A STUDY OF THE PREVALENCE OF PARASITIC INFECTION AND ASPECTS OF THE BIOLOGY OF SOME MEMBERS OF FAMILY CICHLIDAE IN ZARIA DAM, NIGERIA

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A thesis submitted to the Postgraduate School, Ahmadu Bello University, Zaria in partial fulfillment of the requirements for the degree of:

MASTER OF SCIENCE IN FISHERIES

(M.Sc Fisheries)

Department of Biological Sciences

Faculty of Science

Ahmadu Bello University, Zaria,

Nigeria

DECEMBER, 1987

D E D I C A T I O N

This thesis is dedicated to

Late Alhaji Ahmed Musa

and to my

Late Grand Parents.

DECLARATION

I hereby declare that this thesis was written by me and that it is a true record of my own research work.

Tata Shekarau Omar: _____

December, 1987.

C E R T I F I C A T I O N

This thesis entitled "A study of the Prevalence of Parasitic infection and aspects of the Biology of some members of Family Cichlidae in Zaria Dam, Nigeria" by TATA SHEKARAU OMAR meets the regulations governing the award of the degree of Master of Science in Fisheries (M.Sc Fisheries) of Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

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ACKNOWLEDGEMENTS

The author is grateful to Allah for His guidance throughout the research period.

I wish to express my profound gratitude and appreciation to my Supervisors, Dr. Z. Hussain and Professor A.A. Olatunde, for their assistance in the identification of specimens, helpful suggestions, moral and material support and also their patience and understanding to the successful completion of this research work. I am indeed grateful. The help rendered by Mr. S.A.S. Olorunji (Biometrician) of N.A.P.R.I., A.B.U. with the computer analysis is greatly acknowledged. I am also grateful to Miss T.L. Aken'ova of S.B.S, A.B.U. for the materials she made available.

I am also indebted to my numerous friends for the help they rendered and also the use of their vehicles, to Zaria Dam throughout the research period. The technical assistance rendered by Messrs Ansah, Cletus, Solomon and Paul of the Department of Biological Sciences, is greatly acknowledged. My thanks to Mr. Timothy A. Obogbare of Veterinary Medicine who typed the thesis.

Finally, I am grateful to my parents for their encouragement and also to the Bauchi State Government for the scholarship awarded to me. I am most grateful.

Tata S. Omar

December, 1987.

A B S T R A C T

The incidence and distribution of Parasites and some aspects of the biology such as size distribution, Length-weight relationship, condition factor and sex ratio of 567 specimens comprising 308 Oreochromis niloticus, 147 Tilapia zillii, 73 Sarotherodon galilaeus and 39 Hemichromis bimaculatus (Family: Cichlidae) from Zaria dam were investigated for one year between July 1996 to Dune 1987.

Ninety-seven fish specimens (17.1%) were found infected by Protozoan Henneguya sp. (Cysts) recovered from the gill filaments; Clinostomum sp. metacercariae (digenetic trematode) from the branchial region, Diplostomatid cysts (digenetic trematode) from the abdominal cavity, developing Cyclophyllidean cestode from the intestine, Ascarid worm (Nematode) from the gonad region, Neoechinorhynchus sp. (Acanthocephala) from the epithelial lining of the intestine and an unidentified Leech (Hirudinea) recovered on the body surface. Oreochromis niloticus was found to be most infected by parasites with 22.4 percent infection rate. Followed by Tilapia zillii and Sarotherodon galilaeus with 15.65 percent and 6.85 percent infection rate respectively. Hemichromis bimaculatus was found free from parasites. No pathological symptoms or mortality as a result of infection by these parasites were observed in the hosts.

On the size distribution of the species however, the males of Qreochromis niloticus and Tilapia zillii were found to be larger in size than the females, but not in Sarotherodon galilaeus. The 'b' values obtained for all the four species in Length-weight regression analysis, was found to be less than 3. This indicated an allometric growth. All the species were in good condition and their monthly mean condition factor was high throughout the period of study. The sex ratio was approximately one to one.

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CHAPTER ONE

1.0 INTRODUCTION

The continuous creation of dams and impoundments has inevitably led to fisheries activities and irrigation in Nigeria. The fishery industry occupy a unique position in the agricultural sector of the Nigerian economy and Nigeria is reported to be the largest consumer of fish and fishery products in Africa (Iyamabo, 1980). Fish contributes about 40 percent of the animal protein intake among the average Nigerians and only 70 percent of the total demand of fish is met by domestic production. The need for increased fish production is therefore inevitable. (Iyamabo, 1980).

Some of the problems faced by the fishery industry in Nigeria today are lack of good fisheries management policies, inadequate number of trained personnel and lack of infrastructural facilities for research in areas such as, fishery genetics, hatchery technology, fish nutrition, fish physiology, fishery biology and Parasitology.

Our knowledge of fish parasites, diseases and pathology, is inadequate and require due attention. Available documented information predominantly deals with taxonomic studies of fish parasites based on occasional collections by individuals and from museum material. Detailed regional surveys of fish parasites were carried out only in a limited number of water systems like the Volta, the great lakes of eastern and Central Africa, Sudan Nile, Lake Chad, and the Niger. All these surveys were not comprehensive, but rather were

restricted to one or few taxa of parasitic organisms (Paperna, 1980).

The importance of fish parasites cannot be over-emphasised because of the damage they cause to fish species. Parasite devalues the aesthetic quality and palatability of fish, hence lowers their economic value. They also cause inflammatory response to the fish, characterized by an extensive proliferation of fibrous connective tissue elements (Joy and Jones, 1973). Similarly, heavy infection of protozoan parasite like Ichthyophthirius multifiliis on the epithe lium of the skin and gills disturbs the respiratory and excretory function of the organs involved resulting into fish mortality (Hines and Spira, 1973). The effects of Cestode, Ligula intestinalis on cyprinids showed distention of abdomen with loss of streamlining, camouflage and separation of scales thus increasing susceptibility to bacterial and fungal disease; inhibition of gonadal development with associated pitutuary changes; decrease in liver size with comittant reduction in fat and protein metabolism (Sweeting, 1977). Paperna and Vanas (1983) reported that heavy infection of Chilodonella hexasticha (Kiernik) in Cichlids resulted in emaciation and mass mortalities. Infection of the gills caused necrosis and consequent degeneration of the branchial epithelium and occulusions of the capillaries. Eye loss in Sarotherodon galilaeus and Oreochromis niloticus as well as skin ulcerations associated with mortality in Clarias sp has been reported from Lake Kainji, Nigeria (Obiekezie et al., 1985). Other debilitating effects of the infection includes loss of weight, reduced spawning capacity and decreased feeding activities in fishes.

In view of the foregoing harmful effects of Parasites on fish, coupled with the fact that studies on the parasite fauna and the biology of the Family Cichlidae are limited, the present research was initiated. To determine the occurrence and distribution of parasites infecting members of the fish Family Cichlidae. To study some aspects of the biology of the Family such as size ranges, length-weigth relationships, condition factor and sex ratio of the species.

CHAPTER TWO

LITERATURE REVIEW

In Nigeria, however, Fryer (1963) recorded Lamproglena monodi from Tilapia galilaea caught in River Sokoto around Birnin Kebbi, Nigeria. Fryer (1963) again examined Cichlid fishes representing the genus Tilapia for the prevalence of crustacean parasites. The copepod, Lamproglena monodi Capart, was recovered from Tilapia lepidura (Boulenger), Tilapia galilaea (Artedi), Tilapia zillii (Gervais), Tilapia boulengeri (Pellegrin), Tilapia tholloni (Sauvigny) and Oreochromis niloticus. On the other hand, Argulus africanus Theile, was found to infect Tilapia variabilis (Bounlenger) while Argulus rhipidiophorus (Monodi were found to infect Tilapia leucosticta (Trewavas).

Two years later, in their separate study, Awachie (1965) and Ukoli (1965) recorded some parasites in Lake Kainji.repor Awachie (1965) examined 877 fish involving 14 families and 67 fish species. He recovered among the trematodes Aspidogastrids from the eye lens, Paramphistomate fluke, metacercariae of Clinostomum and Euclinostomum. Other parasites recovered were nematodes (Ascaridate), Neoechinorhynchus sp., Palaeacanthocephalan sp. and aquatic mites. On the other hand, Ukoli (1965) examined 1,143 fish species representing 13 families for prevalence of parasites. He observed that 40 percent of the fish examined were infected with nematodes,

37 percent with trematode, 20 percent with cestodarie, 15.5 percent acanthocephalan and 13.5 percent by cestodes.

Fryer (1967) studied copepod parasites infecting Cichlid fishes in Central Africa. His findings revealed the occurrence of Lamproglena monodi Capart, Ergasilus sarsi Capart, Ergasilus cunningtoni Carpart, Ergasilus kandti VanDouwe and Ergasilus latus Fryer.

Paperna and Thurston (1968) examined fish species namely, Barbus altianalis Synodontis victoriae, Schilbe mystus, Eutropius niloticus, Physalia pellucida, Alestes nurse, Clarias mossambicus and Bagrus docmac, from Uganda for monogenetic Trematodes and described five new species; Neodactylogyrus spinicirrus, Ancyrocephalus synodontii, Schilbetrema quadricornis, Schilbetrema acornis, Characidotrema elongata and recorded Quadriacanthus clariadis (Paperna 1961). A year after, Manter and Pritchard (1969) recorded Clinostomatids (digenetic trematode), from Pelmatochromis kingsleyae, Oreochromis noloticus, Auchenoglanis sp., Chrysichthys walkeri, Chrysichthys nigrodigitatus and Clarias sp. collected from Central Africa. Several larval forms of Clinostomum sp. were identified. On the other hand, Paperna (1969a)recovered only monogenetic Trematodes from Cichlid fishes in Uganda and described five new species; Cichlidogyrus brevicirrus, C. haplochromis, C. longicornis, C. sclerosus and C. tubicirrus. Other species recovered were Cichlidogyrus arthracenthus Paperna 1960, C. tiberianus Paperna 1960, and C. tilapiae Paperna 1960. Similar work was carried out by Price et al., (1969a) in South Africa. Two new species of

of monogenean, Cleidodiscus pikei and Cichlidogyrus papernastrema were recovered from the gills of Hydrocynus vittatus (Castelnau) and Tilapia sperrmanii respectively. Price et al., (1969b) also reported Dactylogyrus sp. from Natal cyprinids (African fishes)

Paperna (1969b)examined 622 fish representing 40 species between 1966 and 1968 during a survey carried out in Volta Lake, streams, dams, reservoirs in Southern Ghana. He indicated that 21 percent (52 fish) from Lake Volta were infected with Ergasilids, 1 - 2 percent (3 fish) with Lamprolegna sp. and 0.48 percent (one fish) with the larvae of Argulus sp. He recorded 100 percent infection of Ergasilids in Tilapia heudeloti, while Lernaea was occasionally found in Cichlids from stocked dam reservoirs. In a separate study in Lake George, Uganda, Thurston (1969) investigating copepod ectoparasites recovered Lernaea branimiana on the flanks of large Tilapia and Haplochromis species. The parasite was recovered on the fins, head, mouth and gill chambers of small Tilapia and Haplochromis. He further observed that the life cycle of Lernaea barnimiana was completed on Tilapia and Haplochromis sp. without the involvement of any intermediate host. Later, Thurston (1970) examined the gills of approximately 800 fish from Lakes Victoria, George, Albert, Kyoya, Nile and the fish experimental station at Kajansi, Uganda, for theprevalence of monogenetic Trematodes and Parasitic crustacea. He recovered Cichlidogyrus tubicirrus magnum, C. longicornis gravivaginus, C. tuberianus, C. brevicirrus, C. sclerosus, C. tilapiae, Neodactylogyrus congolensis, Ergasilus lamellifis, Lamproglena monodi, Dolops ranarum, Argulus africanus and Lernaea barnimiana.

Abolarin (1970) examined some freshwater fishes for Trypanosoma from Lake Chad, Lake Kainji, Rivers, streams in Zaria and Panyam Fish Farm, Nigeria. The parasite was recovered from Tilapia zillii (Gervais), Tilapia galilaea (Artedi), Oreochromis niloticus (= Tilapia nilotica) Linnaeus, Tilapia monodi Daget, Hemichromis fasciatus Peters, Pelmatochromis pulcher Boulenger, Gnathonemus senegalensis (Steindachner), Mormyrops deliocious (Leach), Synodontis sp., Auchenoglanis occidentalis Cuvier and Valenciennes, Ctenopoma kingsleyae Gunther, Clarias lazera Cuvier and Valenciennes and Clarias angullaris (Linnaeus). He also recovered Trypanosoma from Tilapia leucostica Trewavas, Tilapia esculenta Graham, Oreochromis niloticus, Haplochromis elagans, Gnathonemus longibarbis Hilgend, Mormyrus kanume Forsk, Synodontis victoriae Worthington, Barbus altinalis Boulenger, Bagrus docmac (Forsk), Clarias lazera, Clarias mossambicus Peters and Clarias carsoni Boulenger, collected from lakes, streams, and fish farms in Uganda and Kenya.

Aderounmu and Adeniyi (1972) examined some fish from a pond at Ile-Ife, Nigeria, to study cestode parasites and found that Clarias lazera was infected with Polyonchobothrium sp., while Hemichromis fasciatus and Oreochromis niloticus were infected with Anomotaenia sp. However, Hemichromis bidorsalis was found free from parasites. About 55 percent of the fish examined by these workers were found to be infected with endoparasites while ectoparasites, protozoans in the blood or any external pathological symptoms were absent.

Khalil and Thurston (1973) conducted a survey of intestinal helminths parasites of Ugandan freshwater fishes. They recovered

the trematodes Eumasenia synodontis, Allocreadium engraulicypridis, Acanthostomum absconditum, Astiotrema reniferum Haplorchoides cahirinus, Clinostomum sp. (metacercariae), Euclinostomum sp. (metacercariae); Cestode Polyonchobothrium clarias, Bothriocephalus sp., Ligula intestinalis, Dilepidid larvae, Proteocephalid procercoid; Nematode Spironoura petrei, Procamallanus laeviconchus, Spirocamallanus sp., Rhabdochona congolensis, Eustrongylides sp. (Larva); Acanthocephala Acanthogyrus tilapiae.

Thulin (1973) recorded Protomonascus sp. in Elops senegalensis from the Gambian coast. The trematode was recovered from the openings of the Pyloric-ceca of the host.

Abolarin (1973) studied gill parasites of fresh water fish collected from Samaru dam, Galma river basin, Shika stream in Zaria and River Niger at Jebba, Kwara State and a stream at Iwo. During these investigations, he described a new species of Myxosporida, Henneguya clariae from the gills of Clarias lazera. Later, Abolarin (1974) examined three species of freshwater Tilapia and described another new species Myxobolus tilapiae.

Shotter (1977) investigated Parasitic copepods in fishes from various streams and ponds in different parts of northern Nigeria. He examined 1,120 fish representing 45 species of 17 families. He recovered Lernae hardingi, Lamproglena wilsoni, Lamproglena werneri, Lamproglena monodi, Paraergasilus sp., Ergasilus cunningtoni, Ergasilus latus, Ergasilus sarsi and Ergasilus sp. from various fish hosts.

Awachie (1976) studied the population dynamics of the parasites of fish in Kainji dam and observed that Copepodid were dorminant in the fishes.

Shotter and Medaiyedu (1978) investigated Parasites of Polypterus endlicheri from River Galma, Zaria. They recorded a digenetic Trematode, Callodistomum sp., fungus Saprolegnia sp., a nematode Spirocamallanus sp. They also recorded a monogenetic trematode Gyrodactylus sp.

Amin (1978) recovered three species of nematodes: Cucullanus barbi from the anterior intestine, Camallanus kirandensis from midgut, Rhabdochona congolensis from posterior intestine; three cestodes: Khawia sp. recovered from midgut, Polyonchobothrium clarias from gall bladder, Bothriocephalus aegyptiacus from intestine; and one acanthocephalan: Acanthosentis tilapiae from small intestine, of some fishes collected from the Nile River at Giza near Cairo, Egypt.

Okaeme (1979) examined Clarias lazera and Hespetus odes, from the reservoir of the international Institute for Tropical Agriculture, Ibadan, Nigeria and found that these two species had lacerations and tumor mass. Similarly, Shotter (1980) examined 213 specimens of Clarias anguillaris, from a small lake and river in the Savannah region of northern Nigeria. He recovered the monogenean Macrogyrodactylus clarii, the digeneans Orientocreadium batrachoides, Opisorchis piscicola and Euclinostomum clarias, the nematode Paracamallanus cyathopharynx and the copepod Ergasilus sarsi.

Okaeme (1980) reported heavy losses of Tilapia zillii stocked in floating cages in Lake Kainji with whitish lesions in the form of postules distributed around the head, operculum, pectoral fins and the gills. He attributed this as the infection of Ichthyopthiriusis with secondary bacterial and fungal invasion resulting in septicemia. Later, Okaeme (1983) collected information on the incidence of fish disease in Nigeria. For this purpose, he sent out questionnaires to all the states fisheries division to gather information on the incidence of fish losses in ponds and reservoirs. The result was discouraging because only Kano and Plateau states responded. One state reported high mortality early in the rainy season most likely due to mineral toxicity while, the other state reported occasional cases of deaths with no apparent cause.

Anyanwu (1983) collected Pseudotolithus sp. off the coast of Lagos and recorded a nematode Philometra translucida from the ovaries of Pseudotolithus senegalensis, Pseudotolithus typus and Pseudotolithus elongatus. Another nematode Contracaecum sp., was observed in the ovaries of two species of Pseudotolithus typus.

Paperna and Vanas (1983) investigated the pathological and histopathological changes induced by infections of Protozoan Chilodonella hexasticha (Kiernik) in wild and cultured Cichlid fishes from Israel and South Africa. They reported heavy infection, emaciation and mortalities.

In Lake Kainji, Okaeme (1984) investigated the prevalence of Protozoa, Fungi and helminth infection in 125 specimens of Tilapia. He recovered Clinostomum tilapiae, Euclinostomum heterostomum, Neprocephalus sp., Acanthocephalus sp., Paramphistomes sp. and Ichthyopthirius multifiliis. The following year however, Obiekezie et al., (1985) investigated the parasitic infections and diseases caused in cultured Oreochromis niloticus, Clarias sp., Sarotherodon galilaeus, Heterobranchus bidarsalis and Tilapia sp. in the hatchery at Kigeria dam and the poultry-Integrated ponds at Kainji Lake Research Institute. Their findings revealed a complete loss of one or both eyes in 15 percent Oreochromis niloticus kept in the hatchery. According to these workers, the eye loss in Oreochromis niloticus might have resulted from the combined effects of Myxobolus sarigi and Saprolegnia sp. infections. Similarly, the gonads of Oreochromis niloticus were also found to be infected with Myxobolus sp which was the first ever reported case from the tropical African region. They described a new species Henneguya pseudolamellaris from Heterobranchus bidorsalis. On the whole, one case of viral infection, four bacterial, one fungal, eight protozoan, one monogenean and three crustracean infections were recorded.

Recently, Ugwuzor (1987) conducted a survey of helminth parasites affecting 14 genera of fish from the Imo river, Nigeria. He recovered Wenyonia virilis Kainji, Wenyonia sp (Trematodes); Procamallanus laeviconchus, Procamallanus sp., Spironoura congolense, Cucullanus sp. and Serradacnitis serrata (Nematodes). The parasites

were found to show some degree of host specificity in their distribution within their host and the age and sex, were found to influence the parasite infection. Similarly, Onwuliri and Mgbemena (1987) investigated the parasitic fauna of Creochromis niloticus, Tilapia zillii and Clarias lazera from ponds, rivers, streams and fish farm in Jos, Nigeria. They recovered two protozoans, Henneguya sp., Myxobolus sp.; three trematode sp. Clinostomum tilapiae, Euclinostomum heterostomum, Diplostomum tragenna; one cestode sp. Polyonchobothrium sp.; two species of nematode Camallanus sp., Procamallanus sp. and one acanthocephala Neoechinorhynchus rutili. Based on the information from the foregoing literature review, and other references, a checklist of parasites of various fish hosts has been prepared (Appendix 1).

As regards studies on the biology of the Cichlid species in Nigeria, little work has been done (Fagade, 1971). He stated that investigation on several aspects of the biology of Cichlids have been confined mainly to East Africa.

Williams (1962) investigated the salinity tolerance of Tilapia m. melanotheron (= Tilapia heudeloti) and Tilapia melanopleura (= Tilapia guineensis) in the Lagos Lagoon, with a brief note on the Food of the species. Banks et al., (1965) found that Sarotherodon niloticus was the most abundant among the Sarotherodon and Tilapia sp. in River Niger. The species were found to be herbivorous.

Burchard (1967) studied the Cichlid fishes of River Niger just before the impoundment. He described six genera; Hemichromis,

Tylochromis, Pelmatochromis, Gobiocichla, Tilapia and Sarotherodon

Botros (1970) studied the length-weight relationship and coefficient of condition of Tilapia nilotica L. and Tilapia zillii Gerv. from Lake Mariut, Egypt.

Fagade (1971) investigated the food and feeding habits of Tilapia mariae (Boulenger), Tilapia guineensis (Bleeker) and Tilapia melanotheron. All the species were found to have similar food and feeding habits. Similarly, Fagade and Olaniyan (1973) studied the food and feeding interrelationships of the fishes in the Lagos Lagoon. Tilapia sp , were found to be deposit feeders with their main food items being algal filaments, diatoms, fragments of higher plants and unidentified organic matter.

Gwahaba (1973) studied the population size of Tilapia nilotica in Lake George, Uganda, using purse seine net. He also determined the mortality rate, size at maturity, production and also the natural and artificial factors which regulate the population of Tilapia nilotica.

Observations on Tilapia with emphasis on Tilapia galilaea was carried out by Johnson,(1973) in Lake Kainji. He reported the presence of Tilapia galilaea, Tilapia nilotica, Tilapia zilli and Tilapia dageti. Lewis (1974) also studied the biology of the Cichlid fishes from Lake Kainji. He reported the Cichlids to be

negligible in the fishery of Lake Kainji where they comprised less than four percent of the total catch.

Bruton and Boltt (1975) worked on the biology of Tilapia mossambica in a natural fresh water lake in South Africa. The species was found to have a wide variety of diets with the fry feeding on detritus rich in diatoms.

The reproductive biology, length-weight relationship and relative condition of Tilapia leucosticta (Trewavas) from Lake Naivasha, Kenya, was investigated by Siddiqui (1977). He found that the length-weight regression coefficient is near to three and with little seasonal fluctuations in relative condition of the fishes.

Hodgkiss and Man (1977) worked on the age composition, growth and body condition of the introduced Sarotherodon mossambicus in Plover core reservoir, Hong Kong. The species was found to exhibit allometric growth and the body condition decreased with increasing age. They also reported the mean body condition of females to be generally higher than that of the males.

In Lekki Lagoon Lagos, Fagade (1978) studied the biology of Tilapia guineensis (Dumeril). The species was found to feed on diatoms, Cladocera, copepods, dipterous larvae and unidentified organic debris. He also reported the body length of the species to be approximately the cube of the body weight and the sex ratio of the population of Tilapia guineensis was slightly in favour of

the males. Fagade (1979) also made observations on the biology of Tilapia guineensis and Tilapia melanotheron from the Lagos Lagoon, Nigeria. He studied among other things, length-weight relationships, age using opercular bones, fecundity and distribution of the species.

Babaker and Ibrahim (1979) studied the biology of reproduction of Tilapia nilotica. The species reaches maturity in the first year of life, with the females species maturing shortly before the males. The females were also found to breed more than once in a season and the fecundity varied with the body weight. Landua (1979) studied the growth and population dynamics of Tilapia galilaea in Lake Kenneret. She found that the weight of the species was proportional to the cube of its total length and the species was found to feed on a variety of food items including crustaceans, detritous sand particles, algal material, chironomid larvae, phytoplankton, diatoms and green algae.

McKaye (1983) studied the ecology and breeding behaviour of a Cichlid, Cyrtocara encirostomus in Lake Malawi. The species fed on zooplankton in the afternoon to avoid predatory catfish which feeds upon them and other Cichlids at night. Madu (1984) in Lake Kainji, conducted a preliminary observations on the growth of Oreochromis niloticus fry, fed with artificially formulated diet containing 25 percent crude protein level and a protein deficient diet which serves as control. No significant difference was reported. Similarly, Nwadairo (1985) investigated the distribution and food habits of dwarf African Cichlid Pelvichromis pulcher in river

Sombreiro, Nigeria. The species was restricted to the upstream zone of cold, soft acid freshwater. He reported a sex ratio (M:F) of one to one (1:1) and the species was found to feed on Benthic algae, higher plant remains, detritus and copepods.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 The study area: Zaria Dam.

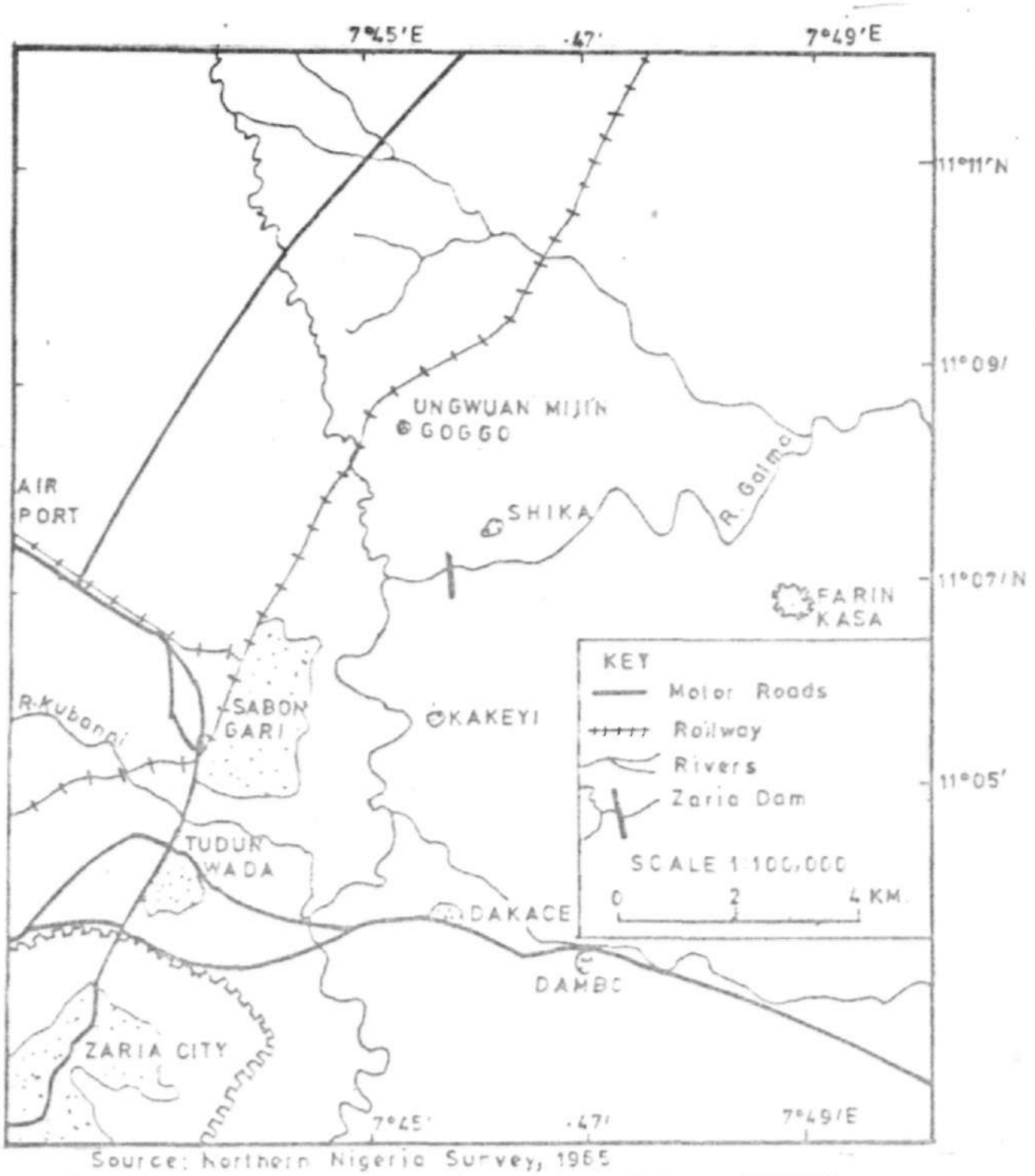
Zaria dam (Fig. 1) lies on longitude $7^{o}46'$E and latitude $11^{o}07'$N. The dam was constructed on the Galma River by Peterson Candy International Limited (P.C.I) London. It was officially commissioned on 3 March, 1975. The Spillway height above river bed is 10.67M and extends up to 25 km in the eastern direction.

The dam was constructed solely for the supply of drinking water to Zaria and environs. It is capable of supplying up to 2,640,000 litres of water per day. Fishing and irrigation are also carried out intensively around the dam. It also serves as a tourist resort.

The fish commonly found in the dam are Tilapia, Lates, Alestes, Synodontis, Malapterurus, Bagrus, Auchenoglanis, Clarias, Physailia, Schilbe, Mormyrus and Hyperopisus species. The dam is also rich in clamps (Unionidae) and also attracts a lot of birds.

3.2 SAMPLING

Live fishes Oreochromis niloticus, Tilapia zillii, Sarotherodon galilaeus and Hemichromis bimaculatus were bought from the fishermen at the dam site early in the morning between 7.00 a.m. to 8.00 a.m. Fish were bought monthly from July 1986 to June 1987.



Source: Northern Nigeria Survey, 1965

FIG.1 LOCATION OF ZARIA DAM ON GALMA RIVER

Personal observation and discussion with the fishermen showed that the fish were caught randomly by cast net, gill net and Hook and line, in the reservoir and below the spill way. The fish were immediately transported to the Laboratory in bucket containing some water. Those that died on the way, were immediately worked upon. The bucket was checked afterwards to see if any ectoparasite was lost.

3.3 THE FISH SPECIES

The Family Cichlidae, are cosmopolitan in their distribution and are found in the freshwater of South and Central America, Sri Lanka, Syria, Jordan Valley, Africa and Madagascar (Fryer and Iles, 1972). Similarly, some have been introduced to the far East from Africa. The Family is represented in Nigeria by the following genera, Hemichromis, Tylochromis, Pelmatochromis, Gabiocichla, Sarotherodon, Oreochromis and Tilapia (Reed et al., 1967).

3.3.1 Oreochromis niloticus

Local Hausa name: Karfashi, Karfasa, Gargaza, Buyu, Falga, Holinga, Bulkuba, Jinka, and Bakaba.

Common English name: Tilapia or Mango Fish.

Oreochromis niloticus is one of the largest Cichlid reaching considerable length of 50 cm (Reed et al., 1967). The body is elongated and the species is easily identified by the characteristic pattern of dark and light bands crossing the caudal fin. The female species is a mouthbrooder and takes sole responsibility of guarding and rearing the fry. Oreochromis niloticus inhabit rivers and lakes. It feeds on plants (Reed et al., 1967).

3.3.2 Tilapia zillii (Gervais)

Local Hausa name: Karfashi, Karfasa, Gargaza, Bugu Falga, Holinga, Bulkuba, Jinka, Bakaba.

Common English name: Tilapia or Mango fish.

This species is widely distributed and is found to penetrate the smallest bodies of water (Reed et al., 1967). It can survive and reproduce under very adverse conditions. It is elongate in shape, flat below and strongly convex dorsally. The species can attain a length of 30 cm but such is usually uncommon, but adult fish can reach 20 cm in total length. It has strong fins with spines which are mottled with dark grey colour usually with a pinkish tinge. Tilapia zillii feeds on insect larvae and coarse plant material (Reed et al., 1967).

3.3.3 Sarotherodon galilaues (Artedi)

Local Hausa name Karfashi, Karfasa, Gargaza, Bugu, Falga, Holinga, Bulkuba, Jinka, Bakaba.

Common English name: Mango fish or Tilapia

Sarotherodon galilaeus is extensively distributed and the species can be found in Laka Galilaea, the Nile basin and most parts of West Africa (Reed et al., 1967). It is deep bodied with a small mouth. The general coloration of the species is pale often with a yellowish tinge with faint narrow dark bars on the sides. The

end of the caudal fin is pinkish red in colour. Sarotherodon galilaeus feeds on green plants (Reed et al., 1967).

3.3.4 Hemichromis bimuculatus Gill.

Local Hausa name Kukula, Dan-Karfasa, Karfasan-Kaya.

Common English name: Jewel fish.

This species is widely distributed and found in virtually the whole of Western, Central and Southern Africa. It was also noticed in the remote regions of the Sahara Desert (Reed et al., 1967). The fish is small with adult individual rarely exceeding 10 cm in total length (Reed et al., 1967). The body is moderately compressed and elongated. The species has a small mouth with pointed snout. Hemichromis bimaculatus has a conspicuous black spot, bordered in gold at the upper rear corner of the operculum, a second large spot on the middle of the side and another inconspicuous spot on the caudal peduncle. It is a carnivorous fish and feeds largely on fish fry and insects (Reed et al., 1967; Akintunde and Imevbore, 1979).

3.4. LABORATORY HANDLING OF FISH

In the laboratory, the fish were anaesthetized according to the techniques reported by (Hines and Spira, 1973; Mann, 1973; Woodland and Jones,1975; Treasurer, 1976; Aken'ova, 1983). One gramme of Ethyl-m-aminobenzoate Methane-Sulfonate, MS 222 Sandoz (Fish anaesthetic powder) was dissolved in 10 litres of water containing the fish.

3.4.1 Measurement of basic fishery data

The following data were taken from the anaesthetized fish and are presented in (Appendix 2 - 11)

(a) Total length (in cm): This is the length from the tip of the snout to the longest tip of the caudal fin when pressed together (Olatunde, 1977).

(b) Standard length (in cm): This is the length from the tip of the snout to the end of the hypural bone (Olatunde, 1977).

(c) Weight (in g): The weight was determined using an electronic balance and when there was no electricity, spring balance was used.

(d) Sex determination: The sex of the fish was determined by slitting the abdomen lengthwise and the gonads were checked visually without the aid of microscope. Young Cichlids, whose sex could not be determined due to their small size were classified as immature.

All fish samples were identified using the book of (Reed et al., 1967; Holden and Reed, 1972). All identifications were later confirmed (See acknowledgement).

Length-weight Relationship

The length-weight relationship of all the four species were calculated using the formula described by LeCren (1951) and cited by Olatunde (1977) which is:

$$W = al^{b}.$$

The data was transformed into Logarithm before the calculations were made. The formular above was similarly transformed as seen below:-

$$\text{Log } W = \text{Log } a + b \text{ Log } L.$$

where W = weight of fish (g)

L = standard length of fish (cm)

a = constant

and b = an exponent.

Condition Factor

The condition factor (K) were calculated for the individual fish examined each month using the formular given by Worthington and Richardo (1930).

$$K = \frac{W \times 100}{L^3}$$

where K = condition factor

W = weight (g)

and L = standard length (cm)

The data were fed into the computer for analysis.

3.4.2 Examination of fish for parasites

Before examining the fish, 0.7% physiological saline (Nacl) was prepared.

The body surface of the fish was examined with the aid of Olympus Stereoscopic, dissection microscope (Model VT-2). Afterwards, the gills were dissected out and placed in petri-dishes containing saline solution and examined arch by arch for parasites.

The internal organs: liver, heart, kidney, operculum, intestine, stomach, spleen, gonads, and gall-bladder were removed and each placed in a separate petri-dish containing saline solution and examined under the microscope for parasites. The buccal cavity, muscles of the body wall, the eye lens, and the abdominal cavity were also checked for parasites. The fish were also checked for any inflammations, leisons and mucus secretions because such symptoms may be places of attachment for parasites. Parasite recovered were counted and recorded. They were also measured, (using ocular and stage micrometer) and photographed. Permanent slides were made, followed by identification by an expert (See acknowledgement).

3.4.3 Treatment of parasites and slide preparation

Parasites recovered were placed in petri dishes containing physiological saline before they were fixed and preserved. Permanent slides were made according to the techniques of (Soulsbry, 1968).

1. Protozoan

The parasite was found in form of cyst on the gill filaments. The gill filaments were removed and placed in petri-dish containing 0.7% physiological saline solution. Smears were made by puncturing the cyst on slide. Temporary preparation of the wet fresh smear

for microscopic examination was made in saline according to the techniques reported by (Abolarin, 1973; Aken'ova, 1983). The slide was examined under the microscope for the spores. Photograph of cyst attached to the gill filament was taken.

2. Trematode

The parasite was put into petri-dishes containing 0.7% physiological saline solution. The worm was removed and placed on a slide and immediately the worm stretched, few drops of fixative Formal-Acetic-Acid (FAA) were added to fix the worm and cover glass was placed over it. The cover glass was pressed down lightly with a dissecting needle so as to prevent curling of the worm. Pressure was maintained for a few minutes until the entire worm turned white. The worm was preserved in FAA solution and later permanent slides were made according to the techniques reported by Soulsbry (1968) below.

The excess fixative was washed away in running water for one to two hours. The worm was treated successively with 30% and 50% alcohol from 15 minutes to one hour. It was placed in 70% iodine-alcohol for one hour. The specimen was transfered to 70% alcohol and left there until the iodine stain disappeared from the specimen. The worm was stained with Semichon's Carmine in 70% alcohol for one hour. The excess stain was washed twice with 70% alcohol. The specimen was destained in 70% acid alcohol until it attained light pink colour. It was washed about three times with 70% alcohol to remove acid and prevent the specimen further from destaining.

The specimen was transferred to 80% and 95% alcohol for one hour each. It was then treated with absolute alcohol twice and cleared in xylol and mounted on a clean slide in balsam medium. The worm was measured and photographed. All trematodes were treated in a similar way.

Trematode cyst

Recovered Trematode cysts were put in petri-dish containing physiological saline solution. Cysts were later preserved in FAA. They were measured and photographed.

3. Cestodes

Cestodes were relaxed by chilling in refrigerator. They were fixed in hot FAA and preserved in formal-alcohol.

Parasites were measured, photographed and permanent slides were prepared as follows:
The worm was passed through 30%, 50% and 70% alcohol for one hour each. The worm was stained for one hour in Harris hematoxylin. Excess stain was washed in water. The worm was transferred to 30% and later 50% alcohol for 30 minutes to one hour in each grade of the alcohol. The material was destained in 70% acid-alcohol until light reddish purple colour was obtained and then washed in 70% alcohol.

The worm was transferred to 80%, 95% and 100% alcohol for one hour to two hours each. It was cleared in xylol and mounted on clean slides according to the techniques reported earlier for trematodes.

4. Nematode

The nematode sp. recovered from the host was killed and fixed by adding warm 70% alcohol. The worm was removed from the alcohol and few drops of Lactophenol in hot 70% glycerine alcohol was added. The alcohol was evaporated in a dessicator until the worm was gradually brought into the pure glycerine medium. It was then mounted in glycerine medium with glass-wool placed around the sides of the cover slip in order to avoid pressure by the cover slips - over the mounted nematode. The worm was measured and photographed.

5. Acanthocephala

The specimen recovered was relaxed and preserved in Bouin's Fluid. The parasite was measured, photographed and slides were made as follows: The worm was transferred directly to 70% alcohol. The alcohol was changed at intervals until the material was no longer yellow. It was treated with 50% and 30% alcohol for 15 minutes each. The worm was stained in Harris hematoxylin for one hour. It was treated in 30%, 50% and 70% alcohol for at least 15 minutes in each grade of the alcohol.

The material was destained in 70% acid-alcohol until light pink colour was obtained. Excess acid was washed in 70% alcohol and the worm was placed in 70% alkaline alcohol until it turned blue in colour.

The material was dehydrated in 80% and 95% alcohol for 15 minutes in each grade of the alcohol. It was transferred to absolute alcohol and left for 15 minutes. The worm was cleared in xylol and mounted in balsam medium.

The project was carried out for a period of one year, from July 1986 to June 1987. The Cichlids were selected for this purpose because of their economic importance and their availability throughout the season.

CHAPTER FOUR

4.0 RESULTS

A total number of 567 fish specimens comprising 308 Oreochromis niloticus, 147 Tilapia zillii, 73 Sarotherodon galilaeus, and 39 Hemichromis bimaculatus were collected during July 1986 to June 1987 and examined for the recovery of parasites (Table 1).

In all, 97 (17.1%) fish specimens were found infected with protozoan, trematode, cestode, nematode, acanthocephala, and hirudinea parasites (Table 2). The rate of infection in respect of each parasitic group was determined. Similarly, the size of the fish species in relation to parasitic infection was also recorded.

4.1 Henneguya sp (Cysts)

Nine specimens of Oreochromis niloticus were found infected with the cysts of Henneguya sp. (Protozoan) with rate of infection as 2.9 percent (Table 3). Cysts were found attached to the gill filaments (Plate I). Fishes with size range between 9 - 13 cm were found to be mostly affected by the infection of these protozoan parasites followed by those of size range between 4 - 8 cm. No cysts were recovered from fishes of size range above 14 cm (Table 4). Tilapia zillii, Sarotherodon galilaeus and Hemichromis bimaculatus were found to be free from this parasitic infection.

TABLE 1: NUMBER OF FISH EXAMINED

Month	Species			
	Oreochromis niloticus	Tilapia zillii	Sarotherodon galilaeus	Hemichromis bimaculatus
July 1986	11	9	4	0
August 1986	21	4	0	0
September 1986	66	0	0	0
October "	65	11	0	0
November "	15	7	3	0
December "	23	15	7	0
January 1987	48	6	6	0
February "	13	27	15	14
March "	12	19	14	18
April "	20	29	2	7
May "	6	9	10	0
June "	8	11	12	0
TOTAL	308	147	73	39
MEAN	25.66	12.25	6.08	3.25

TABLE 2: PREVALENCE OF PARASITIC INFECTION IN FRESH-WATER FISH COLLECTED FROM ZARIA DAM

FISH SPECIES	NUMBER OF FISH EXAMINED	NUMBER OF FISH INFECTED	RATE OF INFECTION (%)
1. Oreochromis niloticus	308	69	22.4
2. Tilapia zillii	147	23	15.65
3. Sarotherodon galilaeus	73	5	6.85
4. Hemichromis bimaculatus	39	0	0
TOTAL	567	97	17.1

4.2 Clinostomum sp. (Metacercariae)

This parasite was recovered only from Oreochromis niloticus. Six fishes were found infected with the metacercariae of Clinostomum sp. with rate of infection as 1.9 percent (Table 3). They were recovered from the branchial region of the host (Plate II). The Clinostomum sp. (Metacercariae) measured from 2.95 mm to 6.0 mm in length with an average of 4.76 mm and 1.14 mm to 1.86 mm in width with an average of 1.42 mm. Similarly, the oral sucker of the trematode ranged from 0.12 mm to 0.30 mm in diameter with an average of 0.18 mm, while the dimensions of the ventral sucker ranged from 0.30 mm to 0.66 mm in diameter with an average of 0.45 mm (Appendix 12). Fishes with size range between 14 - 23 cm were infected with this trematode. This parasite was not recovered from the fishes ranging between 4 - 13 cm (Table 4).

4.3 Diplostomatid (Cysts)

Oreochromis niloticus and Tilapia zillii were the two different fish species infected by this parasite. In Oreochromis niloticus, the rate of infestation of Diplostomatid (Cysts) was recorded as 13.0 percent based on the prevalence in40 fish specimens (Table 3). The most affected fishes were in the size group ranging between 4 - 8 cm followed by fishes of size range 9 - 18 cm. However, no cysts were found in fishes ranging between 19 - 23 cm length (Table 4). Similarly, in Tilapia zillii eight specimens were infected with Diplostomatid (Cysts) having 5.4 percent rate of infection (Table 5). Cysts were mostly recovered from fishes of size range 4 - 8 cm. No such cysts were recovered from other

TABLE 3: DISTRIBUTION OF PARASITES IN *OREOCHROMIS NILOTICUS*

Parasite Group	Site of infection	No. of fish examined	No. of fish infected	Rate of infection (%)	Total No. of Parasites
PROTOZOAN					
Henneguya sp.	Gill filaments	308	9	2.9	-
TREMATODE					
Clinostomum sp (metacercariae)	Branchial region	308	6	1.9	20
Diplostomatid (cysts)	Abdominal cavity	308	40	13.0	124 (Cysts)
ACANTHOCEPHALA					
Neoechinorynchus sp.	Intestine (Epithelial living)	308	13	4.22	83
HIRUDINEA					
Leech (unidentified)	Body surface	308	2	0.7	2

TABLE 4: RATE OF PARASITIC INFECTION IN RELATION TO SIZE OF *OREOCHROMIS NILOTICUS*

Size Range (cm)	*Henneguya* sp (Cysts)			*Clinostomum* sp (Metacercariae)			Diplostomatid cysts			*Neoechinorhynchus* sp			Leech		
	No. of fish exa-mined	No. of fish infec-ted	% infec-ted	No. of fish exa-mined	No. of fish infec-ted	% infec-ted	No. of fish exa-mined	No. of fish infec-ted	% infec-ted	No. of fish exa-mined	No. of fish infec-ted	% infec-ted	No. of fish exa-mined	No. of fish infec-ted	% infec-ted
4-8	149	2	1.34	149	0	0	149	25	16.78	149	1	0.67	149	0	0
9-13	115	7	6.09	115	0	0	115	13	11.30	115	1	0.87	115	2	1.74
14-18	36	0	0	36	3	7.59	36	2	5.56	36	8	22.22	36	0	0
19-23	8	0	0	8	3	37.5	8	0	0	8	3	37.5	8	0	0

size groups (Table 6). The cysts (Plate III) were recovered from the abdominal cavity of the host and they measured from 1.11 mm to 3.15 mm in diameter with an average of 2.45 mm (Appendix 13).

4.4 Cestode

Only one specimen of Tilapia zillii was found infected by developing Cyclophyllidean cestode, thus showing rate of infection as 0.68 percent (Table 5). The parasite (Plate IV) ranged in length from 2.46 mm to 5.76 mm, with an average length of 4.69 mm while, the width ranged from 0.45 mm to 0.90 mm with an average of 0.66 mm (Appendix 14). The cestode was recovered from the intestine of the host and the only fish infected measured 13 cm in length (Table 6).

4.5 Ascarid (Nematode)

Two specimens of Sarotherodon galilaeus were found infected by this nematode with rate of infection as 2.74 percent (Table 7). The nematodes measured from 14.3 mm to 15.0 mm in length with an average of 14.65 mm, while it ranged from 0.33 mm to 0.36 mm in width with an average of 0.35 mm (Appendix 15). The ascarid worms (Plate V) were recovered from around the gonad region of the host. The worms were found in fishes of size range between 14 - 18 cm (Table 8). Oreochromis niloticus, Tilapia zillii and Hemichromis bimaculatus were not infected by this nematode.

TABLE 5: DISTRIBUTION OF PARASITES IN TILAPIA ZILLII

Parasite Group	Site of infection	No. of fish examined	No. of fish infected	Rate of infection (%)	Total No. of Parasites
TREMATODE					
Diplostomatid (cysts)	Abdominal cavity	147	8	5.4	20 (cysts)
CESTODE					
Developing Cyclophyllidean cestode	Intestine	147	1	0.68	7
ACANTHOCEPHALA					
Neoechinorhynchus sp.	Intestine (Epithelial lining)	147	14	9.52	29

TABLE 6: RATE OF PARASITIC INFECTION IN RELATION TO SIZE OF *TILAPIA ZILLII*

SIZE RANGE (cm)	Diplostomatid (cysts)			Cyclophyllidean cestode			*Neoechinorhynchus* sp.		
	No. of fish examined	No. of fish infected	Percent (%) infected	No. of fish examined	No. of fish infected	Percent (%) infected	No. of fish examined	No. of fish infected	Percent (%) infected
4 - 8	99	8	8.08	99	0	0	99	3	3.03
9 - 13	34	0	0	34	1	2.94	34	6	17.65
14 - 18	14	0	0	14	0	0	14	5	35.71
19 - 23	0	0	0	0	0	0	0	0	0

TABLE 7: DISTRIBUTION OF PARASITES IN SAROTHERODON GALILAEUS

Parasite Group	Site of infection	No. of fish examined	No. of fish infected	Rate of infection (%)	Total No. of Parasites
NEMATODE					
Ascarid	Around the Gonad region	73	2	2.74	2
ACANTHOCEPHALA					
Neoechinorhynchus sp.	Intestine (Epithelial lining)	73	1	1.36	10

TABLE 8: RATE OF PARASITIC INFECTION IN RELATION TO SIZE OF SAROTHERODON GALILAEUS

Size range (cm)	Ascarid worm (Nematode)			Neoechinorhynchus sp		
	No. of fish examined	No. of fish infected	Percent infected (%)	No. of fish examined	No. of fish infected	Percent infected (%)
4 - 8	48	0	0	48	1	2.08
9 - 13	13	0	0	13	0	0
14 - 18	5	2	40	5	0	0
19 - 23	3	0	0	3	0	0
24 - 27	4	0	0	4	0	0

4.6 Neoechinorhynchus sp.

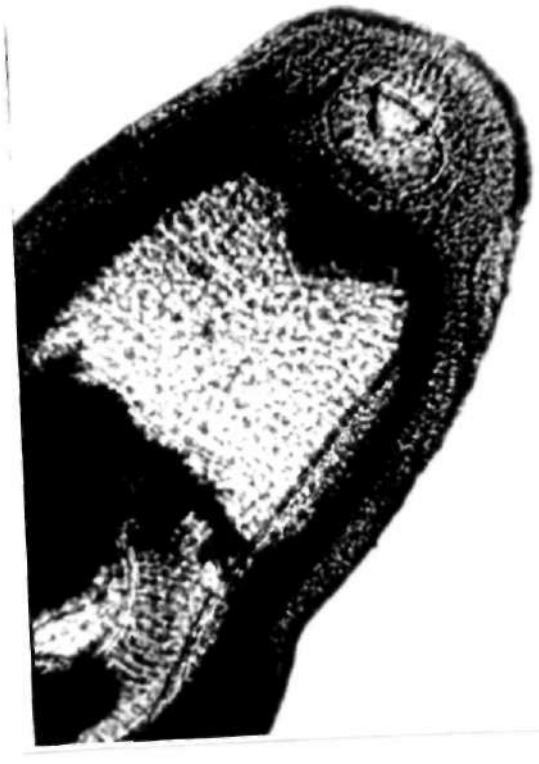
Oreochromis niloticus, Tilapia zillii and Sarotherodon galilaeus were infected with Neoechinorhynchus sp. Thirteen specimens of Oreochromis niloticus were infected with this parasite with 4.22 percent as the rate of infection (Table 3). Fish host with size range between 19 - 23 cm were mostly found to be infected by these worms followed by specimens falling in size range between 14 - 18 cm, 9 - 13 cm and 4-8 cm (Table 4). Fourteen specimens of Tilapia zillii were found infected with Neoechinorhynchus sp. showing rate of infection as 9.52 percent (Table 5). Tilapia zillii of all size groups, were infected except those in size group 19 - 23 cm (Table 6). One specimen of Sarotherodon galilaeus of size 6.8 cm (Table 8) was found infected with this parasite with the rate of infection as 1.36 percent (Table 7). These parasites were recovered from the epithelial lining of the intestine of the hosts (Plate VI). The parasites ranged from 0.99 mm to 2.85 mm in length with an average of 1.82 mm. While the width ranged from 0.21 mm to 1.03 mm with an average of 0.51 mm (Appendix 16).

4.7 Leech (Hirudinea)

An unidentified Leech was recovered from the body surface of two species of Oreochromis niloticus with 0.7 percent as the rate of infection (Table 3). Only specimen with size range between 9 - 13 cm were infected by these parasites (Table 4). No Leeches were recovered from the rest of the fish species.



Plate I: Henneguya sp cysts on Gill filaments of Host.



Anterior part



Posterior apart

Plate II(a and b): Clinostomum sp metacercariae. X40 Mg

Anterior part showing oral and ventral suckers.

Posterior part showing intestines. Parasite was

recovered from the branchial region of host.

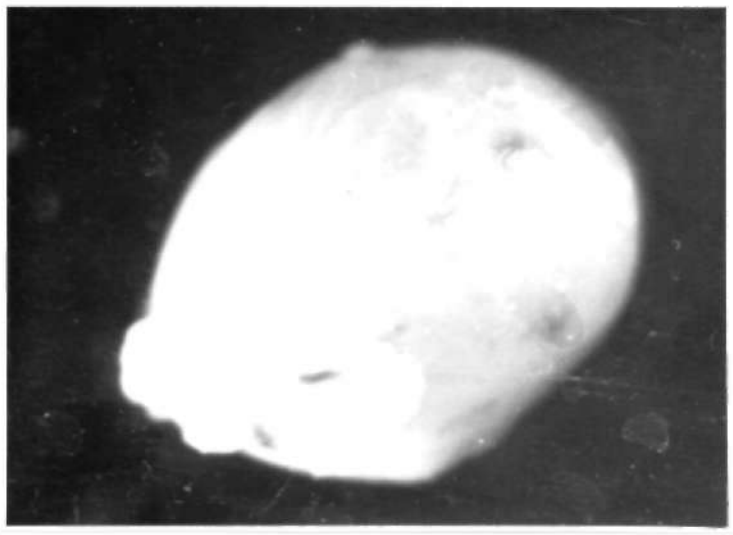
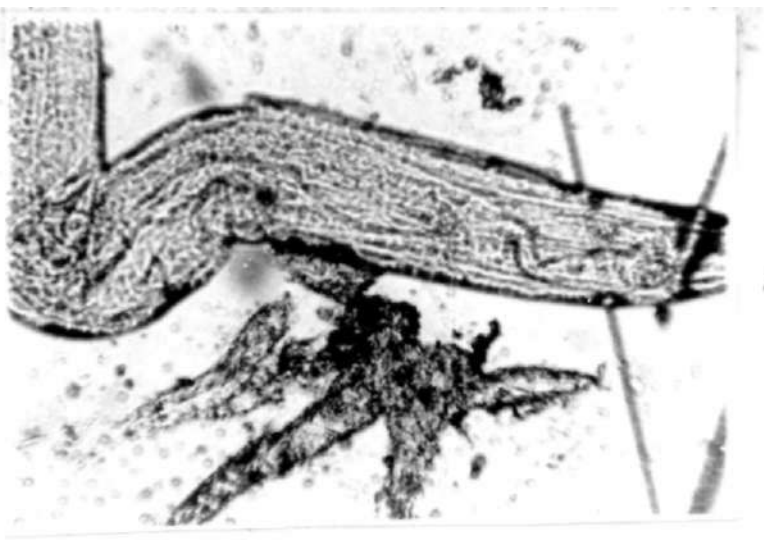


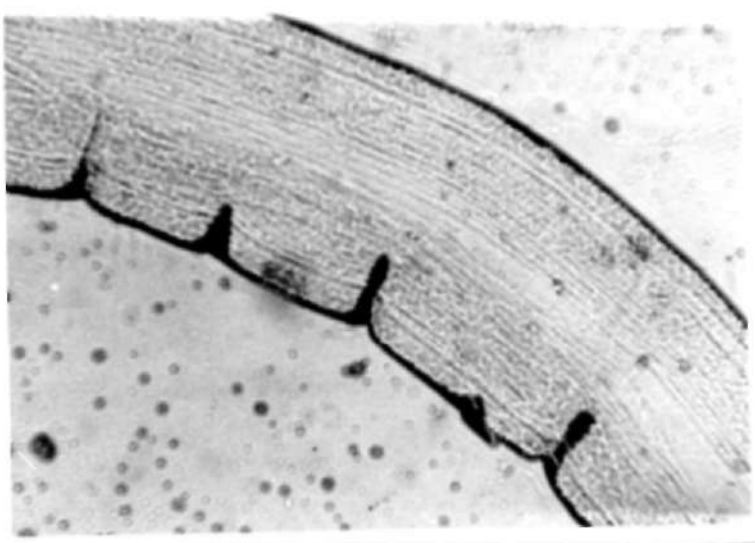
Plate III: Diplostomatid cyst. Recovered from the abdominal cavity of host.



Plate IV: Developing Cyclophyllidean cestode (anterior part). Recovered from the intestine of host. X40 Mg.



Anterior part



Middle part



Posterior part

Plate V: Ascarid worm. Recovered around the gonad region of host. X40 Mg.

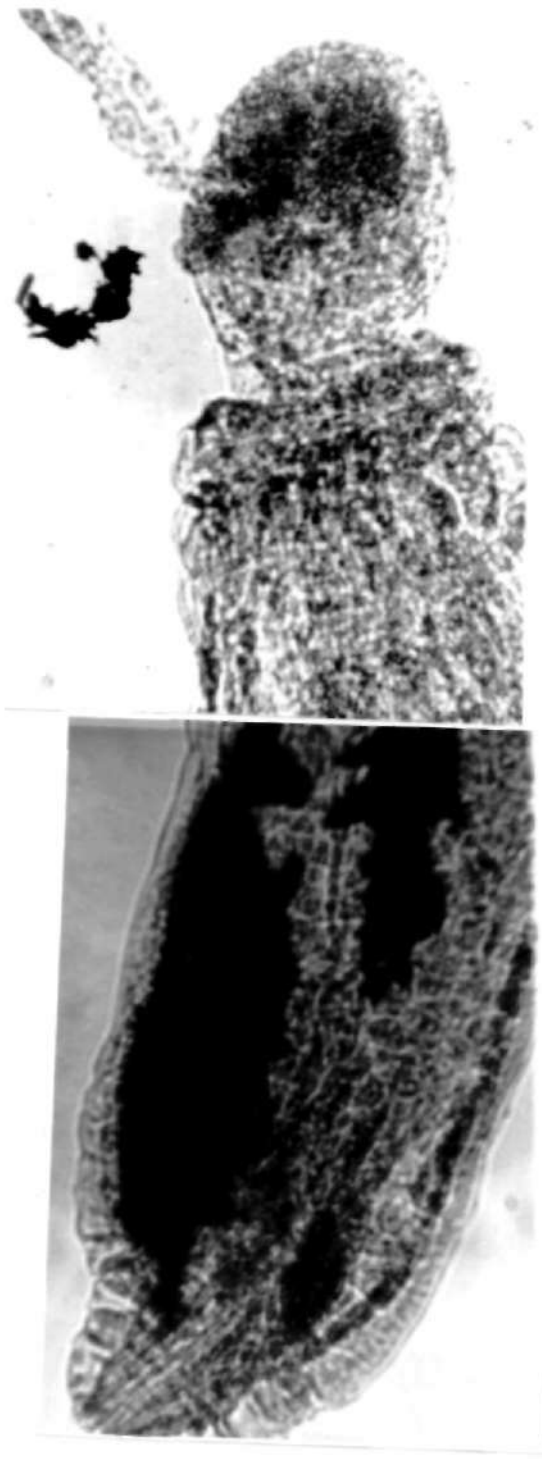


Plate VI: Neoechinorhynchus sp

Recovered from the epithelial lining of intestine of host: X40 Mg

4.8 Relative abundance of Parasites

The relative abundance of parasite groups infecting Oreochromis niloticus, Tilapia zillii and Sarotherodon galilaeus could be seen in Table 9 and figure 2. In Oreochromis niloticus, the trematodes were the most abundant parasites with 62.88 percent relative abundance. This is followed by acanthocephala with 36.25 percent and the leeches with 0.87 percent relative abundance. Numerous protozoan cysts Henneguya spp. were also recovered.

In Tilapia zillii, the acanthocephalan was found in abundance with 51.79 percent relative abundance, followed by the trematode with 35.71 percent and the cestode with 12.5 percent relative abundance. Similarly, in Sarotherodon galilaeus, the acanthocephalan was most abundant with 83.33 percent relative abundance. This is followed by the ascarid nematode with 16.67 percent. On the whole, the rate of infestation among the fish species examined, Oreochromis niloticus was found to be the most infected with parasites showing rate of infection as 22.4 percent, followed by Tilapia zillii with 15.65 percent and Sarotherodon galilaeus with 6.85 percent (Figure 3).

A total number of 39 specimens of Hemichromis bimaculatus were examined and none of these were found infected with any parasite.

TABLE 9: RELATIVE ABUNDANCE OF PARASITES IN VARIOUS FISH SPECIES

Parasite	OREOCHROMIS NILOTICUS		TILAPIA ZILLII		SAROTHERODON GALILAEUS		HEMICHROMIS BIMACULATUS	
	Number of Parasites	Relative abundance (%)	No. of Parasites	Relative abundance (%)	No. of Parasites	Relative abundance (%)	No. of Parasites	Relative abundance (%)
Protozoan	Not counted	0	0	0	0	0	0	0
Trematode	144	62.88	20	35.71	0	0	0	0
Cestode	0	0	7	12.5	0	0	0	0
Nematode	0	0	0	0	2	16.67	0	0
Acanthocephala	83	36.25	29	51.79	10	83.33	0	0
Hirudinea	2	0.87	0	0	0	0	0	0
TOTAL	229	100%	56	100%	12	100%	0	0

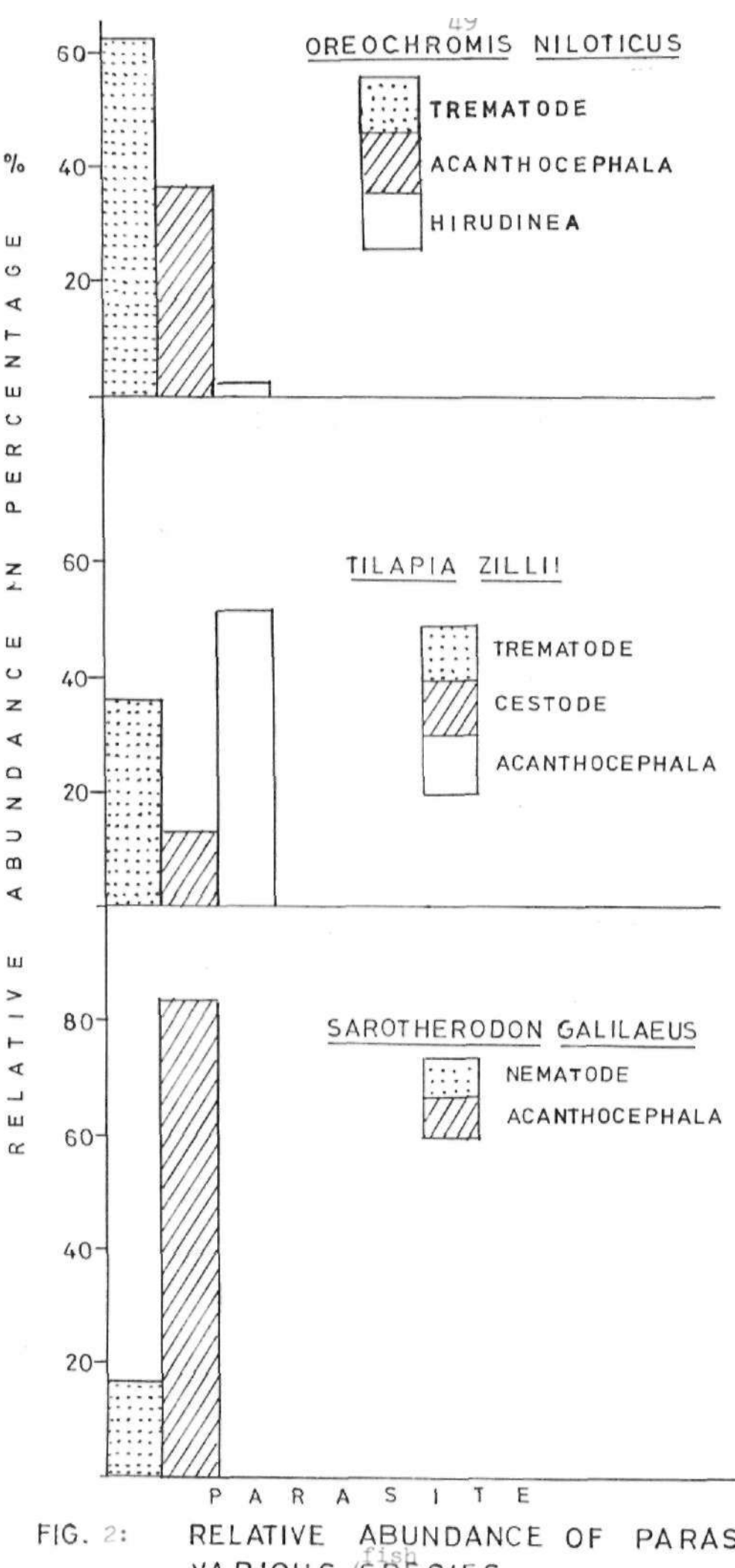


FIG. 2: RELATIVE ABUNDANCE OF PARASITES IN VARIOUS fish SPECIES

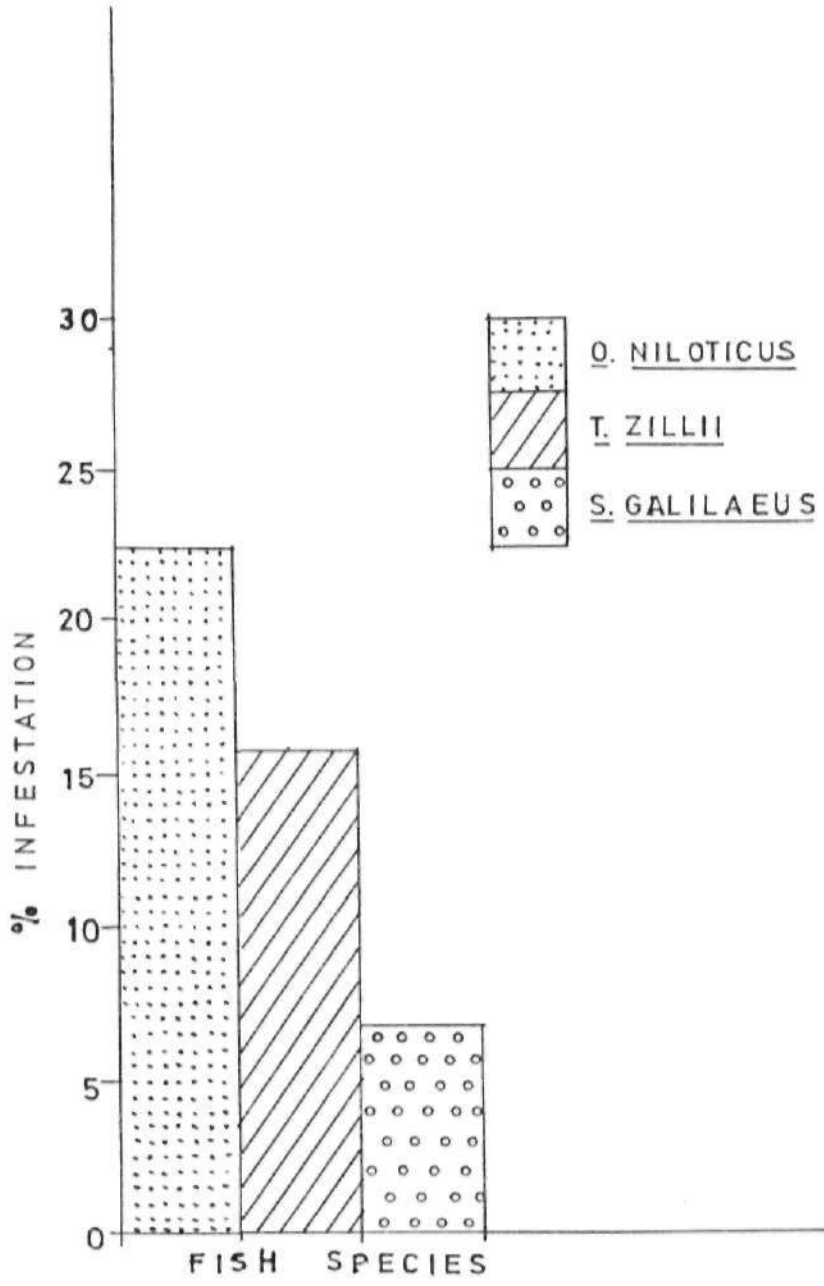


FIG. 3: RATE OF PARASITIC INFECTION AMONG THE SPECIES

4.9 Size Distribution

Oreochromis niloticus

The length and weight ranges of this species are as seen in Table 10. The total lengths of the males, females and immature ranged from 7.10 cm to 27.0 cm, 8.9 cm to 27.3 cm, 5.60 cm to 22.20 cm respectively with a mean of 16.40, 16.40 cm and 10.06 cm respectively. Similarly, the standard length of the males, females and immature ranged from 6.0 cm to 20.5 cm, 6.70 cm to 21.50 cm and 4.20 cm to 18.80 cm respectively with a mean of 12.68 cm, 12.57 cm and 7.72 cm respectively. The body weights of the males varied from 6.70 g to 370.0 g and 18.0 g to 405.5 g for the females, while the immature species ranged from 7.0 g to 192.50 g. The mean body weights for the male, female, and immature species were 112.07 g, 106.13 and 28.46 g respectively. The value obtained for the mean total length, standard length and body weights showed that the males and females are of about equal lengths and weights. The differences were found to be statistically not significant (Table 11).

Figures 4 to 6, shows the standard length frequency distribution of males, females and immature species. Distinct peaks were seen around 9 - 9.9 cm and 18 - 18.9 cm for the males (Fig. 4) indicating different sets of population or age groups. Similarly, two distinct peaks were seen around 12 - 12.9 cm and around 17 17.9 cm for the females (Fig. 5) indicating two population or age groups. Only one peak was seen around 7 - 7.9 cm for the immature species (Fig. 6).

TABLE 10: SIZE RANGES AND K-VALUE OF OREOCHROMIS NILOTICUS FROM ZARIA DAM BETWEEN JULY 1986 - JUNE 1987

	Sex	Total number of fish examined	Minimum size	Maximum size	Mean	Standard deviation	Standard error
Total Length (cm)	Males	67	7.10	27.00	16.4	4.77	0.58
	Females	69	8.90	27.30	16.4	4.01	0.48
	Immature	172	5.60	22.20	10.06	2.63	0.20
Standard Length (cm)	Males	67	6.00	20.50	12.68	3.73	0.45
	Females	69	6.70	21.50	12.63	3.15	0.37
	Immature	172	4.20	18.80	7.72	2.18	0.16
Body Weight (g)	Males	67	6.70	370.00	112.07	94.71	11.57
	Females	69	18.00	405.50	106.13	85.72	10.31
	Immature	172	7.00	192.50	28.46	25.47	1.94
Condition Factor (K-Value)	Males	67	2.29	5.86	4.49	0.72	0.08
	Females	69	2.30	6.40	4.61	0.78	0.09
	Immature	172	3.16	12.70	5.70	1.52	0.11

TABLE 11: STATISTICAL ANALYSIS (T - TEST) FOR SIGNIFICANT DIFFERENCES BETWEEN LENGTHS AND WEIGHTS OF MALES AND FEMALES OREOCHROMIS NILOTICUS

	Sex	Total Number of Fish	Degree of Freedom	Mean	"t"	Mean Significantly different
Total Length (cm)	Males	67	134	16.40	0.03	No
	Females	69		16.40		
Standard Length (cm)	Males	67	134	12.68	0.06	No
	Females	69		12.63		
Body Weight (g)	Males	67	134	112.07	0.83	No
	Females	69		108.15		

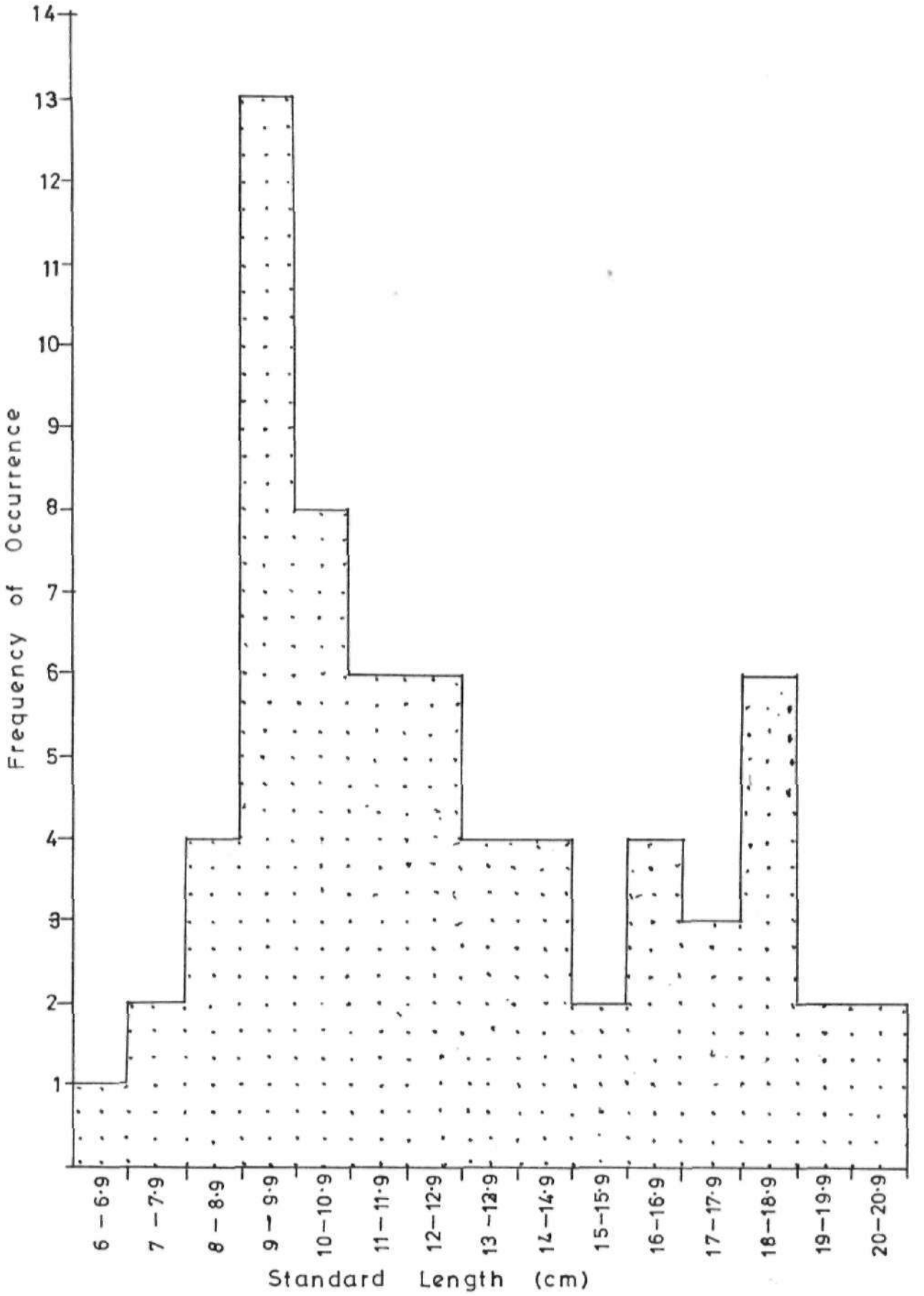


FIG. 4: STANDARD LENGTH FREQUENCY DISTRIBUTION OF OREOCHROMIS NILOTICUS (MALES)

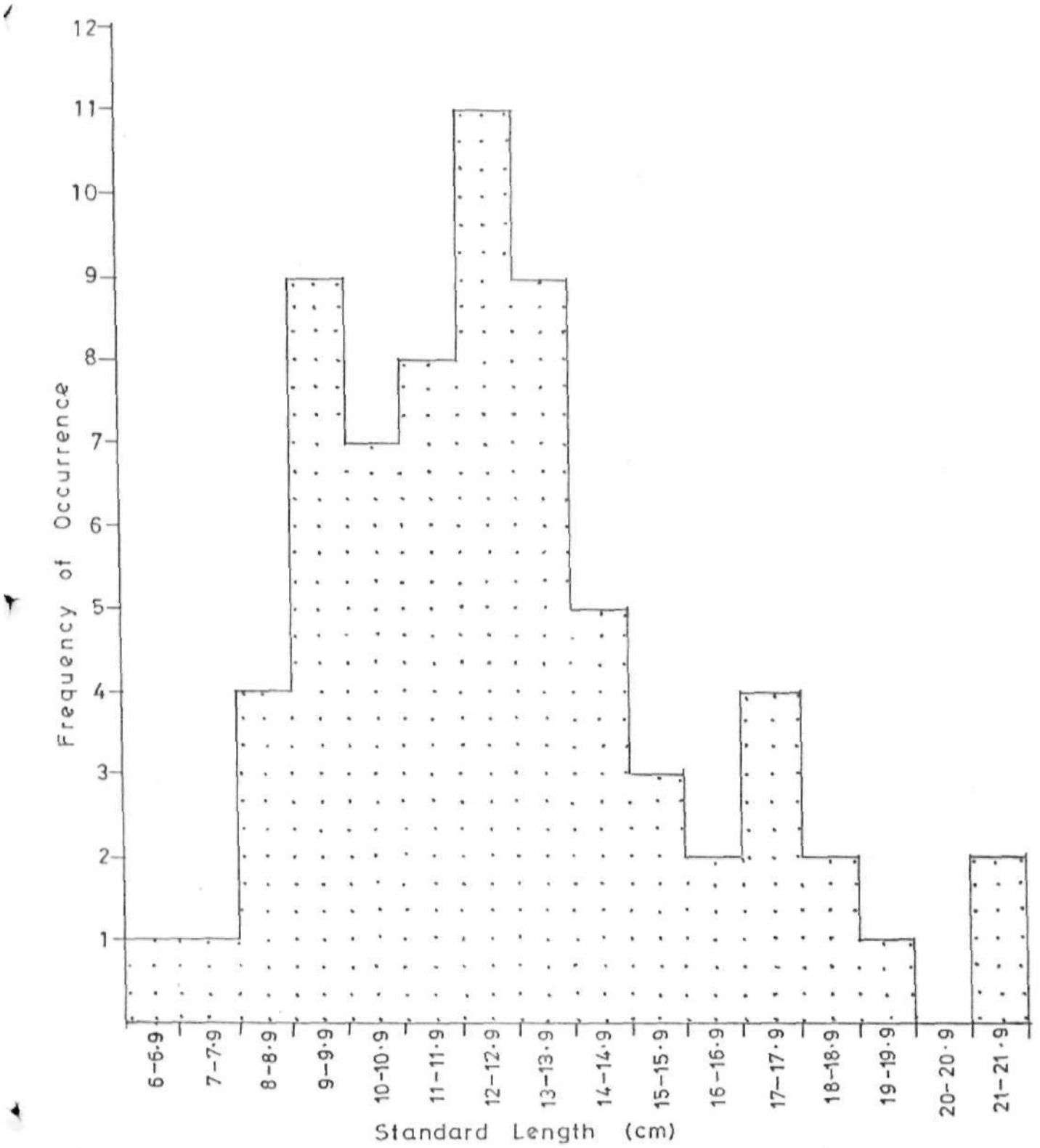


FIG. 5: STANDARD LENGTH FREQUENCY DISTRIBUTION OF OREOCHROMIS NILOTICUS (FEMALES)

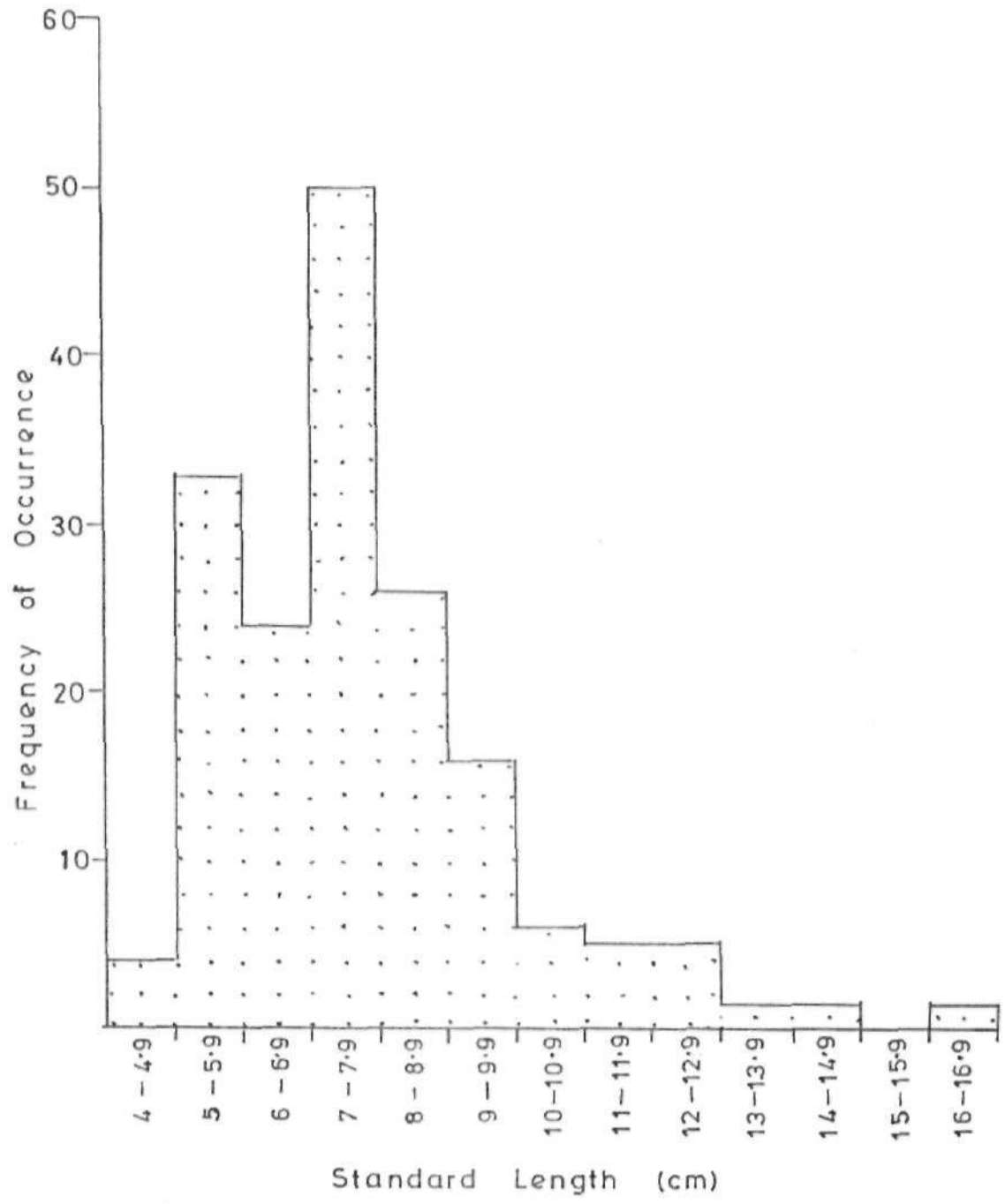


FIG. 6: STANDARD LENGTH FREQUENCY DISTRIBUTION OF OREOCHROMIS NILOTICUS (IMMATURE)

Tilapia zillii

Table 12 shows the length and weight ranges of Tilapia zillii. The total lengths of the males, females and immature ranged from 5.7 cm to 21.0 cm, 6.4 cm to 20.0 cm and 4.90 cm to 11.4 cm respectively. The standard length varied from 5.5 cm to 17.20 cm, 5.0 cm to 15.9 cm and 3.60 cm to 9.1 cm for males, females and immature specimens respectively. The body weight varied from 10.0 g to 142.0 g, 10.0 g to 151.0 g and 4.0 g to 45.0 g for the males, females and immature species respectively. The values obtained for the mean total lengths, standard lengths and body weights of the males and females were tested statistically. The differences were not significant (Table 13).

The length frequency distribution of the males, females and immature species were plotted as seen in Figures 7, 8 and 9. Figure 7, shows three peaks at around 7 - 7.9 cm, 10 - 10.9 cm and 14 - 14.9 cm for the males; while the females (Fig. 8) show two distinct peaks at around 10 - 10.9 cm and 13 - 13.9 cm. Only one peak was distinct around 5 - 5.9 cm for the immature species (Fig. 9).

Sarotherodon galilaeus

Total lengths of the males, females and immature species ranged from 10.20 cm to 32.60 cm, 11.20 cm to 32.60 cm and 5.6 cm to 18.50 cm respectively (Table 14). The standard lengths varied from 7.5 cm to 24.50 cm, 8.5 cm to 25.4 cm and 4.0 cm to 13.90 cm for males, females and immature species respectively. While the

TABLE 12: SIZE RANGES AND K-VALUE OF TILAPIA ZILLII FROM ZARIA - DAM BETWEEN JULY 1986 - JUNE 1987

	Sex	Total number of Fish examined	Minimum size	Maximum size	Mean	Standard deviation	Standard error
Total Length (cm)	Males	46	5.70	21.00	13.00	4.20	0.61
	Females	33	6.40	20.00	13.12	3.50	0.60
	Immature	68	4.90	11.40	7.53	1.34	0.16
Standard Length (cm)	Males	46	5.50	17.20	10.13	3.38	0.49
	Females	33	5.00	15.90	10.11	2.86	0.49
	Immature	68	3.60	9.10	5.82	1.15	0.13
Body Weight (g)	Males	46	10.00	142.00	57.61	44.70	6.59
	Females	33	10.00	151.00	53.90	39.44	6.86
	Immature	68	4.00	45.00	13.81	8.16	0.98
Condition Factor (K-Value)	Males	46	2.66	9.02	4.92	7.80	1.15
	Females	33	2.28	13.22	4.91	1.89	0.32
	Immature	68	3.02	11.80	6.74	1.56	0.18

TABLE 13: STATISTICAL ANALYSIS (T - TEST) FOR SIGNIFICANT DIFFERENCES BETWEEN LENGTHS AND WEIGHTS OF MALES AND FEMALES TILAPIA ZILLII

	Sex	Total Number of Fish	Degree of Freedom	Mean	"t"	Mean Significantly different?
Total Length (cm)	Males	46	77	13.00	0.108	No
	Females	33		13.12		
Standard Length (cm)	Males	46	77	10.13	0.02	No
	Females	33		10.11		
Body Weight (g)	Males	46	77	57.61	1.03	No
	Females	33		53.90		

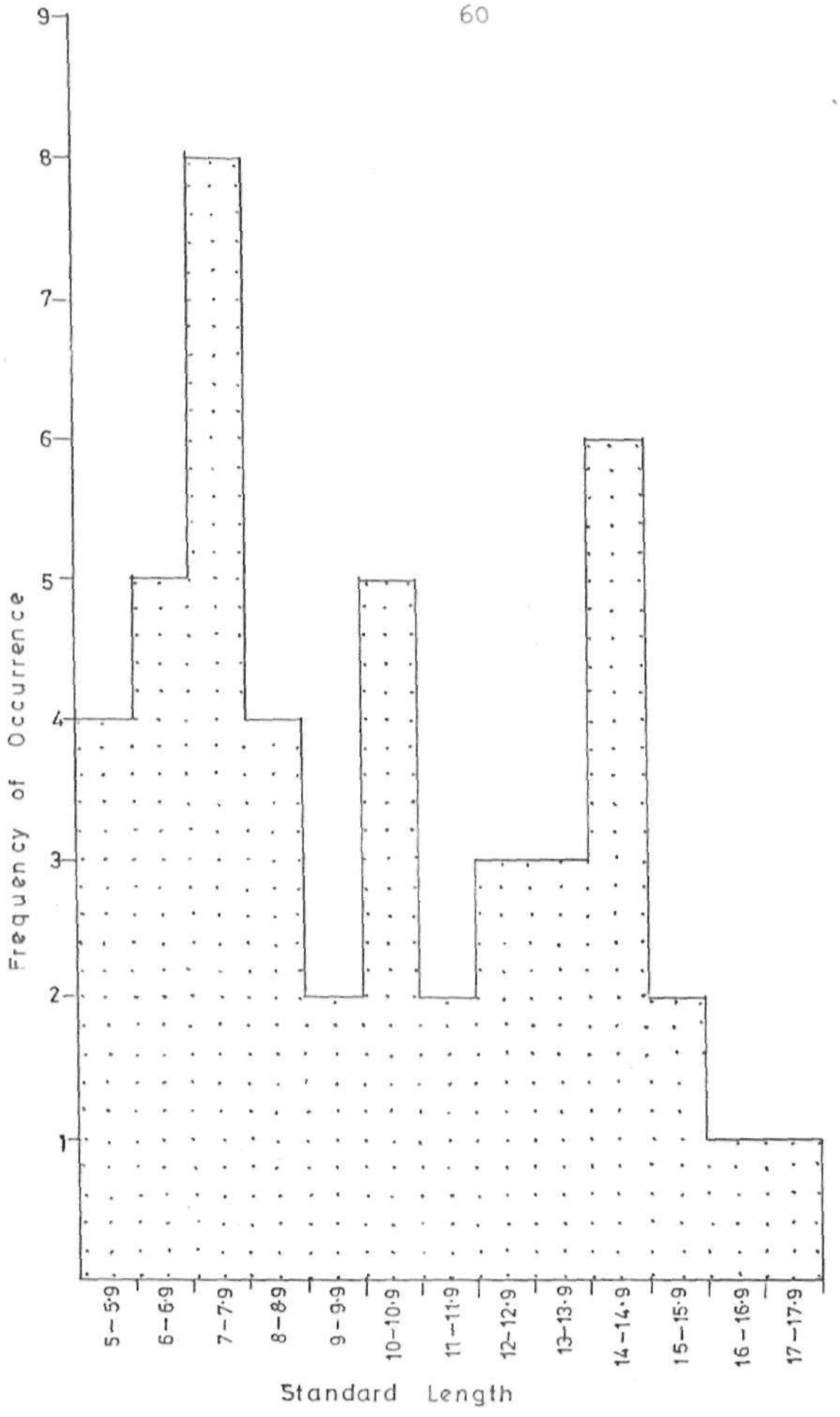


FIG. 7: STANDARD LENGTH FREQUENCY DISTRIBUTION OF TILAPIA ZILLII (MALES)

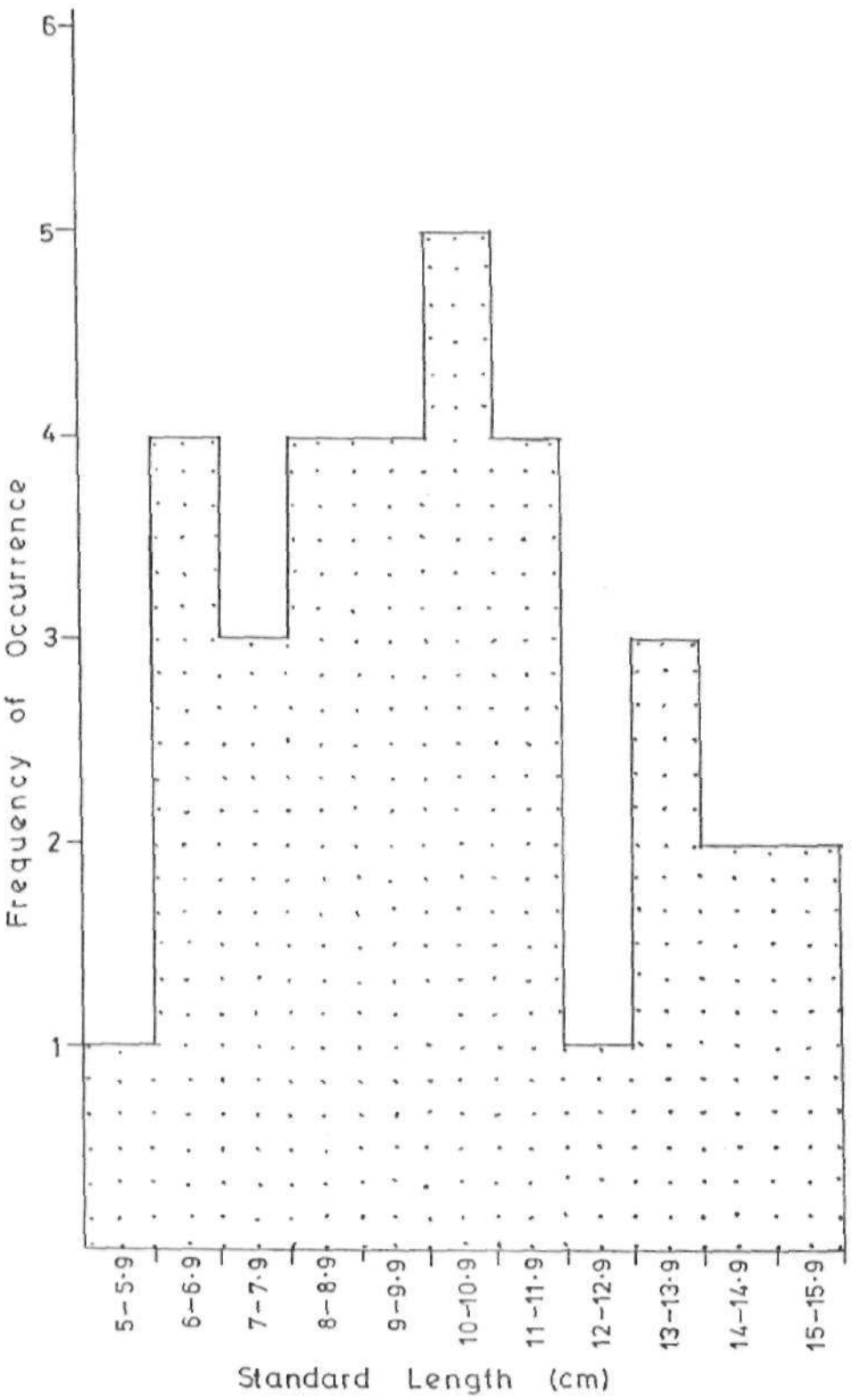


FIG. 8: STANDARD LENGTH FREQUENCY DISTRIBUTION OF TILIPIA ZILLII (FEMALES)

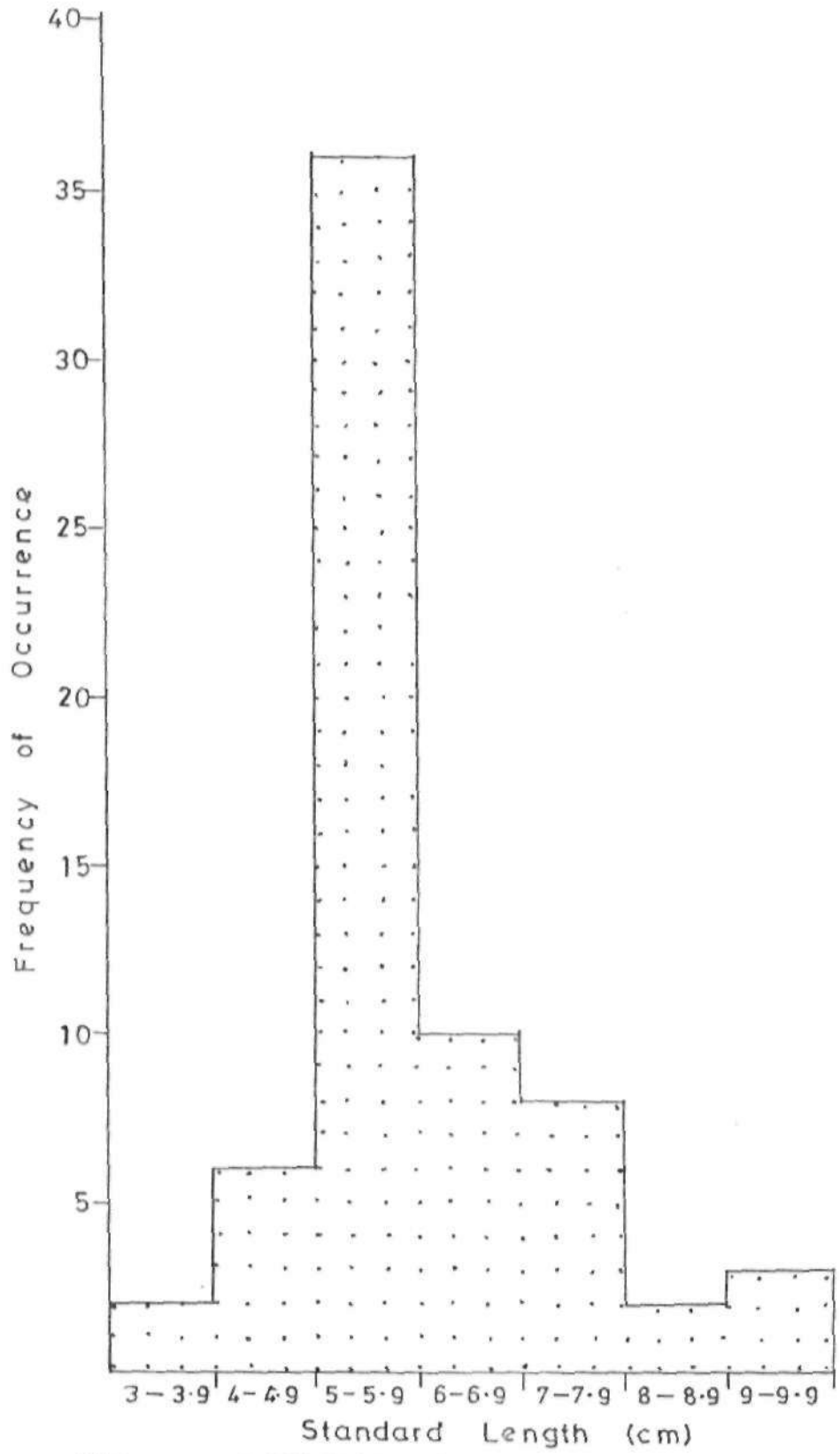


FIG. 9: STANDARD LENGTH FREQUENCY DISTRIBUTION OF TILAPIA ZILLII (IMMATURE)

body weight ranged from 22.0 g to 669.7 g, 22.50 g to 784.3 g and 3.0 g to 125.0 g for males, females and immature species respectively. The value obtained for the mean total lengths, standard lengths and weights shows that the females were generally larger than the males. Statistical tests (Table 15) show that there are significant differences between the lengths and weights of the males and females.

Figure 10 shows the standard length frequency distribution of males, females and immature species combined together. The figure shows two peaks around 7 - 7.9 cm and 21 - 21.9 cm.

Hemichromis bimaculatus

Due to the relative small nature of this species not exceeding 10 cm in length, the sex was not possible to determine even after slitting the abdomen. The species were therefore grouped together with both sexes combined. The length and weight ranges of this species is as seen in (Table 16). The total length, standard length and body weight, ranged from 5.5 cm to 10.0 cm, 4.2 cm to 7.9 cm and 5.0 to 24.5 g respectively. The mean values obtained for the total length, standard length and body weight are 7.25 cm, 5.66 cm and 10.19 g respectively.

The standard length frequency distribution of this species was also plotted as seen in Figure 11. The figure shows one peak at around 5.5 - 5.7 cm. This probably indicates one population or age group.

TABLE 14: SIZE RANGES AND K-VALUE OF SAROTHERODON GALILAEUS FROM ZARIA DAM BETWEEN JULY 1986 - JUNE 1987

	Sex	Total number of Fish examined	Minimum size	Maximum size	Mean	Standard deviation	Standard error
Total Length (cm)	Males	10	10.20	32.60	16.37	6.43	2.03
	Females	18	11.20	32.60	21.27	7.06	1.66
	Immature	45	5.60	18.50	8.96	2.29	0.34
Standard Length (cm)	Males	10	7.50	24.50	12.40	4.83	1.53
	Females	18	8.50	25.40	16.36	5.60	1.31
	Immature	45	4.00	13.90	6.76	1.68	0.25
Body Weight (g)	Males	10	22.00	669.70	119.24	197.11	62.33
	Females	18	22.50	784.30	246.76	258.00	60.81
	Immature	45	3.00	125.00	20.11	18.52	2.76
Condition Factor (K-Value)	Males	10	2.52	5.22	4.01	0.87	0.27
	Females	18	2.00	5.96	4.32	1.19	0.28
	Immature	45	2.69	10.07	5.81	1.57	0.23

TABLE 15: STATISTICAL ANALYSIS (T - TEST) FOR SIGNIFICANT DIFFERENCES BETWEEN LENGTHS AND WEIGHTS OF MALES AND FEMALES SAROTHERODON GALILAEUS

	Sex	Total Number of Fish	Degree of Freedom	Mean	"t"	Mean Significantly different?
Total Length (cm)	Males	10	26	16.37	2.549	YES
	Females	18		21.27		
Standard Length (cm)	Males	10	26	12.40	2.346	YES
	Females	18		16.36		
Body Weight (g)	Males	10	26	119.24	11.49	YES
	Females	18		246.76		

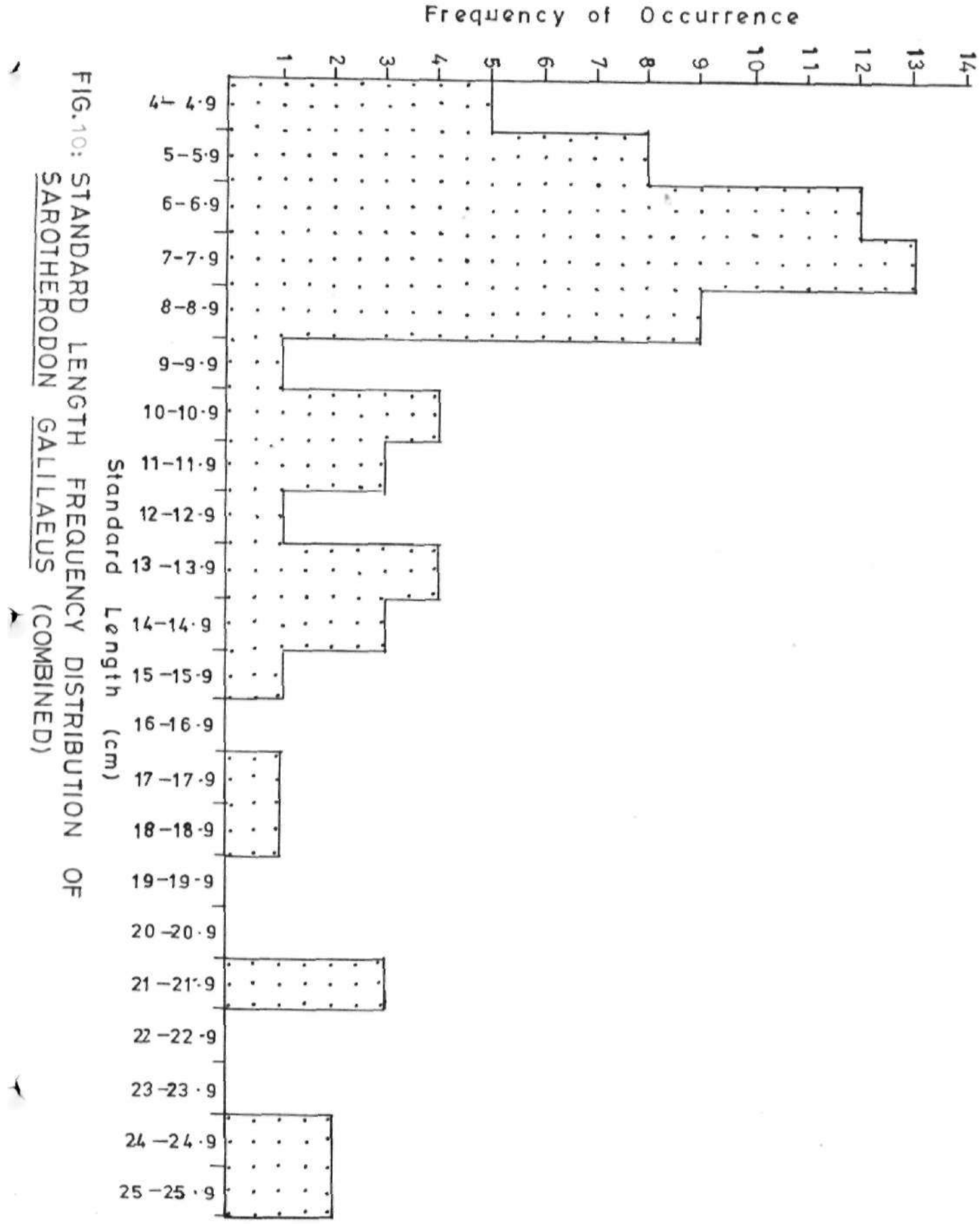


FIG. 10: STANDARD LENGTH FREQUENCY DISTRIBUTION OF SAROTHERODON GALILAEUS (COMBINED)

TABLE 16: SIZE RANGES AND K-VALUE OF **HEMICHROMIS BIMACULATUS** FROM ZARIA DAM BETWEEN JULY 1986 - JUNE 1987

	Total Number of Fish examined	Minimum size	Maximum size	Mean	Standard deviation	Standard error
Total Length (cm)	39	5.50	10.00	7.25	1.07	0.17
Standard Length (cm)	39	4.20	7.90	5.66	0.83	0.13
Body Weight (g)	39	5.00	24.50	10.19	4.35	0.69
Condition Factor (K-Value)	39	3.77	8.41	5.39	1.03	0.16

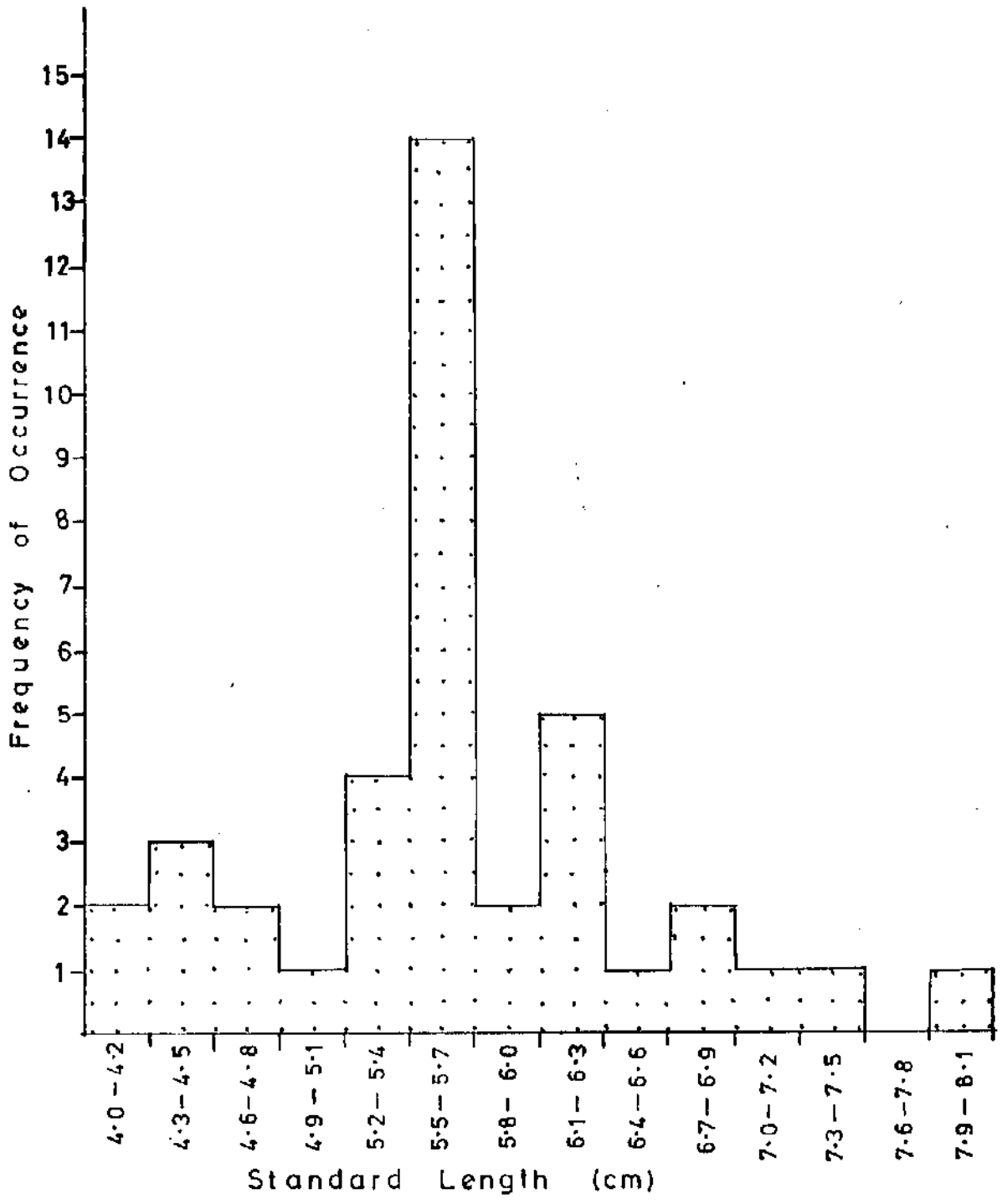


FIG. 11: STANDARD LENGTH FREQUENCY DISTRIBUTION OF HEMICHROMIS BIMACULATUS

4.10 Length-weight relationship

The result of the length-weight regression analysis for Oreochromis niloticus, Tilapia zillii, Sarotherodon galilaeus and Hemichromis bimaculatus are as seen in Tables 17 - 20. The 'b' values of O. niloticus, T. zillii, S. galilaeus and H. bimuculatus, obtained for males, females, immature and both combined are all less than 3. This shows that all these species exhibit negative allometric growth. There was a positive correlation between the lengths and weights of all the four fish species examined. Their 'r' values were high in each case ranging between 0.91 - 0.98 (Tables 17 - 20). Graphs of the length-weight relationships were drawn for different sexes of each of the four fish species (Figures 12 - 24). The graphs shows that as the body weights increase, the standard lengths also increase.

4.11 Condition factor

Tables 21 to 24, show the range, mean and standard deviation of condition factor 'k' in each month for the four species. The monthly mean value of 'k' obtained for Oreochromis niloticus varies from 4.3 to 6.73, while that of Tilapia zillii varies from 4.27 to 7.06. For Sarotherodon galilaeus and Hemichromis bimaculatus, it varies from 3.55 to 6.99 and 5.30 to 5.60 respectively. Figures 25 and 26 show the variations of 'k' values within the period of study. Period which fall below the mean annual 'k' values were regarded as poor condition periods. For Oreochromis niloticus the low periods were in July, October and May/June and in Tilapia zillii from July/August and May/June.

TABLE 17: LENGTH-WEIGHT REGRESSION ANALYSIS OF OREOCHROMIS NILOTICUS FROM ZARIA DAM

	Number of Fish examined	LOG a	"b"	Standard error of b	Correlation Coefficient r
Males	67	-1.18	2.84	0.07	0.97
Females	69	-1.06	2.74	0.08	0.96
Immature	172	-0.62	2.27	0.06	0.93
Combined	308	-0.86	2.55	0.03	0.97

TABLE 18: LENGTH-WEIGHT REGRESSION ANALYSIS OF TILAPIA ZILLII FROM ZARIA DAM

	Number of Fish examined	LOG a	"b"	Standard error of b	Correlation Coefficient r
Males	46	-0.72	2.39	0.07	0.98
Females	33	-0.58	2.24	0.13	0.95
Immature	68	-0.58	2.21	0.12	0.91
Combined	147	-0.67	2.33	0.04	0.97

TABLE 19: LENGTH-WEIGHT REGRESSION ANALYSIS OF SAROTHERODON GALILAEUS FROM ZARIA DAM

	Number of Fish examined	LOG a	"b"	Standard error of 'b'	Correlation Coefficient r
Males	10	-1.34	2.93	0.24	0.97
Females	18	-1.15	2.80	0.23	0.94
Immature	45	-0.96	2.65	0.17	0.91
Combined	73	-0.98	2.65	0.07	0.97

TABLE 20: LENGTH-WEIGHT REGRESSION ANALYSIS OF HEMICHROMIS BIMACULATUS FROM ZARIA DAM

Number of Fish examined	LOG a	"b"	Standard error of b	Correlation Coefficient r
39	-0.98	2.61	0.19	0.91

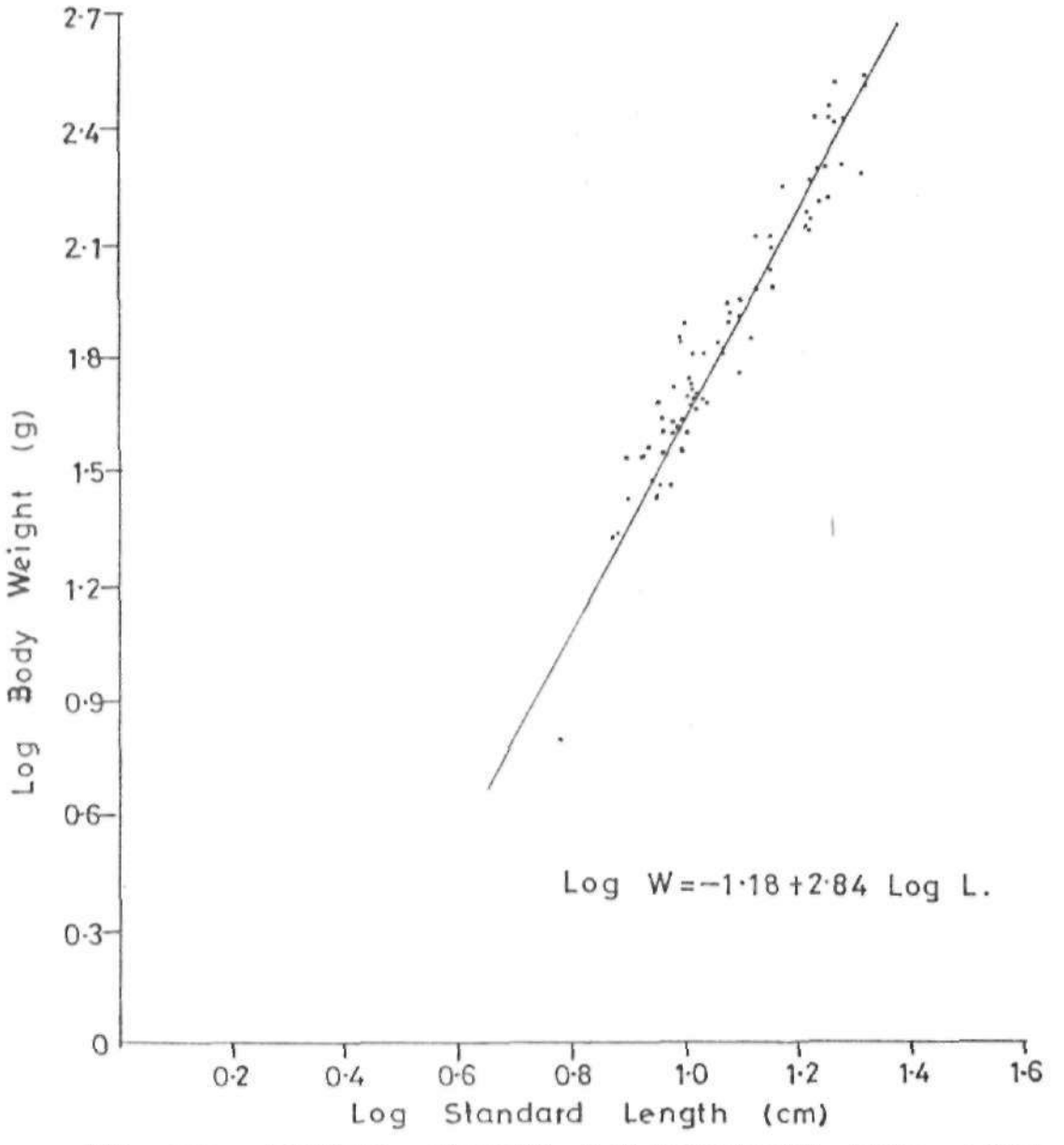


FIG. 12: LENGTH —WEIGHT RELATIONSHIP (LOG—LOG) OF OREOCHROMIS NILOTICUS (MALES)

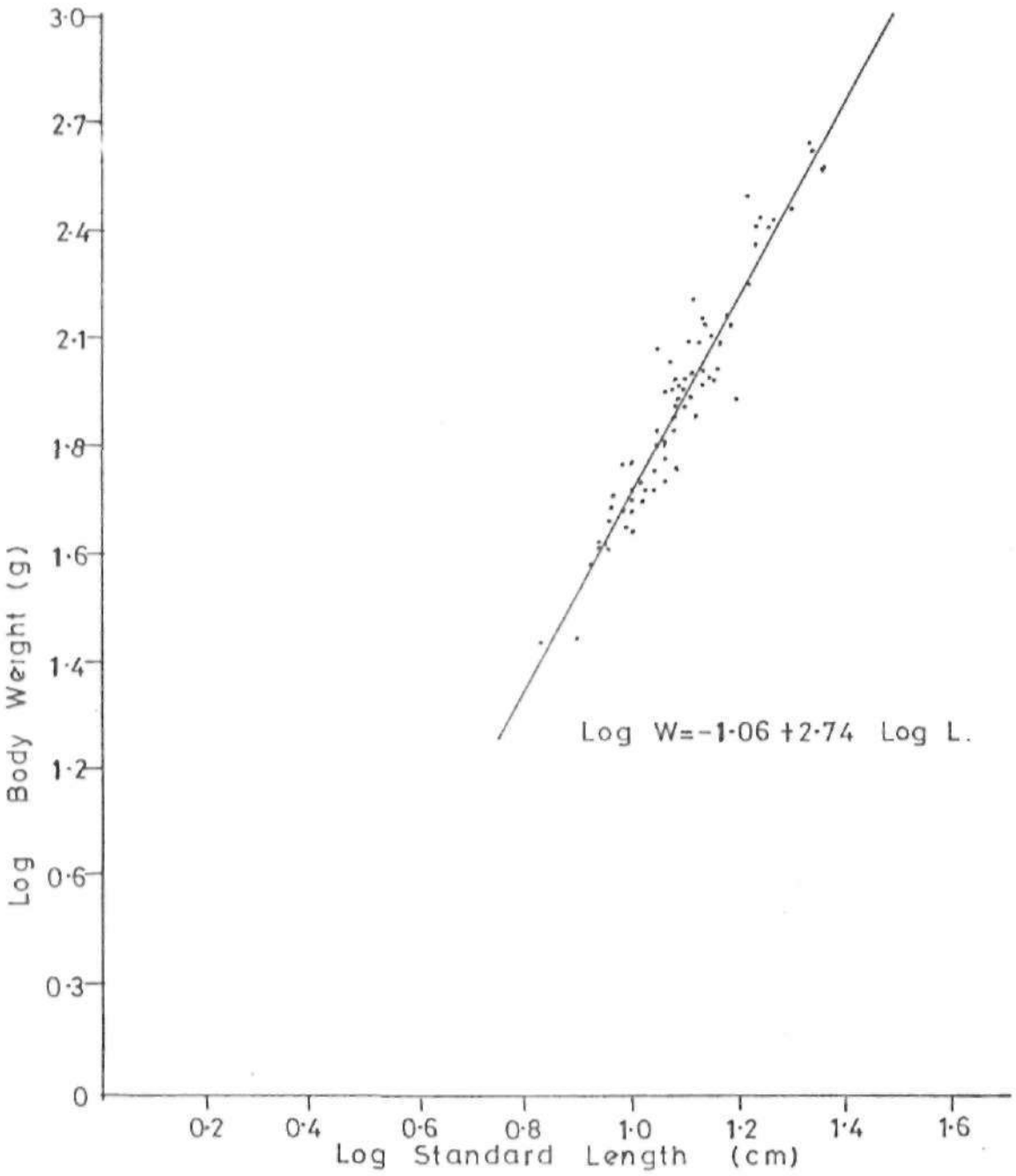


FIG. 13: LENGTH—WEIGHT RELATIONSHIP (LOG-LOG) OF OREOCHROMIS NILOTICUS (FEMALES)

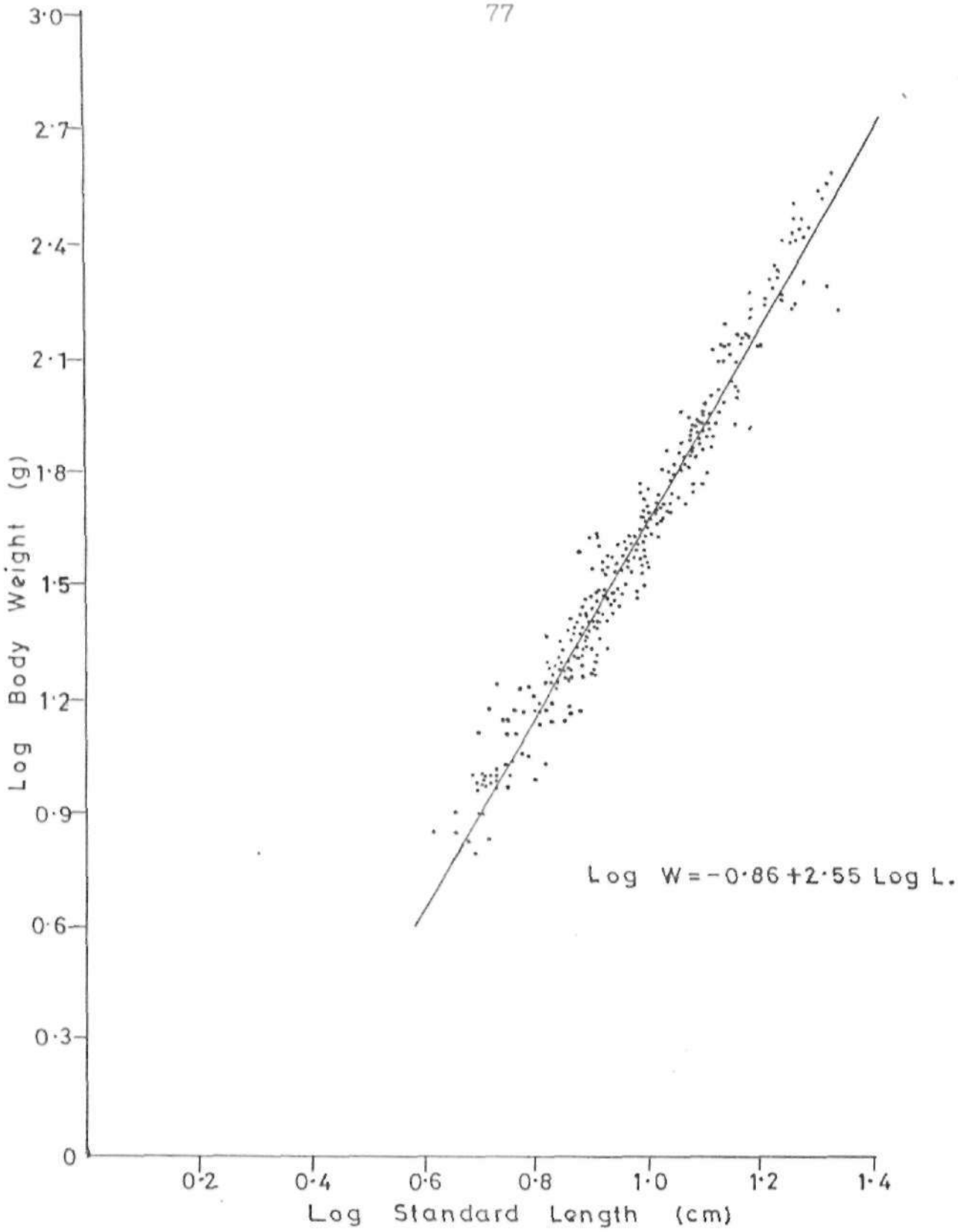


FIG. 15: LENGTH-WEIGHT RELATIONSHIP (LOG-LOG) OF OREOCHROMIS NILOTICUS (COMBINED)

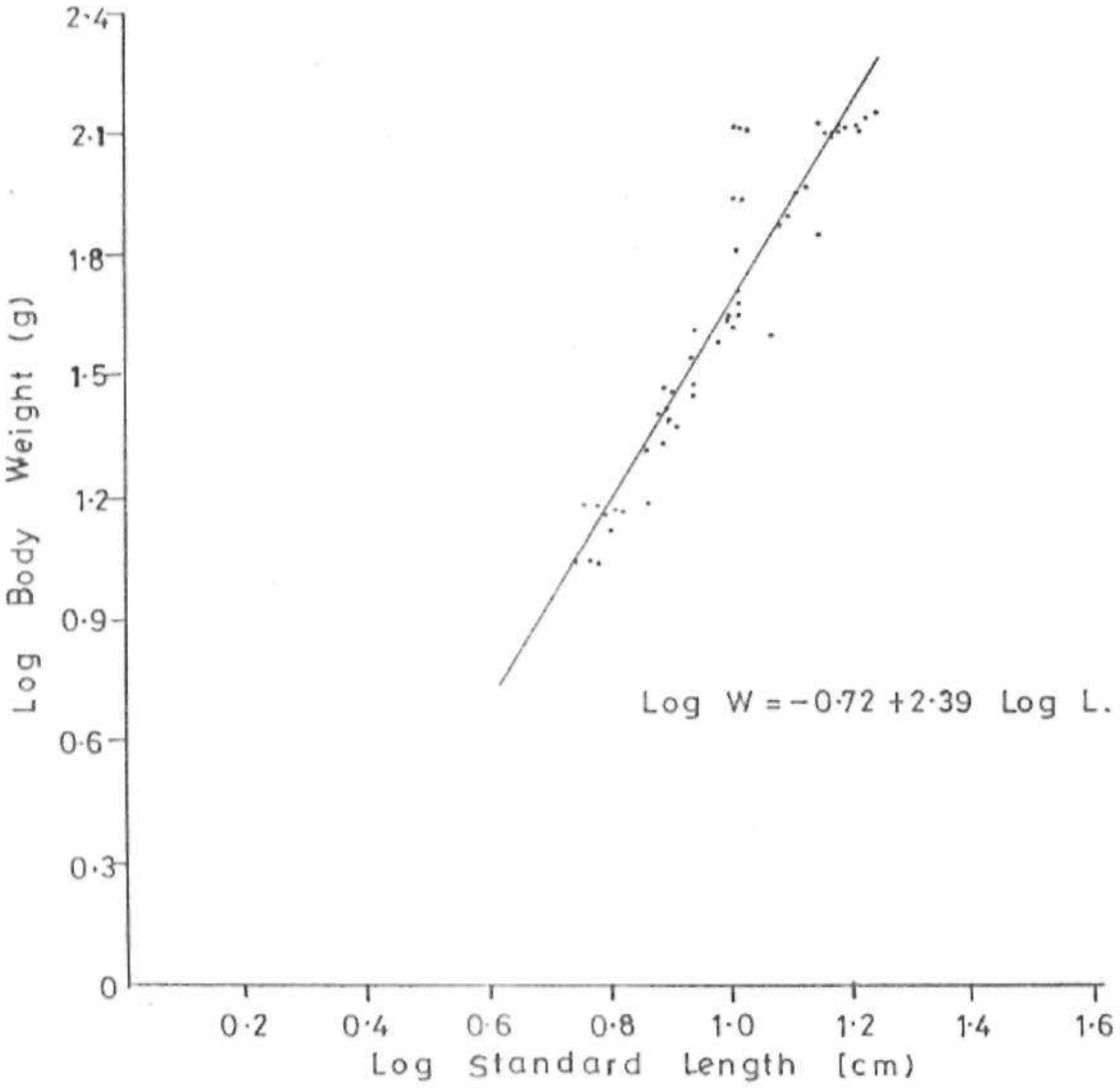


FIG. 16: LENGTH-WEIGHT RELATIONSHIP (LOG-LOG) OF TILAPIA ZILLII (MALES)

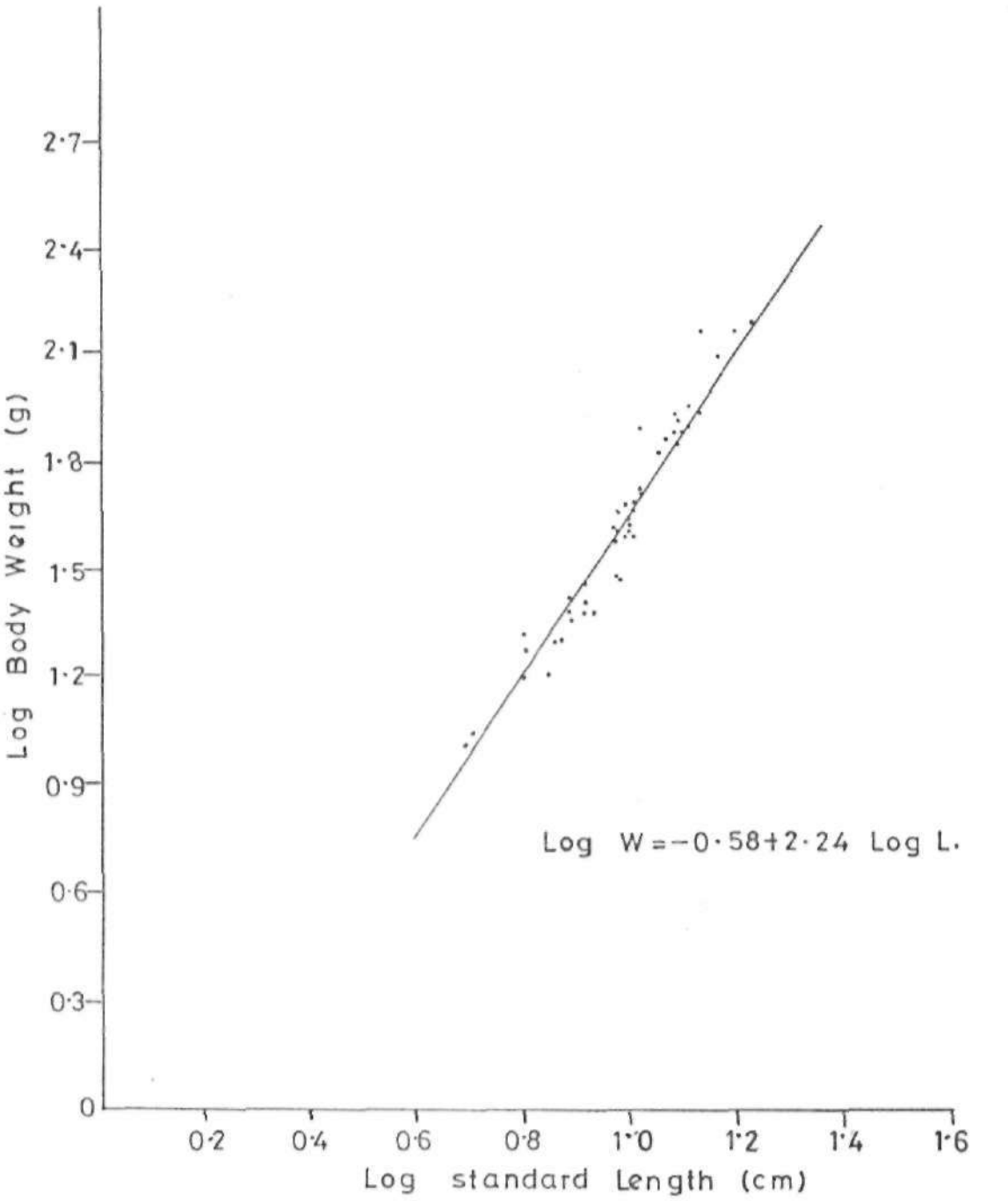


FIG 17: LENGTH — WEIGHT RELATIONSHIP (LOG-LOG) OF TILAPIA ZILLII (FEMALES)

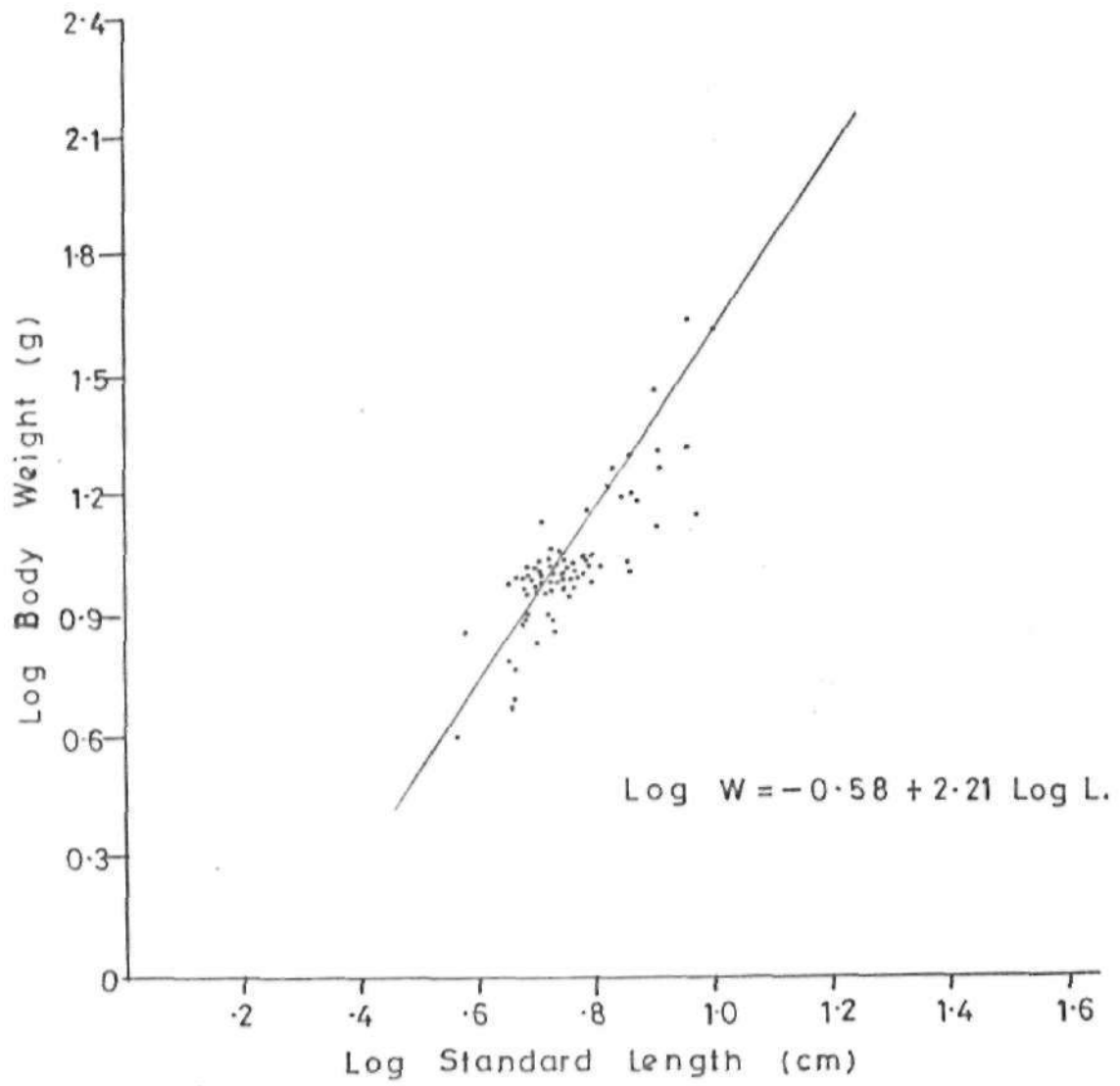


FIG. 18: LENGTH —WEIGHT RELATIONSHIP (LOG— LOG) OF TILAPIA ZILLII (IMMATURE)

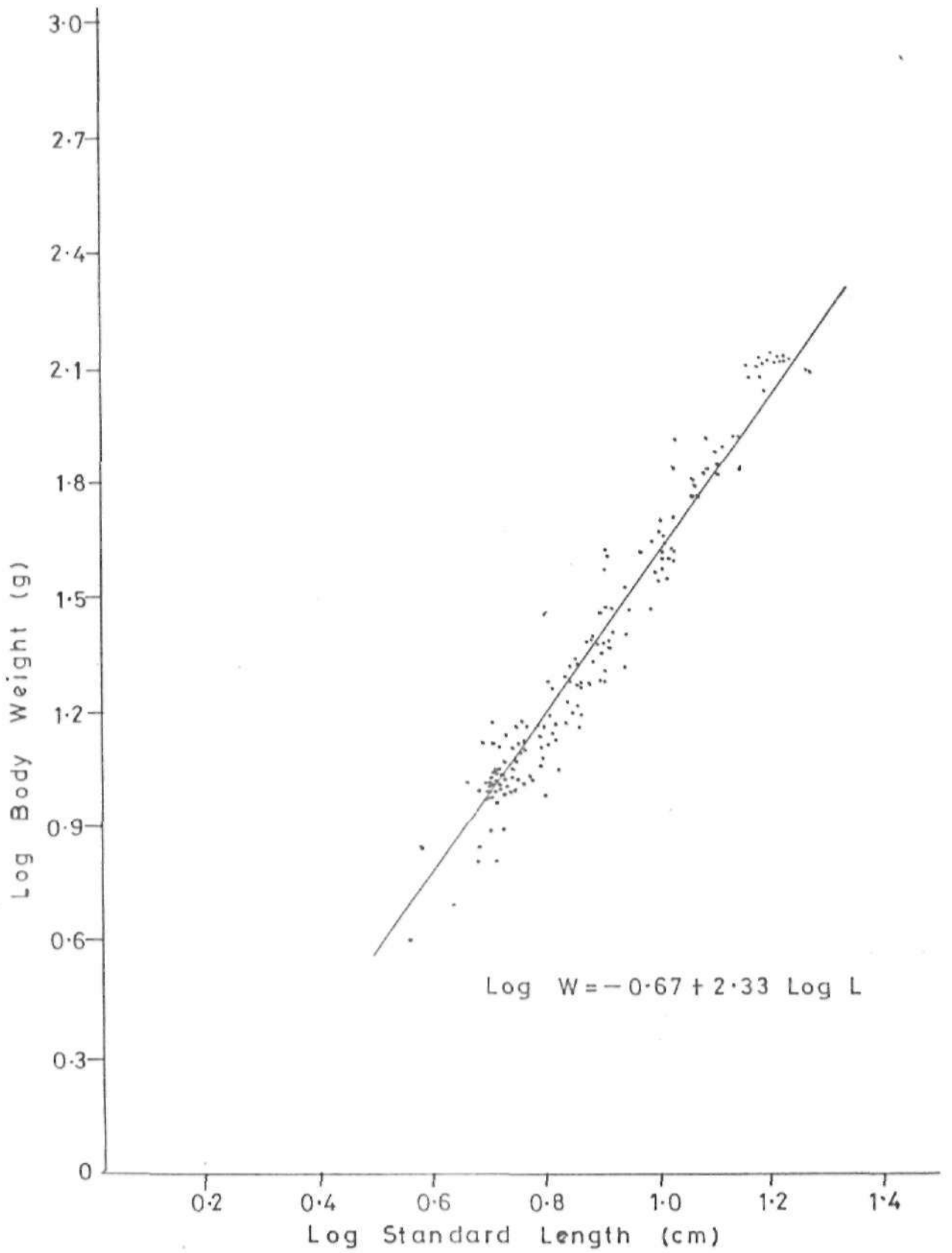


FIG. 19: LENGTH — WEIGHT RELATIONSHIP (LOG — LOG) OF TILAPIA ZILLII (COMBINED)

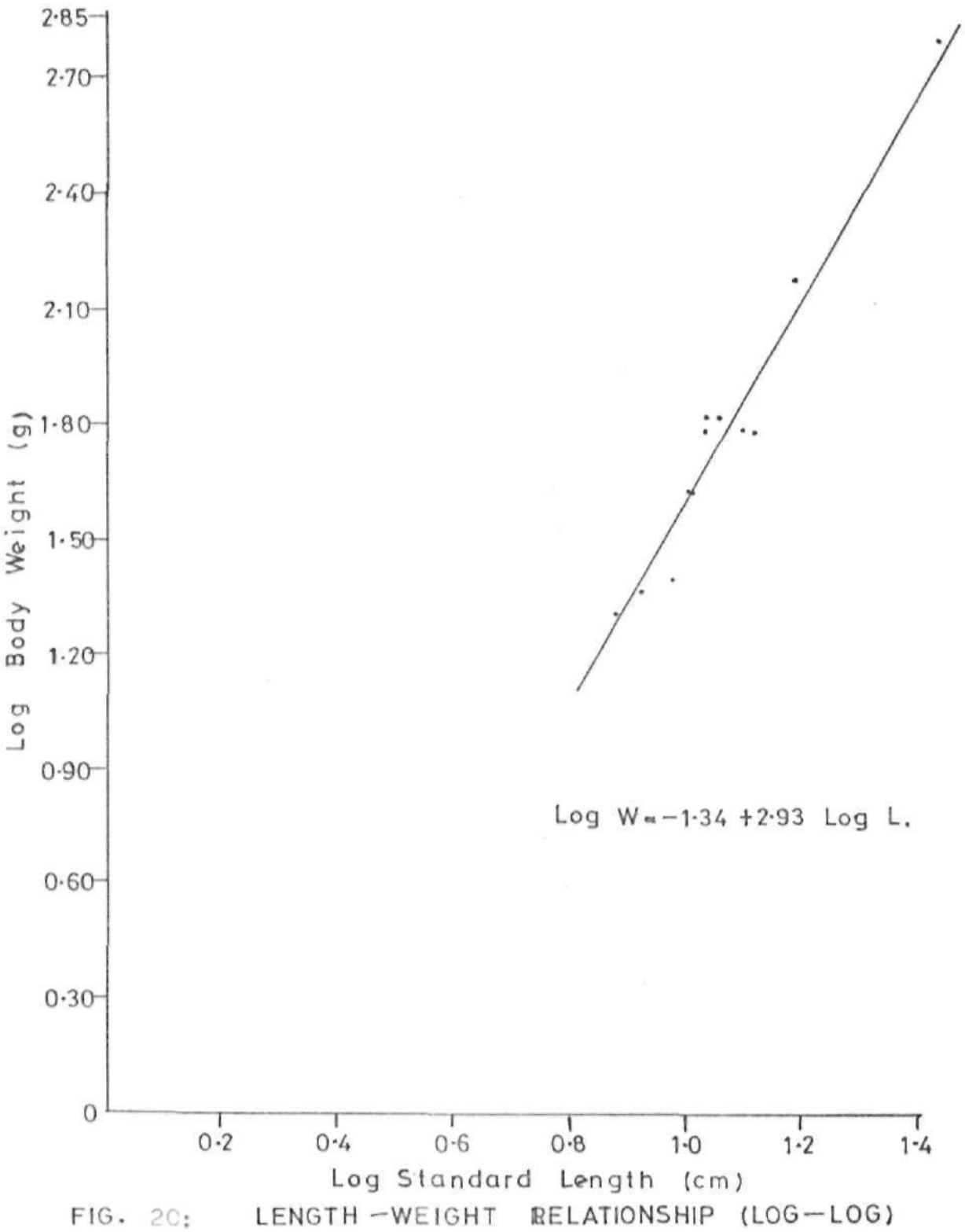


FIG. 20: LENGTH −WEIGHT RELATIONSHIP (LOG−LOG) OF SAROTHERODON GALILAEUS (MALES)

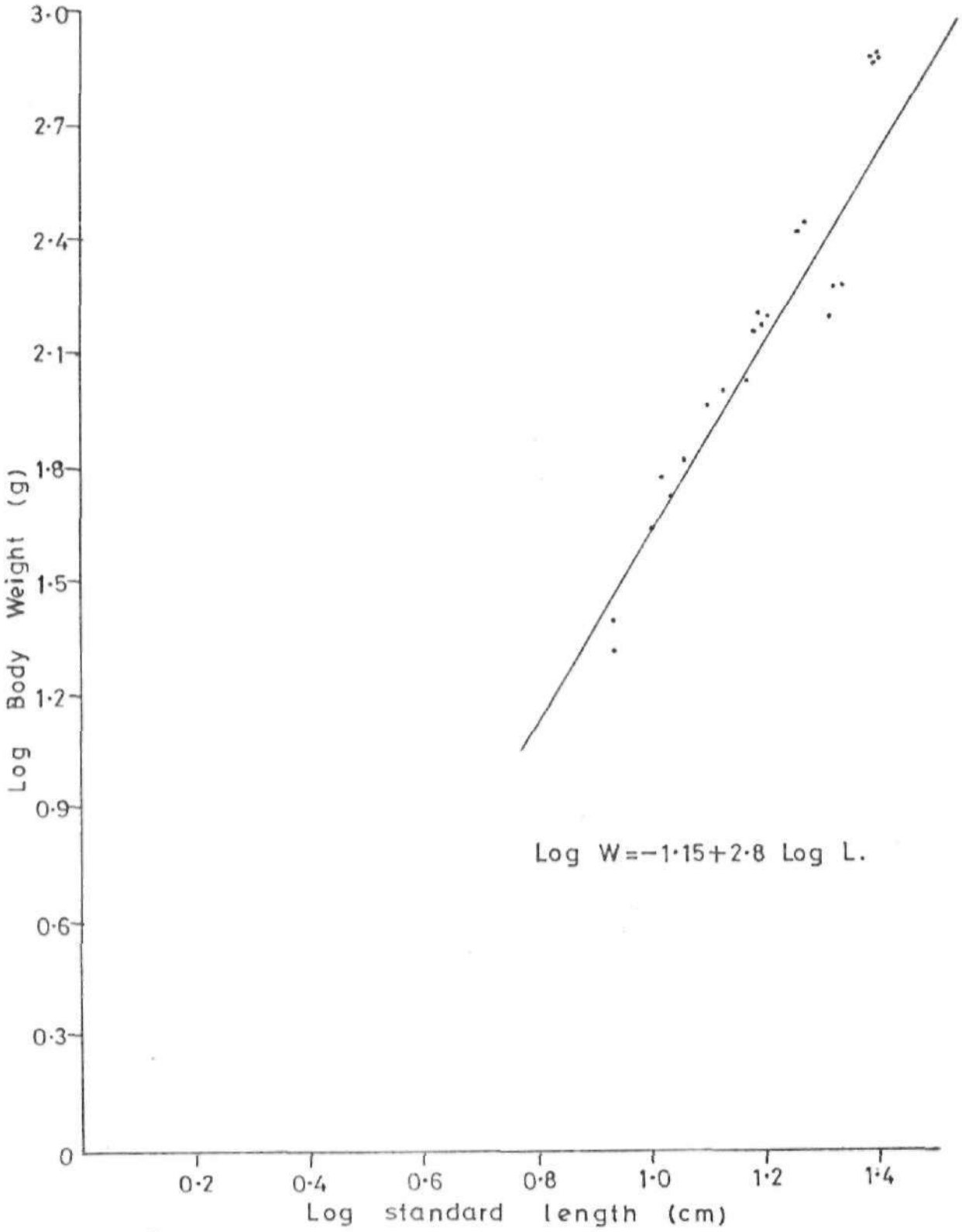


FIG. 21: LENGTH—WEIGHT RELATIONSHIP (LOG–LOG) OF SAROTHERODON GALILAEUS (FEMALES)

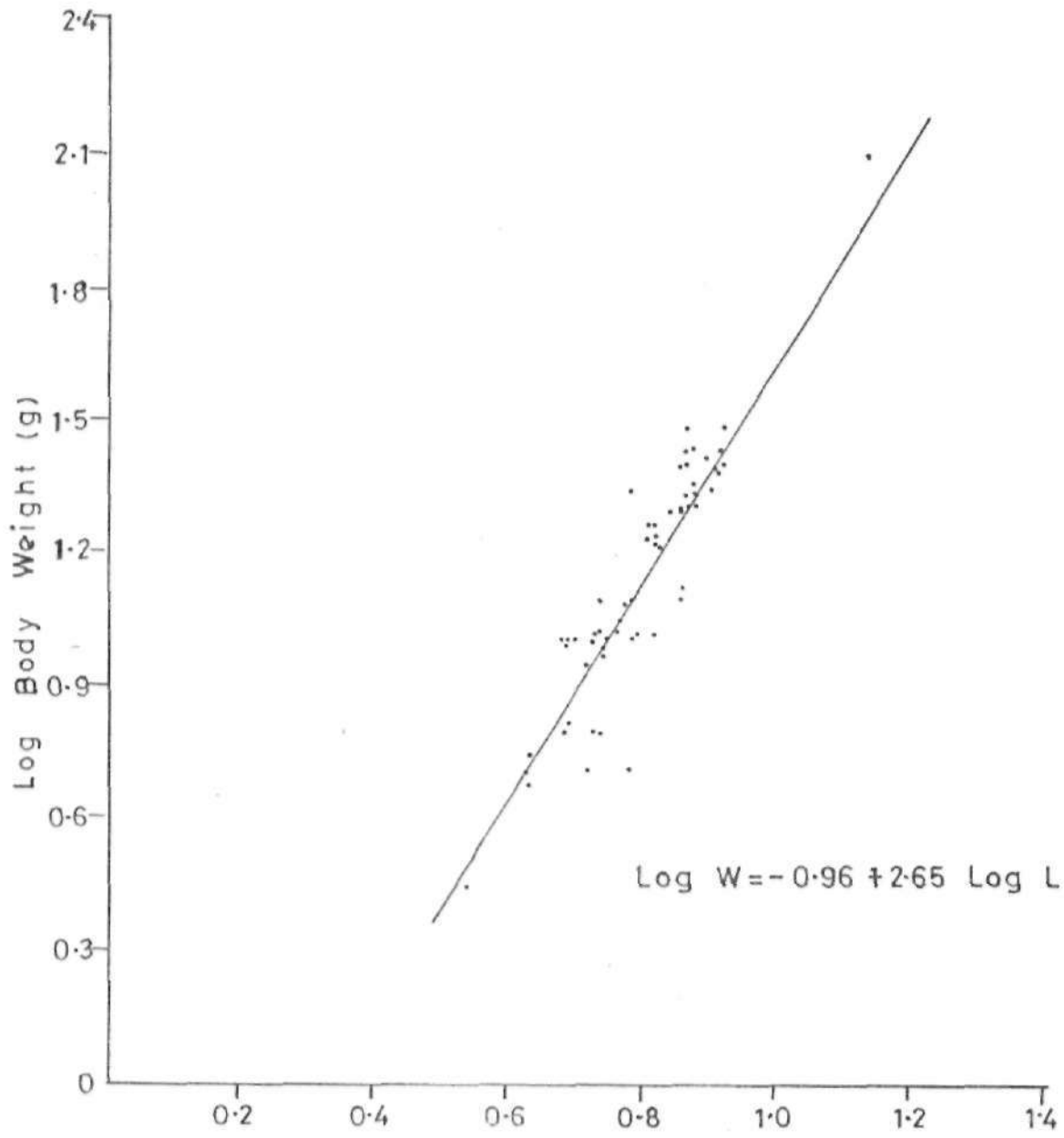


FIG 22: LENGTH-WEIGHT RELATIONSHIP (LOG-LOG) OF SAROTHERODON GALILAEUS (IMMATURE)

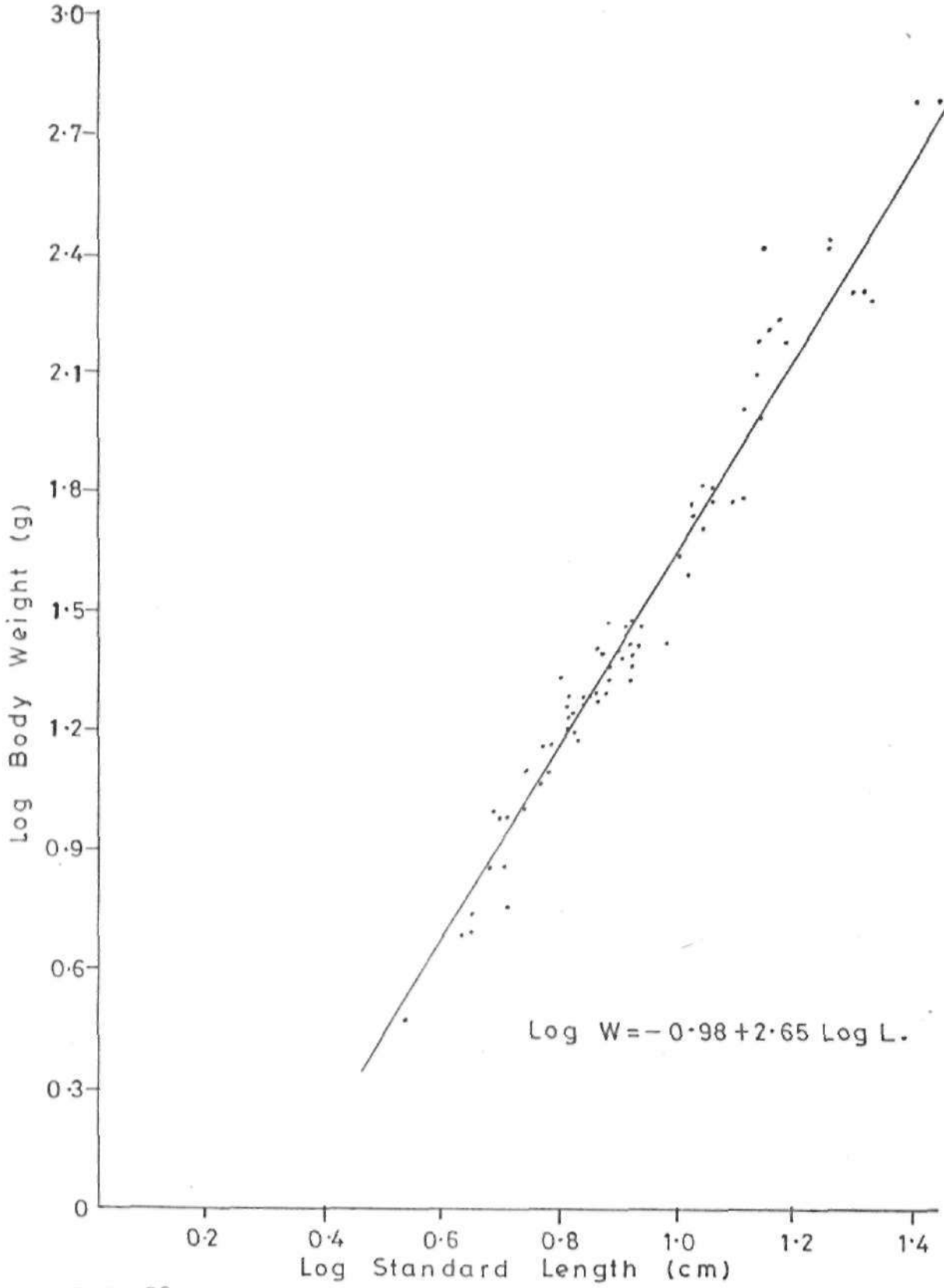


FIG. 23: LENGTH–WEIGHT RELATIONSHIP (LOG–LOG) OF SAROTHERODON GALILAEUS (COMBINED)

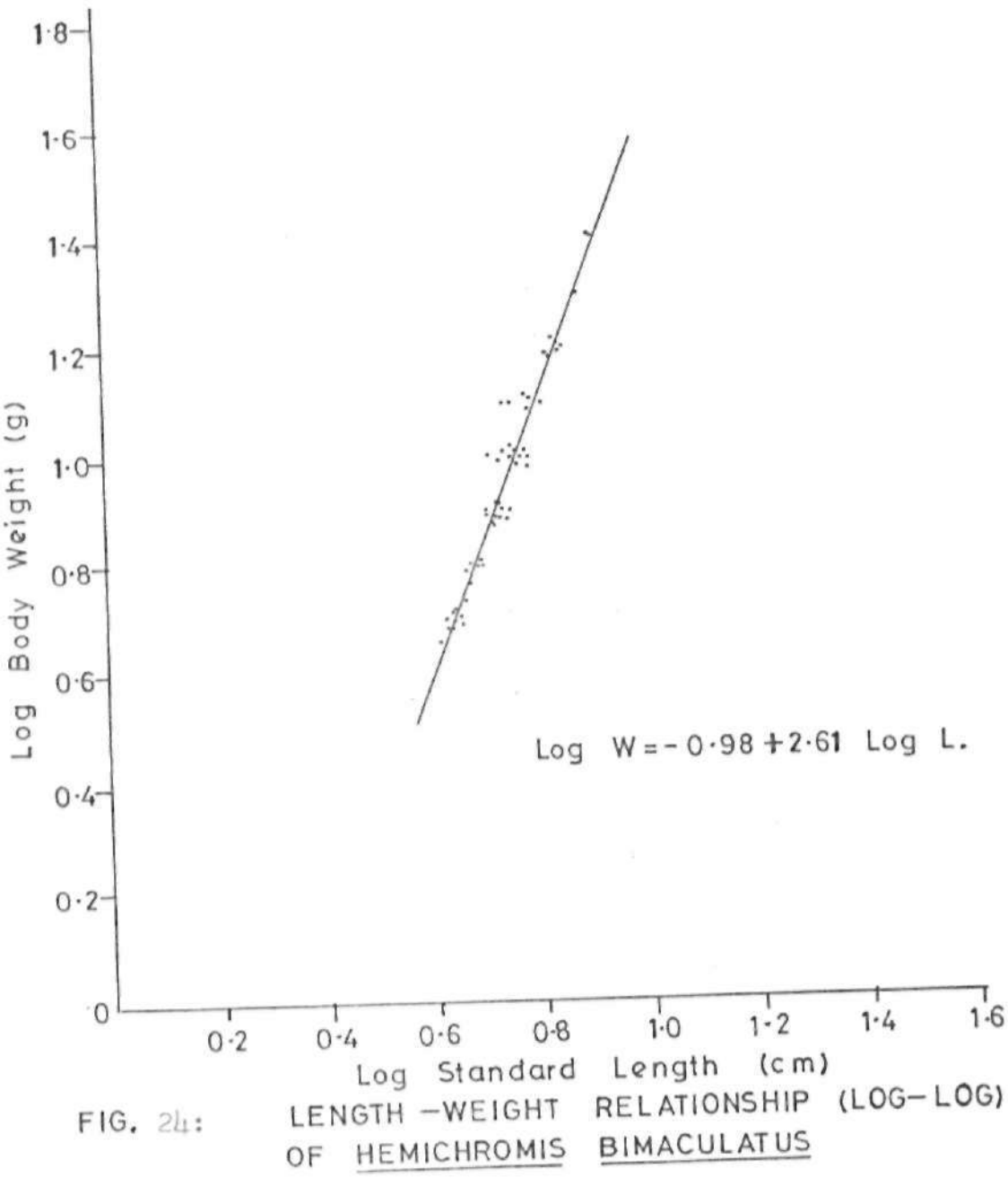


FIG. 24: LENGTH -WEIGHT RELATIONSHIP (LOG- LOG) OF HEMICHROMIS BIMACULATUS

In Sarotherodon galilaeus low periods occurred in July and May/June. All the species were found to be in good condition, although in some months the monthly mean 'k' value fell below the mean annual 'k' values.

Statistical tests show that the differences in the mean condition factor for males and females of Oreochromis niloticus, Tilapia zillii and Sarotherodon galilaeus, were not significant (Table 25).

4.12 Sex ratio

Table 26, shows the number of males and females in the samples and the sex ratio for each month for all the four species. Out of 308 specimens of Oreochromis niloticus examined, 67 were males, while 69 specimens were females giving a sex ratio of one male to 1.03 females. Monthly sex ratio variation for Oreochromis niloticus was approximatly one male to one female. Out of 147 specimens of Tilapia zillii, 46 were males, while 33 were females giving a sex ratio of one male to 0.7 females. The monthly sex ratio variation in this species was almost equal with a sex ratio of approximately one male to one female. Similarly, out 73 specimens of Sarotherodon galilaeus, 10 were found to be males, while 18 were females giving a sex ratio of one male to 1.8 females. The monthly sex ratio variation showed that the females were more than the males except in February and March where the males were dorminant over the females.

TABLE 21: MONTHLY MEAN CONDITION FACTOR FOR *OREOCHROMIS NILOTICUS*

Month		Total Fish examined	Condition Factor			
			Mean	Range	Standard deviation	Standard Error
July	1986	11	4.42	2.29-7.05	1.82	0.54
August	"	21	4.80	3.65-7.96	1.01	0.22
September	"	66	5.35	3.94-6.99	0.67	0.08
October	"	65	4.50	2.99-10.6	1.57	0.19
November	"	15	5.07	3.95-10.30	1.55	0.40
December	"	23	4.63	3.11-6.99	0.94	0.19
January	1987	48	5.26	3.76-8.27	0.80	0.11
February	"	13	6.31	4.8 -9.44	1.39	0.38
March	"	12	6.73	4.49-8.54	1.67	0.48
April	"	20	5.0	4.33-7.19	0.63	0.14
May	"	6	4.46	3.79-5.55	0.78	0.32
June	"	8	4.30	2.92-5.25	0.81	0.28
GRAND MEAN		25.66	5.06	3.66-7.84	1.13	±0.27

TABLE 22: MONTHLY MEAN CONDITION FACTOR FOR TILAPIA ZILLII

Month		Total Fish examined	Condition Factor			
			Mean	Range	Standard deviation	Standard Error
July	1986	9	4.66	2.66-8.59	1.90	0.63
August	"	4	4.77	4.12-5.55	0.58	0.29
September	"	-	-	-	-	-
October	"	11	7.06	4.02-13.22	2.81	0.84
November	"	7	5.65	4.5 -8.0	1.16	0.43
December	"	15	5.85	4.01-10.31	1.77	0.45
January	1987	6	6.40	5.7 -7.28	0.62	0.25
February	"	27	5.97	2.28-9.60	1.76	0.34
March	"	19	5.50	3.38-8.50	1.53	0.35
April	"	29	6.64	4.2 -11.8	1.59	0.29
May	"	9	4.30	3.02-6.08	0.98	0.32
June	"	11	4.27	2.69-6.94	1.22	0.36
GRAND MEAN		13.36	5.54	3.68-8.71	1.44	±0.41

TABLE 23: MONTHLY MEAN CONDITION FACTOR FOR SAROTHERODON GALILAEUS

Month		Total Fish examined	Condition Factor			
			Mean	Range	Standard deviation	Standard error
July	1986	4	3.55	2.16-4.43	0.97	0.48
August	"	-	-	-	-	-
September	"	-	-	-	-	-
October	"	-	-	-	-	-
November	"	3	6.99	5.91-8.50	1.34	0.77
December	"	7	6.46	3.75-10.07	2.16	0.81
January	1987	6	6.64	5.22-8.49	1.15	0.47
February	"	15	5.55	4.21-9.04	1.37	0.35
March	"	14	5.35	3.56-7.81	1.20	0.32
April	"	2	5.13	4.82-5.44	0.43	0.31
May	"	10	4.17	2.15-5.46	1.17	0.37
June	"	12	4.10	2.0 -5.96	1.15	0.33
GRAND MEAN		8.11	5.32	3.75-7.24	1.21	±0.46

TABLE 24: MONTHLY MEAN CONDITION FACTOR FOR HEMICHROMIS BIMACULATUS

Month		Total Fish examined	Condition Factor			
			Mean	Range	Standard deviation	Standard error
July	1986	-	-	-	-	-
August	"	-	-	-	-	-
September	"	-	-	-	-	-
October	"	-	-	-	-	-
November	"	-	-	-	-	-
December	"	-	-	-	-	-
January	1987	-	-	-	-	-
February	"	14	5.30	4.63-8.4	1.05	0.28
March	"	18	5.40	3.77-7.97	1.02	0.24
April	"	7	5.60	3.78-7.11	1.16	0.43
May	"	-	-	-	-	-
June	"	-	-	-	-	-
GRAND MEAN		13	5.41	4.06-7.82	1.07	±0.31

TABLE 25: STATISTICAL ANALYSIS (T - TEST) FOR SIGNIFICANT DIFFERENCE BETWEEN CONDITION FACTOR (K-VALUE) OF MALES AND FEMALES OREOCHROMIS NILOTICUS, TILAPIA ZILLII AND SAROTHERODON GALILAEUS

Species	Sex	Total Number of Fish	Degree of Freedom	Mean	"t"	Mean Significantly different?
Oreochromis niloticus	Male	67	134	4.49	0.28	NO
	Female	69		4.61		
Tilapia zillii	Male	46	77	4.92	0.02	NO
	Female	33		4.91		
Sarotherodon galilaeus	Male	10	26	4.01	0.8	NO
	Female	18		4.32		

TABLE 26: SEX RATIO OF *OREOCHROMIS NILOTICUS*, *TILAPIA ZILLII* AND *SAROTHERODON GALILAEUS*

SPECIES	SEX	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL	SEX RATIO
O. NILOTICUS	MALE	3	2	7	11	3	8	15	2	-	12	3	1	67	1:1.03
	FEMALE	2	7	6	10	5	7	18	-	1	5	3	5	69	
Sex ratio	M:F	1:0.7	1:3.5	1:0.9	1:0.9	1:0.7	1:0.9	1:1.2	1:0	0:1	1:0.4	1:1	1:5	1:103	
T. ZILLII	MALE	4	2	-	8	5	6	1	6	4	-	5	5	46	1:0.7
	FEMALE	3	2	-	1	1	2	1	8	7	1	2	5	33	
Sex ratio	M:F	1:0.8	1:1	0:0	1:0.1	1:0.2	1:0.3	1:1	1:1.3	1:1.8	0:1	1:0.4	1:1	1:0.7	
S. GALILAEUS	MALE	-	-	-	-	-	-	-	3	2	-	3	2	10	1:1.8
	FEMALE	1	-	-	-	-	-	-	1	1	-	7	8	18	
Sex ratio	M:F	0:1	0:0	0:0	0:0	0:0	0:0	0:0	1:0.3	1:0.5	0:0	1:2.3	1:4	1:1.8	

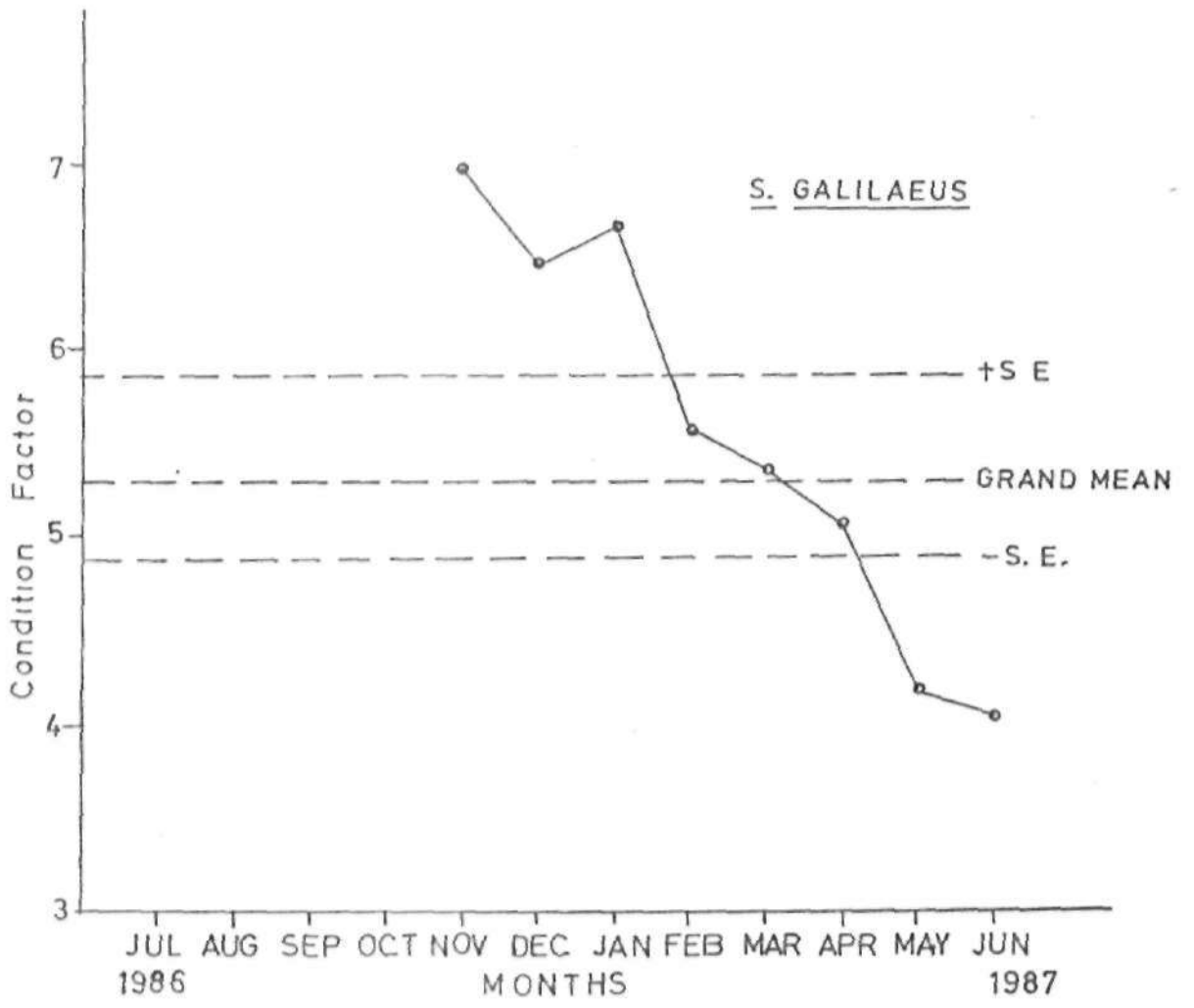


FIG. 26: MEAN MONTHLY CONDITION FACTOR OF SAROTHERODON GALILAEUS

CHAPTER FIVE

5.0 DISCUSSION

The results of present study gives a picture of the parasite fauna as well as some aspects of the biology of the Family Cichlidae from Zaria Dam. A total of 567 fish specimens representing Oreochromis niloticus, Tilapia zillii, Sarotherodon galilaeus and Hemichromis bimaculatus were examined out of which only 17.1 percent were found to be infected by protozoan, digenetic trematodes, cestode, nematode, acanthocephala and an unidentified Leech (Hirudinea).

5.1 Protozoan

The protozoan parasite Henneguya sp (Cysts) of variable sizes were found attached to the gill filaments of Oreochromis niloticus only in size range between 4 - 8 and 9 - 13 cms. These cysts were not found in larger size fishes or older fishes. This could possibly be due to immunity developed in the older fishes. The sex of the fish however, did not influence the incidence or rate of infection of these parasites. Both the sexes were found equally susceptible to the infection. This agrees with the findings of Aken'ova (1983) who observed that there was no difference between the rate of infection between male and female in Clarias lazera infected with Henneguya sp. The cysts of Henneguya spp. infecting fish hosts, were also reported by various research workers; Abolarin (1973) recovered Henneguya clariae from the gills of Clarias lazera in Zaria, River Niger at Jebba and Iwo.

of infection being 1.9 percent and the parasites were found encysted in the branchial region of the host. However, fishes ranging between 4 - 8 cm and 9 - 13 cm were free from the parasite, while those of larger size ranging between 14 - 18cm and 19 - 23 cm were found infected by metacercariae of Clinostomum sp. This agrees with the previous findings that Tilapia sp. of larger size were found to be more infected by Clinostomum sp. and the incidence tends to increase among larger sized fishes (Ukoli, 1965; Paperna, 1980).

The males of Oreochromis niloticus were found more infected with Clinostomum sp. as compared to the females. In the present study, only one female was found infected with this parasite. This might be due to differences in genetic make up, physiology and degree of resistance to infection between the male and female in Oreochromis niloticus. Wickins and Macfarlane (1973) reported some of these factors to be responsible for the differences in infections between different sexes of Plaice, Pleuronectus platessa

No seasonal cycle was observed in the occurrence of Clinostomum sp. (Metacercariae) in the host. The parasites were recovered only in August and April. However, seasonal cycle was reported earlier for this parasite in Tilapia sp. collected from Nungua Dam, South Ghana (Paperna, 1980). The peak infection among the fish occurred towards the end of the rainy season during September - October, while prevalence of infection was at its lowest level during the dry season between December to May.

Several workers have reported Clinostomum sp. (Metacercariae) from the Cichlid fishes notably Oreochromis niloticus, Tilapia zillii, Sarotherodon galilaeus and Haplochromis sp. (Awachie, 1965; Ukoli, 1965; Manter and Pritchard, 1969; Khalil and Thurston, 1973; Paperna, 1980; Okaeme, 1984; Onwuliri and Magbemena, 1987). Other fish species are also found to be infected by this parasites (Appendix 1). The metacercariae are found as nodules under the skin, branchial region, kidney, submucosa of the mouth cavity, gill chamber, below the operculum and pharyngeal bone, muscles of the body, around the heart, abdominal cavity, mesentry and viscera of the swim bladder.

Oreochromis niloticus or other fish are known as the second intermediate host for this parasite. The adult worm is found attached with the help of large sucker in the mouth and the pharynx of fish eating birds (Awachie, 1965; Khalil and Thurston, 1973; Paperna, 1980). Ukoli (1970) reported adult Clinostomum tilapiae in the upper and lower jaw of cattle egret. In the oral cavity of the birds, the worm matures into a fully grown worm within four days. Other birds such us Herons, Darter, Cormorants, Pelicans and Cattle egret are reported to be the definitive host of Clinostomum sp. (Paperna, 1980). While the snails and clams are the first intermediate hosts for this parasite (ReichenBach-Klinke and Elkan, 1965).

In Africa however, the identity of the molluscan intermediate host is unknown (Paperna, 1980). In Zaria Dam, clams and the snails could likely be the first intermediate host for the parasite, as

lot of them were observed to be present in the dam during present investigations. The posthorn snail, Helisoma sp. was reported to be the first intermediate host of Clinostomum sp., in North, South and Central America, while in Asia snails of the Family Planorbidae were reported for this parasite (ReichenBach-Klinke and Elakan, 1965; VanDuijn, 1973).

Although no deliterous effects were noticed on the fish as a result of Clinostomum sp. (Metacercariae) infection, however, its pathological aspects showing clinical symptoms cannot be ruled out. Awachie (1965) reported the death of heavily infected fish with metacercariae of Clinostomum sp. during transportation. Similarly, Okaeme (1984) reported that high counts of Clinostomum tilapiae was found to disfigure the skin and gills. Thus confirming the deliterious effects of this parasite on its fish host.

The Diplostomatid metacercariae in the form of globulur cysts were found buried in the abdominal cavity of the host. The cysts are whitish in colour and of variable sizes (Appendix 13). Diplostomatid cysts were recovered from Oreochromis niloticus and Tilapia zillii, with the rate of infection as 13.0 percent and 5.4 percent respectively.

As much as ten cysts were found infecting a single fish. Sarotherodon galilaeus and Hemichromis bimaculatus were free from this parasite. The juveniles of Oreochromis niloticus and Tilapia

Hemichromis bimaculatus, Tilapia zillii, Tilapia sp., and Carp, Cyprinus carpio (VanDuijn, 1973; Paperna, 1980).

5.3 Cestode

One male specimen of Tilapia zillii was found infected by developing stage of Cyclophyllidean cestode. The rest of the fish examined were found free from the cestode infection. The parasites were recovered from the intestine of the host, and a total number of seven parasites were recorded. Onwuliri and Mgbemena (1987) recorded cysticercoids of cyclophyllidaen cestode from the intestine of Oreochromis niloticus and Tilapia zillii, from Panyam fish farm, Jos. Pathological symptoms as a result of infection by this parasite were not observed in the host possibly because the parasites were very few in number. However, (Paperna, 1980) reported haemorrhagic entiritis, destruction of the intestinal epithelium causing swelling of the abdomen, emaciation and cessation of feeding due to large number of cestodes in the host.

5.4 Nematode

Sarotherodon galilaeus was the only fish species infected with Ascarid worm (nematode). The nematode was recorded in the male specimen only, located around the gonad region. Similarly, Ascarid nematodes were recovered from fishes of the Family Catharinidae and Mormyridae, Tilapia leucosticta and Pseudotolithus spp. respectively (Awachie, 1965; Malvestuto and Ogambo-Ogoma, 1978; Anyanwu, 1983).

Nematodes can cause deliterous effects on their host. Paperna (1980) reported gonadal deformations in the Cichlids of the genus Haplochromis. Similarly, heavy infestation of fish with nematode may cause great losses among fish (Reichenback-Klinke and Elkan, 1965). During the present investigations, no pathological changes were noticed as a result of infection by this parasite in fish.

5.5 Acanthocephala

Oreochromis niloticus, Tilapia zillii and Sarotherodon galilaeus were all found infected by Neoechinorynchus sp. The parasites were found attached to the intestinal lining of the host. Fishes of all size groups were found infected by these parasitic worms and it appears that the size of the host did not influence the establishment of the parasite within the host. Similarly, the sex of the hosts had no apparent effect on acanthocephalan infection.

Seasonal cycle in the occurrence was also noticed and it was observed that the acanthocephalan infection was most prevalent during the dry season from February to May and later in November. Parasites were not recorded during the remaining months.

Although no apparent damage to the intestinal lumen was noticed as a result of attachment of this parasite, however, it is possible that the insertion of proboscis of the parasite into the intestinal lining could destroy the fish intestine leading to bleeding and perforations in the hosts intestine (Paperna, 1980).

Information is not available on the effects of infection in African fish (Paperna, 1980). The infection of Neoechinorynchus sp. was often reported by various research workers in Cichlids, Phoxinus phoxinus, Trouts, Micropterus salmoides, Micropterus dolomieui, Esox lucius and Tilapia zillii (Awachie, 1965; Bibby, 1972; Wootten, 1973; Amin, 1986; Onwuliri and Mgbemena, 1987).

5.6 Hirudinea

A single unidentified Leech was found attached to the body surface of male Oreochromis niloticus. In Africa, a wider range of fish families such as Cichlidae, Clarriidae, Synodontidae, Bagridae and Mormyridae are found to be infected by the Leech (Paperna, 1980). In Zaria dam, the incidence of this parasite is small as only one fish was found infected with Leech throughout the period of study.

5.7 Biology of the Cichlids

Oreochromis niloticus, Tilapia zillii, Sarotherodon galilaeus and Hemichromis bimaculatus were found in the sample during the period of study. O. niloticus was the most abundant of the Cichlids, while Hemichromis bimaculatus was the least. This result agrees with the findings of Banks et al., (1965), who found that Oreochromis niloticus was the most abundant among the Sarotherodon and Tilapia species in River Niger. The possible reasons for the few number of Hemichromis bimaculatus in the sample could be attributed to the deep water dwelling nature of this species (Akintunde and Imevbore, 1979).

Other possible reasons for the few number of Hemichromis bimaculatus in the sample, are likely due to mesh size of the net used by the fishermen, the reproductive rate of the species, life span and differential mortality of the species.

The abundance of the rest of the species in the findings may be due to the fact that these species have been found to be shore-dwellers and live in shallow water margins (Akintunde and Imevbore, 1979). Hence the species were easily caught during fishing.

The analysis of the size ranges of Tilapia zillii and Oreochromis niloticus shows that males grow to a larger size than the females. This finding agrees with the result of (Holden and Reed, 1972; Fryer and Iles, 1972). They said in many species of Tilapia, the males grow to a larger size than females. In a related research, Olatunde (1983) reported that male Clarias lazera grow larger in size than the female. In Sarotherodon galilaeus, the females were found to be larger than the males. This departure from what Holden and Reed (1972), Fryer and Iles (1972) earlier stated could be attributed to the following factors which Olatunde (1983) reported. He said the types of fishing gear used for the capture, season of the year, structural and physiological adaptations which might make one fish more vulnerable to catch than others, may affect the size and sex distribution of captured fish. It is important to note that analysis of sizes based on market samples may not give a true picture of the size ranges present in the dam and the result should be accepted with caution.

Sarotherodon galilaeus rarely grow larger than 33 cm and Tilapia zillii is found to reach a maximum length of 27 cm (Holden and Reed, 1972). This agrees with my results as none of these species exceeded the maximum value reported by (Holden and Reed, 1972). For Oreochromis niloticus, the maximum length varies with localities. The maximum length observed in Zaria Dam was 27.3 cm. The maximum length attained by this species in Sokoto River is 34 cm, River Niger (Kainji), 42 cm; 54 cm in Lake Albert, Uganda; and 63 cm in Lake Rudolf, Kenya (Holden and Reed, 1972). The reasons for this disparities in size could possibly be attributed to genetic and environmental factors. For Hemichromis bimaculatus, the maximum length observed was 10.0 cm. This agrees with the findings of (Reed et al., 1977), where they stated that the adult individuals of H. bimaculatus rarely exceed 10 cm in total length.

The length frequency distribution gave normal distribution curves for all the species. The mode or peak is presumed to be a strong year class. Gwahaba (1973) reported the mode or peak to be a result of accumulation of fish in these length classes. Similar distribution curves were reported for Tilapia guineensis from Lekki Lagoon and for Tilapia melanotheron and Tilapia guineensis from the Lagos Lagoon (Fagade, 1978 and 1979). Gwahaba (1973) and Olatunde (1983 and 1984) also reported normal length distribution curves for Tilapia nilotica from Lake George, Uganda and Clarias lazera and Malapterurus electricus from Zaria area respectively.

The analysis of length-weight relationship showed that as the fish grows in length, the weight also increases for all the four species examined. Where the value of b=3, the fish is said to grow isometrically and values other than 3 show that the fish exhibits allometric growth (Tesh, 1968).

The 'b' values of the four species examined were all less than 3. This suggests that they all exhibit negative allometric growth. This result agrees with the findings of Fagade (1979) who reported Tilapia melanotheron and Tilapia guineensis from Lagos Lagoon, to exhibit allometric growth with their corresponding 'b' values of 2.8 and 2.7 respectively. The 'b' value of a fish is found to be affected by certain factors like increase in weight (due to intake of water, food and gonads development), seasons of the year, time of the day when the fish was captured, stomach fullness and spawning activities (Lagler, 1952).

The mean condition factor obtained for all the species indicated that all the species were in good condition throughout the period of study. No difference was noticed in condition factor between the males and females of all the species. Periods which fell below the mean annual values were regarded as low condition periods. Low periods of condition observed for O. niloticus, T. zillii and S. galilaeus in some months of the rainy season could possibly be due to increased breeding and spawning activities by these fishes. According to Craig (1974) condition of fish falls after spawning. The correlation of 'K' values with spawning activities should be taken with caution. Other factors (e.g. feeding)

othar than spawning activities are known to affect fish condition and in most cases it is hard to separate the effect of one from the other (Le Cren, 1951).

The sex ratio was approximately one to one for males and females in all the species. There was no distinct periods of sex ratio variations throughout the period of study. The result of this work, agrees with the results of several workers who reported a sex ratio of 1:1 or there about for various fish species. For example, Imevbore (1970) reported an almost 1:1 ratio in Eutropius niloticus collected from the coffer dam area of River Niger. Fagade (1978 and 1979) reported a sex ratio of one male to 0.82 female for I. guineensis and one male to 1.21 female for I. melanotheron. Nwadairo (1985) reported a 1:1 sex ratio for the dwarf African Cichlid Pelvicachromis pulcher in River Sombreiro, Nigeria.

Sex ratio is not static and vary from year to year (Fagade, 1978). Factors like sampling variations, vulnerability of one sex to capture, genetic factor, seasonal and breeding migration could cause sex ratio variations (Emere, 1984). Lowe (1955) stated that mouth brooding species of Tilapia shows differential movement of sexes. This differential movement may affect the sex ratio of the catches.

SUMMARY AND CONCLUSION

The incidence and distribution of parasite fauna and some aspects of the biology such as size ranges, length-weight relationships, condition factor and sex ratio of Oreochromis niloticus, Tilapia zillii, Sarotherodon galilaeus and Hemichromis bimaculatus (Family: Cichlidae) from Zaria dam were investigated between July 1986 to June 1987.

Out of 567 fish specimens comprising 308 Oreochromis niloticus, 147 Tilapia zillii, 73 Sarotherodon galilaeus, and 39 Hemichromis bimaculatus examined, 17.1 percent (97 fish specimens) were found infected by Cysts of Henneguya sp. (Protozoan); Clinostomum sp. metacercariae, Diplostomatid cyst (Digenetic trematodes); Cyclophyllidean cestode; Ascarid worm (Nematode); Neoechinorhynchus sp. (Acanthocephala); and unidentified Leech (Hirudinea). Oreochromis niloticus was found to be most infected by parasites with 22.4 percent infection rate. Followed by Tilapia zillii and Sarotherodon galilaeus with 15.65 percent and 6.85 percent infection rate respectively. Hemichromis bimaculatus was found free from parasites.

On the whole, the level of parasitic infection is thought to be minimal as less than 20 percent of the fishes examined were infected by parasites. No pathological symptoms or mortality as a result of infection by these parasites were observed. Therefore, based on the present research work on

Cichlids collected from Zaria dam, it is unlikely that parasitic infection will cause any serious threat to fish (Cichlid) production in this dam. Except of course, the danger poised by the metercercariae of digenetic trematodes which are likely to increase in future and thus requires close monitoring.

Studies on the biology of the family however revealed that Oreochromis niloticus, Tilapia zillii and Sarotherodon galilaeus were the commonest, with Oreochromis niloticus being the most abundant in the sample, while Hemichromis bimaculatus was the least in abundance. Generally, the male species were found to exhibit growth superiority over the females. Length-weight regression coefficients were calculated for each species and sex separately. The length-weight relationship showed an increase in weight, with increase in length for all the fish species and all the species were found to exhibit negative allometric growth. The fish were generally in good condition and there was no significant difference in the mean condition factor of the males and females. The sex ratio between the males and females was approximately one to one (1:1).

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APPENDIX 1

PARASITES OF FRESHWATER FISHES

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
1. VIRAL INFECTION			
Irridovirus	Tilapia amphimelas	Skin	Uganda
	T. esculenta, T.	"	"
	variabilis,	"	"
	Haplochromis elegans	"	"
2. BACTERIAL INFECTION		Skin and Fins	
Aeromonal hydrophyla	Eeels, Anguilla	"	
	mossambica.	"	South Africa
	Tilapia mossambica	"	India
	Tilapia spp.		Israel
Vibrio anguillarum	Various Fish species	"	Israel
Epitheliocystis sp	Tilapia spp, Tilapia	"	Dan reservoir
	mossambica, Carp	"	in Port
	and Mullets (Mugilidae)		Elizabeth
			South Africa.
Epitheliocystis sp	Tilapia spp,	"	Israel
	T. aurea, T. nilotica,	"	"
	Carp, Autochthonous		"
	sp.		"

APPENDIX 1 CONT'D

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
3 FUNGAL INFECTION			
Saprolegnia sp	Tilapia spp Clarias carsoni, Ctenopoma murieri, Mugil cephalus Liza ramada	Mouth, Skin.	South Africa, Kampala - Uganda, Israel and India.
Branchiomyces	Carp, Catfishes	Mouth, Skin.	Africa, South East Asia, Israel and other Mediterranean countries.
4. ECTOPARASITIC PROTOZOAN INFECTION			
Trichodina sp.	Mugilidae (Fingerlings)	Skin, Gills	West, East
	Tilapia sp (juvenile	" "	and South
	and fry), Tilapia	" "	Africa.
	mossambica, Barbus sp,	" "	"
	Alestes sp. Clarias sp	" "	"
	and Carp.	" "	"

APPENDIX 1 CONT'D

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
Costia sp	Carp,		
Costia necatrix	Tilapia mossambica	"	
Costia sp	Aplocheilichthys gambianus	"	Ghana
Childonella cyprini	Tilapia mossambica	"	
Childonella sp	Carp.	"	
Childonella cyprini	Tilapia zillii	"	Lake Kineret Israel.
Scyphidia sp.	Haplochromis sp.	"	Lake Victoria
Epistilis sp.	Synodontis membranaceous	"	Lake Volta
Glossatella sp	Tilapia nilotica	"	Israel
Colponema sp	Mugilidae (Fingerlings)	"	
Ichthyophthirius multifiliis	Tilapia leucosticta, T. nilotica, T. zillii T. mossambica, Clarias lazera, C. carsoni, Ctenopona murieri, Cyprinus carpio, Barbus amphigramma, B. aenus, Anguilla mossambica.	Skin, Fins, and Gills.	Cosmopolitian

APPENDIX 1 CONT'D

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
5. ENDOPARASITIC			
PROTOZOAN			
Trypanosoma, Cryptobia,	Found to infect	Blood	Africa
and Haemogregarina	fishes of African	"	"
species	waters	"	"
Trypanosoma mukasai	Tilapia variabilis,	Blood	Africa
	T. esculenta,	"	"
	T. nilotica,	"	"
	Bagrus docmac,	" "	"
	Mormyridae, Schil-	"	"
	beidae and Protop-	"	"
	teridae	"	"
Protoopalina sp,	The families Schil-	Intestine	
Zelleriella sp,	beidae, Mochocidae	"	
Balantidium sp and	(Synodontis sp.)	"	
Nyctotherus sp.	and Citharinidae.	"	
Dactylosoma mariae	Cichlids, Labeo victorianus.		
D. mariae	Tilapia spp.		Lake Victoria
D. mariae	Tilapia nilotica		Lake George.

APPENDIX 1 CONT'D

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
Hexamita sp.	Liza ramada (Mullet)	Intestine	South Africa.
Haemogregarine nili	Ophicephalus obscurus	Blood	Nile - Egypt.
H. nili	Tilapia lata	Blood	R. Niger.
H. nili	Mugilidae.	Blood	S. Africa.
Crypobia sp.	Carp		-
Henneguya pseudolamellaris	Heterobranchus bidorsalis	Breathing organ.	W. Africa.
H. strongylura	Synodontis schall	Gill.	Nile
H. clariae	Clarias lazera	Gill.	W. Africa.
Henneguya sp.	Lates albertianus	Gill.	Lake Albert
Myxobolus sp	Oreochromis niloticus	Ovary, Gill	Jos - Nigeria
Myxobolus sp.	Tilapia sp (juvenile)	Skin	
Myxobolus sp.	Haplochromis sp	Under scales	
	Tilapia zillii,	Gills	
	Synodontis sp and	"	
	Ctenopoma murieri	"	
Myxobolus ovoidalis	Cyprinids, Barbus sp	Gills.	S. Africa.
	and Carp	"	

APPENDIX 1 CONT'D

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
Myxobolus sp	Varicorhinus ruwenzorii	Gill	
Myxobolus sp	Heterotis niloticus	Gills.	
Myxobolus sp.	Tilapia esculenta	Gills	E. Africa.
Myxobolus sp.	Tilapia variabilis		Lake Victoria
Myxobolus sp.	Tilapia nilotica		Lake George
Myxobolus sp.	Haplochromis angustifrons, H. elagans.		Lake George. "
Myxobolus sp.	Barbus sublineatus		
Myxobolus tilapiae	Tilapia sp.		Nigeria.
Myxobolus sarigi	Oreochromis niloticus	Eye	Nigeria.
TREMATODE (METACERCARIAE)		Skin, gills, Mesentries,	
Diplostomulum spp.	Family Cichlidae	Muscles, Liver,	
Diplostomulum tregenna.	Clarias lazera	Around the brain.	
Neascus spp.	Cichlids, Alestes spp., Barbus spp and Epiplatys spp.	Dermis and the subdermis (blackspot)	

APPENDIX 1 CONT'D

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
Centrocestus app. (heterophyiids)	Cichlids	Gills	East African Lakes
Trematode (Metacercariae)	Haplochromis sp from Barbus sp, Tilapia mossambica, and Tilapia melano-pleura	Eye (Infections	Lake Victoria, and from fish ponds and dam reservoirs in Transvaal South Africa.
Postdiplostomum namum (metacercariae)	Epiplatys spp.	Liver and Peritoneum	Sierra-Leone
Pseudoneodiplostomum thomasi (Proterodiplostomatidae)	Clarias senegalensis	Fat bodies, Kidneys, Ovary and gut wall.	Ghana.
Encysted metacercariae of the family strigeidae and Diplostomidae	Haplochromis spp	Eye ball	
Metacercariae of Heterophyiids.	Mullets (Mugilidae) Tilapia nilotica, Tilapia zillii, Gambusia affinis, Aphanius fasciatus		

APPENDIX 1 CONT'D

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
Phagicola spp	Mullet		
Phagicola longicollis	Tilapia nilotica.		
Phagicola ascolonga	Astatotilapia desfonteinesi, and Hemichromis bimaculatus		Tunis
Prophemistomum vivax	Tilapia nilotica and Mullet.	Muscles	Egypt.
Haplorchis (metacercariae)	Tilapia nilotica, T. galilaea		Egypt.
Pygidiopsis genata	Tilapia zilli		
MONOGENETIC TREMATODE			
Diplectanum spp	Lates sp and other Marine Fishes	-	Lake Kyoga and Victoria Nile
Dactylogyrus sp	Barbus sp		
Dactylogyrus sp	Cyprinidae		
Dogielius sp	Cyprinidae.		

APPENDIX 1 CONT'D

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
Pseudocolpenteron spp	Cyprinidae	Gills, Skin	-
Acolpenteron spp	Micropterus salmoides Centracentridae (American fish introduced to South Africa).	Endoparasitic in the Urethra	American fish introduced to South Africa.
Ancyrocephalus spp.	Freshwater clupeidae, Mormyridae, Synodontidae, and Cyprinidae (genus Barilius)		
Enterogyrus sp	Cichlidae	Stomach	
Onchobdella sp.	Cichlidae (Hemichromis and Pelmatochromis)	Skin	
Annulotrema and Jainus species	Characidae		
Afrocleidodiscus hydrobynusi	Distichodus and Hydrocynus species		
Nanotrema citharini	Citharinidae		
Bagrobdella sp	Bagridae		
Protancylodiscoides	Bagridae		
Quadriacanchus sp	Bagridae and Clariidae		

APPENDIX 1 CONT'D

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
Heterostesia sp	Heterotis niloticus		
Schilbetrema acornis	Schilbe sp		
Schilbetrema bicornis	Schilbeidae, Physalia sp		
Archidiplectanum sp	Mormyridae		
Heteronchocleidus sp	Anabantidae		
Eutrianchoratus sp	Ophicephalus sp		
Cichlidogyrus arthracanthus	Tilapia zillii		
Cichlidogyrus tilapia	Tilapia species		
Cichlidogyrus sclerosus	Tilapia species.		
Annulotrema sp.	Alestes sp.		
Protancylodiscoides chrysichthes	Chrysichthys sp		
MONOGENETIC TREMATODES GYRO-DACTYLIDS			
Gyrodactylus bullatardis	Lebistes reticulatus	Skin, Gills or both.	

APPENDIX 1 CONT'D

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
G. cichlidarum	Tilapia sp		Israel
G. cichlidarum	Tilapia galilaea		W. Africa.
G. medius	Tilapia sp and Carp.		
Macrogyrodactylys polypteri	Polypterus senegalus		Sudan
MONOGENETIC TREMATODES			
Diplozoon aegyptiensis	Barbus sp., Labeo sp., Barilius sp.		
D. ghanense	Alestes sp		
Neodiplozoon sp.	Barbus. sp.		
DIGENETIC TREMATODE			
CLINOSTOMATIDS (Metacercariae)		Large cysts under the scales, on the skin, branchial region, muscles and Visceral tissues.	
Clinostomum complanatum	Clarotes laticeps.		
C. complanatum	Tilapia nilotica, T. galilaea		Ghana, Sudan
C. complanatum	Auchenoglanis biscutatus		

APPENDIX 1 CONT'D

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
C. complanatum	Clarias lazera		
C. complanatum	Synodontis ocellifer	Gill region and eye	
	socket.	socket	
C. complanatum.	Synodontis budgetti.,	Skin, roof of	
	S. gambiensis,	mouth, gill	
	S. nigrita,	chamber.	
	S. membranaceous,	Skin	
	Chrysichthys	Skin, Gill	
	nigrodigigitatus		
C. cutaneum	Cichlids.		Jordan, Kainji Nigeria
Clinostomum sp.	Tilapia sp.		
Clinostomum sp.	Siluroid fish,		Lake kineret,
	Synodontis sp.		Israel.
Clinostomum talapiae	Tilapia zillii		Niger River, Kainji
C. tilapiae	Tilapia monodi		Lake Kineret Israel.
C. tilapiae	Tilapia galilaea	Eyeball and Socket.	South Africa
C. tilapiae	Tilapia nilotica	Gill region	

APPENDIX 1 CONT'D

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
C. marginatum	Tilapia heudeloti, Tilapia aurea	Gill region	Ghana
C. vanderhosti	Eutropius depressirostris	"	North Transvaal S. Africa.
Euclinostomum heterostomum	Tilapia galilaea.	Encystedon body wall	
E. heterostomum	Tilapia nilotica.		Lake Kainji
Euclinostomum sp.	Cichlids, Clarias sp, Tilapia mossambica.		Malawi S. Africa
Nephrocephalus sp.	Heterotis niloticus.	Gill region.	Lower Niger
Nephrocephalus sp.	Synodontis membranaceous.		
Nephrocephalus sp.	Cichlid.		Lake Kainji
Nephrocepnalus sp.	Tristramella simonis		
ADULT TREMATODE			
Nematobothrium labeonis.	Labeo sp.	Digestive tract.	Nile
Sanguinicola sp.	Synodontis schall,	Blood vessels.	
	Auchenoglanis occidentalis	" "	

APPENDIX 1 CONT'D

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
Sanguinicola sp.	Gymnarchus niloticus	Blood vessels	East African
	Bagrus sp,	" "	Lakes.
	Synodontis sp.	" "	
Callodistomum sp.	Polypterus sp.	Gall bladder, Liver.	
Cholepotes sp.	Synodontis sp.	" "	
Opisthorchis sp	Gymnarchus sp.	" "	
Phyllodistomum sp.	Siloroid fishes, Mastacembalus sp., Ctenopoma sp.	Urinary bladder. "	
Aspidogaster sp	Synodontis vermiculatus	Duodenum	
Sphaerostoma sp.	Alestes nurse		
Acanthostomum gymnarchi.	Gymnarchus niloticus		
A. spiniceps.	Bagrus docmac Bagrus filamentosus Bagrus bayad		
Microrchis sp	Synodontis budgetti		

APPENDIX 1 CONT'D

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
Microrchis sp.	Synodontis ocellifer		
	S. sorex,		
	S. gambiensis,		
	S. nigrita		
Diplodiscus sp	Synodontis clarias	Intestine	
	S. vermicalatus,	"	
	S. sorex,	"	
	S. nigrita.	"	
CESTODE INFECTION			
Ligula intestinalis (Pleurocercoids)	Cichlids, Cyprinids (Barbus sp).	Intestine	
Ligula intestinalis	Barbus sp.	Body cavity	
Polyonchobothrium polypteri (immature)	Polypterus bichir		
Proteocephalus sp (immature)	Polypterus bichir		
Proteocephalus sp	Clarotes laticeps		
Electrotaenia sp.	Mormyrus rume		
	Mormyrus macropha-thalmus, Gnathonemus abadii		

APPENDIX 1 CONT'D

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
Electrotaenia sp	Gnathonemus pictus		
Polyonchobothrium sp	Eutropius niloticus		
	Heterobranchus bidorsalis		
Polyonchobothrium clarias	Clarias lazera		
Marsipocephalus heterobranchus	Heterobranchus bidorsalis		
Anomotaenia sp	Hemichromis fasciatus		
	Tilapia n lotica		
LARVAL NEMATODE			
Eustrongylides africanus	Bagrus docmac	Ovaries, Testes	Lake Victori
	Clarias mossambicus,	"	"
	Protopterus eithiopicus,	"	"
	Haplochromis sp.	"	"
Amplicaecum sp	Clarias lazera,	"	"
	Bagrus sp. Polypterus	"	"
	sp., Schilbe sp.,	"	"
	Malapterurus electricus,	"	"
	Lates niloticus, Alestes	"	"
	nurse.	"	"

APPENDIX 1 CONT'D

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
Contracaecum sp.	Bagrus sp. Clarias sp	Mesentries	East and
	Eutropius sp.,	and Intestinal	South Africa.
	Hydrocynus sp.	serosa.	"
	Tilapia sp.		"
	Haplochromis sp,		Lake Naiyasha
	Tilapia leucosticts,		Lake Baringo
	Tilapia nolitica,		Lake Magadi,
	Tilapia grahami		and Nakuru
			Kenya.
	Haplochromis sp		Lake Victoria
	Tilapia nilotica		Lake George
			Uganda.
Amplicaecum sp.	Tilapia sp	Sinus	Sudan Nile
		venosus	
Eustrongylides sp.	Haplochromis sp		Lake Victoria
ADULT NEMATODES			
Thawaitia bagri	Bagrus bayad	Skin	Africa.
Nilomema gymarchi	Gymnarchus niloticus	Air bladder	
Rhabdochona congolense	8 Families of fish		
Spinitectus allaeri	6 Families of fish		

APPENDIX 1 CONT'D.

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
Philometrid worms	Heterotis niloticus Fingerlings.	Operculum	Cameroon
Spirocamallanus spiralis	Siluroid fishes		Sudan Nile
Procamallanus laevionchus	Six different families of fish		West Africa.
Procamallanus cyathopharynx	Clariidae		
Procamalanus laevionchus,	Clarias lazera		Israel
Procamalanus cyathopharynx,	Clarias lazera		"
Citharinella citharinella	Citharinus citharus		Sudan Nile, Lower Niger.
Spironura sp	Distichodus sp		Sudan Nile
Rhabdochona congolense and some species of Spinitectus.	Fishes of Lakes victoria, Edwards and Albert.		
Rhabdochona congolense	Cichlids		East African

APPENDIX 1 CONT'D,

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
Rhabdochona congolense	Haplochromis sp		Lake Victoria
and larval Nematodes			
of Eustrongylides and			
contracaecum			
Thwaitia bagri			Sudan Nile
Nilonema gymnarchi			"
SPINY-HEADED WORMS			
ACANTHOCEPHALA			
Acanthocephala sp	Synodontis resupinatus	Alimentary	Sudan Nile
	Heterotis niloticus	System	Lake Chad.
	Citharinus citharus		
	Polypterus senegalus		
	Cichlids		
	Lates niloticus		
Echinorhynchus	Salmonoids.	"	
salmonis.			
Acanthocephalus	Cichlids.		Lake Kainji
jacksoni.			
Acanthocephalus sp.			
Acanthogyrus tilapiae.	Cichlids		African water
			ways.
Tenuisentis niloticus.	Heterotis niloticus.		

APPENDIX 1 CONT'D.

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
Acanthocephala sp.	Synodontis membranaceous, Tilapia nilotica, Labeo senegalensis, Tilapia zillii		
ANNELID WORMS			
HIRUDINEA			
Leeches	Bagrus docmac,	Skin	
	Barbus altianalis,	Fins	
	Barbus tropidolepis,	"	
	Carp,	"	
	Protopterus aethiopicus"		
	Cichlidae	"	
	Synodontidae	"	
	Bagridae	"	
	Mormyridae	"	
Batrachobdella sp.	Bagrus docmac		L. Victoria
	Protopterus aethiopicus"		"
	Barbus altianalis	"	"
Phyllobdella maculata.	Barbus tropidolepis	"	L. Tanganyika
	Other fish species.		

APPENDIX 1 CONT'D.

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
Leech (unidentified)	Carp, Bagrus docmac		Ghana and L. Victoria.
Piscicola geometra	Trouts, Cyprinids		Eurasia.
Cystobranchus virginicus	Ictalurus catus (American catfish)		
CRUSTACEAN COPEPODS			
Dolops ranarum	Tilapia variabilis		
	Tilapia esculenta		
	Bagrus docmac		
Argulus africanus	Bagrus docmac	Buccal or	
	Tilapia esculenta	Opercular	L. Victoria
	Tilapia variabilis	Mucosa.	"
Argulus species.	Labeo sp.		Dams in S. Africa.
Dolops ranarum	Protopterus sp.		
	Clarias sp		
	Bagrus sp.		
Argulus africanus	Protopterus sp		
	Clarias sp.		
	Bagrus sp		
Argulus cunningtoni	Bagrus decmac,		L. Albert.
	Bagrus bayad and		"
	Lates albertianus		"

APPENDIX 1 CONT'D.

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
Argulus rhipidiophorus	Bagrus docmac,		L. Albert
Dolops ranarum	Bagrus bayad,		"
	Lates albertianus		"
Argulus striatus	Auchenoglanis		L. Tanganyika
Argulus incisus	occidentalis		
Argulus japonicus	Carp		Egypt
Argulus africanus	Bagrus docmac		
Dolops ranarum	Bagrus docmac		
Argulus rhipidiophorus	Fishes		East African Lakes
ERGASILID COPEPODS			
Ergasilus sp.	Fishes in ponds	Gills	Africa.
	Tilapia heudeloti		
Ergasilus lizea	Mugil cephalus	"	Israel
	Liza ramada	"	
	Tilapia spp	"	
	Carp	"	
	Anguilla anguilla	"	
Ergasilus nanus,	Mugilidae	"	Tunis
Ergasilus latus.	Tilapia heudeloti	"	Lagoons in
Paraergasilus lagunaris.	Tilapia heudeloti		Ghana

APPENDIX 1 CONT'D.

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
Ergasilus kandti	Lates albertianus		L. Albert.
Ergasilus lizae	Tilapia aurea		
LERNAEID COPEPODS			
Lernaea barnimiana	Fishes	Skin, or buccal	L. George.
Lernaea bagri	Bagrus sp	Mucosa	
Lernaea haplocephala	Polypterus sp.		
Lernaea tilapiae	Tilapia sp		
Lernaea inflata	Engraulicyris sp		
Opistholernaea laterobranchialis	Tilapia sp.		
Opistholernaea longa	Lates sp.		
Afrolernaea sp	Mormyridae		
Lernaea palati	16 species of Haplochromis		L. Malawi
Lernaea cyprinacea	Tilapia sp	Jaws	L. Victoria
Lernaea barnimiana	Barbus altianalis and Cichlidae		Lakes George, Victoria Nile, L. Victoria.

APPENDIX 1 CONT'D.

PARASITIC INFECTION PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
Lernaea barnimiana	Lates albertianus		L. Albert
Lernaea hardingi	Cichlidae		Africa.
	Chrysichthys mabusi		L. Bangweulu
	Synodontis nigromaculatus		and Mweru.
Lernaea cyprinacea	Bagrus bayad		L. Victoria
	Bagrus docmac		and George
Lernaea barnimiana	Bagrus bayad		L. Albert.
Afrolernaea longicollis.	Mormyrus longirostris		Africa.
Lernaea bagri.	Bagrus meridionalis.		L. Malawi
Lernaea barminiana.	Lates albertianus		L. Albert.
" "	Tilapia nilotica.		
Lernaea cyprinacea	Tilapia variabilis		L. Victoria
Lernaea barnimiana	Barbus altianalis		Victoria Nile
Lernaea cyprinacea	Fish ponds		Israel
Lernaea hardingi	Juvenile and large		Dams
	Tilapia nilotica,		
	Tilapia galilaea		reservoirs,
	Tilapia zillii		and fish
	Tilapia heudeloti		ponds in Ghana

APPENDIX 1 CONT'D.

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
Lernaea sp.	Barbus aeneus		Dam reservoirs in S. Africa
Lernaea barnimiana	Tilapia sp		
Lernaea cyprinacea	Tilapia sp		
Lernaea hardingi	Tilapia sp		
Lernaea tilapiae	Tilapia sp		
Opistholernaea laterobrannialis	Tilapia sp		
Lernaea barnimiana	Lates sp.		
Opistholernaea longa	"		
Lernaea bagri and copepodites of Lernaea barnimiana Lernaea cyprinacea	Bagrus sp.		
Lernaeagiraffa helerotidicola, and Dysphorus torquatus	Heterotis niloticus		
Lernaea cyprinacea	Gambusia affinis, Cultured cichlids, Carp and grass Carp.		
Lernaea barnimiana	Bagrus altianalis	Bucal	Victoria Nile
Lernaea bagri	Bagrus meridionalis	Cavity	

APPENDIX 1 CONT'D.

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
Lernaea cyprinacea	Cichlidae	Gills	
Lernaea tilapiae	"		
Lernaea palati	"		
Lernaea lophiara	"		
Afrolernaea lonsicollis	Mormyridae	Fins	
Opistholernaea laterobranchialis	Tilapia macrochir	Roof of the buccal or branchial cavity	
Engraulicypris sp	Juvenile cichlids		
LAMPROGLENA AND LAMPROGLENOIDES			
Lamproglena monodi	Cichlidae	Gills	L. Victoria
Lamproglena clariae	Clariidae	"	Nile system
Lamproglena hemprichii	Characid genus Hydrocynus		Niger, Congo.
Lamproglena cleopatra	Lates sp		Volta, Zambesi.
Lamproglenoides vermiformis	Labeo sp	"	
Lamproglena elongata	Citharinidae	"	
	Characidae	"	

APPENDIX 1 CONT'D.

PARASITIC INFECTION/ PARASITE SPECIES	FISH HOST	LOCATION ON HOST	GEOGRAPHICAL DISTRIBUTION
Sciaenophilus pharoensis	Lates niloticus, Labeo forskali	Gills	Nile in Egypt.
Paeonodus lagunaris	Tilapia rendalli	Bucal cavity	Sakumo Ghana
CRUSTACEAN ISOPODS			
Lironeca expansus	Citharinid Eugnathichthys eetveldi	Gill cavity	Congo System
Lironeca tanganyika	Cichlid Simochromis diagramma		L. Tanganyika
Nerocila orbignyi	Tilapia galilaea	Fin	Nile Delta
WATER MITES			
Water mites	Synodontis membranaceus	Gills	Volta Lake
TONGUE WORMS			
Larvae of the genus Leiperia	Mastacembelus sp., Chrysichthys sp. Labeo sp. Bathybates and Alestes sp	Tissues	Congo Basin
Pentastomids sp	Tilapia galilaea Tilapia zilli Tilapia heudeloti		Nugua Dam South Ghana

APPENDIX 2

TOTAL LENGTH, STANDARD LENGTH, BODY WEIGHT AND CONDITION FACTOR OF OREOCHROMIS NILOTICUS (MALES

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
July, 1986	7.1	6.0	6.70	3.10
	27.0	20.50	197.02	2.29
	23.0	18.0	189.47	3.25
August, "	21.10	16.30	196.1	4.53
	23.70	18.70	267.0	4.08
Sept., "	18.40	14.30	125.0	4.28
	17.9	14.0	112.0	4.08
	16.0	12.4	85.0	4.46
	14.70	11.30	64.0	4.44
	13.60	10.50	52.50	4.54
	15.80	12.0	85.0	4.92
	13.50	10.30	55.5	5.08
Oct., "	23.70	8.50	265.0	4.19
	17.30	13.60	110.0	4.37
	19.50	16.50	140.0	3.12
	14.50	11.0	65.0	4.88
	15.80	12.20	85.0	4.68
	16.20	12.60	60.0	2.99

APPENDIX 2 CONT'D

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
OCT., 1986	13.9	10.80	55.0	4.37
	15.05	11.70	65.0	4.06
	11.40	8.90	30.0	4.26
	11.80	9.30	30.0	3.73
	12.40	9.70	35.0	3.84
NOV., "	11.50	8.90	35.0	4.97
	15.0	12.0	75.0	4.34
	9.80	7.50	21.0	4.98
DEC., "	11.50	9.0	31.0	4.25
	12.22	9.50	42.2	4.92
	12.50	10.00	36.0	3.60
	16.0	13.0	76.0	3.46
	9.80	7.50	21.0	4.98
	11.50	9.0	31.0	4.25
	13.20	10.0	49.0	4.90
	12.20	9.30	42.0	5.22
JAN., 1987	10.50	8.0	30.0	5.86
	14.20	11.0	50.0	3.76
	12.20	9.30	42.0	5.22
	13.50	10.4	50.50	4.49
	15.20	11.50	80.0	5.26

APPENDIX 2 CONT'D.

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
JAN., 1987	15.0	11.50	67.0	4.41
	15.6	12.5	85.0	4.35
	11.10	8.50	35.0	5.70
	12.40	9.40	48.0	5.78
	12.50	9.70	40.0	4.38
	13.50	10.40	50.0	4.45
	12.30	9.50	40.0	4.67
	12.10	9.40	45.0	5.42
	13.4	10.50	55.0	4.75
	13.0	9.80	55.0	5.84
FEB., 1987	23.50	18.0	295.0	5.06
	12.0	9.0	35.0	4.80
APRIL, 1987	18.30	14.0	130.5	4.76
	21.60	16.50	215.0	4.97
	17.10	13.0	103.0	4.69
	25.6	20.2	360.	4.37
	21.0	15.5	175.1	4.70
	22.5	17.5	270.0	5.04
	19.50	15.2	175.0	4.98
	22.4	17.0	241.0	4.91
	25.2	19.8	370.0	4.77
	23.5	18.4	270.0	4.33
	21.8	16.8	230.0	4.85
	17.8	13.50	128.0	5.20

APPENDIX 2 CONT'D

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
MAY, 1987	24.20	18.8	369.0	5.55
	18.10	14.0	104.0	3.79
	22.80	17.8	231.0	4.10
JUNE, 1987	24.0	19.0	200.5	2.92

APPENDIX 3

TOTAL LENGTH, STANDARD LENGTH, BODY WEIGHT AND CONDITION FACTOR OF OREOCHROMIS NILOTICUS (FEMALES)

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
JULY, 1986	19.0	14.5	84.5	2.77
	20.0	15.5	85.5	2.30
AUG., "	27.3	21.5	405.5	4.08
	26.6	21.0	391.0	4.22
	16.0	12.4	79.0	4.14
	12.0	9.2	36.8	4.73
	21.5	16.6	196.8	4.3
	23.4	18.1	280.5	4.73
	19.3	15.2	147.0	4.19
SEPT., "	15.4	11.7	73.0	4.56
	16.0	11.2	75.0	5.34
	15.6	13.0	83.0	3.78
	14.5	11.20	65.0	4.63
	16.0	12.3	85.0	4.57
	15.8	12.3	86.0	4.62
OCT., "	13.0	10.0	45.0	4.50
	14.7	11.4	65.5	4.42
	15.4	12.1	60.0	3.39
	13.3	10.2	45.0	4.24

APPENDIX 3 CONT'D.

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
OCT., 1986	13.5	10.6	50.0	4.20
	13.9	10.7	55.0	4.49
	15.5	11.8	68.0	4.14
	12.6	9.8	60.0	6.38
	12.4	9.8	38.0	4.04
	12.9	10.0	45.0	4.50
NOV., "	14.3	11.2	55.5	3.95
	17.0	13.5	100.0	4.06
	19.0	14.9	140.0	4.23
	17.0	13.2	95.0	4.13
	15.5	12.2	85.5	4.71
DEC., "	16.1	12.4	90.0	4.72
	18.0	13.4	125.0	5.2
	15.3	12.2	56.5	3.11
	18.0	14.5	101.0	3.31
	18.0	13.9	139.0	5.18
	16.0	12.2	94.0	5.18
	15.5	12.2	85.5	4.71
JAN., 1987	16.1	12.4	90.0	4.72
	16.4	13.0	95.0	4.32
	18.0	13.4	125.0	5.20

APPENDIX 3 CONT'D.

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
JAN., 1987	18.0	14.1	130.0	4.64
	12.0	9.1	35.5	4.71
	18.5	13.5	130.0	5.28
	12,7	9.50	45.0	5.25
	13.5	10.4	55.0	4.89
	15.0	11.4	95.0	6.41
	11.3	8.7	35.0	5.32
	14.0	10.9	55.0	4.25
	11.5	9.0	40.0	5.49
	11.7	8.8	35.5	5.21
	12.5	9.5	40.0	4.67
	10.6	8.1	30.0	5.65
	12.5	9.7	48.0	5.26
	11.8	9.0	45.0	6.17
	11.5	8.7	40.0	6.07
MARCH, 1987	8.90	6.70	18.0	5.98
APRIL, "	22.7	17.5	265.0	4.95
	22.5	17.0	245.0	4.98
	23.0	15.5	185.5	4.98
	21.5	16.5	240.0	5.34
	23.2	18.0	265.0	4.54

APPENDIX 3 CONT'D.

		TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACOTR (K)
MAY	1987	24.5	19.5	282.5	3.81
		22.2	17.0	264.0	5.37
		10.9	7.7	19.0	4.16
JUNE	1987	18.1	14.5	110.0	3.61
		14.5	11.2	55.5	3.95
		17.1	13.5	109.0	4.43
		22.5	17.5	280.5	5.23
		17.0	12.6	82.4	4.12

APPENDIX 4

TOTAL LENGTH, STANDARD LENGTH, BODY WEIGHT AND CONDITION FACTOR OF ORLOCHROMIS NILOTICUS (IMMATURE)

		TOTAL LENGTHA (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
JULY,	1986	10.30	8.0	26.0	5.08
		9.50	7.0	221.0	6.12
		8.80	6.4	18.5	7.05
		10.5	8.10	26.2	4.93
		12.3	9.4	37.0	4.45
		7.60	5.8	14.1	7.22
AUG.,	1986	17.4	13.6	92.0	3.65
		7.6	6.10	12	5.28
		22.2	16.6	192.5	4.20
		8.10	6.5	15.0	5.46
		6.60	5.2	7.0	4.97
		7.0	5.3	10.1	6.78
		9.50	7.2	18.3	4.90
		8.0	6.0	17.20	7.96
		11.1	8.50	30.0	4.88
		13.0	8.60	26.0	4.08
		8.30	6.60	16	5.56
		7.20	6.50	11	4.0

APPENDIX 4 CONT'D.

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
SEPT., 1986	13.0	7.8	25.0	5.26
	9.60	7.30	25.0	6.42
	9.30	7.20	20.0	5.35
	9.0	7.0	20.0	5.83
	14.0	11.50	60.0	3.94
	10.20	7.8	25.0	5.26
	12.4	9.70	45.0	4.93
	10.0	7.50	25.0	5.92
	11.40	9.0	30.50	4.18
	9.90	7.60	24.0	5.46
	11.10	8.40	30.0	5.06
	11.20	8.50	30.50	4.96
	10.5	7.90	25.0	5.07
	11.20	8.60	30.0	4.71
	13.50	10.00	50.0	4.31
	9.4	7.1	20.0	5.58
	11.0	7.9	25.0	5.07
	13.0	9.9	50.0	5.15
	8.30	6.20	15.0	6.29
	9.20	7.10	20.0	5.58
	14.30	10.9	65.0	5.01
	13.4	10.0	50.0	5.0
	10.0	7.50	23.0	5.45
	9.0	7.0	20.0	5.83

APPENDIX 4 CONT'D.

		TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
SEPT.	1986	11.7	8.8	35.0	5.13
		9.0	7.0	20.0	5.83
		9.8	7.50	25.0	5.92
		10.6	8.20	30.0	5.44
		10.20	7.50	25.0	5.92
		11.0	8.50	35.0	5.69
		9.0	6.90	20.0	6.08
		9.90	7.50	25.0	5.92
		9.20	7.0	20.0	5.83
		10.0	7.50	25.0	5.92
		11.50	8.90	40.0	5.67
		9.9	7.50	25.0	5.92
		9.8	7.50	25.0	5.92
		9.7	7.50	25.0	5.92
		9.8	7.40	25.0	6.16
		10.5	8.0	30.0	5.85
		8.4	6.50	15.0	5.46
		11.0	7.50	25.0	5.92
		8.90	6.70	20.0	6.64
		10.50	7.60	25.0	5.69
		9.60	7.20	22.0	5.89
		9.20	7.30	20.	5.14
		9.20	7.0	24.0	6.99
		8.50	6.50	15.0	5.46

APPENDIX 4 CONT'D.

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
SEPT., 1986	10.0	7.50	25.0	5.92
	9.50	7.4	20.0	4.93
	10.40	7.80	25.0	5.26
	8.60	6.4	15.5	5.91
	9.10	6.90	20.0	6.08
OCT., 1986	12.1	9.20	35.0	4.49
	7.60	5.4	210.0	12.70
	15.50	12.1	70.0	3.95
	7.70	6.0	15.0	6.94
	9.70	7.50	18.0	4.26
	7.5	5.50	8.0	4.8
	8.0	6.3	10.0	3.99
	7.0	5.5	7.0	4.20
	12.8	9.9	44.0	4.53
	12.7	9.9	35.0	3.60
	11.8	9.3	30.0	3.72
	11.50	8.9	29.0	4.11
	11.30	8.7	30.0	4.55
	11.0	8.6	25.0	3.93
	11.0	8.5	25.0	3.99
	10.5	8.20	20.0	3.62
	10.6	8.2	25.0	4.53
	10.9	8.6	25.0	3.93

APPENDIX 4 CONTINUED

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
OCT., 1986	9.80	7.70	20.0	4.38
	9.50	7.50	15.0	3.55
	9.6	7.50	15.0	3.55
	9.50	7.50	15.0	3.70
	10.10	7.80	15.0	3.16
	9.0	6.9	14.0	4.26
	9.0	7.0	15.0	4.37
	8.50	6.6	15.0	5.21
	8.8	6.7	15.0	4.98
	8.8	6.8	15.0	4.77
	7.95	6.4	16.0	6.10
	7.6	5.0	15.0	12.0
	7.9	5.20	15.0	10.6
	7.5	5.7	15.0	8.09
	7.0	5.3	10.0	6.71
	7.7	5.7	15.0	8.09
	7.6	5.6	15.0	8.54
	7.0	5.4	10.0	6.35
	7.9	6.0	16.0	7.41
	6.7	5.10	10.0	7.53
	7.2	5.50	10.0	6.01
	6.9	5.20	10.0	7.11
	6.5	5.2	10.0	7.11
	6.5	5.0	10.0	8.0
	6.5	5.0	8.0	6.4
	6.5	5.0	8.0	6.4

APPENDIX 4 CONT'D.

		TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
NOV.,	1986	11.50	9.0	35.0	4.80
		15.5	12.0	178.0	10.30
		12.9	9.80	45.0	4.78
		15.4	12.0	70.0	4.05
		12.4	9.50	45.0	5.24
		11.9	9.20	45.5	5.84
		11.50	8.70	37.0	5.61
DEC.,	1986	11.0	8.6	24.0	3.77
		14.50	11.0	77.0	5.79
		13.9	10.8	46.0	3.65
		15.4	12.0	70.0	4.05
		13.4	10.5	46.0	3.97
		10.9	8.6	44.5	6.99
		11.5	8.70	37.0	5.62
		12.0	7.6	25.0	5.69
JAN.,	1987	12.1	7.6	25.0	5.69
		10.5	8.0	23.0	4.49
		15.0	11.5	73.0	4.79
		12.5	9.6	41.0	4.63
		14.5	11.0	75.0	4.63
		12.9	9.9	50.0	5.15
		11.4	8.1	35.5	6.67
		13.4	10.1	50.0	4.85

APPENDIX 4 CONT'D.

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
JAN., 1987	10.6	8.1	30.0	5.64
	12.2	9.4	40.0	4.81
	9.70 q	7.5	25.0	5.92
	10.3	7.8	25.0	5.26
	10.1	7.5	29.0	6.87
	9.7	7.5	25.0	5.92
	7.9	5.9	17.0	8.27
FEB., 1987	9.0	6.9	17.0	5.17
	9.20	7.0	18.0	5.24
	9.3	7.0	18.0	5.24
	8.4	6.5	15.0	5.46
	7.1	5.4	10.0	6.35
	6.9	5.2	10.0	7.11
	5.6	4.2	7.0	9.44
	7.5	5.70	12.0	6.47
	7.8	5.9	14.0	6.81
	7.2	5.7	12.0	6.47
	7.1	5.5	14.0	8.41
MARCH, 1987	14.1	11.0	61.0	4.58
	19.1	14.7	150.0	4.72
	8.0	7.4	25.0	6.16
	8.4	6.5	15.0	5.46
	7.4	5.7	10.0	5.39

APPENDIX 4 CONT'D.

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
MARCH, 1987	7.1	5.5	10.0	6.01
	6.2	4.6	8.0	8.21
	7.1	5.5	13.0	7.81
	6.3	4.7	10.0	9.63
	6.6	5.1	11.0	8.29
	7.3	5.6	15.0	8.54
APRIL, 1987	16.4	12.6	91.0	4.54
	6.20	4.6	7.0	7.19
	7.2	5.5	10.0	6.01
JUNE, 1987	10.20	7.9	25.9	5.25
	12.3	9.7	44.8	4.91

APPENDIX 5

TOTAL LENGTH, STANDARD LENGTH, BODY WEIGHT AND CONDITION FACTOR OF *TILAPIA ZILLII* (MALES)

		TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
JULY	1986	10.7	9.0	45	6.17
		19.0	15.2	136.0	3.87
		17.5	13.7	91.5	3.56
		17.9	14.0	73.0	2.66
AUG.,	1986	15.9	12.0	71.0	4.12
		17.0	14.20	134	4.68
OCT.,	1986	9.8	7.5	20.0	4.74
		9.2	7.1	15.0	4.19
		8.2	6.3	14.0	5.6
		7.8	6.1	10.0	4.41
		7.8	5.9	15.0	7.3
		5.7	5.5	15.0	9.02
		7.5	5.6	15.0	8.54
		7.5	5.7	15.0	8.10
NOV.,	1986	13.0	10.0	45.0	4.50
		11.5	8.7	30.5	4.63
		9.6	7.2	20.0	5.36
		9.5	7.5	25.0	5.93
		8.9	6.50	15.0	5.46

APPENDIX 5 CONT'D.

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
DEC., 1987	12.5	9.50	36.0	4.20
	13.1	10.1	45.0	4.37
	10.5	7.7	30.0	6.57
	9.6	7.20	20.0	5.36
	9.5	7.5	25.0	5.93
	9.0	6.6	15.0	5.22
JAN., 1987	11.5	8.50	35.0	5.69
FEB., 1987	19.8	15.3	142.0	3.96
	18.8	14.5	130.0	4.26
	12.8	10.0	45.0	4.5
	15.8	12.1	87	4.91
	10.6	8.2	25.5	4.62
	13.9	10.5	52.0	4.49
MARCH, 1987	18.0	14.2	135.0	4.72
	16.5	12.7	90.5	4.42
	19.0	14.5	125.0	4.10
	15.0	11.3	65.0	4.51
MAY, 1987	16.0	11.7	64.5	4.03
	17.0	13.0	80.0	3.64
	17.5	14.0	134	4.88

APPENDIX 5 CONT'D.

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
MAY, 1987	11.7	10.0	40.0	4.0
	10.0	7.70	24.0	5.26
JUNE, 1987	11.0	8.7	25.0	3.8
	21.0	17.2	137	2.69
	19.0	16.21	135	3.17
	7.85	6.0	15.0	6.94
	17.4	13.6	91.0	3.62

APPENDIX 6

TOTAL LENGTH, STANDARD LENGTH, BODY WEIGHT AND CONDITION FACTOR OF TILAPIA ZILLII (FEMALES)

		TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
JULY,	1986	14.1	11.2	48.0	3.43
		16.6	12.5	73.0	3.74
		20.0	15.9	151.0	3.76
AUG.,	1986	18.0	13.9	149	5.55
		15.6	11.5	72.0	4.73
OCT.,	1986	8.6	6.1	30.0	10.0
NOV.,	1986	10.1	7.6	25.0	5.7
DEC.,	1986	8.0	6.5	19	6.92
		11.1	8.6	26	4.09
JAN.,	1987	9.0	6.50	20.0	7.28
FEB.,	1987	13.5	10.0	50.0	5.0
		16.7	15.5	85	2.28
		18.4	14.0	125	4.56
		9.6	7.4	20	4.94
		15.4	11.5	65.5	4.31
		13.0	9.7	38	4.16

APPENDIX 6 CONT'D.

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
FEB., 1987	11.0	8.4	30	5.06
	8.20	6.3	16	6.4
MARCH, 1987	13	9.8	40	4.25
	13.1	10.2	47	4.43
	16.9	13.0	72	3.28
	9.0	14.9	150	4.54
	15.6	11.5	72	4.73
	13.3	10.0	45.2	4.52
	10.5	8.0	24	4.69
APRIL, 1987	6.4	5.0	10.0	8.0
MAY, 1987	16.5	13.0	72.0	3.28
	13.0	10.0	45.0	4.5
JUNE, 1987	12.4	9.4	30.0	3.61
	13.2	10.3	47.0	4.3
	11.3	8.63	26.2	4.08
	9.0	7.0	16.0	4.66
	13.1	9.9	40.0	4.12

APPENDIX 7

TOTAL LENGTH, STANDARD LENGTH, BODY WEIGHT AND CONDITION FACTOR OF TILAPIA ZILLII (IMMATURE)

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
JULY, 1986	10.7	9.0	45	6.17
	9.70	8.0	44	8.59
OCT., 1986	9.20	7.2	15.0	4.02
	7.6	5.6	15	8.54
NOV., 1986	6.90	5.0	10.0	8.0
DEC., 1986	9.4	7.2	23.0	6.16
	9.0	7.0	16.0	4.66
	10.4	8.0	21.0	4.1
	7.2	5.2	14.5	10.31
	9.2	7.2	16.5	4.43
	7.0	5.1	10.0	7.54
	6.9	5.0	10.0	8.0
JAN., 1987	9.5	7.2	23.0	6.16
	8.0	6.0	15.0	6.94
	9.3	7.0	20.0	5.83
	8.2	6.2	15.5	6.5

APPENDIX 7 CONT'D.

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
FEB., 1987	4.9	3.6	4.0	8.57
	8.2	6.2	15.0	6.29
	7.5	5.7	13.0	7.02
	7.0	5.3	10.0	6.72
	6.6	5.1	10.0	7.54
	7.0	5.2	10.0	7.11
	7.5	5.7	14.0	7.56
	7.6	6.0	13.0	6.02
	6.4	5.0	10.0	8.0
	6.5	5.0	10.0	8.0
	7.1	5.6	13.0	7.4
	6.3	5.0	10.0	8.0
	6.5	5.0	12.0	9.6
MARCH, 1987	8.6	6.5	15.0	5.46
	10.1	7.7	24.5	5.37
	6.5	5.5	10.0	6.01
	6.4	4.9	10.0	8.5
	6.4	4.9	10.0	8.5
	7.0	5.2	10.0	7.11
	7.3	5.6	12.0	6.83
	6.5	5.1	10.0	7.54
APRIL, 1987	7.0	5.4	7.0	4.45
	7.0	5.3	10.0	6.72

APPENDIX 7 CONT'D.

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
APRIL, 1987	7.0	5.4	8.0	5.08
	8.9	6.7	17.0	5.65
	8.0	6.2	10.0	4.2
	7.7	6.0	13.0	6.02
	6.9	5.3	8.0	5.37
	7.0	5.4	14.0	8.89
	6.4	5.0	8.0	6.4
	6.6	5.0	10.0	8.0
	7.2	5.5	10.0	6.01
	7.9	6.1	11.0	4.85
	8.2	6.4	15.0	5.72
	7.1	5.7	10.0	5.4
	7.9	6.0	14.0	6.48
	7.0	5.4	10.0	6.35
	6.5	5.0	10.0	8.0
	7.3	5.5	12.0	7.21
	6.3	4.7	7.0	6.74
	7.0	5.2	10.0	7.11
	6.1	4.7	7.2	6.93
	6.8	5.4	10.0	6.35
	6.0	4.5	5.0	5.49
	6.4	5.0	8.0	6.4
	6.2	4.7	10.0	9.63
	7.2	5.5	12.0	7.21

APPENDIX 7 CONT'D.

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
APRIL, 1987	6.5	5.5	10.0	6.01
	5.1	3.9	7.0	11.8
MAY, 1987	8.6	7.9	30.0	6.08
	11.4	9.0	22.0	3.02
JUNE, 1987	10.8	9.10	45.0	5.97

APPENDIX 8

TOTAL LENGTH, STANDARD LENGTH, BODY WEIGHT AND CONDITION FACTOR OF SAROTHERODON GALILAEUS (MALES)

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
FEB., 1987	32.60	24.50	669.7	4.55
	14.80	11.0	65.6	4.93
	13.40	10.20	45.10	4.25
MARCH, 1987	15.40	11.50	60.0	3.95
	11.20	8.50	25.50	4.15
MAY, 1987	20.10	15.20	155.0	4.41
	12.20	9.50	26.50	3.09
	17.40	13.50	62.0	2.52
JUNE, 1987	16.40	12.60	61.0	3.05
	10.20	7.50	22.0	5.22

APPENDIX 9

TOTAL LENGTH, STANDARD LENGTH, BODY WEIGHT AND CONDITION FACTOR OF SAROTHERODON GALILAIUS (FEMALES)

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
JULY, 1986	27.0	21.0	199.60	2.16
FEB., 1987	19.70	14.60	170.0	5.46
MARCH, 1987	32.60	25.40	784.3	4.79
MAY, 1987	24.30	18.10	282.0	4.76
	16.20	11.50	65.30	4.29
	14.10	10.61	55.0	4.61
	27.0	21.0	199.0	2.15
	31.60	24.40	783.0	5.39
	18.70	14.60	170.0	5.46
	31.60	25.0	780.0	4.99
JUNE, 1987	18.70	14.20	110.0	3.84
	17.20	13.50	105.0	4.27
	11.30	8.50	22.50	3.66
	11.20	8.60	25.0	3.93
	18.0	13.9	160.0	5.96
	13.0	10.50	60.0	5.18
	23.30	17.60	272.0	4.99
	27.5	21.50	199.0	2.0

APPENDIX 10

TOTAL LENGTH, STANDARD LENGTH, BODY WEIGHT AND CONDITION FACTOR OF SAROTHERODON GALILAEUS (IMMATURE)

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
JULY, 1986	9.60	7.20	14.0	3.75
	7.0	5.20	6.23	4.43
	6.50	5.0	4.80	3.84
NOV., 1986	8.90	6.60	17.0	5.91
	6.50	4.90	10.0	8.50
	8.70	6.50	18.0	6.55
DEC., 1986	10.80	8.50	23.0	3.75
	8.60	6.20	24.0	10.07
	11.30	8.50	31.0	5.05
	6.20	4.90	10.0	8.50
	8.90	6.60	17.0	5.91
	8.70	6.50	18.0	6.55
	7.50	5.90	11.0	5.36
JAN., 1987	9.80	7.50	22.0	5.22
	10.90	8.10	30.0	5.65
	9.60	7.20	25.0	6.69
	9.50	7.20	25.0	6.69
	10.30	7.50	30.0	7.11
	6.20	4.90	10.0	8.49

APPENDIX 10 CONT'D.

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
FEB., 1987	9.0	6.80	15.0	4.77
	18.50	13.90	125.0	4.65
	6.50	5.50	7.0	4.21
	10.70	8.0	25.50	4.98
	10.10	7.50	24.20	5.74
	10.0	7.40	20.0	4.94
	9.50	7.30	20.0	5.14
	8.40	6.20	15.0	6.29
	8.40	6.20	15.0	6.29
	6.40	4.80	10.0	9.04
	6.60	5.0	10.0	8.0
MARCH, 1987	5.60	4.0	3.0	4.69
	6.60	5.20	5.0	3.56
	14.50	10.8	55.5	4.41
	9.60	7.10	20.0	5.59
	9.60	7.30	20.0	5.14
	9.40	7.0	20.0	5.83
	8.70	6.50	17.0	6.19
	7.40	5.6	10.0	5.69
	8.20	6.20	15.0	6.29
	7.90	6.0	15.0	6.94
	7.10	5.50	13.0	7.81

APPENDIX 10 CONT'D.

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
APRIL, 1987	11.0	8.20	30.0	5.44
	9.50	7.20	18.0	4.82
JUNE, 1987	7.50	6.0	5.80	2.69
	11.0	8.30	25.0	4.37

APPENDIX 11

TOTAL LENGTH, STANDARD LENGTH, BODY WEIGHT AND CONDITION FACTOR OF HEMICHROMIS BIMACULATUS

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
FEB., 1987	5.50	4.20	5.0	6.75
	6.10	4.50	5.0	5.49
	6.10	4.70	5.0	4.82
	5.80	4.50	5.0	4.82
	9.70	7.50	20.0	4.74
	7.60	6.0	10.0	4.63
	8.10	6.4	12.0	4.58
	6.90	5.40	8.0	5.08
	7.20	5.75	10.0	5.26
	7.0	5.30	7.0	4.70
	7.20	6.10	12.0	5.29
	7.0	5.50	8.0	4.81
	6.50	5.50	8.0	4.81
	7.10	5.50	14.0	8.42
MARCH, 1987	8.0	6.20	12.0	5.04
	6.40	5.10	5.0	3.77
	6.0	4.60	5.0	5.14
	5.5	4.20	5.0	6.75
	5.70	4.40	5.0	5.87
	10.0	7.90	24.5	4.97
	9.60	7.0	15.0	4.37

APPENDIX 11 CONT'D.

	TOTAL LENGTH (cm)	STANDARD LENGTH (cm)	BODY WEIGHT (g)	CONDITION FACTOR (K)
MARCH, 1987	7.10	5.50	8.0	4.81
	9.0	6.90	15.0	4.57
	8.0	6.20	17.0	7.13
	7.20	5.70	10.0	5.40
	7.10	5.60	8.0	4.56
	7.80	6.10	12.0	5.29
	7.85	6.10	11.0	4.85
	7.30	5.70	10.0	5.40
	7.30	5.60	9.0	5.13
	7.30	5.70	10.0	5.40
	7.30	5.60	14.0	7.97
APRIL, 1987	6.80	5.70	7.0	3.78
	7.40	5.90	10.0	4.87
	7.20	5.70	10.2	5.51
	8.60	6.70	15.0	4.99
	6.90	5.40	10.0	6.35
	6.60	5.20	10.0	7.11
	7.20	5.50	11.0	6.61

APPENDIX 12

BODY MEASUREMENTS OF CLINOSTOMUM SP (METACERCARIAE)

	LENGTH (mm)	WIDTH (mm)	ORAL SUCKER (mm)	VENTRAL SUCKER (mm)
	3.75	1.56	0.15	0.33
	4.20	1.47	0.21	0.60
	5.10	1.44	0.30	0.57
	3.60	1.56	0.12	0.30
	2.85	1.32	0.15	0.42
	4.56	1.14	0.12	0.42
	4.62	1.50	0.21	0.42
	4.86	1.41	0.15	0.51
	5.01	1.20	0.24	0.39
	4.59	1.20	0.18	0.57
	5.55	1.47	0.15	0.45
	5.40	1.80	0.30	0.66
	5.70	1.38	0.21	0.42
	4.86	1.26	0.15	0.42
	5.40	1.20	0.15	0.33
	4.86	1.50	0.18	0.42
	5.10	1.26	0.15	0.42
	6.0	1.86	0.21	0.51
	4.50	1.41	0.12	0.36
MEAN	4.76	1.42	0.18	0.45

APPENDIX 13

DIAMETER MEASUREMENTS OF DIPLOSTOMATID CYSTS

(METACERCARIAE) IN (MM)

DIAMETER OF CYST (MM)		
2.70	2.79	2.70
2.46	2.91	2.16
2.79	2.94	1.26
2.79	3.15	2.40
2.79	2.91	1.80
2.79	1.80	1.95
2.13	2.25	1.35
2.52	2.25	1.86
2.46	2.19	2.16
2.70	2.31	3.15
2.25	1.50	3.03
2.82	1.11	3.15
2.82	1.86	3.12
2.88	2.55	2.79
2.79	2.58	2.76
3.0	2.46	2.70
2.85	2.34	2.49
2.88	2.1	2.40
3.0	1.68	1.65
2.91	1.86	2.85
2.76	1.56	2.45 MEAN

APPENDIX 13

DIAMETER MEASUREMENTS OF DIPLOSTOMATID CYSTS (METACERCARIAE) IN (MM)

DIAMETER OF CYST (MM)		
2.70	2.79	2.70
2.46	2.91	2.16
2.79	2.94	1.26
2.79	3.15	2.40
2.79	2.91	1.80
2.79	1.80	1.95
2.13	2.25	1.35
2.52	2.25	1.86
2.46	2.19	2.16
2.70	2.31	3.15
2.25	1.50	3.03
2.82	1.11	3.15
2.82	1.86	3.12
2.88	2.55	2.79
2.79	2.58	2.76
3.0	2.46	2.70
2.85	2.34	2.49
2.88	2.1	2.40
3.0	1.68	1.65
2.91	1.86	2.85
2.76	1.56	2.45 MEAN

APPENDIX 13 CONT'D.

2.91	1.53
2.88	3.0
2.76	2.85
2.85	1.26
3.0	1.53
2.82	2.55
2.82	1.95
2.85	2.19
2.85	1.83
2.85	1.95

APPENDIX 14

BODY MEASUREMENTS OF CESTODE

	LENGTH (MM	WIDTH (MM)
	5.76	0.90
	5.43	0.78
	5.10	0.51
	2.46	0.45
MEAN	4.69	0.66

APPENDIX 15

BODY MEASUREMENTS OF NEMATODE

	LENGTH (MM)	WIDTH (MM)
	15.0	0.36
	14.3	0.33
MEAN	14.65	0.35

APPENDIX 16

BODY MEASUREMENTS OF NEOECHINORHYNCHUS SP.

LENGTH (MM)	WIDTH (MM)
2.70	0.81
2.31	0.48
2.70	1.03
2.73	0.63
2.10	0.45
1.74	0.45
1.50	0.36
1.95	0.36
1.26	0.36
1.80	0.30
1.56	0.39
0.90	0.21
1.38	0.48
1.50	0.45
0.99	0.45
2.01	0.78
1.50	0.51
1.50	0.51
2.55	0.69
1.41	0.42
2.31	0.54
1.71	0.48
1.56	0.54

APPENDIX 16 CONT'D.

	LENGTH (MM)		WIDTH (MM)
	1.89		0.54
	1.95		0.45
	1.35		0.54
	2.85		0.75
	1.20		0.24
MEAN	1.82	MEAN	0.51