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AGE AND GROWTH OF ALESTES DENTEX L. (CHARACIDAE) AT JEBEL AULYIA RESERVOIR, SUDAN.

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ABSTRACT

Age, growth and length-weight relationship of **A. dentex** from Jebel Aulyia Reservoir, on the White Nile in the Sudan, have been determined by the analysis of size-frequency distribution, scale and length-weight studies of 7580, 1441 and 1633 fish, respectively. Validity and factors affecting ring formation were studied. The average length and weight of **A. dentex** I, II, III, IV and V age-group is 17.1, 19.3, 24.6, 28.5 and 30.8 cm; and 65.1, 89.9, 169.5, 241.6 and 275.3 gm, respectively. The oldest fish examined was six years old and 32 cm long. **A. dentex** reaches its commercial size by the end of its fourth year of life. The body-scale relation is a straight line with an intercept of 0.8 cm. Weight of a mixed sample captured in several months increases as the 3.347 power of the length. Females slightly dominated age-group I, but females were more numerous in the older age-groups.

INTRODUCTION

In spite of the economic importance of freshwater fishes in the Sudan, studies on their age-determination have began only recently on some species,eg.; **Synodontis schall** (Bishai and Abu Gideiri, 1965), **Lates niloticus** (Mishrigi, 1967) and **Bagrus** spp.(Bishai, 1970).

The family Characidae is represented in the Sudan by three genera: **Hydrocynus, Micralestes** and **Alestes.** The latter includes four species which are **A. nurse** (Ruppel), **A. baremose** (Joannis), A. dentex (L.) and **A. macrolepidotus** (C. & V.). The maximum standard length of those species recorded in the Sudan were 19.5, 310.0, 35.0 and 42.0 cm respectively (Sandon, 1950). Both **Hydrocynus** and **Alestes** spp. have their economic importance as wet-salted fish, which can be easily transported under tropical conditions, and which are widely consumed.

Latif (1974) pointed out that Characid fishes represented 23 to 36% of the annual landing of Lake Nasser during 1966-1971. These species were also abundant in the catch during the survey of Lake Nubia (George, 1971).

In spite of the economic importance of the Characid fishes in Egypt and the Sudan, no dtailed study has been carried out on their biology. The present work, therefore deals with the biology of **A. dentex** which is the most important **Alestes** species, being abundant in numbers and of considerable size.

MATERIAL AND METHODS

Fish were collected from various stations along Jebel Aulyia Reservoir. The latter lies on the White Nile and extends a distance nearly 500 km south of Khartoum. Fish were caught by seine, gill or cast nets of 2-10 cm size.

The length of the fish was recorded as the standard length in cm, and its entire weight was measured by a scale balance to the nearest gm. For age determination, scales of 1441 **A. dentex** , 2-36 cm long, and in few cases vertebrae and opercular bones were examined. Scales were taken from the region between the dorsal fin and the lateral line. In addition, lengthfrequency and length-weight relationship of 7580 and 1633 **A. dentex** respectively was recorded.

RESULTS

Validation of Annual Formation

Alternating annual rings with narrow and broad circuli were clearly shown on the surface of the scales, vertebrae or opercular bones. It was found that there is a close agreement between the number of annual rings on scales, vertebrae and opercular bones especially for fishes less than three years old. Nevertheless, annual rings were better shown on scales compared to other structures which were examined for confirmation. The annual formation of these rings was confirmed by the following : a) the number of annual rings increases with increase of fish length; b) there is a relation between the type of annual circuli (narrow or broad) and the season of growth; and c) there is an agreement between age determination using scales, length-frequency or back-calculation methods.

Time of Ring Formation

A study of the position of the outermost narrow annual circuli during different months of the year (Fig.1), has shown that: i) it is near the margin during October, November and December; ii) at the margin during January and the first half of February; iii) just within the margin during the last half of February, March and April, and iv) far from the margin during May to September. This means that formation of narrow circuli hence, slow rate of growth takes place during October to January or Februay. On the other hand, the annual band of wide circuli, correlated with a high rate of growth, is formed during March to September.

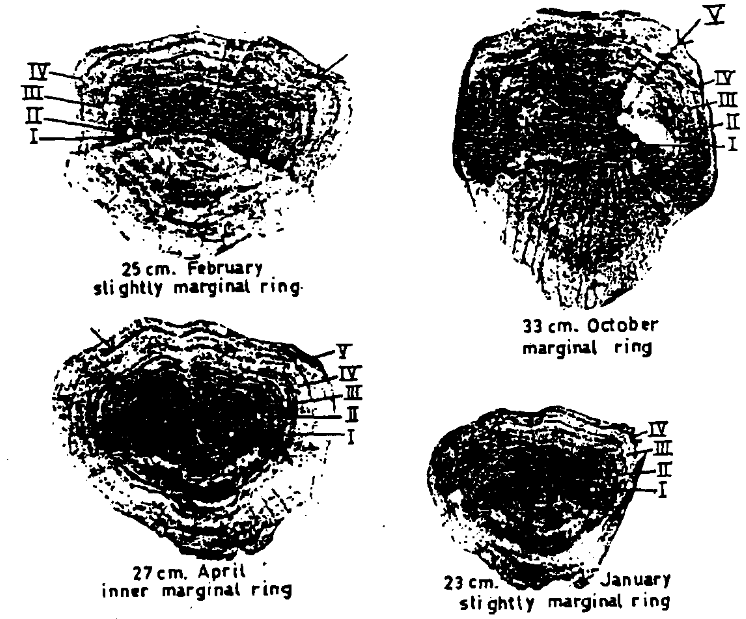


Fig. 1. Scales of A. **dentex**, showing annual rings and time of ring formation. Notice formation of outermost marginal ring (indicated by arrows) during different months: marginal - October; slightly marginal - January and February; and inner marginal - April.

When both the first narrow and broad circuli are not completely formed the fish are said to belong to age-group 0. Fishes with one, two and three narrow and broad circuli belong to age-group I,II or III respectively.

Age Composition

Age-group II was dominant either among fish examined for age being 56% or for length-freauency (Fig. 2A). An under representation of the younger A. **dentex** was to be expected since the nets had meshes too wide to catch large numbers of age-group 0, and may have samples age-group I inefficiently. Age-group III formed 25.7% of the fishes examined. Age-group IV and V were less frequent forming 7.1 and 2.3% of the fishes examined respectively. Only one specimen 32 cm belonging to age-group VI was found. (Table 1).

Relationship between Age and Sex

The percentage of females (Table 3, Fig. 2B) for age-groups IV is higher than that of males and it increased with age. Thus, while the percentage

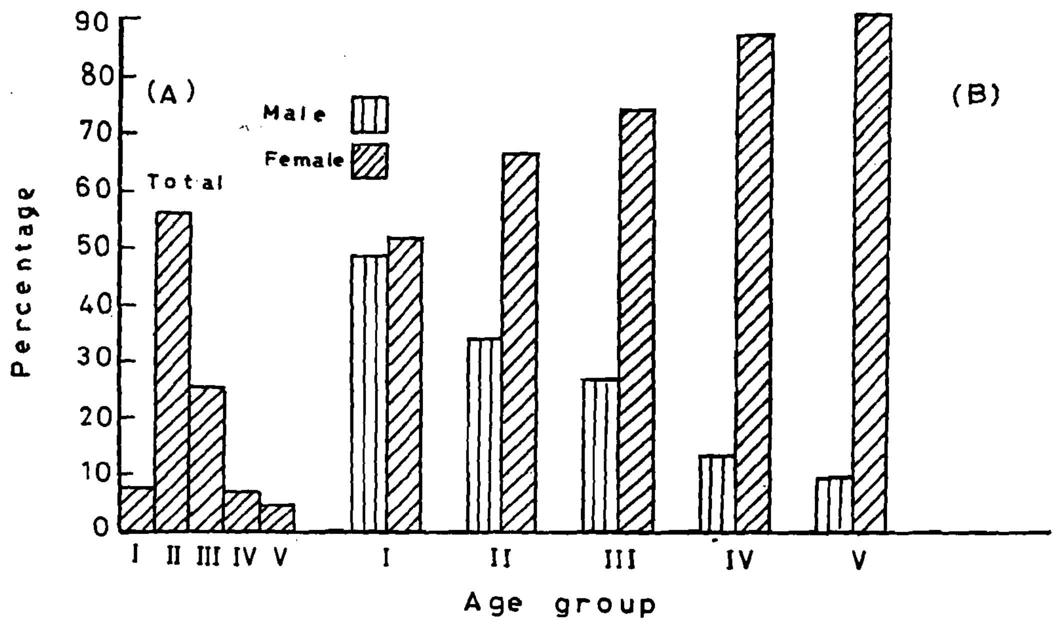


Fig. 2. (A): Percentage age groups of **A. dentex.**
(B): Percentage male and female **A. dentex** for each age group.

of female **A. dentex** is nearly equal to that of males for age-group I, it forms 66.1, 73.4, 86.5 and 90.6% of fish II, III, IV and V age-groups respectively. The sex ratio of all females to males is nearly 2:1.

Moreover, a study of length distribution of different age-groups (Fig. 3) shows that, for age groups I-V females are represented by fish longer than males (except fish less than 18 cm long). Back calculation studies have shown that the increment of length and weight of females is higher than that of males (Table 2, Fig. 9A).

Length - Frequency

The length-frequency of 7580 A. **dentex** 15-34 cm long was studied (Fig.4). It was noticed that due to the use of nets with wide mesh size (2 cm) fish less than 16 cm long, i.e 0 to I age-groups were poorly represented in the catch. The first peak shown in figure 4 is 18 cm long during November and December 1967, January and February 1968. This peak represents the modal size of II age-group. Its length increases being 19 cm long during March and 21 cm in April and June 1968. The percentage of this modal size is few being 6% during November 1967, reaches its maximum (36.3%) in January, then it decreases steadily to 14.1% in June.

Table (1). Relationship between length (L), Weight (W) and age of **A. dentex** from Jebel Aulia Reservoir, Sudan.

		Length (cm)		Weight (gm)		Increment		% Increment	
Age	No.	Range	Average	Range	Average	L (cm)	W (gm)	L.	Wt.
0	22	02 - 15	7	003 - 060	25				
I	126	15 - 19	17.1 ± o.3	040 - 080	065.1 ± 2.3	10.1	40.1	144.3	160.4
II	794	15 - 25	19.3 ± 1.6	045 - 145	089.9 ± 2.3	02.2	24.8	012.9	038.0
III	365	19 - 31	24.6 ± 2.2	100 - 250	169.5 ± 2.2	05.3	79.6	027.5	088.6
IV	100	23 - 35	28.2 ± 2.0	150 - 350	241.6 ± 3.6	03.9	72.1	015.9	042.5
V	33	27 - 35	30.8 ± 2.4	220 - 660	275.3	02.3	33.7	008.1	013.9
VI	1	32	32	660	660				

Table (2). Calculated standard length of male and female **A. dentex** at the end of each year of life for each age - group.

		Length (cm) at end of year							
Age	No. of	1		2		3		4	
group	fishes	Male	Female	Male	Female	Male	Female	Male	Female
I	023	11.9	12.4						
II	531	10.4	10.9	13.9	14.9				
III	239	12.1	12.9	16.7	17.1	21.6	21.8		
IV	069	12.1	12.7	16.4	17.9	21.3	22.6	25.0	26.3
Grand average calc. length		11.0	11.5	14.8	16.0	21.5	22.9	25.0	26.3
Increment of average		11.0	11.5	03.8	04.5	06.7	06.9	03.5	03.4
Average length at time of capture		16.8	17.3	18.6	19.6	23.1	24.9	27.8	28.6

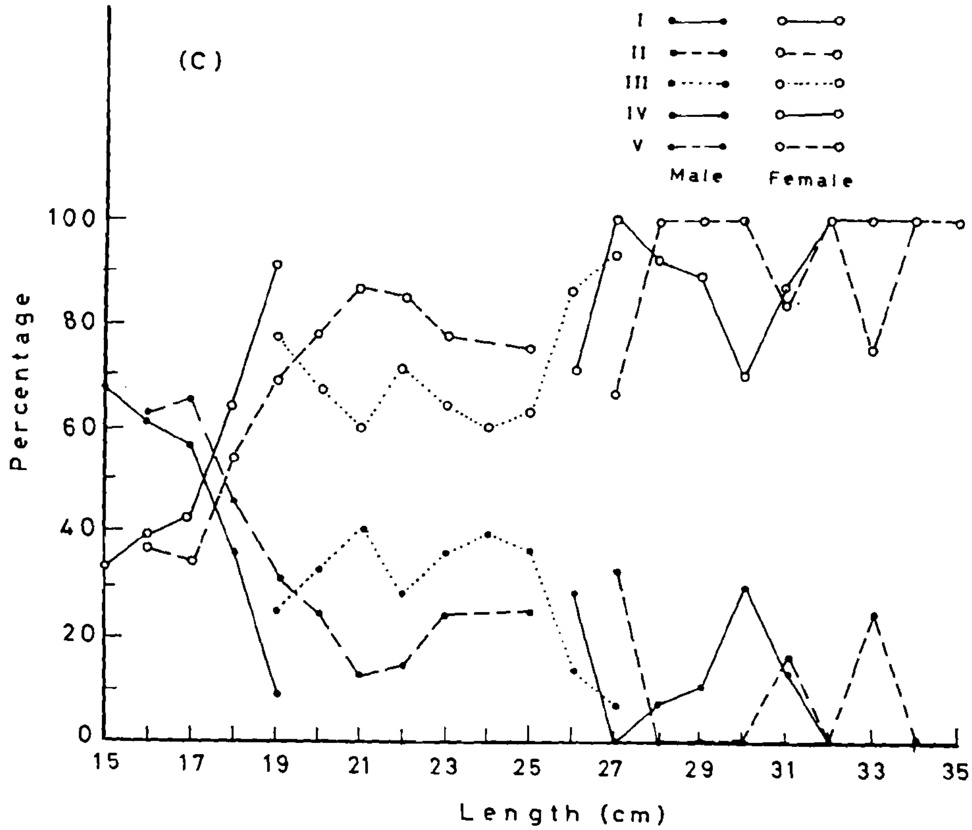


Fig. 3. Percentage length distribution of male and female
A. dentex age groups I - V.

The second peak represents the modal size of age-group III. Its length was 23 cm during November and December 1967, 24 cm during January and February 1968 and 26 cm during March, April and June. This modal size was well represented in November 1967 (21.4%) and poorly represented (1.0-10.2 %) during January to June.

No marked change was noticed in the length of modal sizes of age-groups IV (28 cm) and V (32 cm) during different months. This is attributed to the poor representation of these age groups in the catch being 0.3-0.4% of the total catch.

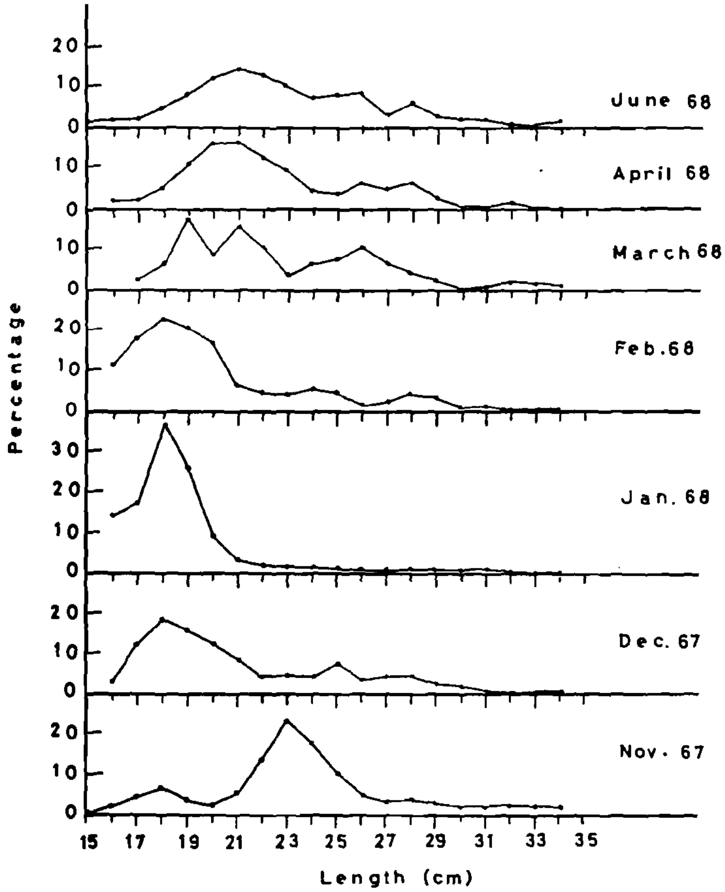


Fig. 4. Percentage length - frequency of **A. dentex** during November 1967 to June 1968.

It is quite evident that there is a marked increase in the length of the modal sizes representing II and III age-groups early (March-June) during the growth season.

LENGTH-WEIGHT RELATION

The general parabola $W=cL^n$, where W= weight, L= length and c and n are empirically determined constants, was used to describe the general length-weight relation of **A. dentex** (Fig. 5). The length-weight equation

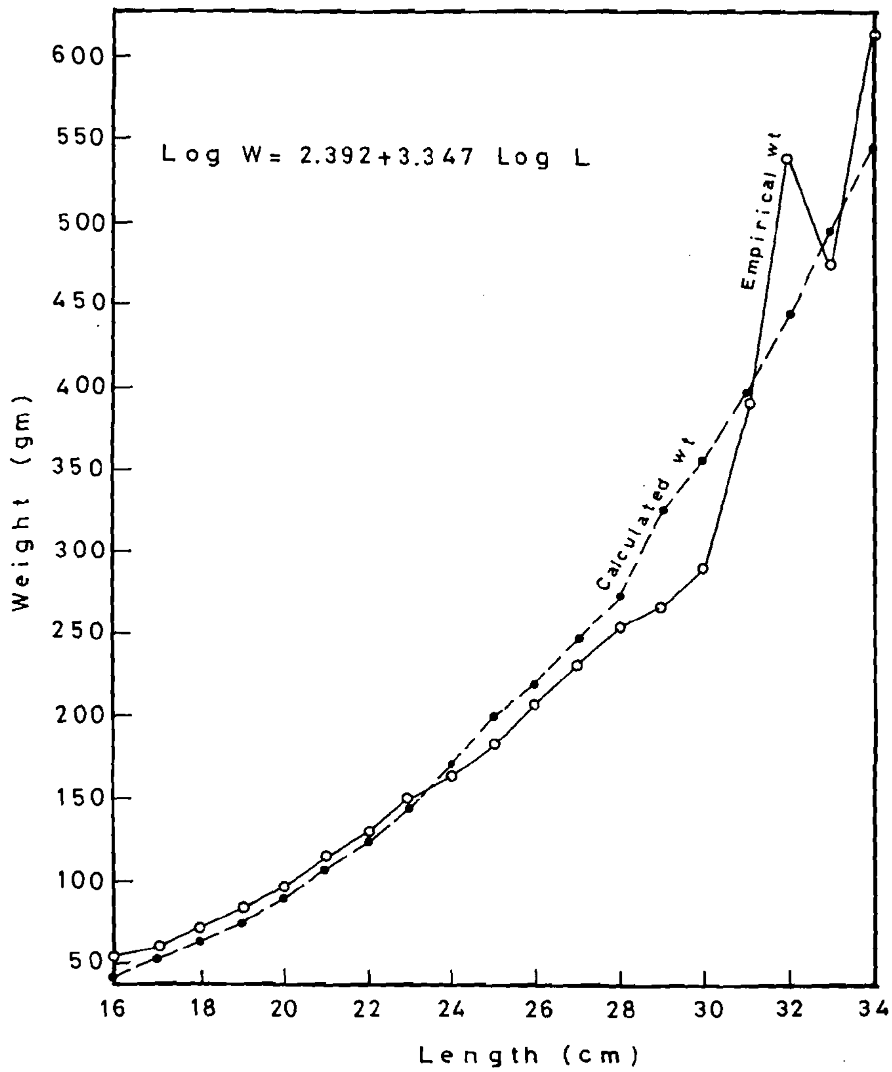


Fig. 5. Calculated and empirical weight of **A. dentex.**

determined by fitting a straight line to the logarithms of the lengths and weights is

$$\text{Log } W = -2.392 + 3.349 \text{ Log } L,$$

where, W= weight in gm and L= length in cm. The value of 'n' 3.349 indicates that weight increases more rapidly than the cube of the lenght.

The largest discrepancies between calculated and empirical weights (Fig. 5) were at the greater lengths (> 31 cm) where numbers of fish were small and actual weights were great enough to make relatively modest percentage disagreements seem larger. The range in variation in weight is 4.2-17.0 gm, i.e. 2.5-8.5% for fishes 16 to 27 cm. These discrepancies result from the use of a mixed sample irrespective of sex, month or state of maturity.

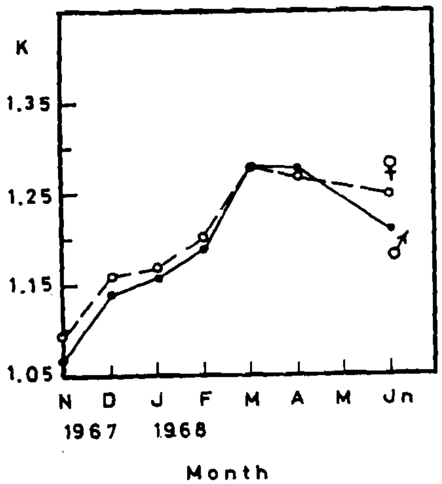


Fig. 6 (A). Monthly coefficient of condition (k) of male and female **A. dentex**.

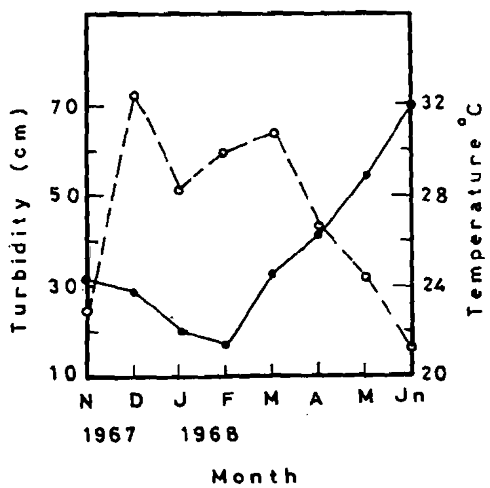


Fig. 6 (B). Monthly temperature (___) and turbidity (---) at Jebel Aulia Reservoir during 1967/1968.

Table (3). Average length and weight of **A. dentex** at time of capture and at end of each year of life as shown by back-calculation.

Age group	No. of fishes	Percentage Male	Percentage Female	Sex Ratio	AVERAGE LENGTH (CM). At Capture.	At end of year of life 1	2	3	4	5
I	125	48.8	51.2	1 : 1	17.1	12.1				
II	794	33.9	66.1	1 : 2	19.3	10.8	14.6			
III	365	23.5	76.5	1 : 3	24.6	12.1	17.0	21.8		
IV	100	13.5	86.5	1 : 6	28.5	12.8	17.8	22.5	26.1	
V	33	9.4	90.6	1 :10	30.8	11.6	16.6	20.6	24.7	28.2
Grand average calculated length (cm)						11.4	15.6	21.8	25.8	28.2
Calculated weight (gm) at end of year of life						14.3	40.2	122.5	217.0	292.0
Percent increment in weight							181.1	204.7	77.1	34.6

The coefficient of condition 'k' varies from 0.96 to 1.95 with a grand average of 1.2. It is high for young fishes (Fig. 7) and decreases with increase of length up to 27 cm for males and 30 cm for females and becomes irregular for larger sizes. 'K' ranges from 1.30-1.75, 1.20-1.26 and 1.04-1.20 for fishes 9-16, 17-22 and 24-30 cm, respectively. 'K' and similarly weight for the length of A. **dentex** slightly varies according to sex, state of maturity and month (Fig. 7). Generally, females have higher 'K' values than males, with a grand average of 1.14 and 1.23. In most cases ripning, ripe or spawning male and female **A. dentex** have a higher values for 'K' than quiescent or spent ones.

The coefficient of condition is low (1.071.19) during November 1967 to February 1968 (Fig. 6A) and high during March to June (1.21-1.28).

CALCULATED GROWTH

Body-scale Relationship

A plot of average fish lengths for 1 cm groupings, against the average scale diameters indicated that a straight line best fitted to the data (Fig. 8). The equation for the line, fitted by least squares, is

$$L = 0.8 + 0.61 \quad S \text{..........} (1)$$

where, L = standard length of fish, and S = scale diameter (x 100, in cm).

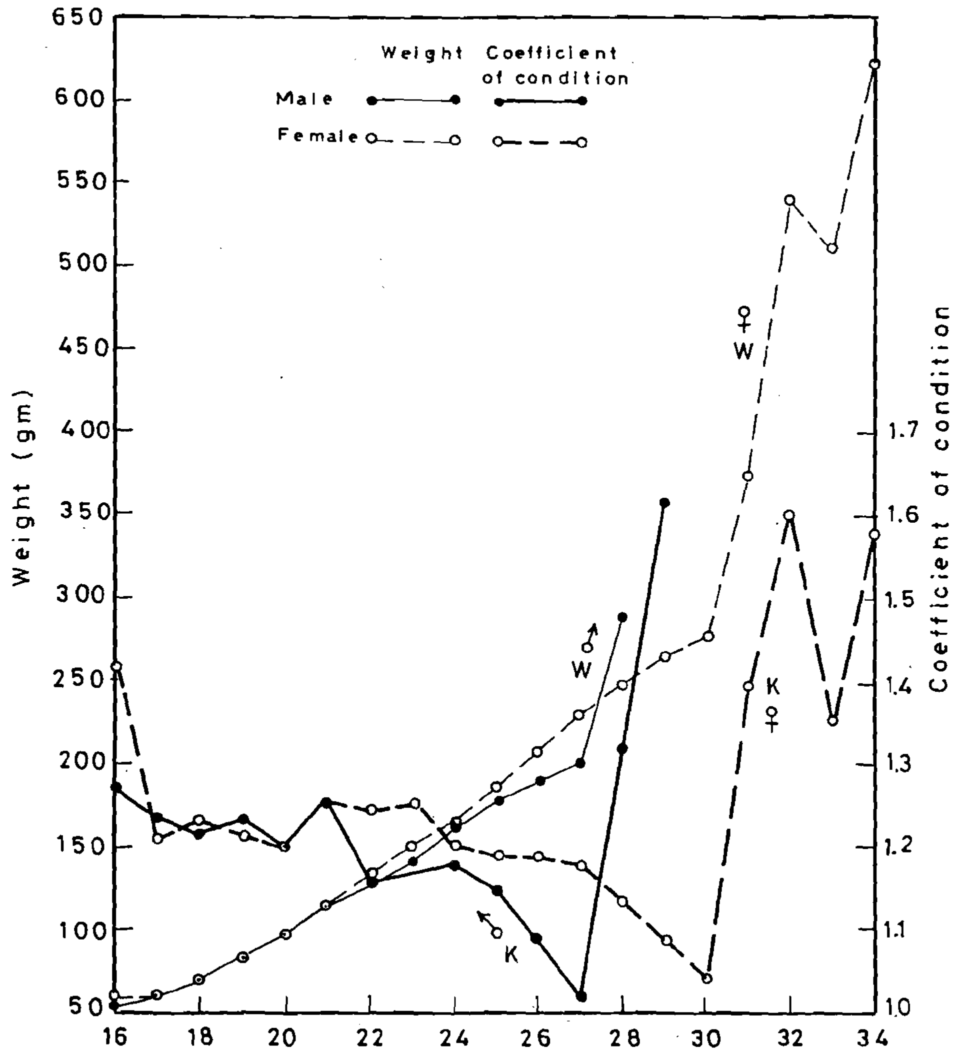


Fig. 7. Length - weight relationship and coefficient of condition of male and female **A. dentex.**

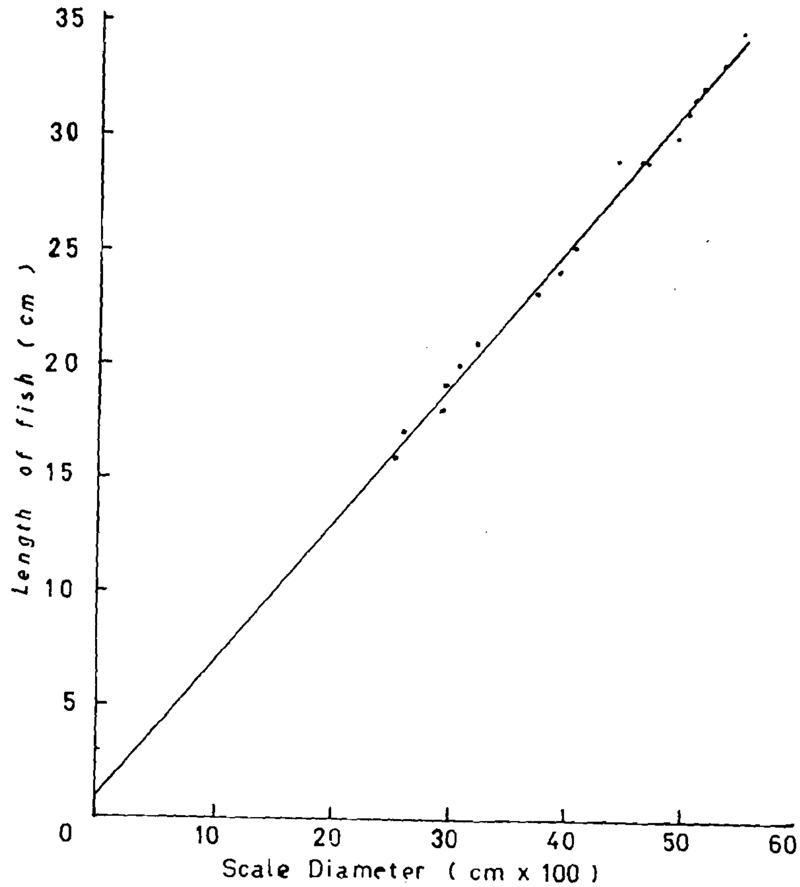


Fig. 8. Relation between length and magnified scale diameter of **A. dentex.**

The growth in length of **A. dentex** was calculated by the formula

$$L_n = 0.8 + L_t - 0.8 / st \ S_n \ ....(2)$$

where, L_n equals the length of the fish at the end of the n^{th} year of life, S_n equals the diameter of the scale within the n^{th} annulus, L_t equals the standard length of the fish at capture, S_t equals the anterior diameter of the scale, and 0.8 is the intercept (Fig. 8). The relation between the standard length of the fish over the magnified scale diameter is a constant ranging from 6.2 to 6.6 with an average of 6.3.

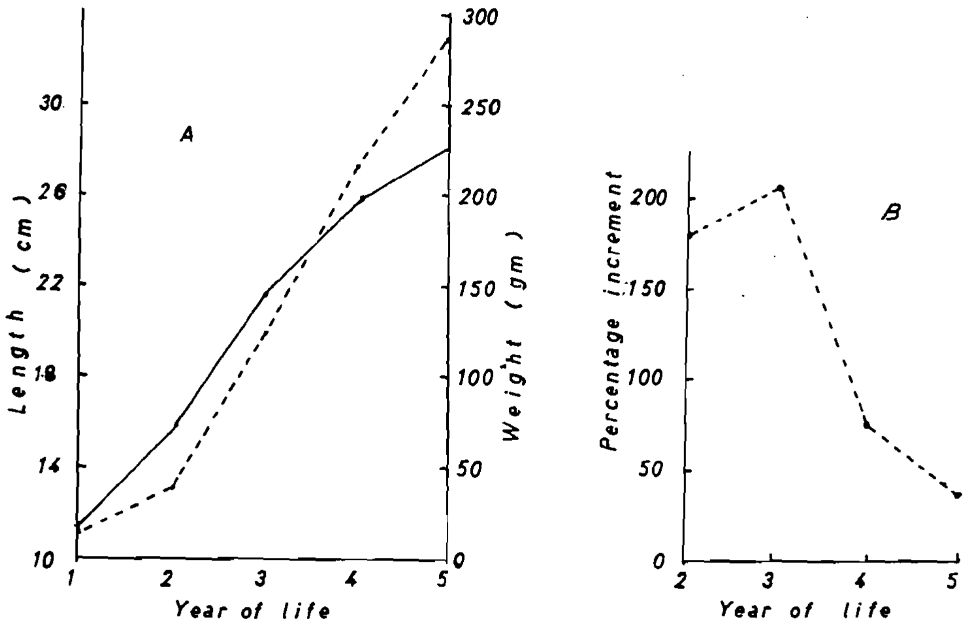


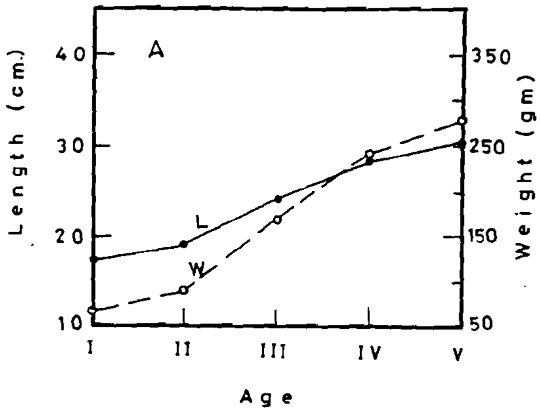
Fig. 9 (A). Calculated length and weight at end of year of life of A. **dentex**.

Fig. 9 (B). Percentage increment of weight at end of year of life of A. **dentex**.

Calculated Growth in Length

The average calculated lengths of males and females **A. dentex** in various age groups gave an evidence of sex differentiation in the growth rate (Table 2). Generally, the average calculated growth of female is higher than that of male and the difference increases with age being 0.57, 1.16, 1.39 and 1.52 for fishes at the end of the first, second, third and fourth years of life, respectively. It was also found that the average length at capture of female **A. dentex** I, II and III age-groups is higher than that of male by 0.47, 1.02 and 1.80 cm, respectively. The mean lengths of the age-groups I, II, III, IV and V are 17.1, 19.3, 24.6, 28.2, 30.8 and 32.0 cm, respectively (Table 1, Fig. 10).

The growth histories of **A. dentex** was calculated by applying the above mentioned formula (2) are 11.4, 15.6, 21.8, 25.8 and 28.2 at the end of the first, second, third, fourth and fifth year of life, respectively (Table 3, Fig. 9A). These have a low value than the corresponding actual lengths,



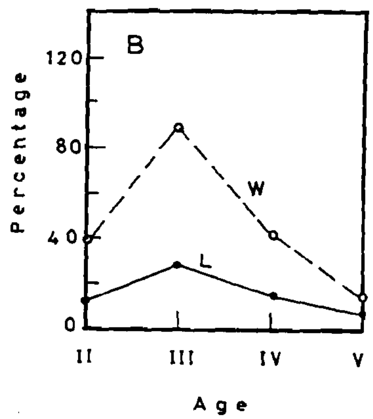


Fig. 10 (A). Relation between age, length and weight of **A. dentex.**

Fig. 10 (B). Relation between age and percentage increment of length and weight of **A. dentex.**

this is attributed to the fact that the actual lengths for any age group was measured either just after the formation of the narrow annual circuli or few months later. The most rapid growth in length (144.3%) prevails in the first year of life (Table 1, Fig. 10), afterwhich, the rate of growth decreases in the second year of life (12.9%), slightly increases during the third year (27.5%), then it decreases progressively during the fourth and fifth years of life being 15.9 and 8.1%, respectively. From Table 4, it is evident that the 1965 year class is a strong one with better rate of growth than other year classes.

Claculated Growth in Weight

Calculated growth in weight (Table 3) was determined by applying calculated lengths to length-weight relation. The annual increment of weight (Fig.9B) is high at the end of the second year of life (181.1%), it reaches its maximum during the third year of life (204.7%). Thereafter, the annual increment decreases gradually being 77.1% and 34.6% at the end of the fourth and fifth years, respectively. **A. dentex** reaches its commercial size at the end of its fourth year being 25.8 cm and 217.0 gm.

Weight increments of **A. dentex** in individual years of life were small in the first (14.3 gm) and second (25.9 gm) year of life, reaches its maximum in the fourth year (94.5 gm), then it slightly decreases (75.0 gm) in the fifth year of life.

The actual weights of the sampled fishes exhibit nearly the same picture, with a maximum increase in weight for age group III (88.6 %), (Table 1, Fig. 10 B).

Table (4). Length of different year classes at the end of each year of life.

Age group	YEAR CLASS 1964	1965	1966	1967	1968
I	11.6	12.8	12.1	10.8	12.1
II		16.6	17.8	17.0	14.6
III			20.6	22.5	21.8
IV				24.6	26.1
V					28.2

DISCUSSION

De Vasudarm (1952) stated that "Winter cannot affect the fish of the tropical waters to the extent as to make it stop feeding, and thereby cause disturbance in the growth of fish in general and the scales in particular". Seshappa and Bhimachar (1951), Pantulu (1961) and Thakur (1967) indicated that factors other than winter could be responcible for the deposition of annuli on the scales of fishes in the tropical waters. They stated that, " Retardation of feeding due to reduction in availability of food in monsoon months in the young and in addition the closely following spawning season in the adults are jointly responcible for the deposition or the periodic checks ". Chugunova (1959) and Laglar et. al. (1962) have stated that " In tropical regions growth marks correspond to the onset of dry season ".

A study of the relation between annual ring formation on scales of **A. dentex** and surface water temperature, turbidity, flood and water level have shown that: i) the annual ring of narrow circuli is formed during the period October to February, ii) it is accompanied by a decrease in surface water temperature (21.4 - 24.3 $^{\circ}$C), increase of transparency of water (Fig. 6 A and B) during November to February (51.1 - 72.5 cm), increase of water level just after floods which ends in September. This leads to the conclusion that during these months feeding activity is low causing a check in growth and hence formation of the narrow annual band of circuli.

The present results confirm those of Brown (1945), Nikolski (1963) and Coble (1966 and 1967), who agree that the time at which rings are laid down is the result of simultaneous factors and processes, both internal and external. These include temperature, quantity of food, space limitation, light cycles, oxygen content,...etc. In cold and temperate regions, temperature acts as one of the main factors causing ring formation.

Bishai and Abu Gideiri (1965) and Mishrigi (1967), studied the age of **Synodontis schall** and **Lates niloticus**, respectively in the Sudan, and pointed out that formation of dark rings coincides with the flood season (July to September). Bishai (1970) studied the age of **Bagrus** species in the Sudan and reported that broad annual rings are formed during March to October, with the onset of high temperature, decrease of water level from March to June and it continues during the flood season.

Female **A. dentex** are much more abundant than males more than one year old. The percentage of female II, III, IV and V age groups is 66.1, 75.4, 86.5 and 90.6 respectively. The sex ratio of male to female is about 1:2. Similar observations were found in case of yellow perch **Perca flavescens** (Carlander, 1950) where the sex ratio of male to female is nearly 1:2 and the percentage of females reaches 700% that of males belonging to age group VI.

Generally, however, the sex ratio in the entire sample of a fish species is 1:1 (Edsall, 1960; Pantulu, 1961; Dryer, 1963; Wydoski and Copper, 1966). In some cases females predominate in older age groups (Cooper, 1932; Applegate, 1943; Hile, 1954; Dryer, 1963; Bailey, 1969 and Bishai, 1970).An excellent review of sex ratio may be found in a paper by Alm (1959). Many fishery biologists have associated early maturity of males with a faster metabolic rate and hence a higher mortality. Alm (1959) disagrees with this hypothesis because experiments in ponds in ponds and lakes have given no evidence of a greater mortality of males. He assumes that the prolongation of the life of the males is due to the absence of fishing predators in the experimental ponds and lakes and not to any physiological reason. In order to explain the higher mortality of males in the wild he suggests that males are more active than females. On this account a greater number of males is caught already at a lower age and they are more exposed to the attack of predators.

The maximum size of **A. dentex** examined during the course of this study in 33 cm and 502 gm for males and 36 cm and 715 gm for females. However, in comparison, **A. dentex** in Lake Albert and Murchison Nile (Uganda) attains a lower weight (450 gm) but a longer length (55 cm total length, i.e. about 48 cm standard length) as staed by Greenwood (1958). On the other hand, the size of eleven **A. dentex** examined by Reynolds et al (1969) from Lake Volta lay within the size range of fishes examined during the present investigation, but they were comparatively heavier (23-31 cm standard length and 170-540 gm). This disparity between results may be attributed to the low number of fish examined by the latter author.

Although the number of **A. dentex** 6-15 cm was small (25 fish) to be representative of the length groups (Table 1), yet it may be compared with other specimens from other regions for length-weight relation studies. The coefficient of body condition "K" for fishes 6 and 7 cm was exceptionally high being 4.6 and 3.5, respectively. It decreases with increase of length being 1.71, 1.75 and 1.56 for fish 9, 10 and 13 cm, respectively.

'K' for **A. dentex** caught from Jebel Aulyia Reservoir is higher than for those from Lake Volta and from the Niger as mentioned by Reynolds et al (1969). The latter authors calculated their 'K' values by examination of three fishes ranging from 7.6-8.3 cm from Lake Volta (k= 1.47), and a group of fish 12.9 cm from the Niger (k= 1.42).

Generally, 'K' for ripening, ripe and spawning **A. dentex** is higher than that for immature or quiescent one, and for mature females is higher than mature males. This is in agreement with the results found by Edsall (1960) and Bishai (1970) in case of **Coregonus clupeaformis** and **Bagrus** spp., respectively.

REFERENCES

Alm, G., 1959. Connection between maturity size and age in fishes. **Rept. Inst. Freswater Research**, Drottinghom, 40: 5-145.

Applegate, V.C., 1943. Partial analysis of growth in a population of mudminnows **Umbra limi** (Kirtland). **Copeia**, 2: 92-96.

Bailey, M.M., 1969. Age, growth and maturity of the longnose sucker **Castastomous catastomous**, of western Lake Superior. **J. Fish. Res. Bd. Canada**, 26: 1289-1299.

Bishai, H.M. and Y.B. Abu Gideiri, 1965. Study on biology of genus **Synodontis** at Khartoum. I.Age and growth. **Hydrobiologia**, 26: 85-97.

Bishai, R.M. 1970. **Studies on the biology of family** Bagridae **in the Sudan.** (Ph.D. Thesis, Cairo University).

Brown, M.E. 1945. Growth of brown trout (**Salmo trutta** Linn.). III. The effect of temperature on the growth of two-year old trout. **J. exp. Biol.** 13: 145-155.

Garlander, K.D., 1959. Growth study of saugers, **Stizostedion flavecens** (Mitchill) from Lake of the Woods, Minnesota.**Trans. Am. Fish. Soc.** 79: 30-42.

Chugunova, N. I. 1959. **Age and growth studies in fish.** Academy of Sciences of the U.S.S.R. Israel Program for Scientific Translation, Jeurosalem (1963).

Coble, D.W., 1966. Dependance of total annual growth in yellow perch on temperature. **J. Fish. Res. Bd. Canada**, 23:1520.

Coble, D.W., 1967. Relationship of temperature to total annual growth in adult smallmouth bass. **J. Fish. Res. Bd. Canada**, 24:87-99.

Copper, G.P. 1932. Food habits, age and growth of the white perch **Morone americana. Fish. Surv. Rep.** 4: 122-154.

Devasundaram, M.P. 1952. Scale study of **Mugil cephalus** of Chilka Lake. **J. Madras University. B.** 22: 147-163.

Dryer, W.R. 1963. Age and growth of the whitefish in Lake Superior. **Fish. Bull. U.S.**, 109: 87-138.

Edsall, T.A. 1960. Age and growth of the whitfish, **Coregonus clupeaformis** of Munising Bay, Lake Superior. **Trans. Am. Fish. Soc.** 89: 323-332.

George, T.T. 1971. Preliminary account of the fish and fisheries of Lake Nubbia during 1967-1968. **Journal Fisheries Association India**, 1:65-88.

Greenwood, P.H. 1958. **The fishes of Uganda**. The Uganda Socity Kampala.

Hile, R. 1954. Fluctuation of growth and year class strength of the walleye in Saginaw Bay. **Fish. Bull. U.S.**, 56: 7-59.

Lagler, K.E., E.J. Bardach and R.R. Miller, 1962. **Ichthyology.** First edition, Jhon Wiley and Sons Inc., New York.

Latif, A.F.A. 1974. **Fisheries of Lake Nasser**. Aswan Regional Planning, Lake Nasser Development Centre. Aswan, Egypt. A.R.E.

Nishrigi, S.Y. 1967. Study of age and growth in **Lates niloticus** (Centropomidae) at Khartoum. **Hydrobiologia**, 30: 4556.

Nikolski, G.V. 1963. **The ecology of fishes.** Academic Press, London and New York Translated from Russian by L. Birkitt. Third printing. 1968.

Pantulu, R.V. 1961. Determination of age and growth of **Mystus golio** by the use of pectoral spines, with observations on the biology and fishery in Hooghly Esturay. **Proc. Nat. Inst. Sci., India**, 27 B: 198-225.

Reynolds, S.D. 1967. **Notes on juveniles of commercial fishes attracted to light on the Volta Lake 1966-1967.** Victoria Basin Research Project, Technical Report. 10:21.

Sandon, H. 1950. **An illustrated guide to the freshwater fishes of the Sudan.** Sudan Notes and Records.

Seshappa, G. and B.S., Bhimachar, 1951. Age determination studies in fishes by means of scales with special reference to the Malabar Sole. **Curr. Sci.**, 20:260-262.

Thakur, N.K. 1967. Studies on age and growth of **Mugil cephalus** Linnaeus from the Manahadi estuaries system. **Proc. natn. Inst. Sci. India.**, 33 B:128143.

Wydoski, R. and E.L. Copper, 1966. Maturation and fecundity of brook trout from infertile steams. **J.Fish.Res.Bd.Canada**, 23: 623-649.