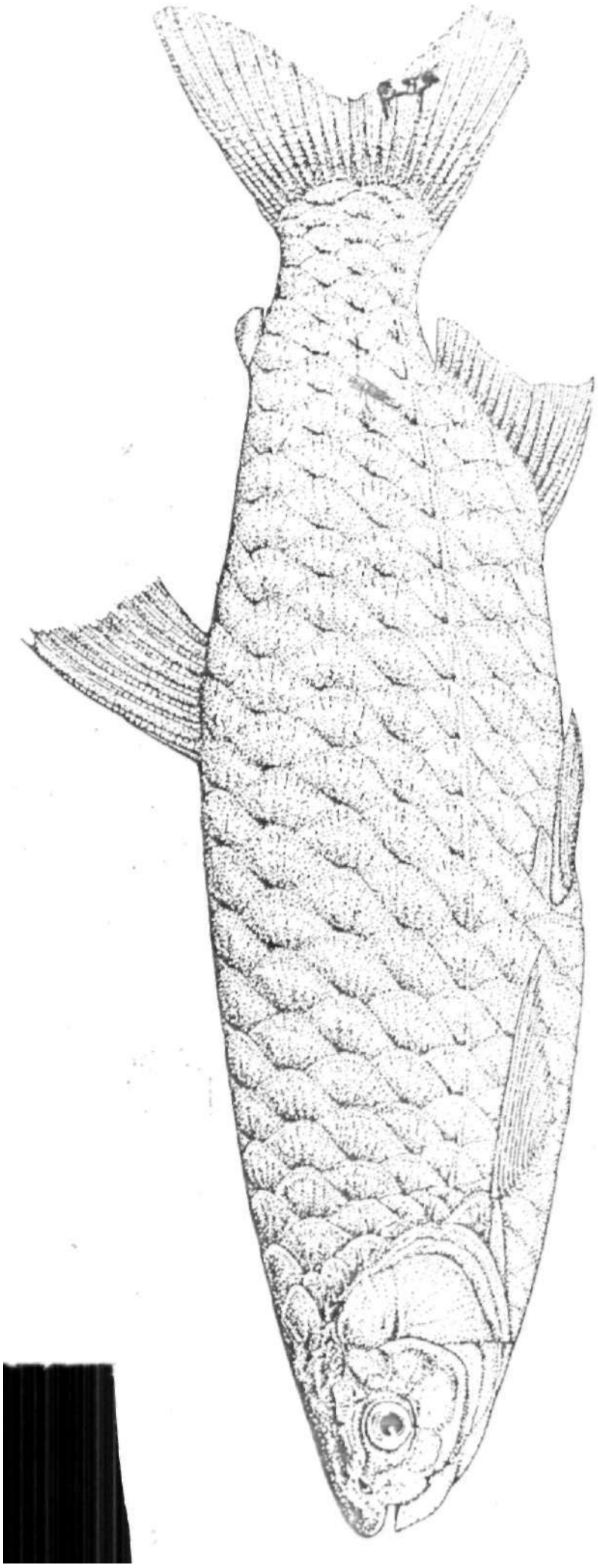


FIG. 3 *Alestes nurse* (Actual size)

(After Lewis 1974)



(Actual size)

Alestes macrolepidotus

(After Lewis 1974)

FIG. 4

- . -

in two rows. The first row on the edge of the jaw near the snout is made up of sharp and pointed teeth. The second row on the floor of the mouth is made up of thick pleuricuspid or molariform teeth Figure 8. The mean dorsal spiny fin ray count was found to be II and the mean for soft rays was 8. The mean count for the gill rakers was 15.

3.1c. Hydrocynus vittatus Castelnau

This is a very handsome fish and is one of the best freshwater sporting and fighting fish in the world. The body is elongated and compressed and the belly rounded. The scales are moderately large. The dorsal fin has from 10 to 11 rays and the ventral fin has from 13 to 18 rays. There is a small adipose fin. The back is medium brown, the sides yellowish silvery while the whole length has black points and dark blue-grey longitudinal markings Figure 5. The mouth is large and furnished with very strong pointed more or less compressed sharp edged teeth, wide apart and forming a single series. These teeth are seen even when the mouth is closed Figure 9. The dorsal fin is pale brown, edged with red while the adipose fin is black. The pectoral, ventral and anal fins are transparently grey and have chrome-orange colours at their tips. The middle base of the caudal fin is dark while the upper lobe is transparently brownish with a broad red margin.

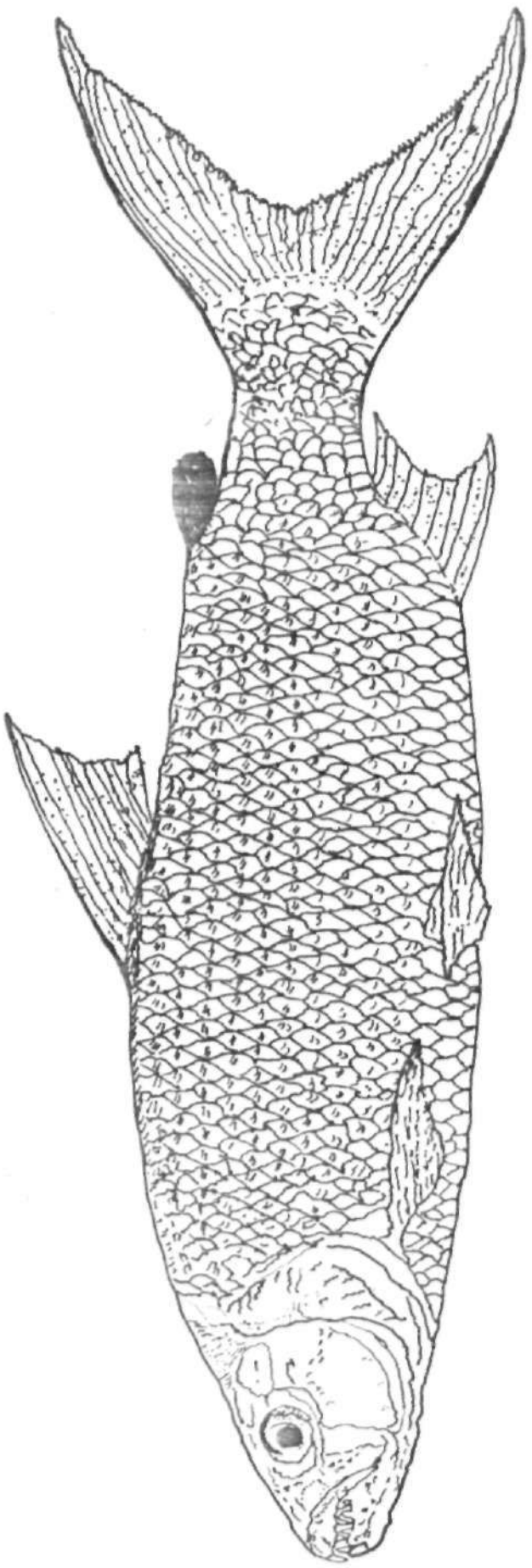
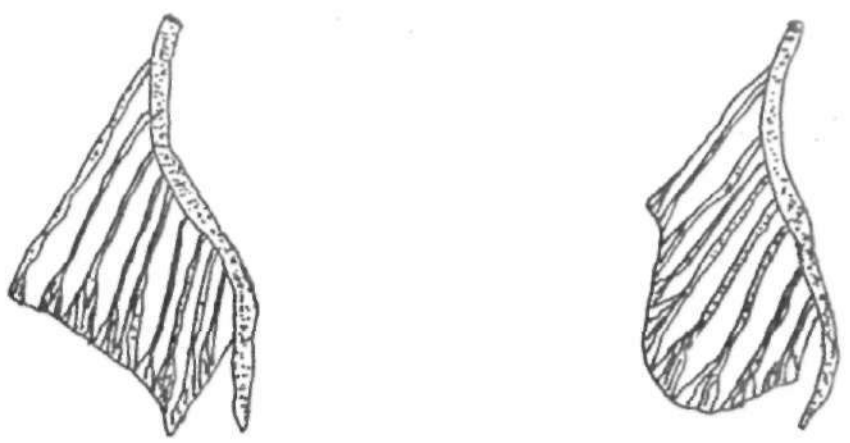


FIG. 5 HYDROCYNUS VITTATUS (ACTUAL SIZE)



X3 MALE FEMALE X3

FIG. 6

SHAPE OF ANAL FINS IN GENUS ALESTES

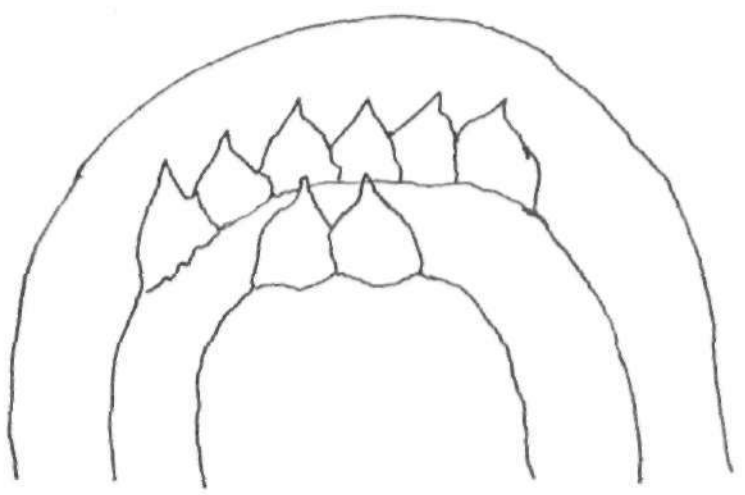


FIG 7 ALESTES NURSE : TEETH OF LOWER JAW

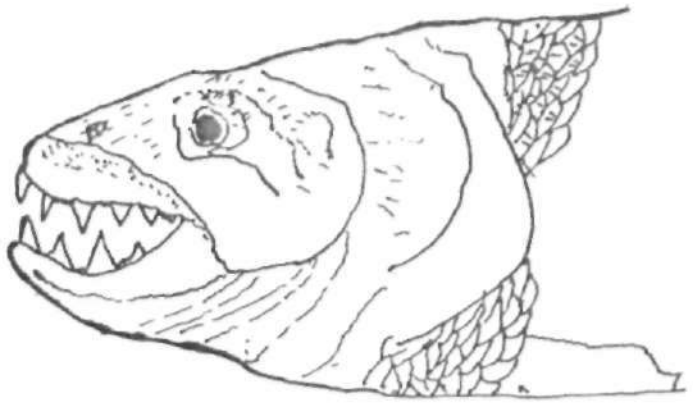


FIG. 9 (ACTUAL SIZE)

HEAD OF HYDROCYNS VITTATUS (FEMALE)
SHOWING TEETH.

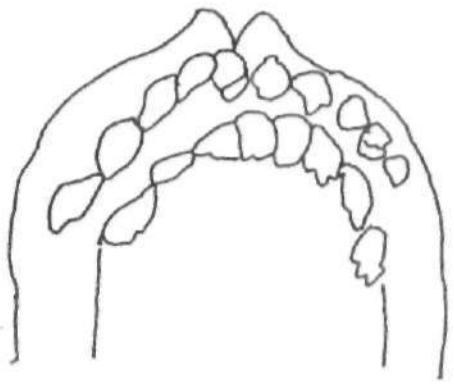


FIG. 8 X 3

ALESTES MACROLEPIDOTUS : TEETH OF UPPER JAW

3.2 SIZE DISTRIBUTION

The number of fish examined each month is shown in Table 2. A look at the family Characidae in the market showed that Alestes nurse was most abundant all the time followed by Alestes macrolepidotus while Hydrocynus vittatus was the fewest in number. These market situation could as well reflect the abundance of these fish species in the wild.

3.2.1 Alestes nurse

The standard lengths of the females ranged from 4.5cm to 13.8cm while that of the males ranged from 4.5cm to 13.7cm. The mean standard length for the males was 8.81cm while that for the females was 9.18cm. The weight varied between 2.5 gm and 57.9gm for the females and 3.3gm to 50.6gm for the males Table 3. The statistical analysis showed that the mean weight and standard lengths for the males and females were not significantly different (Table 4.)

The length frequency histograms were plotted for males Figure 11, females Figure 10 and both males and females combined Figure 12. The males, females, and both males and females combined showed peaks between 5-7cm and 10 to 12.5cm.

3.2.2. Alestes macrolepidotus

The standard lengths of the females ranged from 4.7cm to 18.3cm while that of the males ranged from

- -

TABLE 2 THE NUMBER OF FISH EXAMINED EACH MONTH

Month	Alestes nurse	Alestes macrolepidotus	Hydrocynus vittatus
March	34	22	0
April	40	26	0
May	64	33	0
June	42	16	0
July	85	29	0
August	98	25	0
September	56	22	0
October	56	32	0
November	61	26	0
December	40	19	4
TOTAL	576	250	4

TABLE 3 LENGTH AND WEIGHT MEASUREMENTS

Fish Species		Sex	Number Examined	Minimum	Maximum	Range	Mean	Variance	Standard Deviation	Standard Error
Alestes nurse	Standard length (cm)	M	139	4.5	13.9	9.2	8.81	4.59	2.08	0.65
		F	437	4.5	13.8	9.3	9.18	47.74	4.40	0.62
	Weight (gm)	M	139	3.3	50.6	47.3	21.60	113.54	10.26	2.99
		F	437	2.5	57.9	55.4	20.56	311.47	16.03	2.36
Alestes macrolepidotus	Standard length (cm)	M	72	6.0	19.3	13.3	10.78	5.35	2.13	0.82
		F	178	4.7	18.3	13.6	10.64	6.52	2.36	1.18
	Weight (gm)	M	72	4.6	108.2	103.5	33.34	389.31	21.58	7.23
		F	178	3.6	103.3	99.7	34.35	422.39	20.00	4.82
Hydrocynus vittatus	Standard length (cm)	M	1	9.1	9.1	-	-	-	-	-
		F	3	6.9	10.4	3.5	8.43	2.13	1.78	1.02
	Weight (gm)	M	1	163.7	163.7	-	-	-	-	-
		F	3	67.7	211.9	144.2	135.7	3897.86	72.43	41.86

- - -

6cm to 19.3cm. The mean standard length for the males was 10.78cm while that of the females was 10.64cm. The weights varied between 3.6gms and 10.3gms for the females and 4.6gms to 108.20gms for the males. The mean weight for the males was 33.34gms while that of the females was 34.35gms.

The statistical analysis (Table 5) showed that the mean weights and standard lengths of the males and females were not significantly different. Length frequency histograms were plotted for males Figure 13, females Figure 14 and both males and females combined Figure 15. All showed peaks between 10cm and 12.25cm.

3.2.3 Hydrocynus vittatus

The standard lengths for the females ranged between 17.2cm to 26.0cm while their weights varied between 67.7gms and 211.9gms. There was only one male with a standard length of 22.7cm and weight of 163.7gms.

3.3.1. LENGTH WEIGHT RELATIONSHIP

The length weight relationship was calculated using the conventional formula described by Le Cren (1951)

$$W = {}_{a}L^{b} \quad \ldots\ldots\ldots (1)$$

TABLE 4 STATISTICAL ANALYSIS FOR SIGNIFICANT DIFFERENCES BETWEEN LENGTHS AND WEIGHTS OF MALES AND FEMALES OF *Alestes nurse* IN ZARIA

	Sex	Degree of freedom	Mean	"t"	Mean Significantly different	Level
Total length (cm)	M F	248	11.60 12.55	3.03	Yes	0.01
Standard length (cm)	M F	248	8.85 9.28	0.16	No	0.9
Weight (gm)	M F	248	21.60 22.46	-1.47	No	0.2

TABLE 5 STATISTICAL ANALYSIS FOR SIGNIFICANT DIFFERENCES BETWEEN LENGTHS AND WEIGHTS OF MALES AND FEMALES OF *Alestes macrolepidotus* IN ZARIA

	Sex	Degree of freedom	Mean	"t"	Mean significantly different	Level
Total length (cm)	M F	574	13.74 14.19	1.60	No	0.1
Standard lengh (cm)	M F	574	10.56 10.59	1.5	No	0.1
Weight (gm)	M F	574	33.34 34.41	1.18	No	0.1

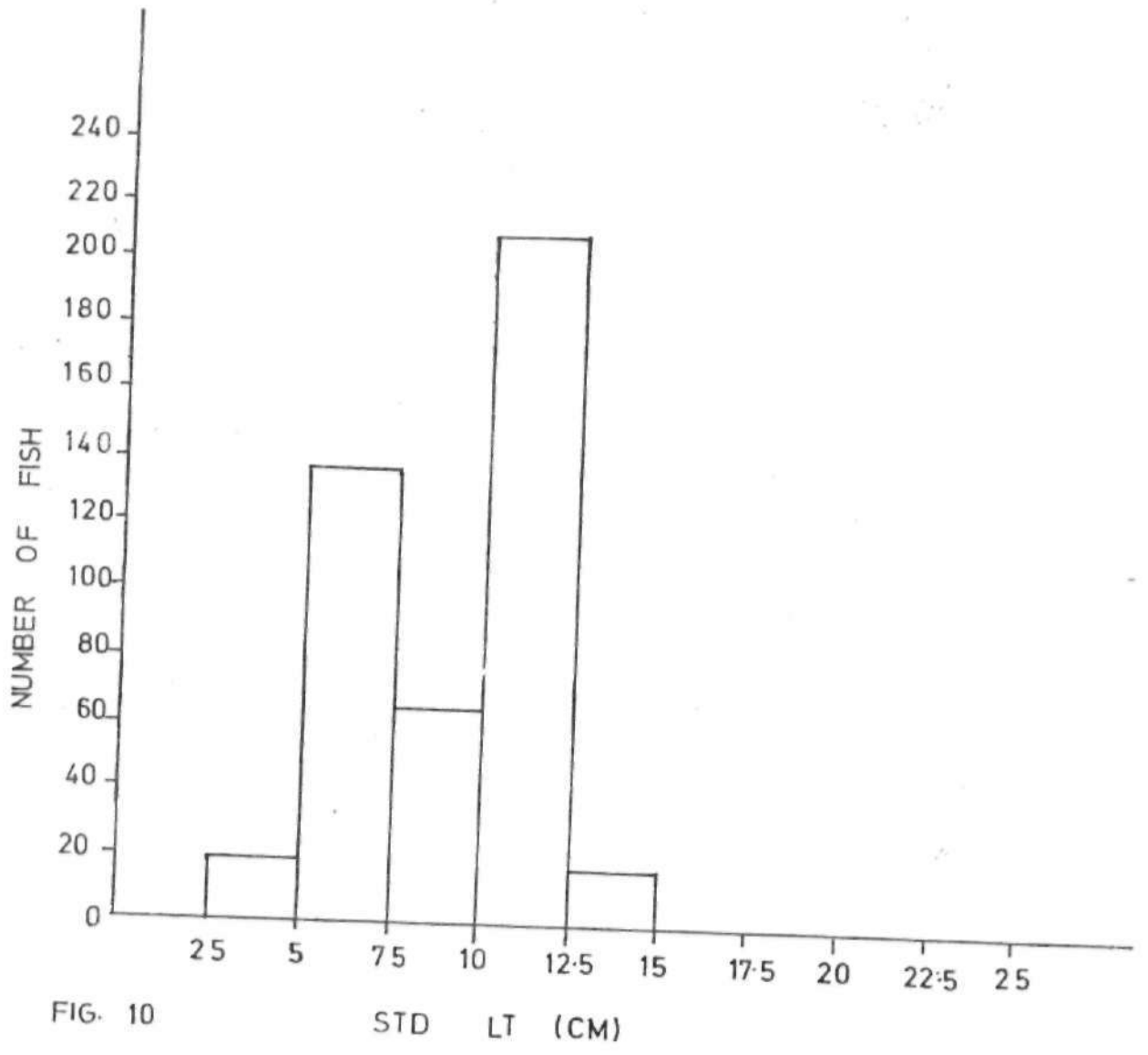


FIG. 10 STANDARD LENGTH DISTRIBUTION — ALESTES NURSE (FEMALE)

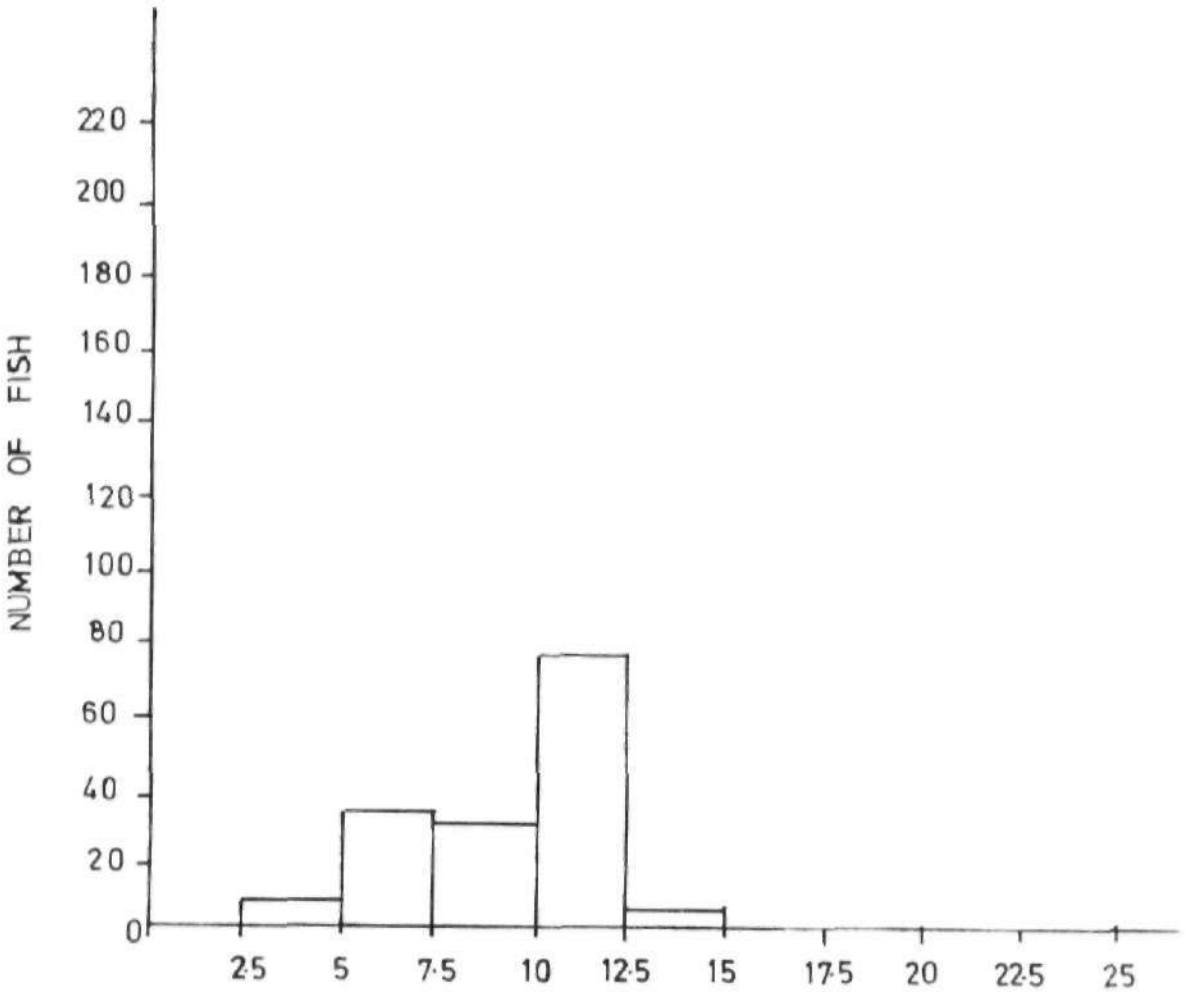


FIG 11 STANDARD LENGTH DISTRIBUTION ALESTES NURSE (M.

(MALE)

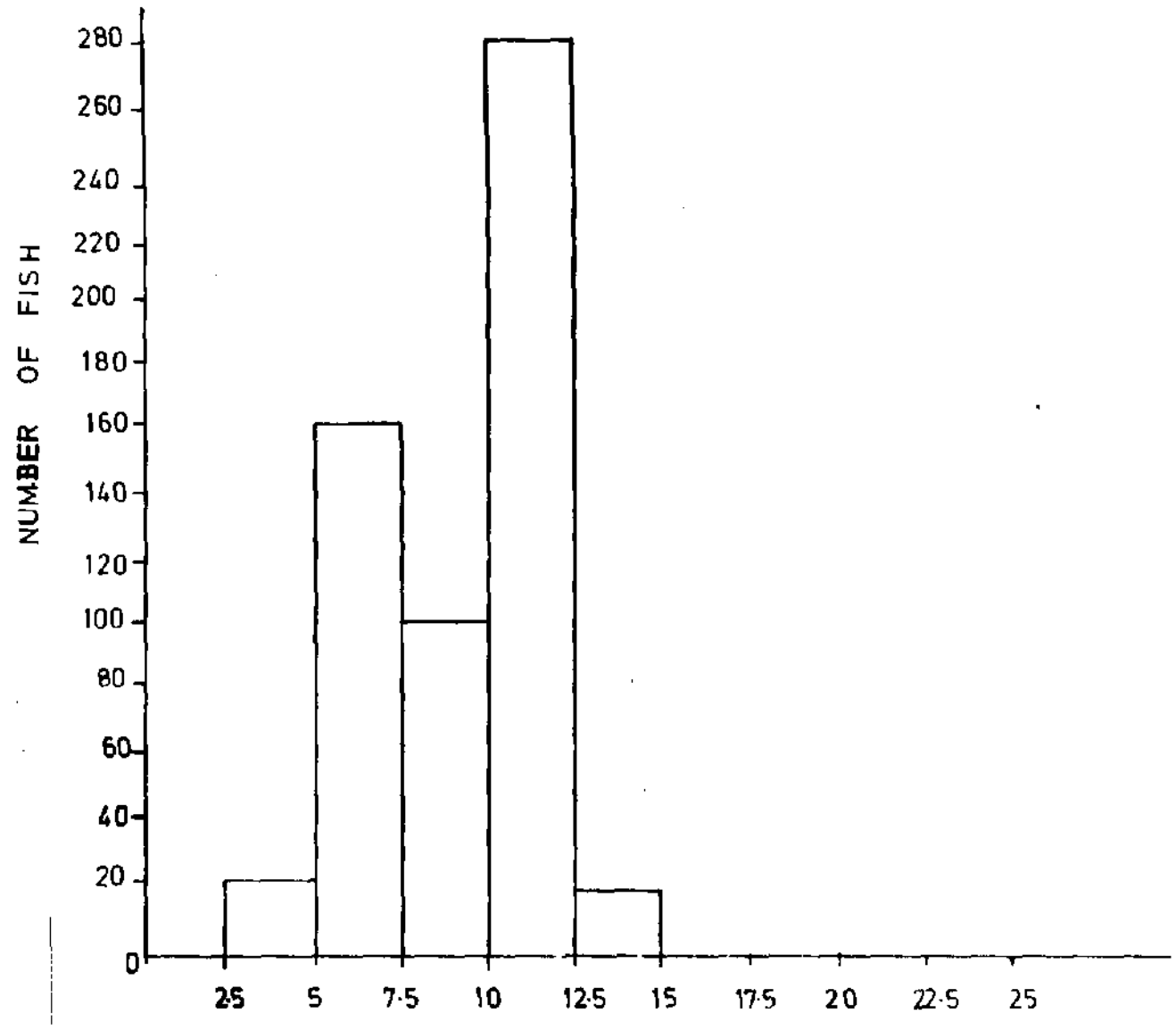


FIG. 12

STANDARD LENGTH DISTRIBUTION — ALESTES NURSE

(MALE AND FEMALE COMBINED

- -

The above equation (1) and the data were changed to logarithms before the calculations were made thus transforming equation (1) into:

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

where W = weight of fish in grams

L = standard length of fish in centimetres

a = a constant

and b = an exponent

The results of the regression analysis and the correlation co-efficients are shown in Tables 6 and 7. The correlation co-efficients between the lengths and weights were found to be high and highly significant ($P = 0.01$). The "b" values for all the species was between 2.5 and 3.4. The "b" values for Alestes nurse indicate that their growth was allometric while the "b" values for Alestes macrolepidotus indicated that their growth was isometric. Appendices 1, 2, 3, and 4 show that the mean weights increased with the standard lengths for both males and females.

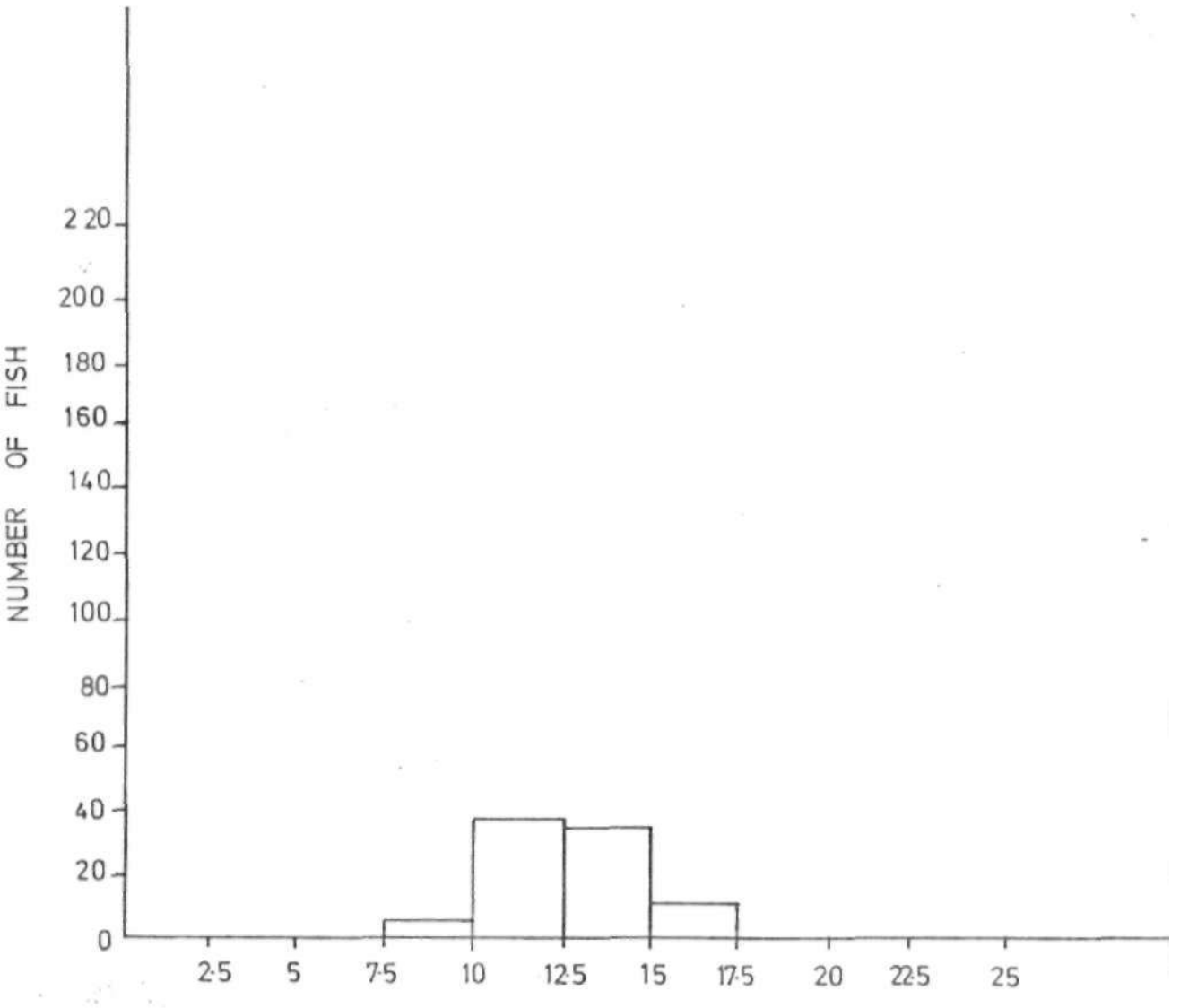


FIG. 13

STANDARD LENGTH DISTRIBUTION ALESTES MACROLEPIDOTUS (MA

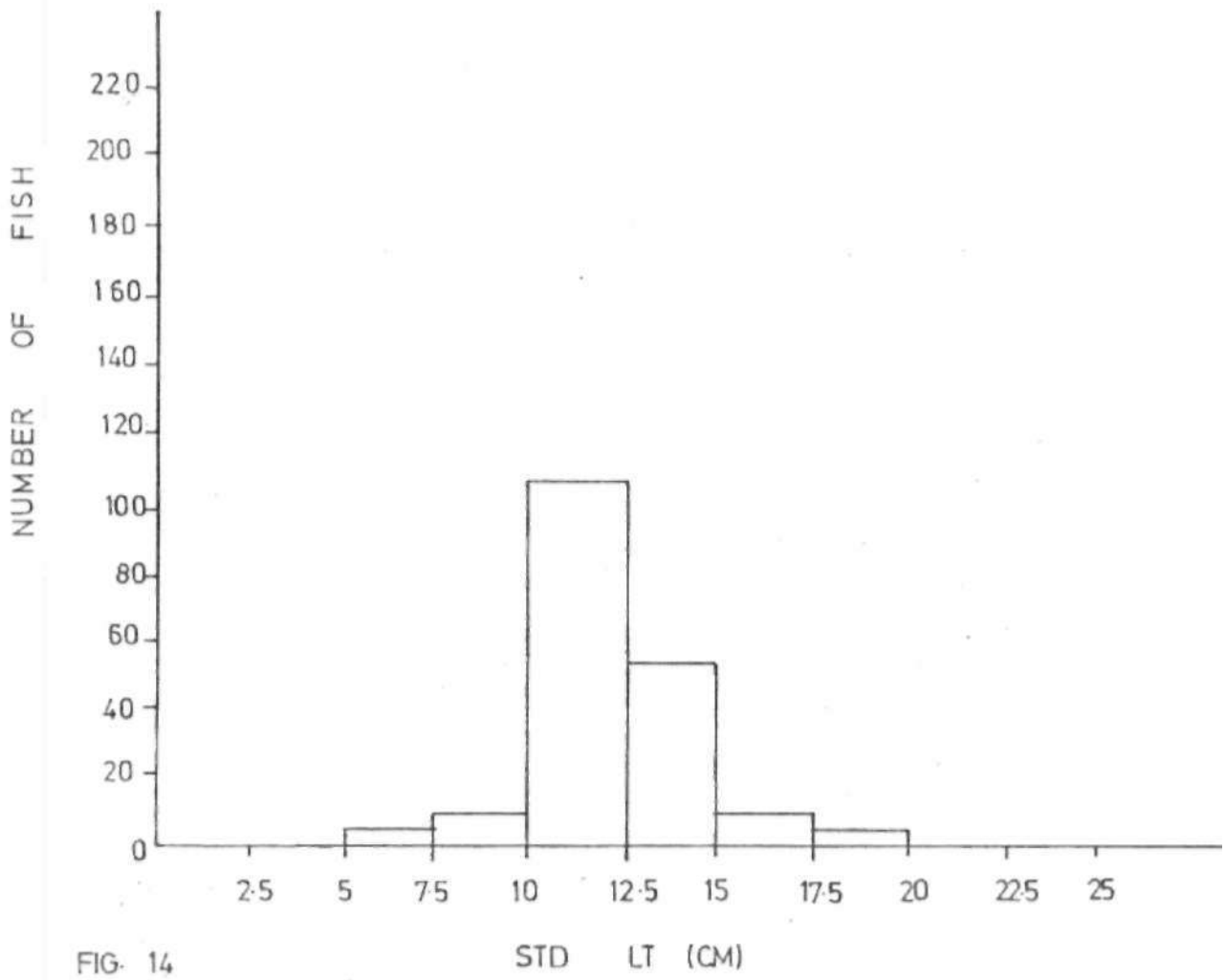


FIG. 14

STANDARD LENGTH DISTRIBUTION — ALESTES MACROLEPIDOTUS

(FEMALE)

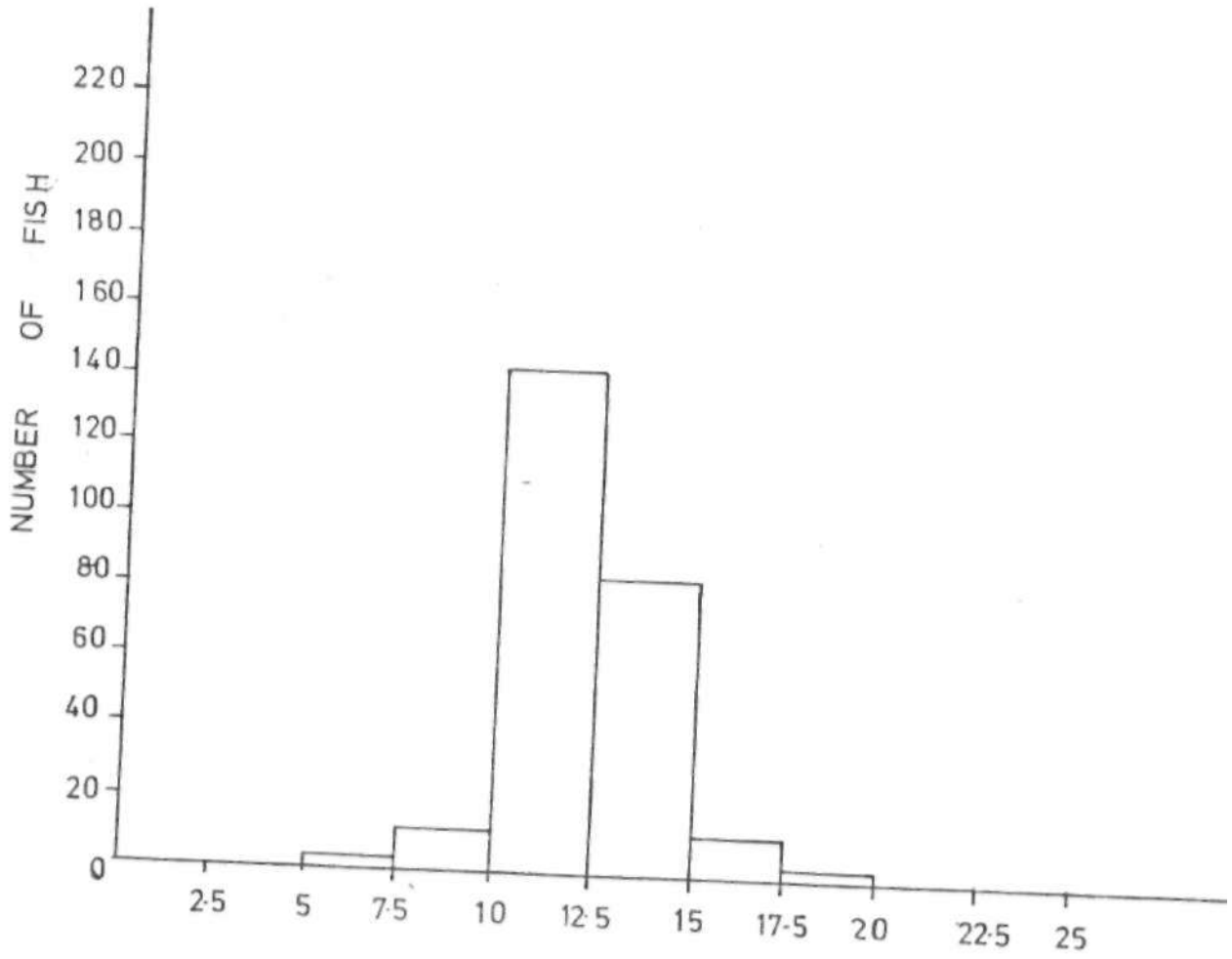


FIG. 15

STANDARD LENGTH DISTRIBUTION ALESTES MACROLEPIDOT

(MALE AND FEMALE COMBINED)

The females had lower mean body weights at standard lengths below 8.8cm for Alestes nurse and lower mean body weights at standard lengths below 10.64cm for Alestes macrolepidotus.

Figures 16, 17, 18, 19, show the log-log relationship of the lengths and weights of the females and males of both Alestes nurse and Alestes macrolepidotus As expected there was in all a linear relationship showing an increase in body weight with increase in standard length.

3.3.2. CONDITION FACTOR:

The condition factors "K" were calculated for individual fish for each month using the conventional equation by Worthington and Richards (1930).

$$K = \frac{W \times 100}{L^3} \quad \ldots\ldots\ (3)$$

where K = conditon factor

W = weight (gm)

and L = standard length (cm)

The relationship between the standard length and the mean condition factors are shown in Tables 8, 9,

No wide differences between mean condition factor of one length group and another was noticed as are shown in the tables in all the species of the family. Monthly mean condition factors and their standard deviations of the species for males and females are shown in Tables 10, 11, 12, and 13

TABLE 6 LENGTH-WEIGHT REGRESSION ANALYSIS OF FEMALES AND MALES OF *Alestes nurse* IN ZARIA

	Number of fish examined	Log a	b	Standard error of b	Correlation coefficients
Males	139	-2.73	2.54	0.0675	0.955
Females	437	-2.98	2.65	0.0326	0.968
Both	576	-2.93	2.62	0.029	0.965

TABLE 7 LENGTH-WEIGHT REGRESSION ANALYSIS OF FEMALES AND MALES OF Alestes macrolepidotus IN ZARIA

	Number of fish examined	Log a	b	Stardard error of b	Correlation coefficients
Males	72	-3.44	2.88	0.1091	0.953
Females	178	-3.269	2.7886	0.0697	0.9494
Both	250	-3.318	2.814	0.0587	0.950

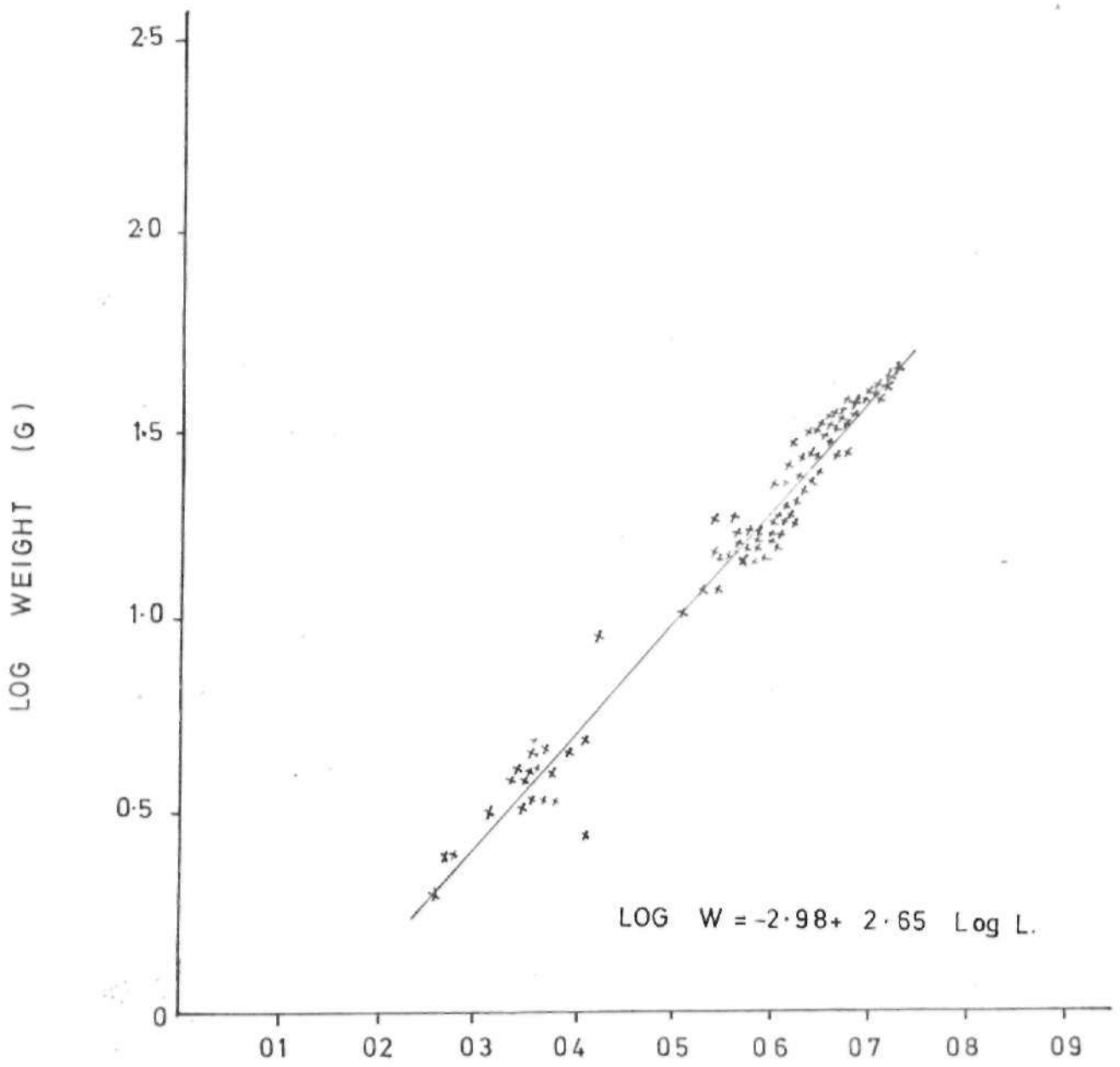


FIG. 16 LENGTH WEIGHT RELATIONSHIP LOG-LOG OF ALESTES NURSE (FEMAL

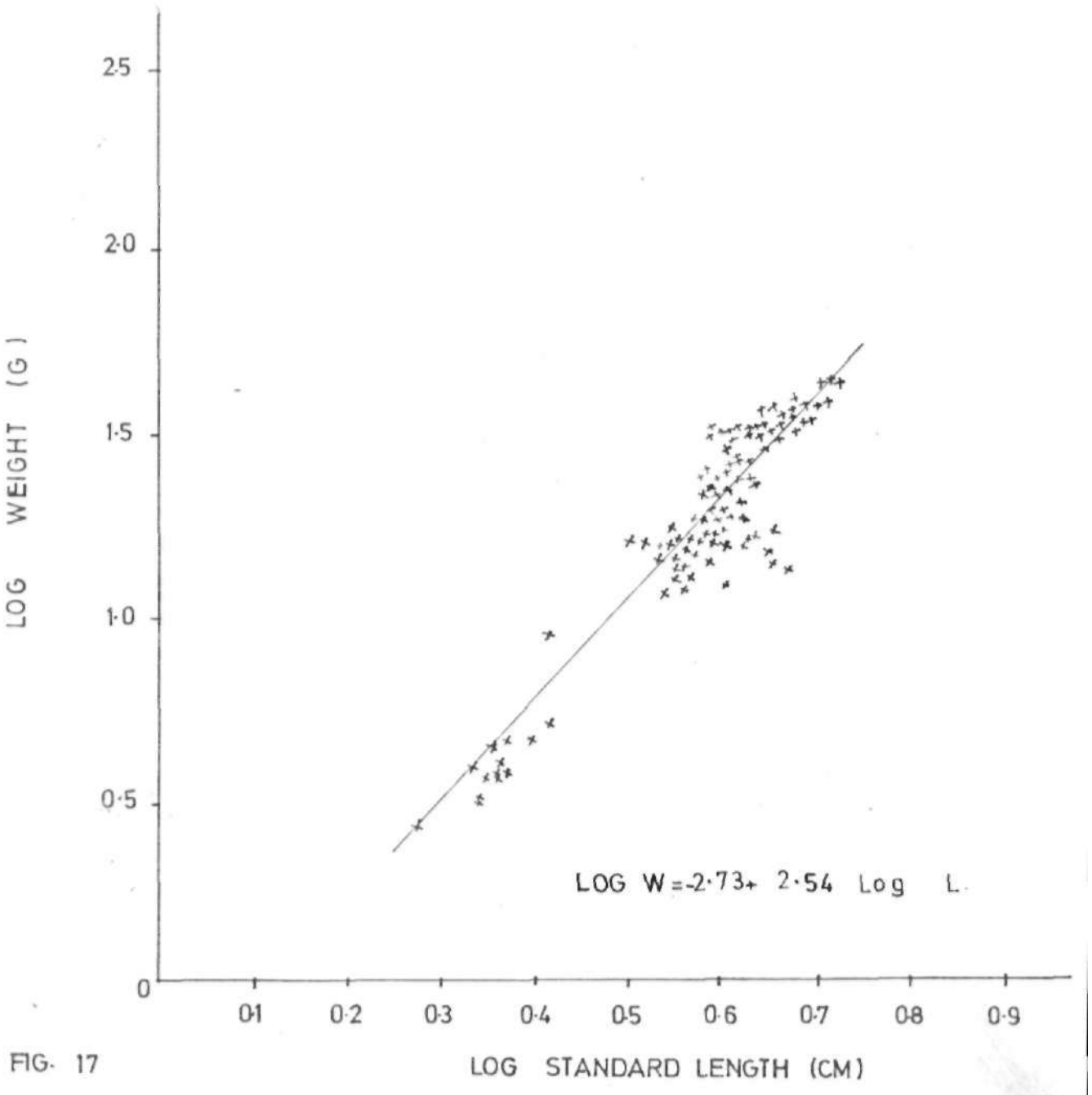


FIG. 17

LENGTH WEIGHT RELATIONSHIP (LOG – LOG) OF ALESTES NURSE

(MALE)

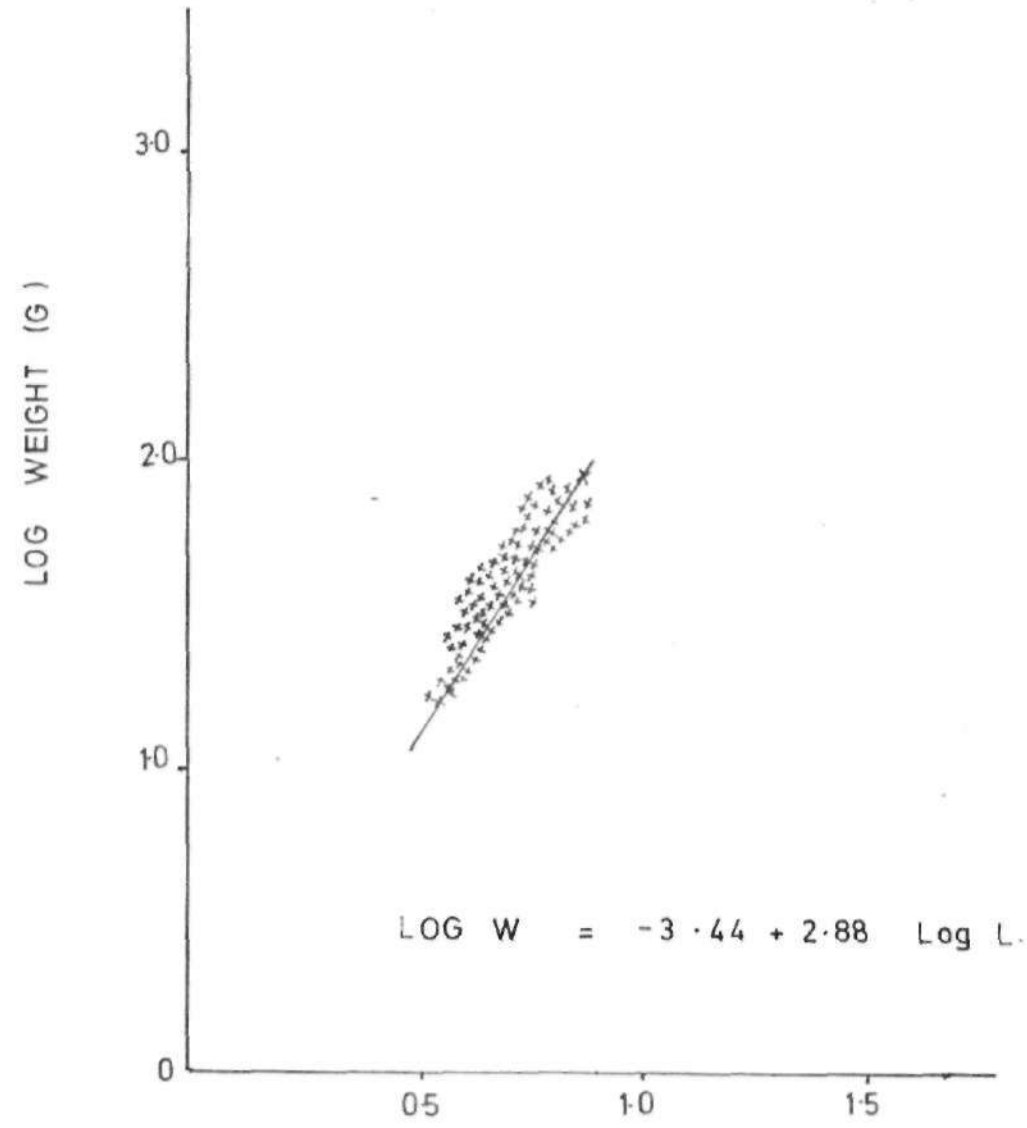


FIG 18 LENGTH WEIGHT RELATIONSHIP (LOG-LOG) OF ALESTES MACROLEPIDOTUS (MALE)

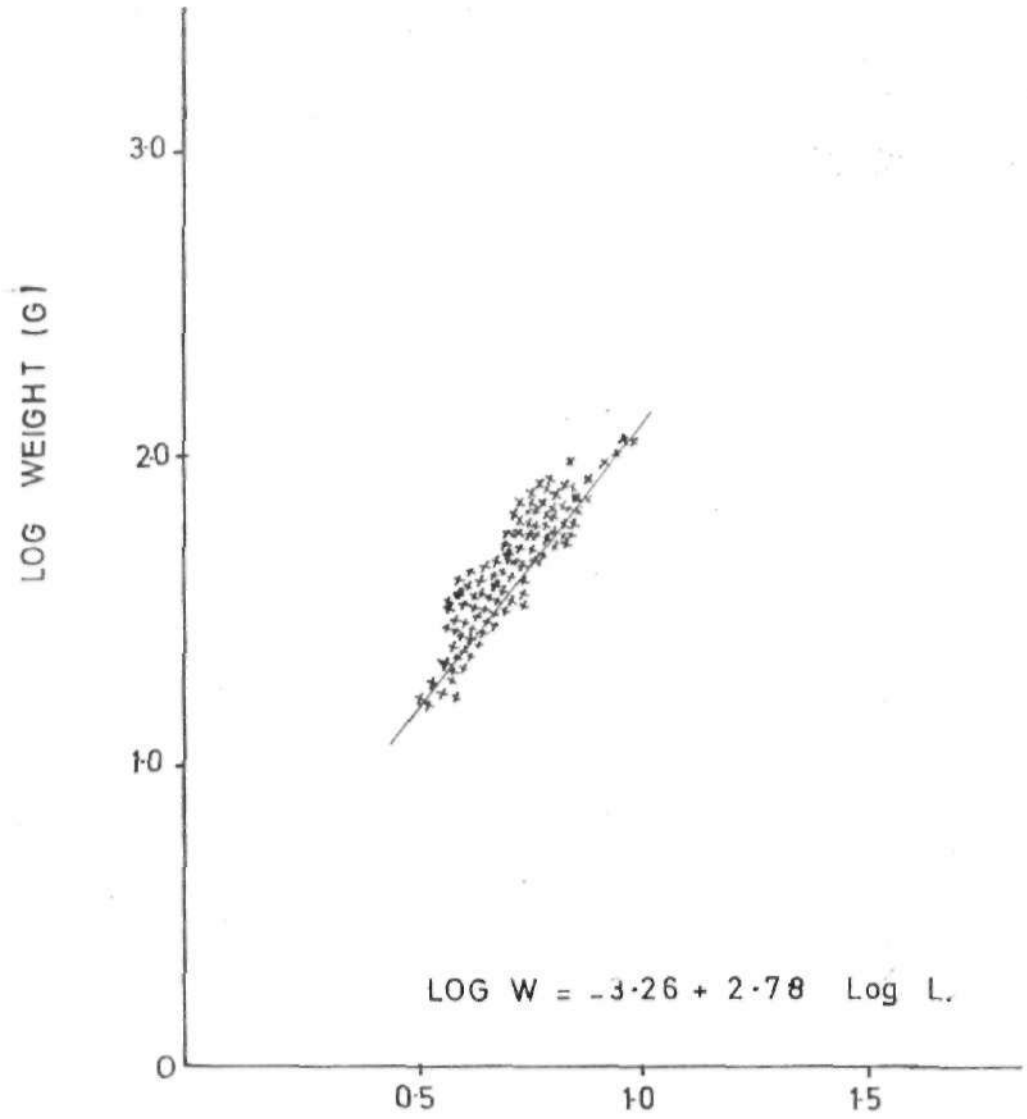


FIG. 19 LENGTH WEIGHT RELATIONSHIP (LOG – LOG) OF ALESTES MACROLEPIDOTUS (FEMALE)

TABLE 8 RELATIONSHIP BETWEEN STANDARD LENGTH AND MEAN CONDITION FACTOR OF *Alestes nurse*

Sex	Standard length (cm)	Condition factor range	Number of fish examined	Mean	Standard deviation
Female	4-9	1.39-6.56	234	2.53	0.28
Male	4-9	1.79-7.14	84	2.68	0.32
Female	10-16	0.68-3.58	196	1.97	0.31
Male	10-16	1.15-2.85	54	2.12	0.21

TABLE 9 RELATIONSHIP BETWEEN STANDARD LENGTH AND MEAN CONDITION FACTOR OF *Alestes macrolepidotus*

Sex	Standard length (cm)	Condition factor range	Number of fish examined	Mean	Standard deviation
Female	4-9	1.73-3.56	54	2.69	0.42
Male	4-9	1.46-3.60	18	2.52	0.40
Female	10-16	1.14-4.10	120	2.27	0.10
Male	10-16	1.53-3.36	53	2.44	0.29

TABLE 10 MONTHLY CONDITION FACTOR FOR *Alestes nurse* (Females)

Month	Number of fish examined	CONDITION FACTOR Range	Mean	Standard deviation	Standard error
March	26	0.68-2.76	1.93	0.44	0.08
April	30	1.68-2.69	2.25	0.20	0.03
May	50	1.16-3.58	2.27	0.48	0.06
June	31	1.77-3.32	2.35	0.43	0.07
July	72	1.46-3.70	2.64	0.60	0.07
August	72	1.46-3.87	2.44	0.55	0.06
September	41	1.33-3.70	2.65	0.47	0.07
October	44	1.06-3.31	2.07	0.63	0.09
November	41	1.91-4.19	2.97	0.83	0.13
December	30	1.82-4.62	2.62	0.72	0.13

Mean condition factor March August (during the rainy season) = 2·31

Mean condition factor Sept. Dec. (during the hot season) = 2·57

TABLE 11 MONTHLY CONDITION FACTOR FOR *Alestes nurse* (Male)

Month	Number of fish examined	CONDITION FACTOR Range	Mean	Standard deviation	Standard error
March	8	1.53-2.54	2.18	0.42	0.14
April	10	1.19-3.62	2.48	0.81	0.25
May	14	1.79-3.27	2.45	0.39	0.10
June	11	1.95-3.31	2.47	0.41	0.11
July	13	1.98-3.48	2.57	0.38	0.10
August	26	1.66-3.76	2.64	0.62	0.12
September	15	2.07-3.32	2.38	0.30	0.078
October	12	2.16-3.30	2.75	0.38	0.11
November	20	1.15-3.48	3.06	1.45	0.46
December	10	1.97-7.14	3.06	1.45	0.46

Mean condition factor March - August (during the rainy season) = 2·46

Mean condition factor Sept. – Dec. (during hot season) = 2·81

TABLE 12 MONTHLY CONDITION FACTOR FOR *Alestes macrolepidotus* (Female)

		CONDITION FACTOR			
Month	Number of fish examined	Range	Mean	Standard deviation	Standard error
March	17	1.41-3.20	2.06	0.63	0.15
April	20	1.33-2.69	2.11	0.29	0.06
May	22	1.92-2.93	2.36	0.29	[illegible]
June	13	2.18-2.80	2.34	0.17	0.04
July	21	1.18-3.20	2.27	0.52	0.11
August	16	2.00-2.77	2.36	0.22	0.05
September	14	1.14-3.24	2.27	0.72	0.19
October	22	1.39-3.56	2.38	0.59	0.12
November	19	2.20-3.27	2.60	0.32	0.07
December	14	2.14-4.10	2.70	0.47	0.12

Mean condition factor March – August (during rainy season)
= 2·25

Mean condition factor Sept – Dec (during hot season)
= 2·48

TABLE 13. MONTHLY CONDITION FACTOR FOR *Alestes macrolepidotus* (Male)

Month	Number of fish examined	CONDITION FACTOR Range	Mean	Standard deviation	Standard error
March	5	1.50-2.64	2.18	0.42	0.21
April	6	1.33-3.6	2.48	0.81	0.34
May	11	1.46-2.55	2.45	0.39	0.09
June	3	2.18-2.66	2.47	0.41	0.13
July	8	1.82-3.12	2.57	0.38	0.17
August	9	1.55-3.20	2.64	0.62	0.19
September	8	1.83-3.36	2.38	0.30	0.17
October	10	2.11-3.33	2.75	0.38	0.11
November	7	1.79-3.02	3.06	1.45	0.25
December	5	1.63-3.06	3.06	1.45	0.17

Mean condition factor March – August (during the rainy season) = 2·46

Mean condition factor Sept – Dec (during the hot season) = 2·81

- ' -

The values obtained showed that the fish were in good condition throughout the period of investigation.

3.4. FOOD AND FEEDING HABITS

3.4. 1. COMPOSITION OF THE STOMACH CONTENTS

The list of food types and their grouping as found in the different stomachs are given below:-

(a) Higher plants:

These were made up of fruits and seeds, bark and tree leaves all of which had been partially broken up into bits.

(b) Insect Remains:

These included the various parts of insects such as legs, wings, head, eyes and antennae.

(c) Algae:

These were primarily made up of chlorophyta (green algae). Few cases of the occurence of cyanophyta (blue-green algae) were noticed.

(d) Fish Remains:

These were made up of vertebrae, skulls and muscles.

(e) Fish:

This was made up of unidentified juvenile stages.

(f) Detritus:

These are bottom deposits such as sand particles and unidentified materials.

(g) Crustacea:

Few specimens of shrimps (Pinaeus species) were recorded.

(h) Insects:

Included in this group are cockroach nymphs cricket, (Gryllus species); termite nymph, leaf beetle, (Chrysochus species); megarrhyssa species and butterfly larva.

3.4.2. Alestes nurse

(a) The Food Items Selected:

The food items found in Alestes nurse are shown in Table 16. The result of the analysis of the food of this species shows that plants and plant remains dominated the food with a percentage occurence of about 73% and a total points score of about 32 percent. This was followed by detritus which had a percentage occurence of about 23 percent and a total points score of about 5 percent. Other food items were less important because they formed less than 5 percent of the total diet and were consumed by less than 4 percent of the fish with food in their stomachs.

(b) Monthly Feeding INDEX

The numerical value of the fish with food and those with empty stomachs was recorded for

- -

TABLE 14 PERCENTAGE COMPOSITION AND RELATIVE IMPORTANCE OF DIETARY ITEMS IN THE STOMACH OF Ajestes nurse

	% Occurence	% Points Count
Green algae		
Spirogyra sp.	2.0%	0.1
Cladophora sp.	2.0%	0.1
Plant Remains		
(Seeds, Fruits etc.)	72.5	32.29
Detritus	22.9	5.3
Fish		
(unidentified juvenile stages)	1.2	0.1
Crustacea		
Pinnaeus sp	0.4	0.04
Insects		
Blatta sp	2.5	0.24
Microtermes sp	0.8	0.20
Toxoptera sp	0.8	0.2
Megarhyssa sp	1.2	0.4
Chrysochus sp	0.4	0.18
Papilio sp	0.8	0.20
Insect Remains	7.4	2.1

Number Examined	576
Number with food	244 (42.36%)
Number without food	332 (57.63%)

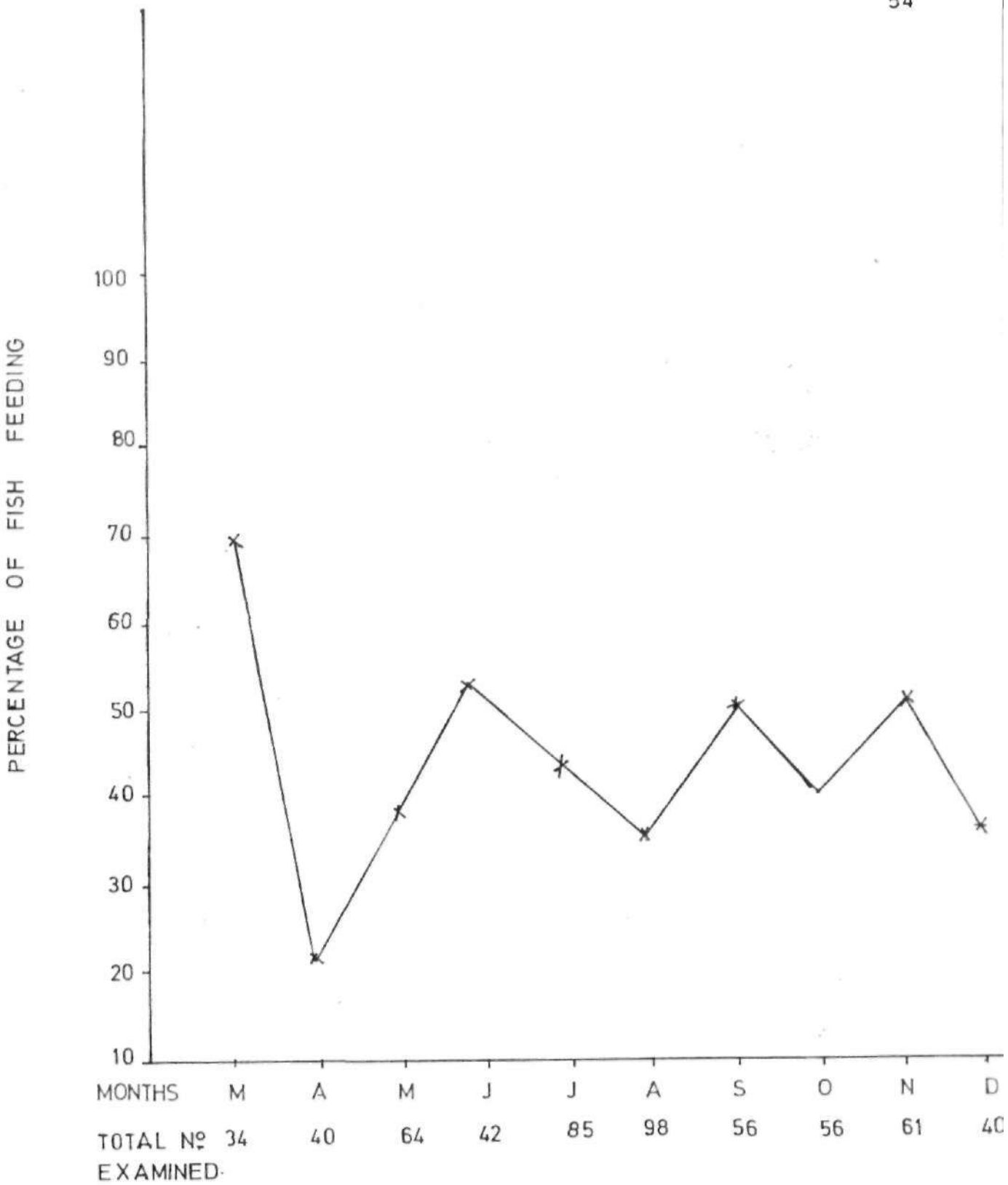


FIG. 20
MONTHLY FEEDING INDEX OF ALESTES NURSE

each month throughout the period of investigation. From this observation the percentages of fish with each food item were calculated (appendix 5). The monthly feeding intensity is shown in Figure 20. It was noticed that about 42 percentage of of fish were feeding for most of the months. It was also observed that feeding was continuous throughout the period of investigation and that the percentage feeding was highest between the months of June and September.

(c) Monthly Variations in the Food Items Selected:

Figure 21 shows the monthly variation in the dietary composition of Alestes nurse. The results of the analysis showed that plant and plant remains dominated the diet of this species throughout the months of investigation. Plants constituted about 10 percent of the food items for each month of the investigation followed by detritus which formed over 5 percent. Other food items were less important because they formed less than 5 percent of the total diet consumed each month throughout the period of investigation.

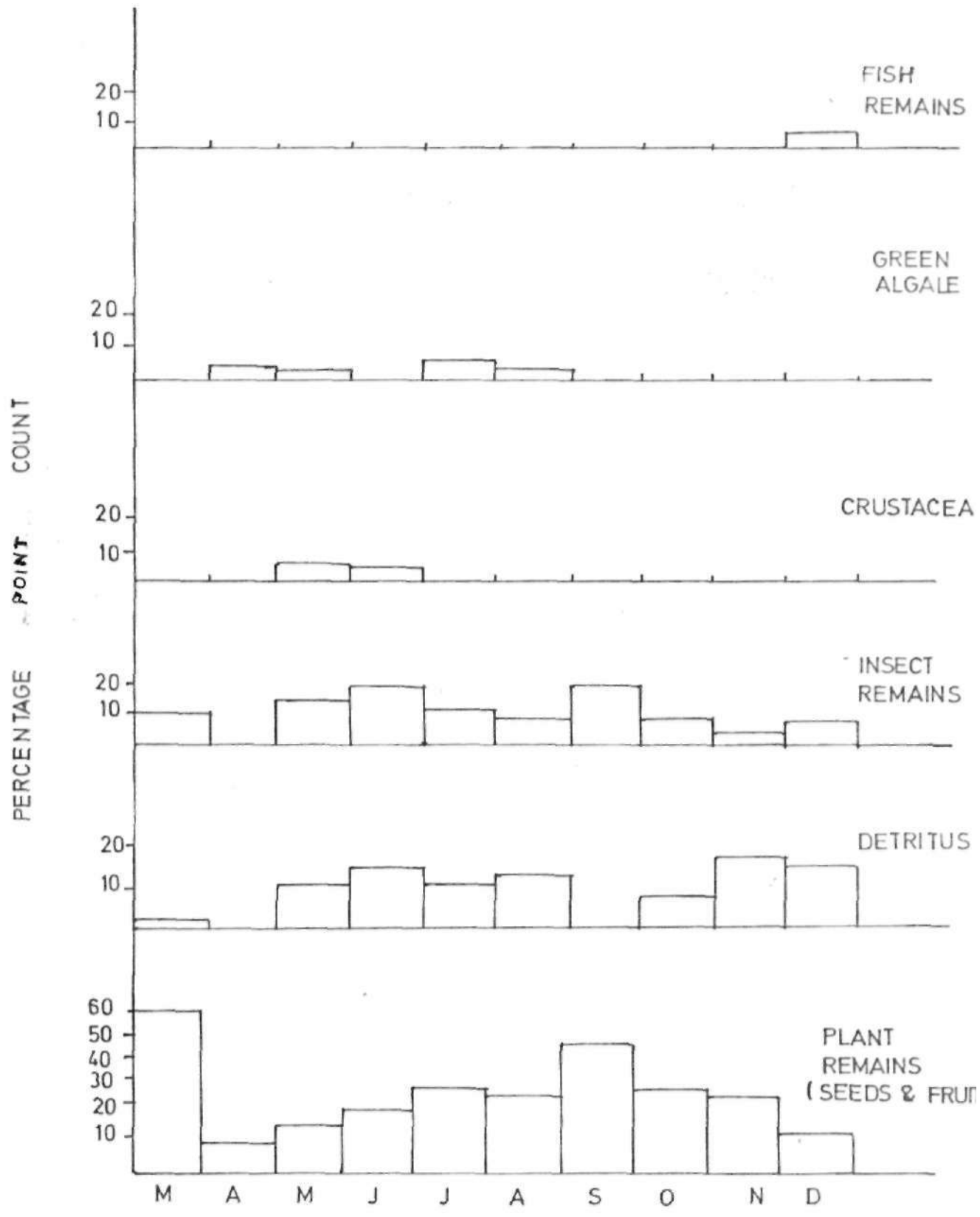


FIG. 21

SEASONAL VARIATION IN DIET COMPOSITION OF ALESTES NURSE

3.4.3. Alestes macrolepidotus:

(a) The Food Items Selected:

Table 15 shows the relative importance and the composition of the dietary items found in the stomach of Alestes macrolepidotus.

The result of the analysis of the food of this species showed that it fed principally on plant or plant materials. The percentage occurence was 56 percentage with a total points score of about 28 percent. This was followed by detritus with a percentage occurence of 21 percent and a points score of 5 percent. Other dietary items were insects and insect remains with a percentage occurence of 6 percent, algae which constituted about 7 percent, fish and fish remains which formed less than one percent. There was no occurence of crustacea in all the specimens.

(b) Monthly Feeding Index :-

The monthly feeding intensity of Alestes macrolepidotus is shown in Figure 22. The percentage of fish feeding showed that there was fairly a high rate of feeding activity (over 50%) throughout the period of investigation. Observations

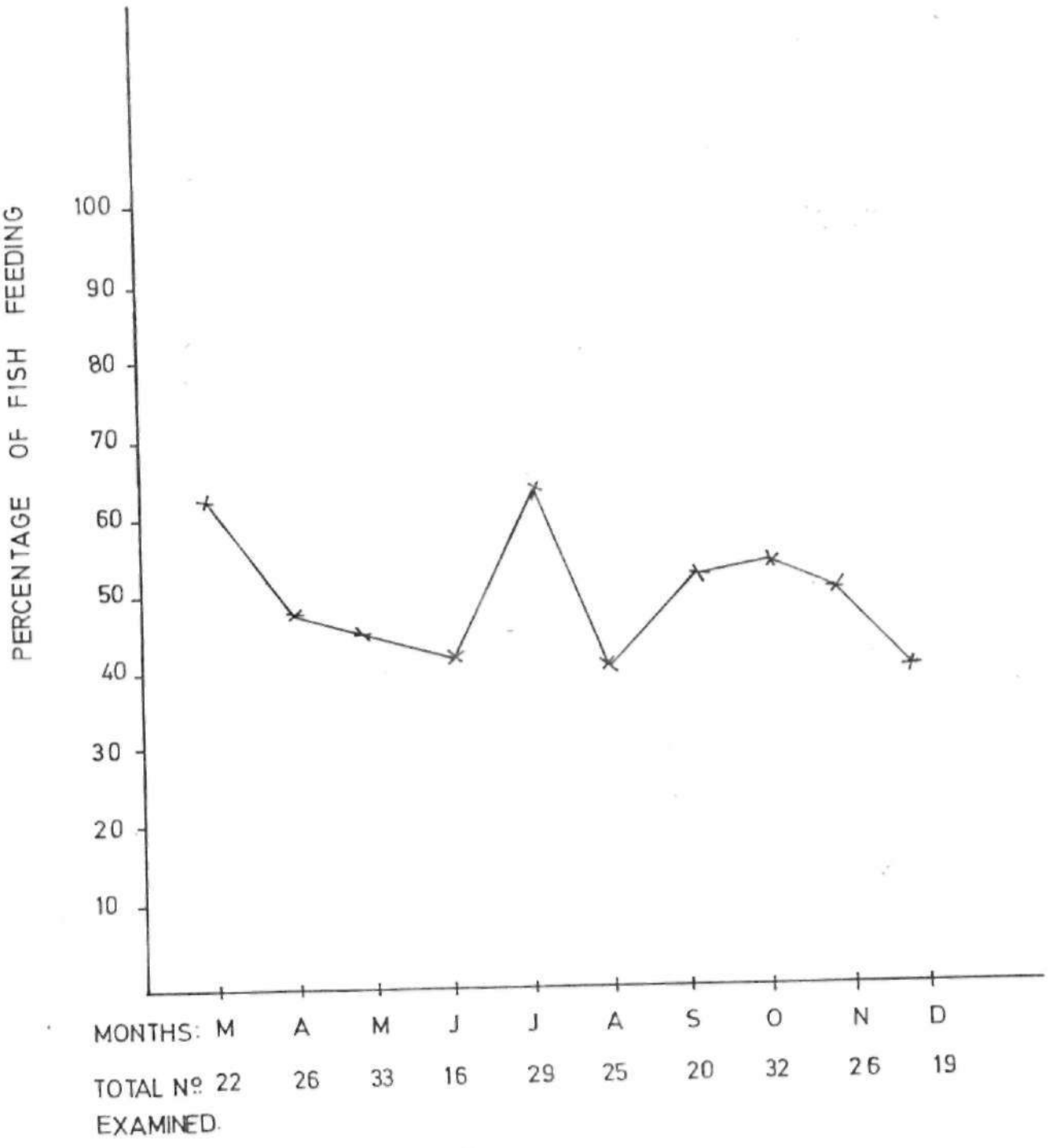


FIG. 22

MONTHLY FEEDING INDEX OF ALESTES MACROLEPIDOTUS

of the percentages of fish with each food item for every month was calculated.

(c) Monthly Variations in the Food Items Selected:- The monthly variation in the food items selected of Alestes macrolepidotus is shown in Figure23. The fish is predominantly herbivorous. Plants and plants fragments were observed to form the major part of the diet. Plant remains formed the dominant item of each stomach for each month of the investigation (Figure 23). Detritus was next in importance. It was consumed throughout the sampling period. Insect and insect remains was next in importance. Although they were not found in the fish every month, they occured more frequently than the algae or fish. The algae constituted about 7 percent of the diet of the fish feeding and were found only in July.

There was complete absence of crustacea in the diet and fish was found only in December during the period of investigation.

3.4.4. Hydrocynus vittatus

Only four specimens of Hydrocynus vittatus were encountered during the sampling period. These were found to have fed on fish.

TABLE 15 PERCENTAGE COMPOSITION AND RELATIVE IMPORTANCE OF DIETARY ITEMS IN THE STOMACH OF *Alestes macrolepidotus*

	% Occurence	% Points Count
Blue gree algae		
Anabaena sp.	1.6%	0.6
Green algae		
Spirogyra sp.	3.9%	1.6
Ulothrix sp.	1.6	0.6
Plant Remains		
(Seeds, fruits etc.)	55.9	27.8
Detritus	20.5	3.6
Fish	0.8	100
Crustacea	0	0
Insect		
Gryllus sp	0.8	0.2
Pedetontus sp	1.5	0.3

Number examined	250	
Number with food	127	(50.8%)
Number without food	123	(49.2%)

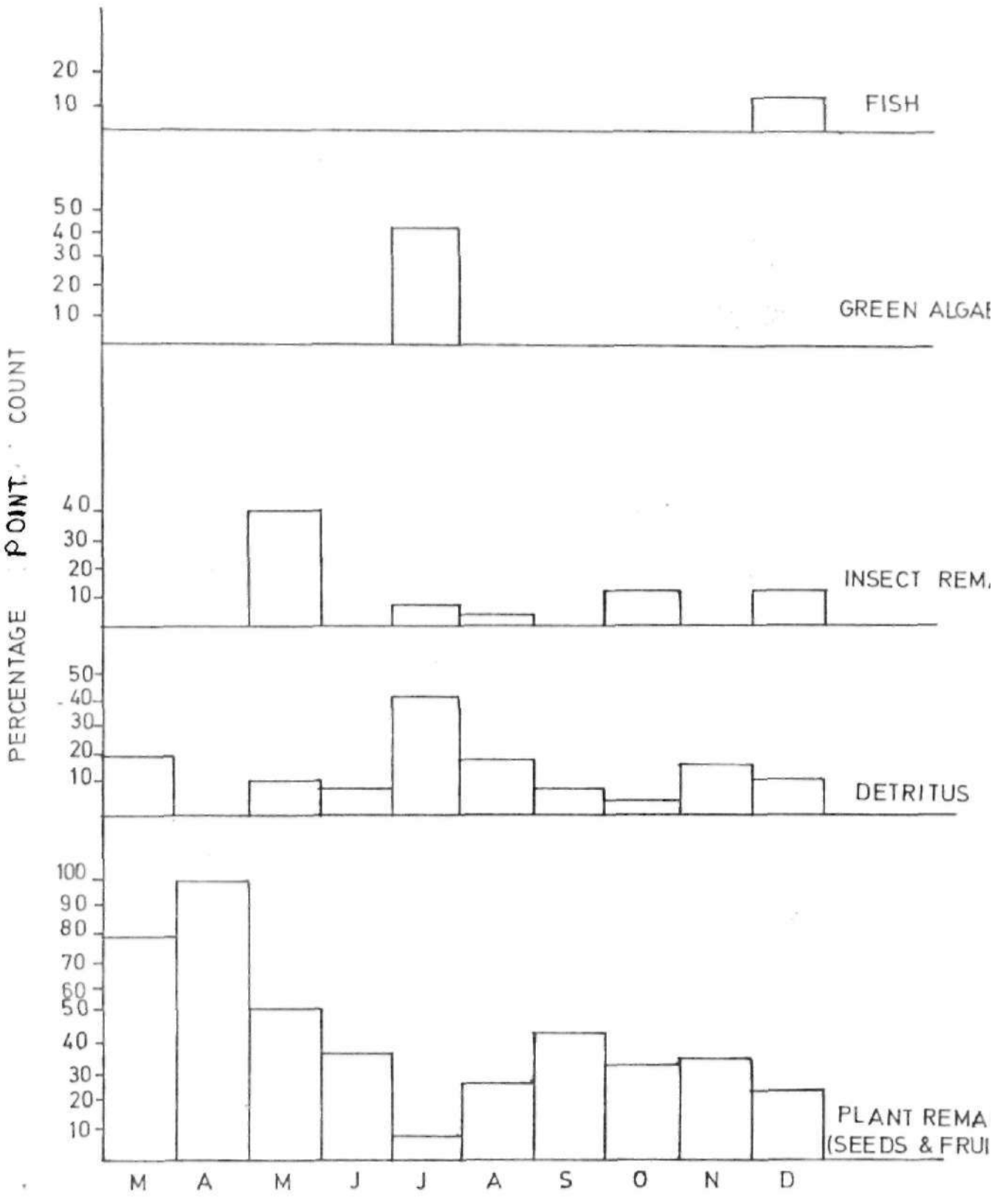


FIG. 23

SEASONAL VARIATION IN THE DIET COMPOSITION OF ALESTES MACROLEPIDOTUS

3.5. SEX RATIO: REPRODUCTIVE CYCLE AND FECUNDITY

3.5.1. SEX RATIO:

The sex ratio of the species of family Characidae in Zaria area is shown in Table 16. In Alestes nurse, out of the total number of 576 fish species investigated, 139 were males while 437 were females. This gave a ratio of 1 male to 3.14 females (1:3). In Alestes macrolepidotus there were 72 males to 178 females. This gave a sex ratio of 1 male to 2.4 females (1:2). In Hydrocynus vittatus out of the four fish specimens examined one was a male while the other three were females. This gave a sex ratio of one male to three females (1:3).

The monthly seasonal variations in the sex ratio of the different species were recorded. The sex ratio was in favour of the females throughout the period of investigation. The seasonal variation in the sex ratio of Alestes nurse is shown in Table 17, while those of Alestes macrolepidotus is shown in Table 18

3.5.2. SIZE AT MATURITY

The different sizes of individuals at maturity is shown in Table 19. As the specimens were bought from the market it was not clear whether these sizes recorded were their sizes at first maturity. From the results recorded, the female Alestes nurse had a minimum standard length of 9.7cm and a maximum standard length of 14.5cm at maturity. The males had

TABLE 16 SEX RATIO OF THE FAMILY CHARACIDAE IN ZARIA AREA

Species	Total number with recognisable gonads	Number of males	Number of females	Sex Ratio M	Sex Ratio F
Alestes nurse	576	139	437	1	3.1
Alestes macrolepidotus	250	72	178	1	2.4
Hydrocynus vittatus	4	1	3	1	3

TABLE 17 SEASONAL VARIATIONS IN THE SEX RATIO OF *Alestes nurse*

Months	March	April	May	June	July	August	September	October	November	December
Females	26	30	50	31	72	72	41	44	41	30
Males	8	10	14	11	13	26	15	12	20	10
Total number Examined	34	40	64	42	85	98	56	56	61	40
Ratio M:F	1:3.2	1:3	1:3.5	1:2.8	1:5.5	1:2.7	1:.2.7	1:3.6	1:2	1:3

TABLE 18 SEASONAL VARIATIONS IN THE SEX RATIO OF *Alestes macrolepidotus*

Months	March	April	May	June	July	August	September	October	November	December
Females	17	20	22	13	21	15	14	22	19	14
Males	5	6	11	3	8	9	8	10	7	5
Total number Examined	22	26	33	16	29	25	22	32	26	19
Ratio M:F	1:3.4	1:3.3	1:2	1:4.3	1:2.6	1:1.7	1:1.7	1:2.2	1:2.7	1:2.8

TABLE 19 SIZE AT MATURITY

Species	Sex	Number examined	Size Ranges of Matured Specimen Standard length (cm) Minimum	Maximum
Alestes nurse	M	20	8.5	13.7
	F	73	9.7	14.5
Alestes macrolepidotus	M	10	0.2	13.2
	F	35	0.5	17.0
Hydrocynus vittatus	M	1		
	F	3		

a minimum standard length of 8.5cm and a maximum standard length of 13.7cm.

In Alestes macrolepidotus the females attained a minimum standard length of 10.5cm and a maximum standard length of 17.00cm at maturity while the males had a minimum standard length of 10.2cm and a maximum standard length of 13.2cm at maturity. The few specimens of Hydrocynus vittatus were not found in matured stage.

3.5.3. REPRODUCTIVE CYCLE:

The monthly occurence of the different stages of the gonad and the number of fishes in the various stages of maturity in Alestes nurse are shown in Table 20. Table 20 also shows the presence of matured and fully matured males and females in all the months from March to December. Running gonads of the male species of Alestes nurse were not found in April, May, July, August, October and December while running female gonads were not found in April, May, June, and July. Spent female gonads were found in March, September, October, Novemebr and December while spent male gonads were not recorded during the period of investigation. Fully matured female ovaries were found in May, June, July and August. This indicates that for this species spawning was most prominent during the rainy season between August and November.

The monthly occurence of the different stages of gonads in specimens of Alestes macrolepidotus is shown in Table 21 The running stages was only recorded for

TABLE 20 MONTHLY OCCURENCE OF DIFFERENT STAGES OF GONADS IN SPECIMENS OF *Alestes nurse*

Months	Sex	I	II	III	IV	V	VI	Total Examined
March	M	2	3	1	1	1	0	
	F	7	12	4	0	1	2	34
April	M	4	4	2	0	0	0	
	F	15	12	3	0	0	0	40
May	M	1	8	5	0	0	0	
	F	6	19	14	11	0	0	64
June	M	2	5	3	0	1	0	
	F	5	16	4	6	0	0	42
July	M	2	8	3	0	0	0	
	F	54	11	5	2	0	0	85
August	M	16	8	2	0	0	0	
	F	25	33	7	2	5	0	98
September	M	5	7	0	0	3	0	
	F	7	20	8	0	4	2	56
October	M	5	7	0	0	3	0	
	F	14	22	3	0	2	3	56
November	M	4	12	2	0	2	0	
	F	22	15	1	0	2	1	61
December	M	3	5	1	0	1	0	40
	F	10	15	4	0	0	1	

TABLE 21 MONTHLY OCCURENCE OF DIFFERENT STAGES OF GONAD IN SPECIMENS OF *Alestes macrolepidotus*

Months	Sex	I	II	III	IV	V	IV	Total Examined
March	M	2	3	0	0	0	0	
	F	6	7	3	0	0	1	22
April	M	2	2	2	0	0	0	
	F	7	10	2	0	1	0	26
May	M	5	3	2	1	0	0	
	F	5	9	5	3	0	0	33
June	M	0	2	1	0	0	0	
	F	3	4	2	3	0	1	16
July	M	2	4	1	0	0	1	
	F	5	11	0	4	1	0	29
August	M	3	4	0	0	0	2	
	F	6	7	1	0	0	2	25
September	M	1	4	0	0	0	3	
	F	3	6	2	3	0	0	22
October	M	2	3	2	0	2	1	
	F	3	12	2	2	3	0	32
November	M	4	2	1	0	0	0	
	F	7	5	3	0	3	1	26
December	M	1	3	1	0	0	0	
	F	5	5	2	0	0	2	19

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one female in March and three females each in October and November while running stages for the males were only recorded in October. Spent gonads were recorded for one female in June, two females August, one female in November and two females in December while spent male gonads were recorded in July, August, September, and October. There was a record of only one male in stage IV gonad maturity while fully matured females were not seen in the months of March, April, August, November and December. Developing gonad stages were seen throughout the period of investigation. It seems therefore that breeding occured throughout the period of investigation and actual spawning occured between August and November.

3.5.4. FECUNDITY:

The fecundity of Alestes nurse in Zaria area is shown in Table 22. The estimated fecundity ranged between 914 to 1667 with a mean of 6834.85 (SD ± 4698) Figure 24 shows the number of eggs against the standard length and shows a non-linear relationship; that is an increase in fecundity did not necessarily occur as the fish length increased. The lowest fecundity was not necessarily recorded for the smallest fish. The graph of the relationship of the weight against the egg number also seems to show a non-linear

TABLE 22 FECUNDITY OF *Alestes nurse* IN ZARIA AREA

	Standard length (cm)	Fish weight (g)	Gonad weight (g)	Total dried egg weight (g)	Fecundity
	10.5	27.0	4.61	1.45	5577
	10.5	28.6	2.6	0.90	8571
	10.75	29.8	2.35	1.10	3607
	11.2	35.1	1.0	0.1	4000
	11.25	35.9	6.8	2.50	16667
	11.25	35.5	0.85	0.16	914
	11.5	38.0	3.2	1.18	7612
	11.75	40.75	7.42	2.20	10731
	11.75	38.0	1.2	0.15	1500
	11.75	42.75	9.2	3.4	13076
	11.75	34.0	5.7	0.95	3166
	11.75	34.45	6.6	2.0	8163
	12.0	41.55	6.95	2.60	14857
	12.25	37.61	1.25	0.55	1834
	12.50	44.5	2.8	0.90	8571
	12.5	50.7	4.0	0.45	1800
	13.0	51.4	4.6	1.35	6750
	13.0	50.8	2.6	0.76	3040
	13.25	55.6	2.35	0.60	2400
	13.25	53.2	5.7	2.68	12761
	13.50	55.2	3.5	1.23	7935
Mean	11.95	40.97	4.06	1.35	6834.85
Standard deviation	0.90	8.84	2.39	0.81	4697.5
Standard error	0.19	1.96	0.53	0.18	1025.65
Variance	0.77	78.14	5.71	0.66	21015874

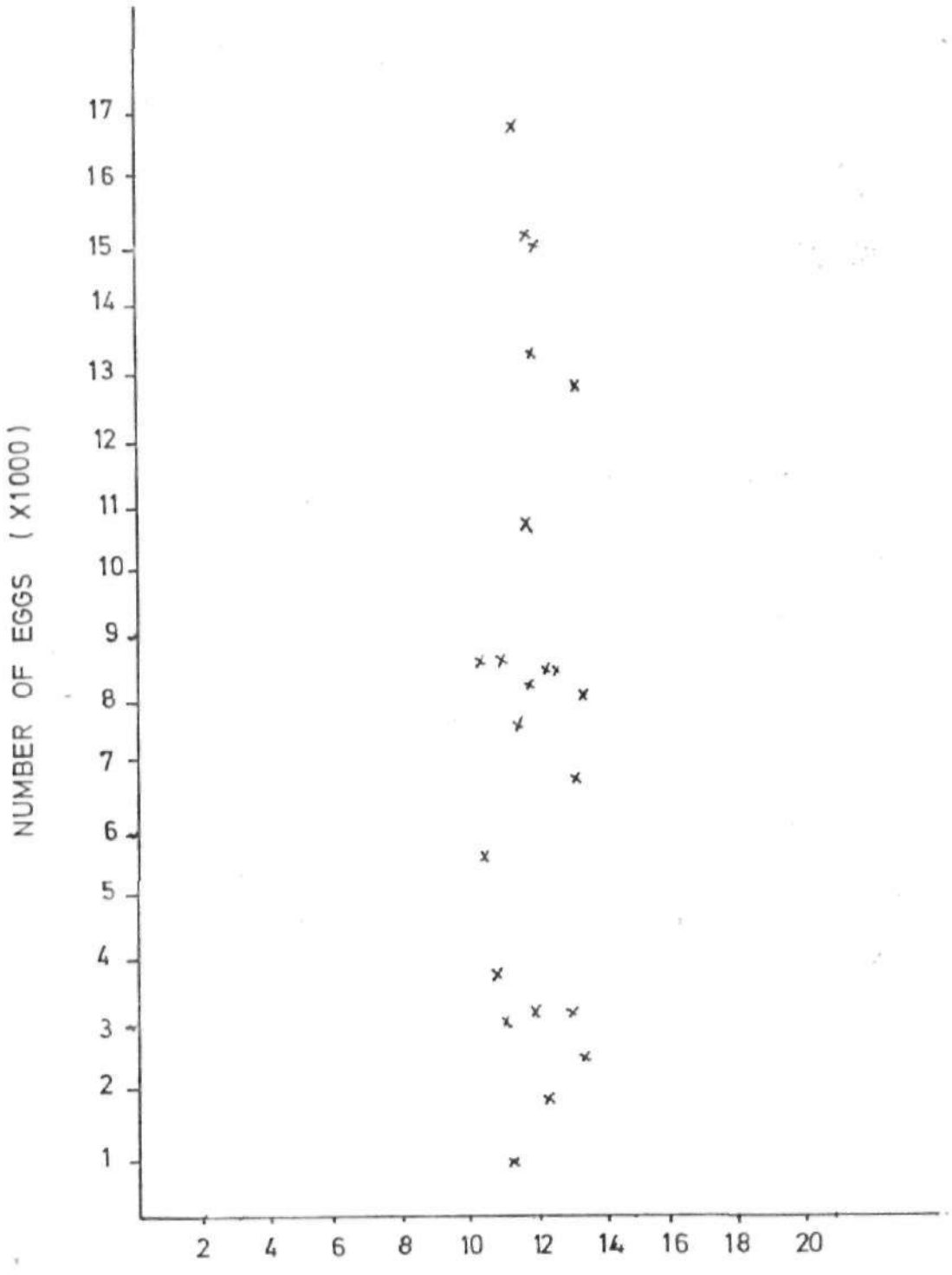


FIG. 24 RELATIONSHIP BETWEEN STANDARD LENGTH AND FECUNDITY OF ALESTES NURSE

relationship. This indicates that fecundity did not increase linearly with the fish weight (Figure 25).

Table 23 shows the fecundity of Alestes macrolepidotus in Zaria area. The estimated fecundity ranged between 1138 and 8923 with a mean of 5980.5 (SD ± 2592); Table 24. The relationship between the fish standard length and the number of eggs is shown in Figure 26. It could also be seen that the smallest fish did not necessarily have the lowest fecundity and fecundity did not increase linearly with either increase in length or weight of the fish; Figure 27.

The fecundity of Hydrocynus vittatus could not be estimated because the few specimens got were not with matured eggs.

Apart from the fish species of the family Characidae studied, other species of fish are also found in Zaria. These include Tilapia species, Hemichromis bimaculatus, Hyperopisis bebe; Schilbe mystus, Mormyrus macrophthalmus, Eutropius niloticus, Chrysichthys nigrodigitatus, Synodontis schall and Malapterurus electricus. Others include Bagrus bayad, Lates niloticus, Gnathonemus species, Clarias species Labeo species and Auchenoglanis species.

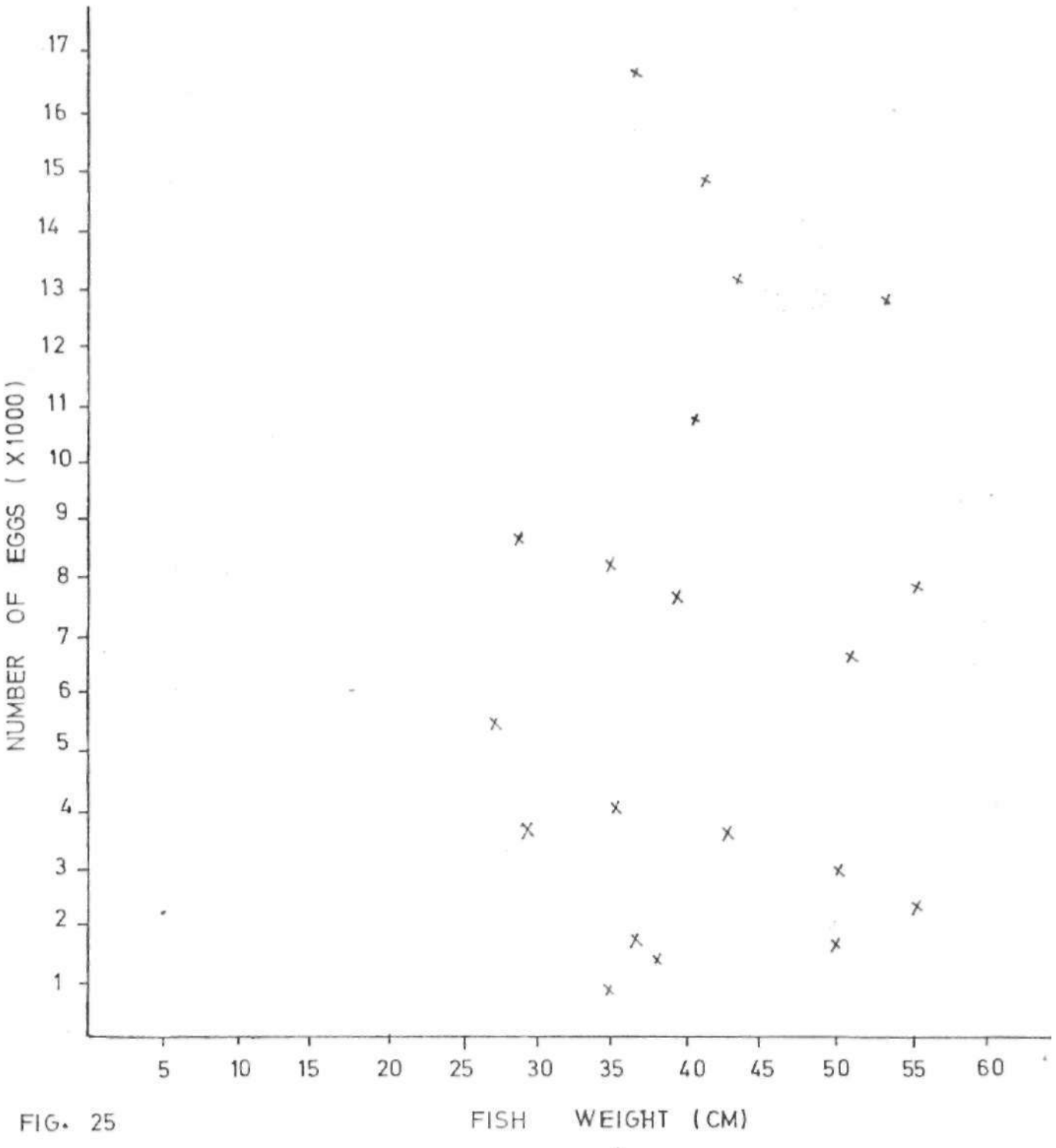


FIG. 25 RELATIONSHIP BETWEEN WEIGHT AND FECUNDITY IN ALESTES NURSE

TABLE 23 FECUNITY OF Alestes macrolepidotus IN ZARIA AREA

	Standard length (cm)	Fish weight (g)	Gonad weight (g)	Total dried egg weight (g)	Fecundity
	12.5	50.5	12.0	2.10	7000
	13.0	60.5	2.58	1.35	5400
	13.5	62.2	6.8	0.56	5600
	14.0	69.0	12.1	1.45	7667
	14.0	62.0	8.3	0.37	1138
	14.5	72.6	9.65	2.60	8125
	14.5	83.7	2.65	0.70	2333
	14.75	83.2	5.1	1.85	5285
	15.25	91.5	2.8	2.50	8334
	17.0	120	15.5	2.90	8923
Mean	14.3	75.52	7.64	1.63	5980.5
Standard deviation	1.25	20.06	4.67	0.89	2590.56
Standard error	0.397	6.34	1.48	0.28	819.79
Variance	1.42	362.25	19.69	0.79	6039935.5

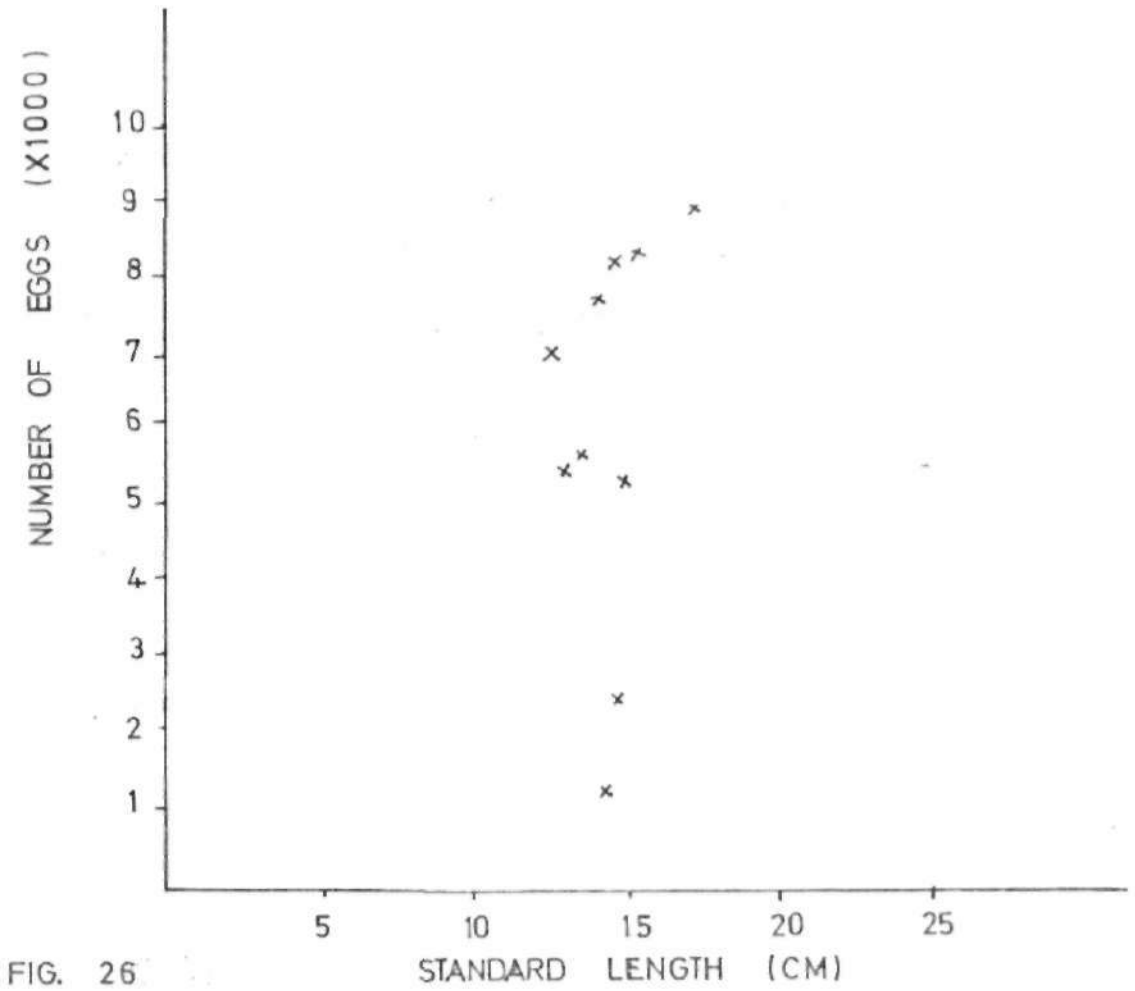


FIG. 26 RELATIONSHIP BETWEEN STANDARD LENGTH AND FECUNDITY OF ALESTES MACROLEPIDOTUS

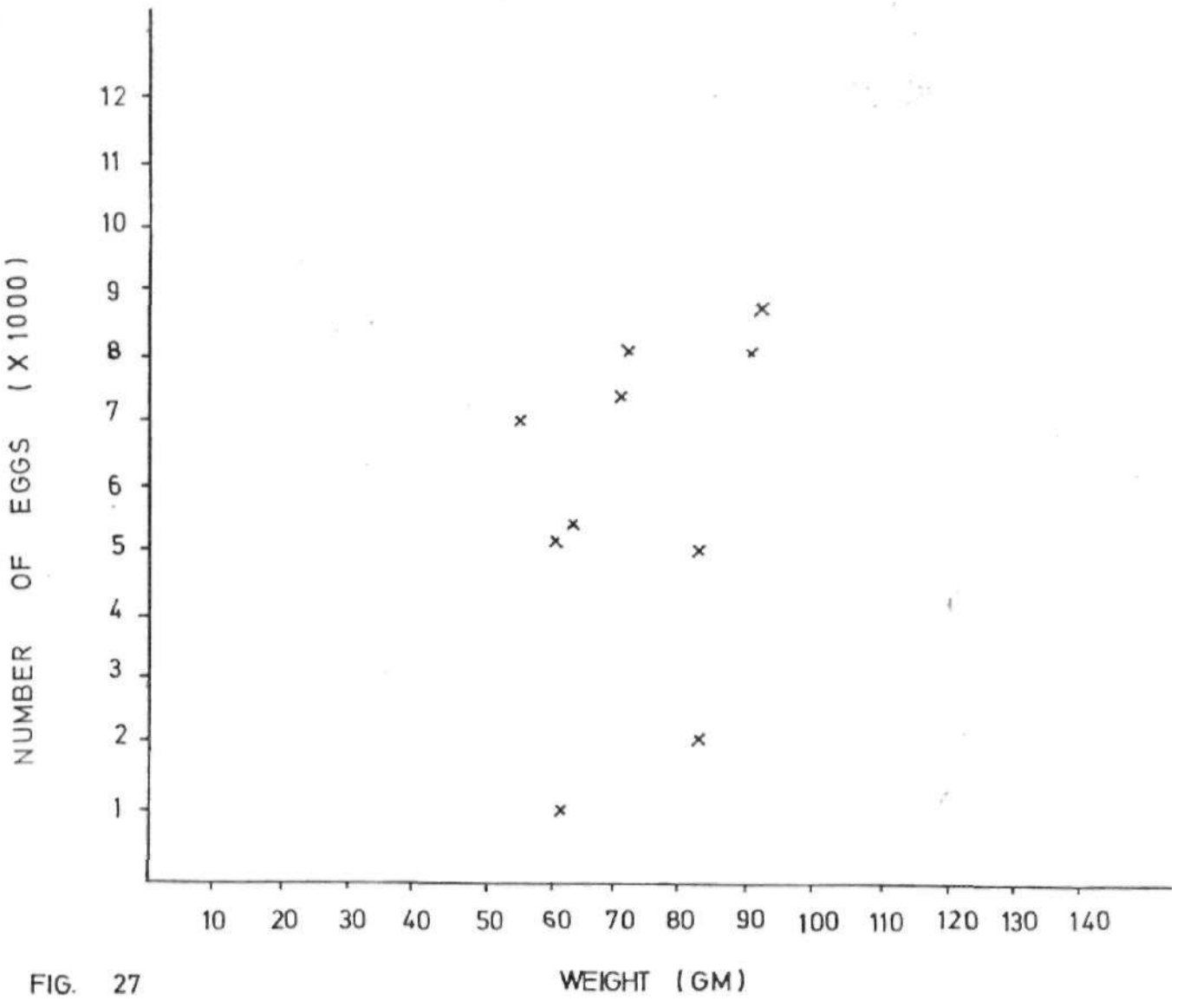


FIG. 27

RELATIONSHIP BETWEEN WEIGHT AND FECUNDITY OF ALESTES MACROLEPIDOTUS

TABLE 24 THE FECUNDITY OF THE SPECIES OF THE FAMILY CHARACIDE IN ZARIA AREA

Species	Number examined	Standard length (cm)	Range of fecundity estimate	Mean of fecundity estimate	Standard deviation
Alestes nurse	21	10.5-13.5	914-16667	6834.8	4697.5
Alestes macrolepidotus	10	12.5-17.0	1138-8923	5980.5	2590.5
Hydrocynus vittatus	4	17.2-26.0	-	-	-

CHAPTER FOUR

DISCUSSION

The analysis of the size ranges of Alestes nurse and Alestes macrolepidotus shows variations and differences in the sizes of both males and females. In both species the females were significantly larger than the males. These observations seem to agree with the records of Ben-Tuvia (1960), Bhatnagar (1963), Qasim and Qayyum (1964) and Reynolds (1973b) all of whom have noticed that in many fishes the males grow smaller and mature at a smaller size than the females. Olatunde (1983) gave various reasons which may affect the size and sex distribution of captured fish as follows:-

(a) The type of fishing gears used for capture

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

(c) Structural and physiological adaptations which make one fish more vulnerable to catch than others and

(d) Analysis based on market samples might not give a true picture of the size ranges present in the wild population.

Any or some of the limitations cited above could be responsible for the variations in sizes which were obtained in the samples.

The length frequency showed normal distribution curves in both species. The growth pattern of the different fish species under investigation was indicated by the value of

"b" in the length-weight regression analysis. When the value of "b" is 3 or close to 3, this indicates an isometric growth compared to values below or above 3 which indicate allometric growth; provided that the specific gravity of the body remains constant (Tesch 1968). The regression analysis showed that the males and females of Alestes nurse exhibited an allometric growth respectively while the males and females of Alestes macrolepidotus exhibited an isometric growth respectively.

It has been observed that certain factors such as an increase in weight due to intake of water or food and gonads; seasons of the year, and time of the day when the fish was captured; loss of weight due to food regurgitation and spawning can among other things affect the "b" values (Lagler, 1952). Although in most cases, samples are often pooled together for calculation, Vasnetsov (1953) had shown that fish during their development pass through several stages or stanzas each of which may have its own length-weight relationship.

The mean condition factor indicated that the fish species were in good condition throughout the period of investigation. There was no marked variation in the condition factor with the seasons of the year, sex or increase in length. Sexual differences, age, changes in the seasons, gonad maturity levels of the fish, the length and weight of the fish, the nutritional level of the fish or stomach fullness and the maturity level of the fish can influence the values of the condition factor "K" (Lagler, 1952).

It seems that there are two populations which can be interpreted in terms of year classes or age groups. (Figures 16 and 17). Existence of year classes may be due to differences in habitat where sizes or growth rates might differ.

There were differences in the mean 'K' values for males and females of Alestes nurse and Alestes macrolepidotus at standard lengths between 4-9cm and 10-16cm. The mean condition factor was higher between standard lengths of 4-9cm when compared with the mean condition factor at standard lengths between 10-16cm. This could mean that at standard lengths between 4-9cm the fish were in good condition and grew better.

The mean condition factor dropped very low in March and October. (Tables 12, 13, 14, 15) for both Alestes nurse and Alestes macrolepidotus. This might be caused by body readjustment to seasonal changes, (from dry to rainy season and vice versa.) which led to less activity and less feeding, low metabolism and hence a drop in the mean 'K' value.

The contents of the stomachs were analysed using the "points" method and frequency of occurence. Hynes (1950) reviewed the methods used in the studies of the food of fishes. However the advantages of the Points method are as follows:-

(a) It is rapid and easy

(b) There is no special apparatus needed for the measurement

(c) It is not influenced by frequent occurence of a small organism in small numbers nor of heavy bodies.

(d) It doesn't involve trying to count large number of small and broken organisms.

One of the disadvantages of this method is that it is subjective. The investigator may be prejudiced in his allotment of points.

Several authors have used or slightly modified the Points method in the analysis of diets of fish and obtained satisfactory results. Such authors include Swynnerton and Worthington (1940) who studied the food of fish in Haweswater (Westmorland), Frost (1943) who studied the natural history of the minnow, Phoxinus phoxinus; Van Someren (1946) who studied the food of young blue gill sunfish Lepomis macrochirus; and Fagade (1979) who studied the biology of two species of Tilapia from the Lagos Lagoon in Nigeria.

The characins exhibit diversity of variations in their feeding habits. Among the specialized structures used in feeding are the gill rakers and teeth of diverse structures. Irvine (1947) had noticed that the teeth of Alestes has ten outer and eight inner teeth with thick bases and cusped ridged crowns. Lewis (1974) reported that there is sexual dimorphism in the head region of the male and female Hydrocynus species. The teeth are compressed and spaced in one row in each jaw. The observations by Irvine (1947) and Lewis (1974) agree with the observations made on Hydrocynus vittatus seen in Zaria. It is assumed that the teeth of the different species of Alestes were used to bite off and ingest plant materials, vegetation, animal organisms blue green and green algae. Hydrocynus vittatus used its teeth to prey upon other fish. Jackson (1961) had observed that Hydrocynus vittatus almost invariably swallows prey whole and because of this habit must of

necessity prey upon fishes much smaller than itself.

The natural food of fishes comes from the many groups of plants and animals that inhabit waters as well as others that do not. Daget (1954), Jackson (1961), Blache (1964), Reynolds (1967) and Lewis (1974) have all studied the food of the different species of the genus Alestes.

Owing to differential digestion and other factors, it is not possible to identify all stomach contents with equal precision. It follows that recorded figures for occurence may often fall short of values and therefore may not give an accurate picture of the food materials in the wild.

The food of Alestes nurse and Alestes macrolepidotus in Zaria was found to be primarily made up of seeds and fruits, plant remains or fragments, detritus and insects. Occasional occurences of green and blue-green algae together with some crustacea and other fish were recorded. The food of Hydrocynus vittatus was primarily other smaller fish species.

Vaas (1954) had noted that the fallen fruits and leaves are food for certain fish species and that in the flood the leaves of trees and shrubs may be eaten off the trees. In the annual report of the East African Fisheries Research Organisation (1958) it has been reported that a rich source of food for fishes is the rotting tree trunks and branches which harbour abundant insects and insect larvae. Hickling (1961) had observed that partially digested plants whether by bacteria, protozoa or fish seem a common food for fishes. Some, he said, had a great ability to ingest great quantitites of vegetation. Reynolds (1967) reported that the

food of the family Characidae was made up mainly of terrestrial insects, aquatic insects, submerged macrophytic terrestrial plants and small amounts of plankton.

Alestes nurse is considered a surface feeder (Petr 1974). Graham (1929) found plants, insects, fish and molluscs in the diet of Alestes nurse and concluded that the diet was varied. Daget (1954) found that the young Alestes nurse of the River Niger in the flood plains fed on insects and seeds. In Alestes macrolepidotus it was noted that insects occured as food supplements otherwise the food of this species was made up of roots, seeds and fruits, bark and tree leaves evidently grazed off the flooded ground. Whitehead (1969) found that the food of Alestes nurse was dominated by seeds, aquatic and terrestrial insects both easily available during the rising water. Also Whitehead (1969) noted that the diet of the young Alestes fish was mixed consisting mainly of aquatic and terrestrial insects and higher plants. The present results of the food of the different species in this family agree with most of the above findings.

Hickling (1961) has observed that some fish feed directly or indirectly on detritus or broken down organic matter. He also noted that detritus are soft bottom deposits and are rich in crude protein. There were therefore some nutritional benefits derived from the intake of organic deposits.

Filamentous algae were sometimes represented in the diet. The blue green algae may not be normally digested by many fish. Fish (1955) had reported that

Tilapia esculanta and Tilapia variabilis in Lake Victoria ingested green and blue green algae which they were unable to digest. These algae pass through the gut so entirely unharmed that cultures may be made from blue green algae in the faeces. Moriarty (1973) had observed that algae were digested by the herbivorous species of Tilapia in Lake George, Uganda.

Many of the Alestes species had empty stomach. This might be due to capture techniques. Some capture techniques for fishes provide an opportunity for the fish to regurgitate its food leading to empty stomachs.

In the few specimens of Hydrocynus vittatus observed it was seen that the food items were fish. This means that Hydrocynus vittatus is predacious. Predation by Hydrocynus has prompted much discussion in the past (Fryer, 1965). Lagler et al (1962) have recorded that digestion by highly specialized predatory fishes is reported to be rapid. Munro (1967) had reported that under tropical condition, Hydrocynus vittatus may take less than a day to digest a small fish. Lewis (1974) has noted that a high incidence of empty stomachs is common in carnivorous fish during most of the year.

Hydrocynus vittatus locates its food by sight and most of its feeding will take place during the day. It then would follow that the fishes without food were those caught before dawn and had digested the food taken the previous day,

It is a biological phenomemon for fish to change its feeding habits with the time of the day and season. Keast and Welsh (1968) and Elliot (1970) have found or reported that diet and feeding intensity can very during the diurnal cycle. The characin fishes in Zaria show similar seasonal changes in feeding habits. The seasonal

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fluctuations may be probably due to actual variations in the numbers of the various food items in the habitat or partly to varying relative availability. The feeding intensity of all the Alestes species was high during the period of high water level (June to October) when variety of food materials were available while low feeding intensity was recorded during the period of low water level (March to May; November to December) when there were less variety of food materials.

Blanc et al (1955) have observed that the fisheries of the Delta of the Middle Niger are rich inspite of the infertile water because the fish find a very great feeding area in the flood plain when the river is high. Hickling (1961) observed that an important part of the food of fish may not be derived from the water at all but from the land when the river rises in the flood and overspreads the flood plains or valleys so that the fish has an access to a vast store of food of all kinds. Fagade (1971) has noted that variations in the stomach contents of fish confirm the accepted fact that the food of fish varies with the seasons depending on what is available and on the habitat of the fish. Moriarty and Moriarty (1973) reported that major herbivorous fish species adopt phytoplanktonic feeding after a period of Zooplanktonic or omnivorous feeding as a fry.

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There were no marked changes in the food composition and feeding habits of the different sizes and age groups of the different species of the characins in Zaria. This might be due to the fact that a very large number of small fish species was not examined.

Reproduction in many West African freshwater fishes appear to occur during definite seasons, often shortly after the onset of the rains (Daget 1954). There was seasonal variation in the number and sex ratio of the species of the family Characidae in Zaria. Differences in the numbers or relative abundance of the different species during the investigation may be caused by divergencies in their breeding patterns. The variations in sex ratio from time to time might be due to the following factors:-

(a) Genetic factor

(b) Seasonal and breeding migrations and

(c) Vulnerability of one sex to capture.

There were more females than males during the breeding season. The works of Olatunde (1978a) on Schilbeidae fishes and Fagade (1979) on Tilapia melanotheron agree with this assertion. Mathur (1964) on Hilsa ilisha has reported a preponderance of females during the breeding season. Fryer and Iles (1972) and Olatunde (1978b) have suggested that females may be more in number than the males during the

breeding season because more females may be expected to associate with the males where there are few males in the population. Sex ratio divergencies might also be due to sampling variations, behaviour patterns of fish, habitat preferences or school formation.

Fecundity is known as the number of eggs in the female prior to the next spawning period (Bagenal 1968). Bagenal (1966) had reckoned that fish species exhibit wide fecundity variations even among fish of the same length, weight and age. The fecundity of the fish species studied varied from a few eggs (914) in one Alestes nurse to many thousands of eggs (16,667) in another; and (about 8,923) in an Alestes macrolepidotus. Hydrocynus vittatus with eggs was not seen. It was observed that specimens with standard lengths below 13cm showed more variations in their fecundity while specimens whose standard lengths were above13cm exhibited less variation in their fecundity.

One explanation advanced often for the fecundity variability in fish attributes it to different quantities of food consumed by fish. A number of papers putting foward this suggestion are quoted by Nikolsky (1962) and Woodhead (1960). It may be assumed that most of the better fed fish grew faster, matured and contained significantly more and smaller eggs. Some of the results agree with the conclusions of Scott (1962) who also found that reduced diet led to a lower percentage of maturity and lower fecundity in the rainbow trout, Salmo giardneri although he suggested that something

other than diet restriction predetermined egg size.

The biggest specimen did not record the highest fecundity and vice versa. Nikolsky (1963) has reported that the number of eggs carried by matured individuals at first gradually increased with age but as selinity approaches, it decreases.

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SUMMARY AND CONCLUSION

Investigations were carried out on some aspects of the biology of the family Characidae in Zaria between the months of March to December, 1983. The fish samples were bought from Zaria main market at least once every week. Two genera with three species were found during the course of investigation. These were Alestes nurse Ruppell; Alestes macrolepidotus Cuvier and Valenciennes and Hydrocynus vittatus Castelnau. Alestes nurse was the most abundant while Hydrocynus vittatus was rare. The females are bigger than the males. The length-weight relationship showed that the weight of the fish increased as the length increased. The length-weight regression analysis showed that all the species of Alestes macrolepidotus exhibited isometric growth while Alestes nurse exhibited an allometric growth.

The fish were in good condition as was shown by the mean condition factor throughout the period of investigation. There were no variations in the condition factor with the seasons of the year or length of fishes. The species exhibited little diversity in feeding habits. Alestes species were primarily herbivorous. They fed also on other food items ranging from algae, insects, to fish. The feeding intensity pattern varied from season to season. Variations occured in the sex ratio from season to season. There were generally more

females than males in all the months during the period of investigation. Fecundity varied from one individual to another. Alestes nurse were more fecund than Alestes macrolepidotus. The highest fecundity was not recorded for the largest fish and vice versa. These results compare favourably with those obtained by the few workers already cited in this work.

Although this work is a preliminary observation, it might act as an incentive for other researchers and a foundation to build future researches on the family Characidae in Zaria area upon

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APPENDIX 1

MONTHLY MEAN CONDITION FACTOR OF *Alestes nurse* (Females)

Month	Total fish examined	Mean total length	Mean standard length	Mean weight	Condition Factor: Mean	Condition Factor: Standard deviation
March	26	13.3	10.6	25.89	1.93	0.44
April	30	10.19	7.73	11.73	2.25	0.204
May	50	15.9	12.48	29.92	2.27	0.48
June	31	16.26	10.08	27.38	2.35	0.43
July	72	9.33	6.30	12.28	2.64	0.60
August	72	14.23	11.02	38.0	2.07	0.63
September	41	12.63	9.74	25.75	2.65	0.47
October	44	11.92	8.46	18.03	2.07	0.63
November	41	10.25	7.62	15.74	2.97	0.83
December	30	11.55	8.80	19.92	2.62	0.72

APPENDIX 2

MONTHLY MEAN CONDITION FACTOR FOR *Alestes nurse* (Males)

Month	Total fish examined	Mean total length	Mean standard length	Mean weight	Condition factor: Mean	Condition factor: Standard deviation
March	8	11.17	8.38	18.25	2.18	0.42
April	10	11.19	8.53	16.33	2.48	0.81
May	14	12.7	9.72	24.04	2.45	0.39
June	11	9.37	7.61	12.17	2.47	0.41
July	13	12.66	8.83	25.03	2.57	0.38
August	26	9.38	7.2	11.07	2.64	0.62
September	15	11.98	9.11	20.25	2.38	0.30
October	12	8.66	6.61	7.45	2.75	0.38
November	20	14.47	11.27	40.74	3.06	1.45
December	10	14.47	11.27	40.74	3.06	1.45

APPENDIX 3

MONTHLY MEAN CONDITION FACTOR FOR *Alestes macrolepidotus* (Females)

Month	Total fish examined	Mean total length	Mean standard length	Mean weight	Condition factor	
					Mean	Stanard devition
March	17	13.83	10.20	27.22	2.06	0.3
April	20	12.37	10.01	21.8	2.11	0.9
May	22	14.34	11.10	34.95	2.36	0.3
June	13	13.88	11.3	36.8	2.34	0.7
July	21	13.73	10.01	37.42	2.27	0.5
August	16	19.95	10.64	31.4	2.36	0.2
September	14	13.95	10.79	32.9	2.27	0.72
October	22	12.55	10.0	41.18	2.33	0.59
November	19	14.43	11.06	38.48	2.50	0.32
December	14	14.0	11.38	42.0	2.79	0.47

APPENDIX 4

MONTHLY MEAN CONDITION FACTOR FOR *Alestes macrolepidotus* (Males)

Month	Total fish examined	Mean total length	Mean standard length	Mean weight	Condition factor: Mean	Condition factor: Standard deviation
March	5	12.44	9.25	27.04	1.96	0.47
April	6	11.35	8.9	18.31	2.53	0.84
May	11	12.80	10.05	24.75	2.24	0.30
June	3	14.1	11.13	33.36	2.41	0.23
July	8	12.66	8.83	25.03	2.57	0.38
August	9	14.78	11.34	37.78	2.38	0.59
September	8	14.37	11.21	39.68	2.53	0.49
October,	10	14.61	12.1	51.61	2.77	0.37
November	7	15.1	11.42	37.78	2.5	0.56
December	5	15.1	11.38	38.14	2.5	0.56

APPENDIX 5

NUMERICAL VALUE AND PERCENTAGE MONTHLY FEEDING VARIATION OF Alestes nurse

Month	Total No fish caught	No. with food	%	No.with empty stom-ach	%	Plant remains	%	Detu-tis	%	Insect remains	%	Cuest-acea	%	Green algae	%	Fish	%
March	34	24	70.5	10	29.41	20	58.8	1	2.9	3	8.8	-	-	-	-	-	-
April	40	8	20.0	32	80.0	4	10	-	-	-	-	-	-	1	2.5	-	-
May	64	25	39.06	39	60.93	10	15.6	8	12.5	8	12.5	2	3.12	1	1.56	-	-
June	42	23	54.76	19	45.23	10	23.8	6	14.2	7	16.6	1	2.3	-	-	-	-
July	85	38	44.70	47	55.29	27	31.76	8	9.41	9	10.58	-	-	5	5.88	-	-
Aug.	98	35	35.71	63	64.28	30	30.6	13	13.2	7	7.14	-	-	3	3.06	-	-
Sept.	56	27	48.21	29	51.78	26	46.42	-	-	11	19.64	-	-	-	-	-	-
Oct.	56	21	37.5	35	62.5	19	33.92	3	5.35	4	7.14	-	-	-	-	-	-
Nov.	61	29	47.54	32	52.45	20	32.78	10	16.39	2	3.27	-	-	-	-	-	-
Dec.	40	14	35.0	26	65.0	7	17.5	6	15.0	2	5.0	-	-	-	-	3	7.5
Total	576	244		332		173		55		53		3		10		3	

APPENDIX 6

NUMERICAL VALUE AND PERCENTAGE OF MONTHLY FEEDING VARIATIONS OF *Alestes macrolepidotus*

Month	Total No. fish caught	No.with food	%	No.with empty stomach	%	Plant remains	%	Detu-tis	%	Insect remains	%	Cuest-acea	%	Green algae	%	Fish	%
March	22	14	63.6	8	36.3	11	78.5	3	21.4	-	-	-	-	-	-	-	-
April	26	12	46.15	14	53.8	12	100	-	-	-	-	-	-	-	-	-	-
May	33	15	45.45	18	54.5	8	53.3	2	13.3	6	40	-	-	-	-	-	-
June	16	7	43.7	9	56.2	6	37.5	2	12.5	-	-	-	-	-	-	-	-
July	29	18	62.06	11	37.9	3	10.3	12	41.3	2	6.89	-	-	12	41.3	-	-
Aug.	25	10	40.0	15	60.0	7	28.0	5	20.0	1	4.0	-	-	-	-	-	-
Sept.	22	12	54.5	10	45.4	10	45.4	2	9.09	-	-	-	-	-	-	-	-
Oct.	32	18	56.25	14	43.7	11	34.3	2	6.25	3	9.37	-	-	-	-	-	-
Nov.	26	13	50.0	13	50.0	9	34.6	5	19.2	-	-	-	-	-	-	-	-
Dec.	19	8	42.10	11	57.8	5	26.3	3	15.78	2	10.51	-	-	-	-	1	5.26
Total	250	127		123		71		26		14		0	-	12	-	1	

APPENDIX 7

COMPARISON OF THE FECUNDITY OF FAMILY CHARACIDAE IN ZARIA WITH SOME CATFISHES (Family Mochokidae) IN LAKE KAINJI

Fish Species	Number examined	Standard length (cm)	Range of estimated fecundity
Alestes nurse	12	10.5-11.75	914-16667
Alestes macrolepidotus	10	12.5-17.0	1138-8334
Physalia pellucida	15	6.2-11.6	1204-3923
Schilbe mystus	2	16.5-16.6	9037-9088
Synodontis nigrita	35	15.0-26.0	952-11400