ON THE BIOLOGY OF THE BLACK JAW' TILAPIA *SAROTHERODIN MELANOTHERON* (RUPELL) IN A TROPICAL FRESHWATER LAKE

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ABSTRACT

the biology of the cichlid *Sarotherodon melanotheron* (Rupell), a brackish-water tilapia introduced into a freshwater lake was studied. Racial data of the species in Awba lake, Ibadan, conform with previous information on its biology. Growth in the species was negatively showed positive correlation. Condition factor was high and decreased with increase in fish size.

Food consist mainly of blue green algae and detritus, while green algae and diatoms were supplementary and zooplankton dinofigellates and euglenoids were of minor importance. A dietary difersification and effective utilization of availabe food suggests an adaptation to reduce possible competition. Females dominates males in the lake numerically. Eggs in the species were large while fecundity was low.

Gonadosomatic indices recorded during most of the study were high, indicating non-seasonal spwaning. Six gonad maturation stages were elucidated in the species;

Meristic and morphometric data from previous and present studies as *S. melanotheron* The length and weight of the fish showed positive correlation and growth was negative.y allometric. The condition factor was comparatively higher in the smaller sizes. Food consist mainly of blue green algae and detritus. Diatoms and green algae were supplementary while dinoflagellates, englenoids, zoopklanton and vegetable matter were of minor importance. Augmentation of main food items with others possibly reduces competition for food with other fish species.

Female *S. melanotheron* outhumber males in the lake abd egg sizes were large while egg counts were low.

Gonadosomatic indices were high throughout the study period, indicating a non-seasonal spawning fish.

Six maturation stages were elucidated during the study.

INTRODUCTION

Tilapias are common in many rivers, lakes, estuaries and lagoons of tropical Africa. Some of them such as *Oreochromis mossambicus* occur both in brakish-waters and freshwaters. Interest in the group is enhanced by the suitability of many of its species for fish culture as well as being a cheap source of animal protein (Lowe Mc Connell, 1985; Huet. 1972 and Fagade, 1979).

Trewavas and Fryer (1965) divdided Tilapias into substrate spawners, guarders and mouth brooders on the basis of the degree of parential care exhibited by them. Earlier, the mouth brooders were classified as *Sarotherodon* while the substrate brooders were referred to as *Tilapia*. Trewavas (1983) however assigned material mouth brooders to the genus *Orechromis* while the bipaternal mouth brooders retained the name *Sarotherodon*.

Sarptherodon melanotheron is now widely distributed through introduction in South America, part of India, Isreal and Europr. It is relatively abundant in brackishwaters and lagoons of coastal regions of West Africa (william, 1962; Fagade and Olaniyan, 1974; and Trewavas, 1982). The flood of Augaust 31,1980 in Ibadan, Nigeria resulted in the escapes of *S.melanotheron* from some neighbouring fish ponds into Awba lake. The species has since established itself in the permanently freshwater condition in the lake; numerically it ranks third after *Orechromis niloticus* and *Tilapis Zillii* (Ugwunba, 1990. There is a possibility of further colonisation of the entire course of the Awba stream and adjoining streams and rivers by the species. This report is the first on the biology of *S. melanotheron* in Awba lake, Ibadan. Aspects of the biology studied include the morphometric and meristic features of the species, lenght-weight relationship, condition factor, food and feeding habits and aspects of the reproductive biology of the species.

Study Area

Awba Lake is an artificial reservior formed by the impoundment of the Awba streams at a point where it flowed through a natural valley. The lake is located in the south eastern end of the University of Ibadan, lying between latitudes of 7° 26' and 7° 27'N and longitude 3° 53' - 3° 54'E, at an altitude of 185 m above sea level (Figure 1). It has an area of about 6 ha, a maximum lenght of 700 metres and a maximum depth of 5.5 metres. It can hold about 230 million litres high, 110 metres long with a crest of 12.2 metres. Ita (1974), Omotosho (1981) and Ugwumba (1990) the lake experienced a clear division of the year into a rainy season between May and October and a dry season from November to April. Ugwumba (1990) also recorded the highest mean surface water temperature of 30.8° c in April amd the lowest of 26.3° c in October 1987. Water transparency in the lake ranged from 0.48 - 0.70 m while the dissolved oxygen content varied from6.2 - 8.4 mg/litre and the total ionic content of water measured as the conductivity ranged from 240-320 s/cm at 25° c. The total monthly rainfall ranged from 0.0-272.8 mm while the total range of monthly hours of sunshine was 112.7-230.5 hours and the monthly relative humidity ranged from 42.0-79-.0%.

The reservoir is surrounded by grasses, mainly *Paspalum* along with a few trees, weeds and submerged plants. The ichthyofauna is dominated by cichlids. Other fishes included *Heterotis niloticus*, *Clarias gariepinus*, *Chana obscura*, *Barbus* callipterus and *Alestes longipinnins(Omotosho, 1981)*.

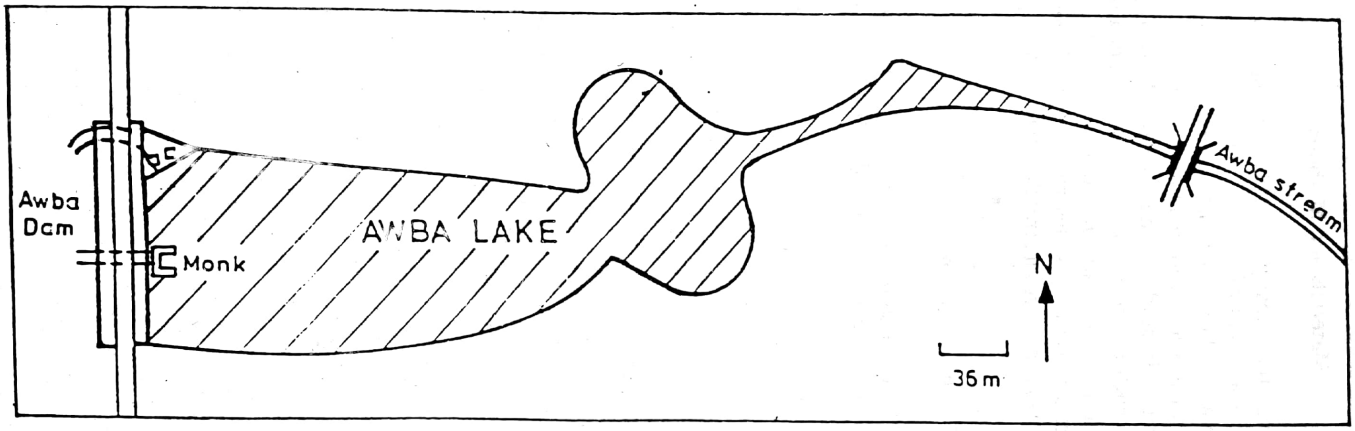


Fig. 1:

Specimens were collected during monthly fishing trips between January 1986 and January 1989. Cast nets of 1.5 - 4.5 cm mesh sizes were used. Specimens were kept chilled in an ice box after capture and transfered to the freezer on arrival at the laboratory untill they were examined. Sizes or specimens used for the morphometric and meristic studies ranged from 14.0 to 16.0cm (SL). All measurement were taken with a pair of dial calipers and measurements were recorded to the nearest millimetre on a measuring board.

The lenght-weight relationship was described as in Bagena (1978); $W=aL^b$, whose logarithmic transformation gives a straight line relatiosnip:

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

Where W = Weight in grammes
L = total lenght in centimetres
a = constant
b = exponent, ranging between 2 - 4. The conditoin factor K, based on Fluto's condition exponent (Bagenal, 1978) was calculated by the formula

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

Where K = conditions factor
W = weight in grammes
L = total lenght in centimetre

Each specimen was sissected and the gut (from the oesophagus to the rectum) was removed. The contents were emptied into a petric dish and examined under a binocular microscope. The numerical, occurence and "points" methods were employed in the analysis of the stomach and gut contents. The relative importance index (RI) which combines the Principles of the"numerical" "occurrence" and "Point" methods was calculated from George and Hadly (1978) and Hyslop (1980). This was given as;

$$RI = 100\ AI / \sum_{1}^{n} AI$$

Where AI = Absolute omportance index = % occurence + % total points (sustituted for % total volume)
n = number of different food items

The sex of each specimen was determined by visual and microscopic examination based on Nikolsky's (1963) scale. The gonads were dissected, weighed and preserved in Gilson's fluid. Small pieces from the fore part were cut off and fixed in Bouins fluid. These were embeded in parafin wax of melting point 56 ^{o}oc, cut at 5-8 m abd stained with Erlich's haematoxylin stain.

The egg diameter was measured using and occular micrometer in a binocular microscope. A mean of fifty randomly selected eggs were measured for each ovary.

The data of the body and gonad weights were used to determined the Gonadosomatic index (GSI) from the formula:

$$GSI = \frac{w}{W} \times 100$$

where w = weight of gonad in grammes
W = weight of fish including gonad in grammes

The fecundity was taken as the number of ripening eggs prior to next spawning (Bagenal, 1978). The number of eggs in the ripe ovaries were determined by direct enumeration. Counting individual eggs eliminated the technical variations of calculated egg numbers.

Results

Morphometric and Meristic features

The morphometric and meristic data are presented in Table 1.

Mean values of 4.9, 2.4, 1.8, 1.2, 1.5 and 2.5 cm were recorded for head lengh, head depth, body depth, snout lengh, eye diameter and caudal peduncle respectively. Head to idorsal fin origin in the species ranged from 4.6 - 6.6 cm.

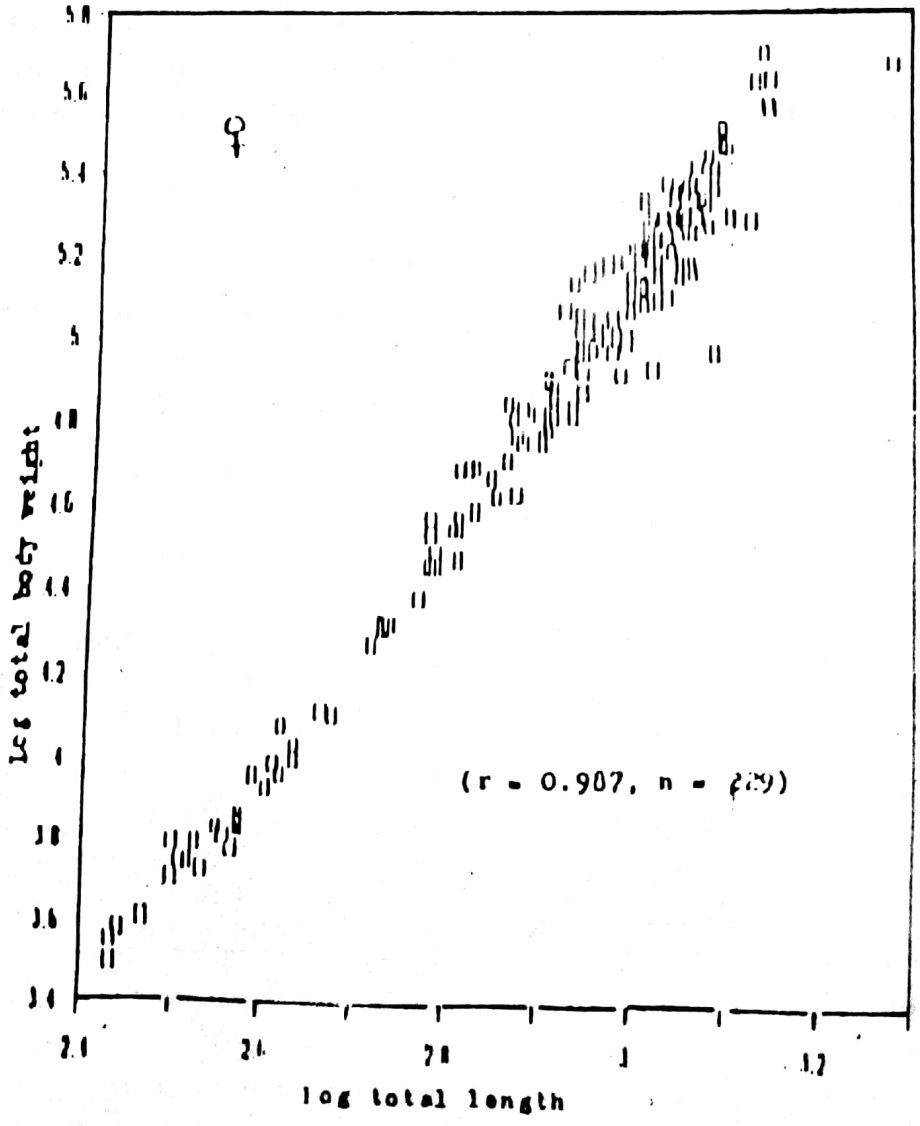
Table 1. Morphometric and meristic features of *S. melanotheron* from different sources

Morphometric Features	*T. heudeloti* Boseman (1963) Niger Delta	*T. heudeloti* Daget and Iltis (1965) Ivory Coast	*T. melano theron* Fagade (1969) Lagos Lagoon	*S. melano theron* Present study Awba-Lake
Standard length range	7.8-23.0cm	-	5.5-20.2cm	14.0-16.0cm
Head length	3.2-3.9	-	3.2-4.1	3.6-5.2
Head depth	-	-	-	1.8-2.8
Body depth	3.9-5.0	-	3.9-4.5	3.6-5.3
Snout length	3.4-4.1	-	1.8-3.6	1.1-3.4
Eye diameter	1.9-2.9	-	1.8-3.1	1.2-2.6
Caudal peduncle length	-	-	2.6-3.9	1.8-2.7
Head to dorsal fin origin	-	-	-	4.6-6.6

Head length in fish standard length	3.6-3.9	-	3.2-4.1	2.7-3.4
Body depth in fish standard length	3.9-5.0	-	3.9-4.5	4.2-5.6
Eye diameter in fish head length	1.9-2.9	-	1.8-3.1	2.0-3.6
Snout length in fish head length	3.4-4.1	-	1.8-3.6	3.2-4.7

Meristic Features.

Dorsal Fin	XIV-XVI 10-12	XV-XVI 10-13	XIV-XVI 8-12	XV-XVI 10-12
Pectoral fin	—	—	—	12 — 13
Pelvic fin	—	—	—	6
Anal fin	III 8-9 (1)	III 7-10	III 7-9	III 8-9
Gill rakers	16 — 18	—	15 — 18	16 — 20
Branchiostergal rays	—	—	—	4 OR 5
Vertebrae	—	—	—	26 — 28

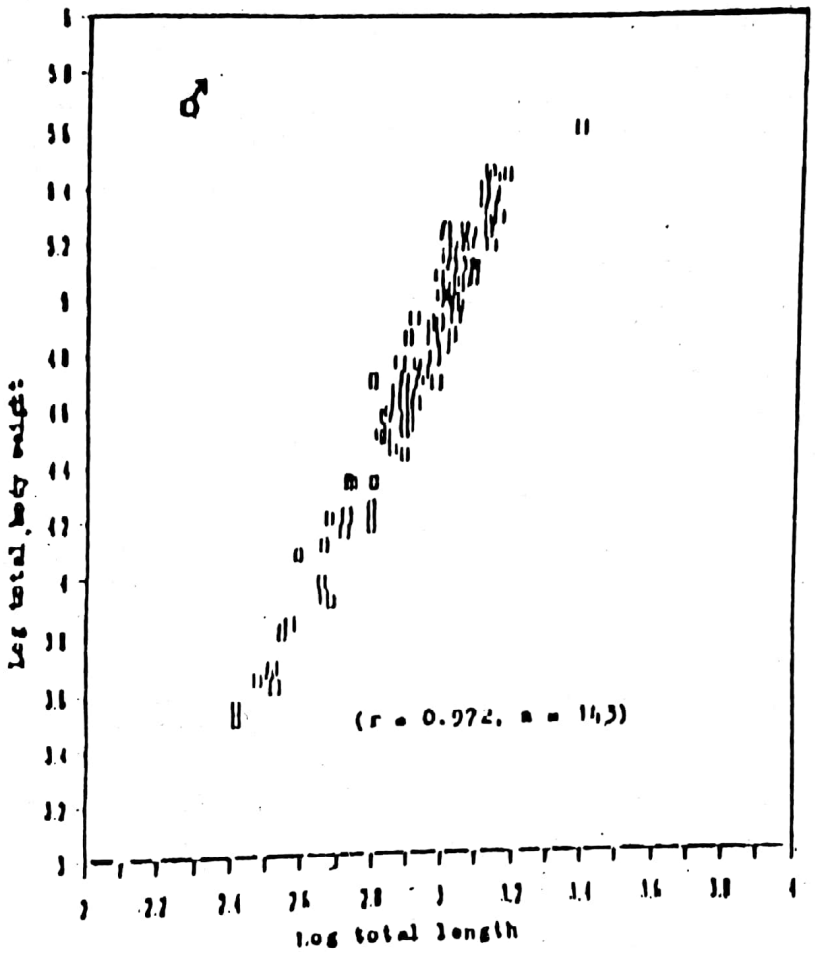


Length - weight relationship

The length -weight relationship in the species is shown in Figure II. The plot of the logarithmic values gave the following regression equations:

Females: Log w = -3.5 + 2.9 Log L (r = 0.987)

Males: Log w = -2.9 + 2.7 Log L (r = 0.972)



Condition factor (k)

The condition factor of male *S. melanotheron* in Awba lake ranged from 1.10 - 2.56 (mean: 1.87) while in females it ranged from 1.5 - 2.63 (mean: 2.07). The mean condition factors of 2.20 (male) and 2.26 (female) were obtained in the smallest size group (8.0-12.0 cm). This decreased to 1.52 (male) and 1.63 (female) in the largest size group (25. 0 - 30.0 cm).

Food

of the 444 specimens examined, 102 (25.25%) had empty stomachs. The stomach contents of S. *melanotheron* showed that the dietary items include phytoplankton, Zooplankton, plant materials, sand grains, organic debris and insects.

As shown in Table II, *Microcystis* was the most important blue green algea in terms of bulk, constituting 32.3%. Agmenellum made up 8.4% by points. The occured most frequently in the stomachs than other blue green algea (81.2 and 80.0% respectively). Other blue green algea, *Anabeana* , *Nostoc* and *Oscillatoria* constituted 13.5 and 6.9% by number and points respectively.

The most important diatoms, *Synedra* and *Melosira* constituted 6.6% and 6.2% by number and 1.8 and 0.8% by points respectively. other diatoms encountered wer *Navicula* and *Cyclotella.* The green algae, *Scenedesmus*, *Pediastrum*, *Closterium*, *Staurastrum* and *Cosmarium* contributed 11.4% by number and 1.3% by points of the stomach content. The Dinoflagellate, *Perdinium* occured in 39.4% of the stomachs and accounted for 6.0 and 0.2% by number and points respectively. Euglenophyceae *Phacus* and *Euglena* constituted 0.2% by number and 3.9% by points.

Zooplankton, represented by rotifers, Cladocera, Copepods, nauplii larvae and rhizopod *(Difflugia)* and insect larvae (chironomids) constituted 8.5% by number and 7.7% by points. Higher plant materials were detected in 20.0% of the stomachs and accounted for 1.)% by points.

Sand grains and organic debris occured in 79.4 and 78.8% and constituted 4.4 and 30.5% by points respectively.

The relative importance index (R1) of the phytoplankton food was highest. The blue green algae had the highest RI value of 62.3% and was followed by diatoms (57.2%), green algae (31.1%) dinoflagellate (16.1%) and euglenoids (15.2%). Amongst the Zooplankton, rotifers recorded the highest RI value of 26.9%' They were followed by chironomid larvae (11.1%) and copedos (8.5%). The rhizopod, cladocerans and nauplii larvae had RI values of less than 3.0% each.

Table II. Summary of stomach contents of *S. melanotheron* from Awba Lake with Relative Importance Index (RI) of different significant food groups.

	Numerical Method Percent	Occurrence Method Percent	Points Method Percent	RI %
Phytoplankton				
Blue green algae				62.3
Microcystis	25.5	81.2	32.3	
Agmenellum	30.8	80.0	8.4	
Anabaena	2.1	47.6	1.6	
Nostoc	2.5	45.1	1.6	
Oscillatoria	8.9	44.9	3.7	
Diatoms				57.2
Synedra	6.6	68.1	1.8	
Melosira	5.2	58.8	0.8	
Navicula	0.3	8.5	0.1	
Cyclotella	0.2	3.0	0.1	

				31.1
Green alagae				
Snenedesmus	4.7	74.0	0.7	
Pediastrum	1.3	44.6	0.3	
Closteruim	1.8	32.7	0.1	
Staurastrum	1.4	27.3	0.1	
Cosmarium	2.2	23.0	0.1	
				16.1
Dinoflagellete				
Peridinum	6.0	39.4	0.2	
				15.2
Euglenoids				
Phagus	0.1	40.9	0.1	
Euglena	0.1	7.9	3.8	
Zooplankton				
Rotifer	2.4	44.3	1.1	26.9
Cladocera	1.1	1.8	0.2	2.0
Copepod	1.6	3.6	1.3	8.5
Nauplius larvae	1.2	3.6	0.2	2.7
Rhizopod				
Difflugia	1.9	3.6	2.0	
				11.1
Insects				
Chironomid larvae	0.3	4.5	2.9	
Higher Plant Materials	–	20.0	1.0	
Sand grains	–	79.4	4.4	
Organic debris	–	78.8	30.5	
Unidentified Mass	–	37.0	6.7	

Sex ratio

Of the 444 gonads examined, 168 were males while 276 were females giving a sex ratio of 1:3.3 in favour of the female *S. melanotheron.*

Egg size

Egg diameter in the species ranged from 1.01 mm–3.98 mm for a ripe gonad. Mean egg diameter increased with maturation of the ovary and the ripe fish had a mean egg diameter of 3.40 mm.

Gonadosomatic index (GSI)

OSI in the species ranged from 0.07 – 6.93% with a mean of 1.77%. GSI increased with gonad maturation and dropped after the fish spawned (Figure III). GSI values were highest for January, March and June while in February, May and September, the values were low.

Fecundity

Fecundity in *S. melanotheron* from Awba Lake ranged from 61 – 590 eggs with a mean of 432 eggs.

Fecundity-length and fecundity-weight relationships gave the following linear equations respectively.

$X = 160 + 2.41\ Y^e$ $(r = 0.68)$
$X = 101 + 1.90\ Y^w$ $(r = 0.41)$
where X = Fecundity
Y^e = Standard length (cm)
Y^w = Body weight (g)
r = correlation coefficient

Gonad morphology and maturation

The gonads of *S. melanotheron* were paired and elongated. They lay separately in the body cavity and were joined posteriorily. Colour of gonads changed with maturation. Immature ovaries were whitish. The ripe ovaries turned brownish red with sign of heavy vascularization. The testes were translucent, flat and ribbon-like.

Six maturation stages adapted after Nikolsky (1963) were recognised in the female *S. melanotheron*. These were:

State I Immature: Threadlike, translucent strands. Colour tend greyish white and eggs were not discernible

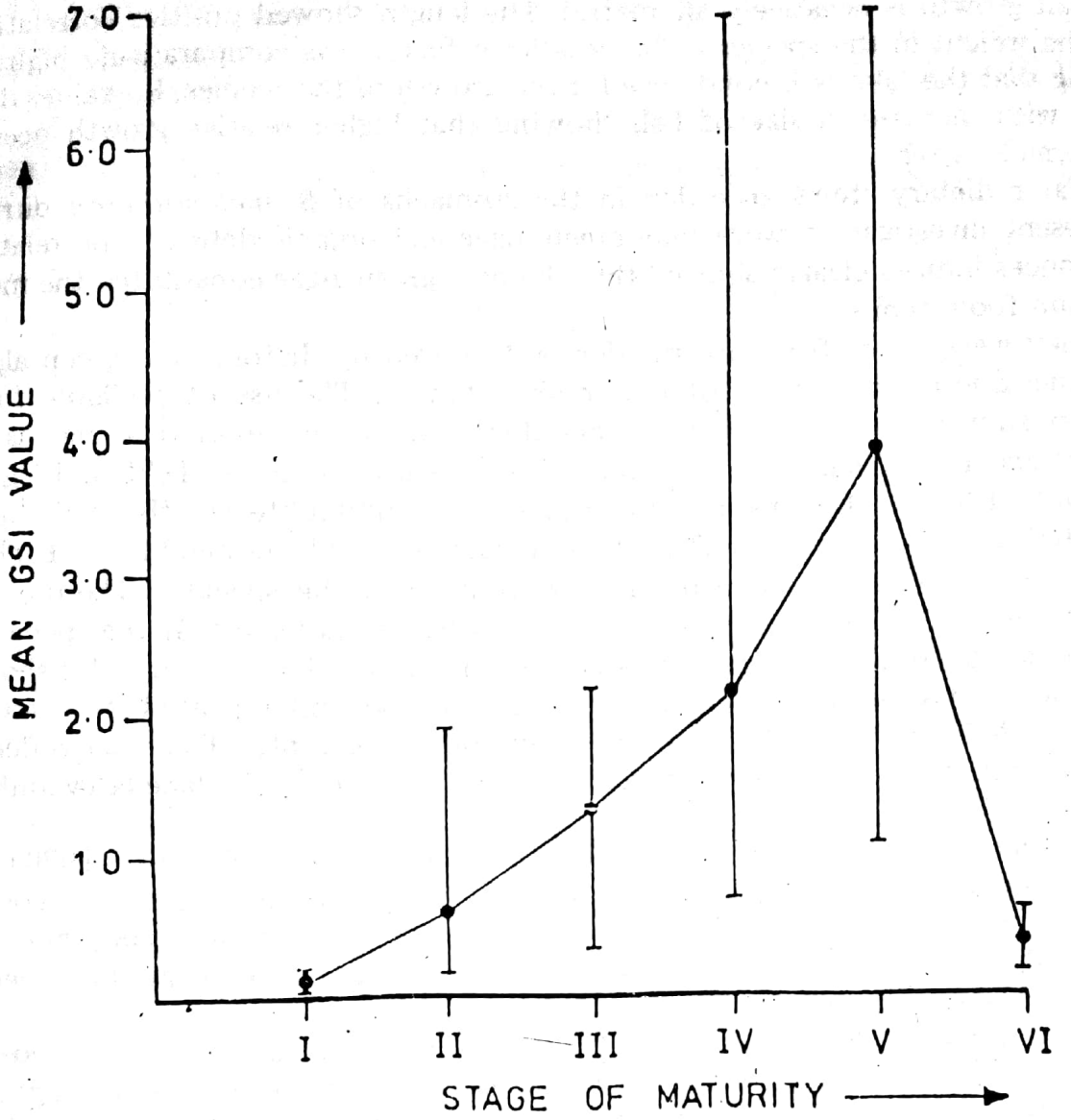
Stage II Immature/developing: Ovaries are enlarged as yellow to reddish grey sacs. Tiny eggs are visible to the naked eye.

Stage III Ripening: Eggs are more discernible, pale red swollen and saclike. Ovaries occupy more than half of viscera

Stage IV Ripe: Ovaries greatly enlarged and occupy almost entire visceral cavity. They are brownish red in colour.

Stage V Running: Ovaries are reduced in size due to extrusion of eggs. Colour is reddish with blood capillaries.

Stage VI Spent: Ovaries are flaccid with few residual opaque eggs.



DISCUSSION

The species *S. melanotheron* is identified instantly by black spots on cheek and lower jaw hence the name 'black jaw' tilapia (ugwumba and Fagade, 1989). The body proportions present a strongly compressed but slender fish. The racial data obtained in the present study are in agreement with boeseman (1963), Daget and Lltis (1965) for *Tilapia heudeloti* from Niger Delta and Ivory Coast respectively as well as with Fagade (1969) for*Tilapia melanotheron* in Lagos Lagoon. *T. heudeloti* is considered a subspecies of *S. melanotheron* (Trewavas, 1983). The slpecimens in Awba lake were flooded from nearby fish ponds which were stocked with *S. melatheron* fingerlings from Lagos Lagoon (Ugwumba, 1990)

The b exponent of *S' melanotheron* in Awba lake is less than 3 thus indicating that growth is negatively allometric. The length showed positive correlation with the weight in the species. The condition factor was comparatively high suggesting that the lake is is conducive for the growth of the species. K - values decreased with increase in size of fish showing that higher relative growth occurs in the smaller sizes.

Major dietary items recorded in the stomachs of *S. melanotheron* during the present investigation were blue green algae and organic debris. The relative importances indices clearly showed that the blue green algae constituted the most important food item.

They were, apart from organic debris, followed by diatoms and green algae while the Zooplankton were of minor importance. The use of available food items to augment major and important diets have been reported as means of ing inter and intraspecific competition in fish species (Weatherly 1972 and Ugwumba, O.A. 1988); Diatoms and green algea were undoubtedtly the main supplemented its food with dinoflagellates, englenoids and zooplankton. Higher plant materials were also detected in the stomach of the species. The dietary items recorded showed a fairly broad spectrum which indicate that the species could be phytophagous, a deposit feeder or omnivorous. The feeding habit shows a suitable dietry diversation which according to Ugwumba at al (1989) would tend to reduce competition among the fish species present. This also reflects effective utilisation of food availabe in the different niches in the lake (Ugwumba, 1990).

Information on the food of the species include those of pauly (1976) in Sakimo Lagoon, Fagade (1979) and Ugwumba, A.A.A. (1988) in Lagos Lagoon. In all the reports, blue green algae, diatoms, organic matter and zooplankton were the dietary items. All reports from the blackishwater habitats are in agreement with present study in a freshwater environment.

Female 9S. melanotheron were more than males in Awba Lake. This may no be unconnected with spawning activities that may expose more females to capture than males. Egg sizes were large while fecundity was low. The low fecundity correlates with the degree of parental care characteristics of some fishes including tilapias (Fagade 1969 and Adebisi, 1978). GSI values were relatively high and peak values were recorded in ripe and running ovaries. High values for most of the year indicates that the fish has no definite spawing period, a typical characteristics of tilapias (Fryer and Iles, 1972). Gonad maturation showed six maturity stages which were recorded throughout the duration of the study, further confirming non-seasonality of spawing in the species.

The succes of *S. melanotheron*, traditonally associated with brackishwater systems in a freshwater lake as found in this study suggest that the species could be cultured effectively in inland freshwater pounds. Aspects of the biology of *S. melanotheron* studied confirm its existence, survival and success in Awba Lake, a freshwater lake. Result of the study suggest and predicts that a high production level may be obtained when the species is cluture in freshwater ponds.

REFERENCES

Adebisi, A.A. (1978) Studies on the Ecology, growth and reproduction of the fishes of Upper Ogun River, Nigeria. Ph.D Thesis, University of Ibadan.

Bagenal, T. (1978) *Method for Assessment of Fish Production in Freshwater* (Ed.) Bagenal). Blackwell Scientific Publications 219 255 pp.

Boeseman, M. (1963) An Annotated List of Fishes from the Niger Delta. *Zool. Verhan* 61, 1 48 pp

Daget J. and Iltis, A. (1965) Poissons de Cote d'Ivoire (cause doues et saumatres). *Mem. Inst. Fr. Afr. Noire* No. 74

Fagade, S.O. (1969) Studies on the Biology of some fishes and the fisheries of the Lagos Lagoon. Ph.D Thesis University of Lagos.

Fagade, S.O. (1979). The food and feeding habits of *Tilapia* species in Lagos Lagoon. *J. Fish Biol.* 3: 151 156 pp.

Fagade, S.O. and Olaniyan, C.I.O. (1974). Seasonal distribution of the fish fauma in Lagos Lagoon. *Bull. Inst. Fr. Afr. Noire.* 36: Ser. A. No. I 245 – 252 pp.

Fryer, G. and Iles, T.D. (1972) *The Cichlid Fishes of the Great Lakes of Africa.* Their Biology and Evolution. Edinghurgh Oliver and Boyd 641p.

George, E.L. and Hadly W.F. (1978). Food and feeding habit partitioning between rock bass *(Ambloptites rupestris)* and small mouth bass *(Micropterus dolomieni)* Young of the Year. *Trans. Am. Fish, Soc.* 108: 253 261pp.

Hassan, A.T. (1974) Studies on the ecology, behaviour and life history of Libelluline Dragon Flies. Ph.D. Thesis, University of Ibadan, Nigeria.

Huet, M. (1972) *Textbook of Fish Culture, Breeding and Cultivation of Fish.* Translated by Rohn H. Fishing News Ltd. Fonham, Survey, England. 301p.

Hyslop, E.J. (1980) Stomach content analysis, a review of methods and their application. *J. Fish Biol.* 17: 411 – 429pp.

Ita, S.O. (1971) Food and feeding relationship of fish in a tropical fish pond. M.Sc. Thesis, University of Ibadan, Ibadan.

Lowe Mc Connel, R.H. (1958) Observations on the biology of *Tilapia nilotica* in East African waters. *Rev. Zool Bot. Afr.* 57; 129 -- 170 pp.

Nikolsky, G. (1963) *The ecology of fishes.* Academic Press New York, 352p.

Omotosho, J.S. (1981). Comparative studies of the reproductive biology of two cichlids *Tilapia zillii* (Gervais) and *Sarotherodon niloticus* (Linnaeus Trewavas) from a small lake in Ibadan. M.Sc. Dissertation, University of Ibadan.

Pauly, D. (1976) The biology, fishery and potential for aquaculture of *S. melanotheron* in a small West African Lagoon. *Aquaculture* 7: 33 – 49 pp.

Trewavas, E. and Fryer, G. (1965) Species of *Tilapia* (Pisces, Cichlidae) in Lake Kitangiri, Tanzania, East Africa. *J. Zool.* 147; 108 – 1118 pp.

Trewavas, E. (1982) Generic grouping of Tilapias used in Aquaculture. *Aquaculture* 27; 79 – 81pp

Trewavas, E. (1988) Tilapine fishes of the genera *Sarotherondon, Oreochromis* and *Danekitia*. British Museum (Natural History), London, 583 pp.

Ugwumba, A.A.A. (1988) Food and feeding habits of juveniles of some culturable fish species in Nigeria *NIOMR Occ Pap.* 31; 24p.

Ugwumba, A.A.A. (1990) Food and feeding ecology of *Oreochromis niloticus, Sarotherodon melanotheron* and *Heterotis niloticus* (Pisces: Osteichthyes) in Awba Reservoir, Ibadan. Ph.D Thesis, University of Ibadan.

Ugwumba, O.A. (1988) Food and feeding habits of the Ten-pounder *Elops lacerta* (Val.) in Lekki Lagoon, Lagos Lagoon, and Off-Lagos Coast, Nigeria, *Nig. Journ. of Nat. Sci.* (In press).

Ugwumba, O.A., Ugwumba, A.A.A. and Mbu-Oben, Pius (1989) Food and Feeding Ecology of the Mormyrids of Lekki Lagoon, Nigeria. *Nig. Journ. Nat: Sc.* (In press)

Ugwumba, O.A. and Fagade, S.O. (1989). Diagnostic feature of culturable fish species. Aquaculture Extensionist in Commonwealth Africa – Training, Programme Paper 17p.

Weatherly, A.H. (1972) *Growth and Ecology of Fish Population.* Academic Press Inc. London Ltd. 129 – 134pp.

Williams, M.V. (1962). The seasonal distribution of the Teleost - fish fauna in Lagos Harbour, Creek and Lagoon in relation to salt tolerance. M.Sc. Thesis, Univ. Coll. North Wales, Bangor.