THE USE OF VERTEBRAE FOR DETERMINING AGE AND GROWTH OF THE NILE CATFISH *CLARIAS LAZERA* (CUV. & VAL.) IN THE A.R.E.

By

A. R. El Bolock
Institute of Inland Fisheries and Fish Culture

I. INTRODUCTION

Since ancient times *Clarias* spp. has attracted the attention as an important food fish in Egypt (Boulenger 1907). Nowadays species of this genus are playing a good role as pond culture fish in many countries of the Near and Far East (El Ila & El Bolock 1972 and Sidthmunka et al, 1966).

Rearing any fish successfully in fish ponds necessitates detailed knowledge of its life history including age determination and rate of growth. Although techniques of age and rate of growth determination have been well applied on scaled fish (El Bolock & Koura 1960 and El Zarka 1961). similar studies of cat-fish have not been widely done. El Bolock and Koura (1960) gave only some observations on age and growth of *Clarias lazera* in Barrage ponds (near Cairo). The present work is a more detailed study on the use of vertebrae in the determination of age and growth of this species. It is also a part in a series of studies including the biology and culture of *Clarias lazera* in Egyptian ponds.

II. MATERIALS AND METHODS

The materials used in this study were collected from Serow Experimental ponds (Near Lake Manzallah) during the draining season of the ponds (January and February) as well as at different intervals from 1964 to 1969.

For age determination a total of 535 specimens including 89 O group (less than the year) fish were examined. For the relationship between the total length of the fish and the vertebral radius measurement of 514 specimens were used. While for the length-weight relationship a total of 2183 measurements were used. All the data were taken from fresh material either in the field or when brought to the laboratory.

Total lengths from the tip of the snout to the end of the caudal fin were recorded in millimeters. The weights were recorded in grams. Age determination was based on the conventional method of reading annuli from the vertebrae.

The fish were classified into age groups according to the numbers of completed years of life. Ages were expressed by Roman numerals equivalent to the number of annuli found on the vertebrae. A "virtual" annulus is assumed to be present on the edge of the vertebrae collected in January (Hile 1948 and El Zarka 1957), which means that each fish is considered to pass into the next higher age group in January.

All the formulae and equations used in this study are applied after Van Oosten (1941), Beckman (1948), Le Cren (1951) and Chugunova (1959), who gave detailed description of the methods and forumulae used in the studies of age and growth of fishes.

III. AGE DETERMINATION

The use of bony structures for the determination of age in fishes has long been widely accepted. Le Cren (1947), Lewis (1949), Appelget & Smith (1951), Currier (1951) and Sneed (1951) have used different bony structures such as otoliths, opercular bones, fin spines and vertebrae for determination of age in fishes.

In the present investigation the vertebral method of determining the age of *Clasias* was adopted. The winter rings on the vertebrae are easy to read and the vertebrae can be easily secured, prepared and examined.

Collection and preparation of vertebrae

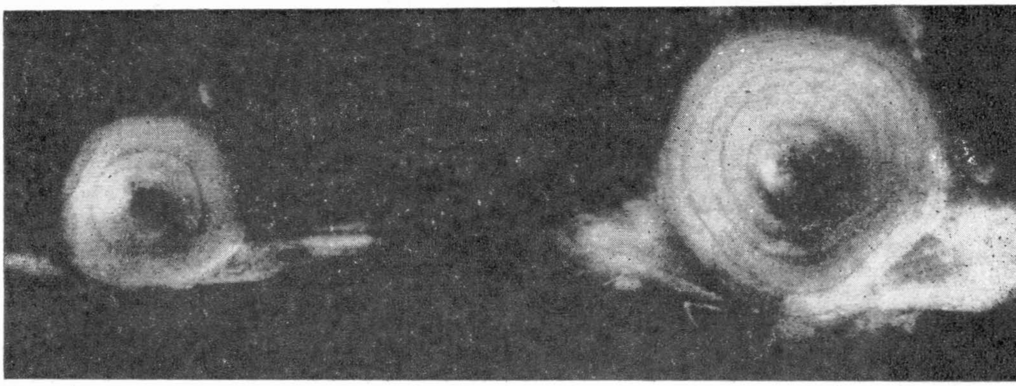
El Bolock & Koura (1960), mentioned that the first detachable vertebra of *Clarias lazera* showed the essential markings for age determination. However, they advised the use of the second or third vertebrae since they are readily detached and their rings are more easy to read.

For obtaining the vertebrae, the fish was cut 3 to 4 centimeters behind the head. The heads were then boiled for five minutes or till the flesh can be easily removed. This process helped to detach the vertebrae and to remove the adhering tissue. If the heads were needed for other purpose, a transverse cut just behind the occipital process was made. The incision was deep enough to serve the vertebral column and the flesh at this part. Another incision 3 to 4 centimeters posteriorly was also done and the part in between including a section of the vertebral column having 4 to 5 vertebrae was taken. After boiling the vertebrae were then thoroughly cleaned with running water, and were left to dry in the air for a few hours. The dry vertebrae were placed in scale envelopes on which the collection data were recorded, and the envelopes were stored under conditions favourable for storing.

Designation of growth marks

Before counting the growth marks, it was necessary to establish a criterion to distinguish between the true annual rings and the accessory ones. On examination of the well cleaned vertebrae, the annual rings are defined in this study as dark translucent bands alternating with broad white opaque ones (Fig. I). The dark bands represent the winter growth, while the summer growth is indicated by the white bands.

The true year marks are complete and concentric with the rim of the vertebrae. The accessory rings on the other hand are faint, not complete and are not associated with depressions in the surface of the centra as the true winter rings. A year mark may vary in width from little more than a line, to what could be called a proper zone. Close examination of the growth rings showed that they are concentric circuli either very close to each other as in the winter rings, or widely separated from each other as in the summer growth.



a b

FIG. 1. (a).—A 2-year's old female *Clarias* 370 mm. total length and 300 g. weight, fished at 8.3.1967. (b) A 5-year's old male *Clarias* 620 mm. total length and 1408 g. weight, fished at 5.3 1968. (Notice the last ring at the edge of the centrum).

Examination of the prepared vertebrae

In this work the posterior side of the third detachable vertebra was used for examination. The number of year marks or annuli on the dorsal radius of the vertebra was determined by means of a Sterioscopic Microscope having 20 × magnification. Measurements were made by placing the zero graduatian of the micrometer eye piece on the center of the vertebral centrum, and the rest of the graduation along the dorsal radius of the vertebra. The distances from the zero graduation to each dark band or winter ring were recorded.

IV. LENGTH-WEIGH RELATIONSHIP

An important relationship in the growth studies of fishes, is that of length and weight. The knowledge of the length at which the fish increases most rapidly in growth is of great value in determining the size at which it may be most profitably harvested. In the presentation of our data, and the methods used to derive the formulae and to compute the factors are shown so that the observations can be easily compared with those of other workers.

The determination of the length-wight relationship of *Clarias lazera* in Serow ponds was based on the combination of the data regardless date capture, sex, and state of maturity. The equation used was that of the general parabola.

$W = c\,L^n$ (Beckman, 1948 and Le Cren, 1951)

where W = weight in grams

L = length in millimeters

and c & n are constants. Hile (1939) showed that this equation gives a better result in expressing the length-weight relationship Than does the cubic parabola

$$W = c\,L^3$$

where W = weight in grams,

L = length in millimeters,

and c constant.

The equation $W = c\,L^n$ was proved by many authors in different countries and for different fish species to describe the length-weight relationship more satisfactory (Hile & Jobes, 1941 & 1942; Van Oosten, 1942: El Zarka, 1959: and El Bolock & Koura, 1960) .

The equation $W = c\,L^n$ expressed in logarithmic form becomes: $\text{Log } W = \text{Log } c + n \log L$

The values of log c and log n are computed from the following normal equations:

$$\text{Log } c = \frac{\Sigma \text{ Log } W \times \Sigma (\text{Log } L)^2 - \Sigma \text{ Log } L \times \Sigma (\text{Log } L \times \text{Log } W)}{N \times \Sigma (\text{Log } L)^2 - (\Sigma \text{ Log } L)^2}$$

$$\text{and } n = \frac{\text{Log } W - N \times \text{Log } c}{\Sigma \text{ Log } L}$$

N = number of length intervals taken.

The calculation of Log c and n led to the equation:

$$\text{Log } W = -4.7114 + 2.8155 \text{ Log } L$$

or

$$\text{Log } W = 0.2886 + 2.8155 \text{ Log } L$$

The equation can be written in the form:

$$W = 1.944 \times 10^{-5}\, L^{2.8155}$$

From the equations it is evident that *Clarias lazera* increased in weight at a rate nearly equals to the cube of the lengrh ($n = 2.8155$). This value is little higher than that of the same species in Barrage ponds ($n = 2.7505$). Hile (1936) and Martin (1949) showed that the exponent' n' usually lies between 2.5 and 4.0. According to Allen (1938), 3.0 is the ideal value.

Table I shows an illustration of the methods used for the compilation of information of length-weight relationship. This is an excerpt from the origional tabulation for *Clarias lazera*. Data on the length-weight relationship are presented in Table 2. The table includes total length in millimeters, average empirical weight, calculated wieght and 'K' or coefficient of condition. The discrepances between the calculated and empirical weight are small except for sizes bigger than 660 millimeters. However this difference which does not exceed 40 grams is insignificant compared to the actual weights. This difference may be attributed to the small number of specimens used.

TABLE 1.– EXCERPT FROM DATA ON *Clarias lazera* FROM SEROW PONDS TO ILLUSTRATE THE METHOD USED FOR THE COMPILATION OF INFORMATION ON LENGTH- WEIGHT RELATIONSHIP.

Total leng. mm	No. of Fish	Avg. wgt (g)	Log L	Log W	Log L x Log W	$(\text{Log L})^2$	Log calcu wgt	Calcul. wgt (g)
130	82	18	2.1139	1.2553	2.6536	4.4686	1.2405	17
140	112	21	2.1461	1.3222	2.8376	4.6057	1.3309	21
150	129	25	2.1761	1.3979	3.0420	4.7354	1.4154	26
160	116	30	2.2041	1.4771	3.2557	4.8581	1.4942	31
170	108	36	2.2304	1.5563	3.4712	4.9797	1.5683	37

Figure II is the graphical representation of the length-weight relationship of *Clarias lazesa* derived from Table 2. Comparison of the actual and calculated weights shows that the equation fits the empirical weights very well. For the lengths from 60 to 200 mm where the weights are small and could not be clearly represented in the original curve, the lengths and weights are represents in a curve with bigger scale in the same figure

Another use of the cube law relationship is the so callled ' condition factor' or the coefficient of condition, which is an expression of the relative well-being or robustness of the fish. This can also be called ponderal index, weight-length factor and 'K' factor (Thompson, 1942; Hile, 1936). The coefficient of condition for *Clarias lazesa* is determined by the well known formaul:

$$K = \frac{W \times 10^5}{L^3}$$

where W = weight in grams,

L = Tatal length in millimeters.

TABLE 2.—LENGTH - WEIGHT NELATIONSHIP OF *Clarias lazesa* IN SEROW PONDS BASED ON TOTAL LENGTHS AND WEIGHTS OF INDIVIDUALS

T.L. (mm.)	No. of Fish	Averg. Empi. W. (g)	Calcu-lated W. (g)	Difference	K.	T.L. (mm.)	No. of Fish	Averg. Empi W. (g)	Calcul-ated W. (g)	Diff.	K
60	14	2	2	—	0.81	390	48	388	383	−5	0.65
70	28	3	3	—	0.87	400	27	415	412	−3	0.64
80	19	5	4	−1	0.97	410	26	440	441	1	0.63
90	14	6	6	—	0.82	420	26	472	472	—	0.63
100	24	8	8	—	0.80	430	27	510	505	−5	0.64
110	47	10	10	—	0.75	440	29	547	539	−8	0.64
120	44	14	14	—	0.81	450	27	580	574	−6	0.63
130	82	18	17	−1	0.81	460	18	615	611	−4	0.63
140	112	21	21	—	0.95	470	24	650	649	−1	0.62
150	129	25	26	1	0.74	480	11	690	688	−2	0.62
160	116	30	31	1	0.97	490	17	740	729	11	0.62
170	108	36	37	1	0.73	500	18	780	772	−8	0.62
180	95	43	43	—	0.73	510	9	820	817	−3	0.61
190	74	51	51	—	0.73	520	8	835	860	−3	0.61
200	76	58	58	—	0.72	530	10	900	909	9	0.61
210	25	66	67	1	0.71	540	9	950	953	8	0.60
220	26	76	76	—	0.71	550	8	1000	1009	9	0.60
230	35	85	86	1	0.69	560	5	1060	1062	2	0.60
240	30	96	97	1	0.69	570	5	1120	1116	−4	0.60
250	30	115	110	−5	0.73	580	6	1190	1172	−18	0.60
260	34	124	123	−1	0.70	590	5	1250	1230	−20	0.60
270	49	138	136	−2	0.70	600	2	1300	1290	−10	0.60
280	43	150	151	1	0.68	610	5	1370	1351	−19	0.60
290	58	165	166	1	0.67	620	5	1420	1415	−5	0.59
300	37	181	183	2	0.67	630	1	1480	1479	−1	0.59
310	49	202	201	−1	0.67	640	1	1550	1547	−3	0.59
320	71	224	220	−4	0.68	650	1	1600	1615	15	0.58
330	60	245	240	−5	0.68	660	3	1670	1686	16	0.58
340	56	270	261	−9	0.68	670	1	1720	1760	30	0.57
350	61	290	283	−7	0.67	680	1	1800	1834	34	0.57
360	49	309	306	−3	0.66	690	3	1880	1910	30	0.57
370	42	330	331	1	0.65	700	3	1950	1990	40	0.56
380	57	360	354	−6	0.65	—	—	—	—	—	—
Total No. of Fish		Average K					2183				0.67

* Calculated weights were obtained by means of the equation ;

$$W = 1.944 \times 10^{-5} L^{2.8155}$$

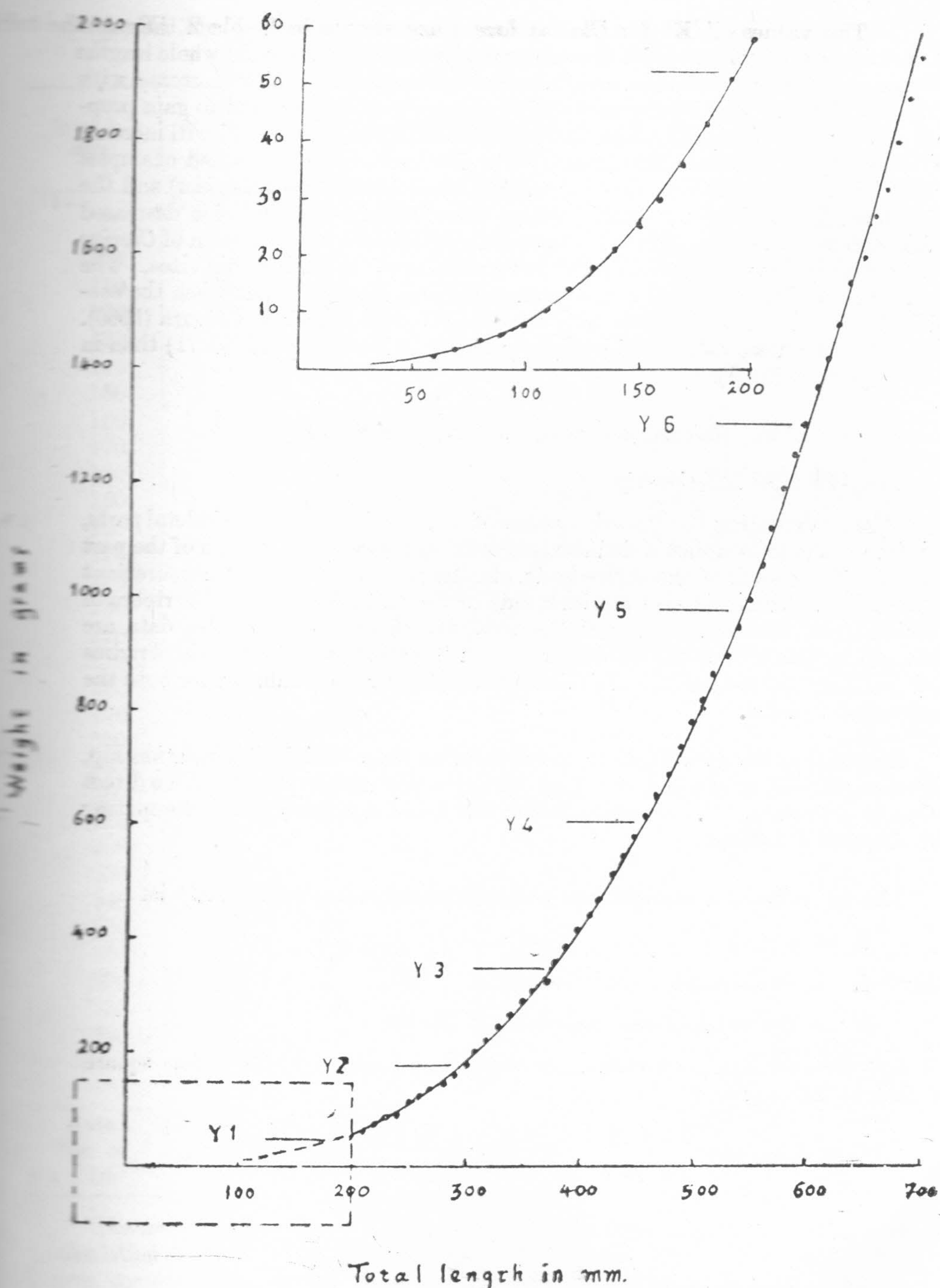


FIG. II.—Length-weight relationship of *Clarias lasera* in Setow ponds. Smooth curve represents the calculated weights. Dots represent the empirical weights.

The values of 'K' for *Cla ias laze a* are shown in Table 2. From the table it is clear that the value of K is not subject to fluctuations along the whole lengths observed. However there is a general trend for the value of K to decrease with increase of age. This is unusual since as fish grow older they tend to gain proportionately more in weight than in length, so that the value of K will increase with age (Rounsefell and Everhart, 1960). Beckman (1948), recorded examples of Michigan fishes such as the largemouth black bass (*Huro salmoides*) and the rock bass (*Qmbloplites r. rubestris*) where the coefficients of condition desreased with increase of length. This decrease of the coefficient of condietion of *Clarius laze a* with increase of size indicates bad condition of the fish at big sizes. The same observation was found for the same species in Barrags ponds when the coefficient of condition was calculated from the data of El bolock and Koura (1960). However, the mean value of K is slightly higher in Barrage ponds (0.71) than in serow ponds (0.67).

V. Calculated Grouth in Lenghth and Weight

1— *Body-Ve'tebra Relationship*

When calculating the growth system of a fish using scales or skeletal parts, it is important to establish a definite relationship between the growth of the part used and the growth of the entire body. In the present study the mensurement of the dorsal radius of the posterimor side of the third 'detatchable' vertebra of *Clarius lazera* was compared with the total length of the fish. The data are arranged in Table 3 as the total length in millimeters, average vertebral radius and the length-vertebral ratio (L/V.) determined for ages combined for both the males and females.

By plotting the data Table 3) to the formula for a straight line relationship, the straight line origin did not pass through the zero as in case of the direct proportion formula. A correction factor was found nesessary when computing the calculated lenghts.

The formula for a straight line body-vertebral radius relationship is:

$$L = a + b\,V$$

where L = total length in millimeters,

V = Vertebral rdaius measurement (X 20)

a + b = conâtants whose values were computed by the least square mrthod as follows :—

$$b \text{ or slope} = \frac{Nx\,(\sum L \times V) - (\sum V)\,(L)}{Nx\,\sum V^2 \quad - \quad (\sum V)^2}$$

(N = number of length intervals or frequencies)

$$\text{and a or intersept} = \frac{L - b \sum V}{N}$$

TABLE 3.—BODY VERTICAL RADIUS L/VR RELATIONSHIP OF *Clarias lazera* IN SEROW PONDS.

Total L. (mm)	No. of Fish	Averg. V (x20)	L/Vr	Total L. (mm)	No. of Fish	Averg. V (x20)	L/Vr
100	2	13	7.69	400	16	65	6.15
110	2	13	8.46	410	21	64	6.40
120	4	17	7.05	420	24	64	6.56
130	9	15	8.66	430	13	68	6.32
140	14	19	7.36	440	12	70	6.28
150	14	20	7.50	450	7	69	7.52
160	18	22	7.27	460	8	72	6.38
170	11	25	6.80	470	7	77	6.10
180	6	24	7.50	480	3	81	5.92
190	8	26	7.30	490	5	75	6.53
200	14	27	7.40	500	4	83	6.02
210	6	30	7.00	520	3	76	6.84
220	5	29	7.58	530	2	83	6.38
230	5	33	6.96	540	3	87	6.2[illegible]
240	5	36	6.66	550	2	8[illegible]	6.70
250	9	35	7.14	560	2	88	6.36
260	9	34	7.64	570	3	89	6.40
270	10	37	7.29	580	2	89	6.51
280	11	42	6.66	590	2	93	6.34
290	14	41	7.07	600	2	92	6.52
300	13	45	6.66	610	2	102	5.98
310	14	46	6.73	620	1	95	6 52
320	22	49	6.53	640	1	111	5 76
330	24	49	6.73	670	2	105	6.39
340	8	49	6.93	680	1	100	6.80
350	10	53	6.60	690	1	120	5.57
360	27	56	6.42	700	1	114	6.14
370	22	55	6.72	710	1	111	6.39
380	32	57	6.66	770	2	129	5.95
390	34	59	6.61	---	---	---	---
Total No. of Fish	544		Grand Average L/Vr				6.73

The amount of intersept of *Clarias lazera* (40.4 mm) was not neglected in calculation of growth of the direct - proportion calculated lengths for all age groups were corrected by means of the formula :

$$L\,n = \frac{V\,n\,(L - 40.4)}{V} + 40.4$$

For *Clarias lazera* in Serow ponds the values of a and b were found 40.4 and 5 ; 83 respectively. Therefore a regression line having an intersept on the lenght axis of 40.4 mm. (correction factor) and a slope of 5.83 was found to fit the plotted data (Table 3 and Fig III). The equation thus computed was: **L**= 40.4 + 5.83 V. This intersept of correction factor means that the fish attained

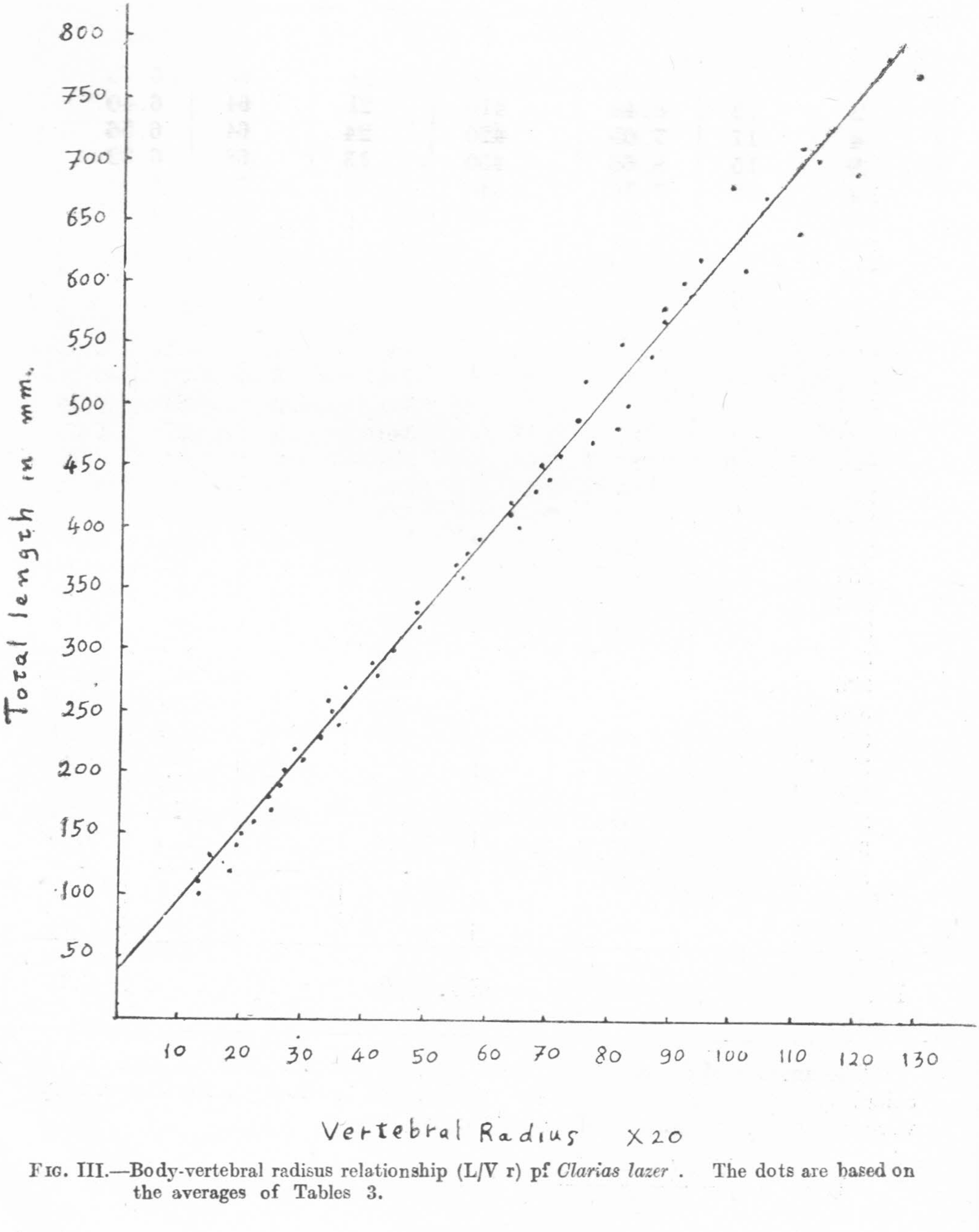


Fig. III.—Body-vertebral radisus relationship (L/V r) pf *Clarias lazer* . The dots are based on the averages of Tables 3.

about 40 mm. in length before the vertebra has been formed or the examined vertebra has been ossificated. This phenomenon was also observed in the cat-catfish *Ictalurus punctatus* by Appelget (1951). Cases of intersepts in scaled fish were also found by El Bolock and Koura (1960), El Zarka (1961) and Van Oosten (1942)

Such correction was first applied by Fraser (1916) to the Dahl-lea formula (See the end of this chapter) to compensate for the late scale or vertebra formation. This correction was expressed by Lee (1920) in the formula:

$$L\,n = S\,n \times \frac{L - C}{S} + C \text{ for scales}$$

or $$L\,n = V\,n \times \frac{L - C}{V} + C \text{ for vertebrae}$$

where C = length at time of scale or vertebrae formation

The amount of intersept of *Clarias lazeta* (40.4mms) was not neglected in calculation of growth. Tge direct — proportion calculated length for age groups were cottected by means of the formula,

$$Ln = \frac{Vn\ (L - 40.4)}{V} + 40.4$$

where Ln = calculated length at end of n years;

L = total length at capture

Vn = vertebral radius measurement at n th annulus (X 20)

V = average vertebral radius measurement.

El Bolock and Koura (1960) found that for *Clarias lazera* in Barrage ponds, no correction factor was needed and for back calculation of total lengths at different annuli, the direct - proportion method was used. The formula used was:

$$L\,n = V\,n\ \frac{L}{V}$$

where Ln = length of fish at end of *nth* year of life,

Vn = vertebral radius measurement within the *nth* annulus,

L = length of fish at capture and V = vertebral radius measurement to its margin. This lack of correction factor for *Clarias lazera* in Barrage ponds can be attributed to the scarcity of samples (only 60 specimens) in comparison with 544 specimens used in this work. The above mentioned fromula is equivalent to the original scale formula envolved by Lea (1910), and applied by Dahl (1910) and is called Dahl - Lea formula. This formula is written as follows:

$$L\,n = S\,n\ \frac{L}{S}\ (S = \text{scale measurement}).$$

2. *Calculated Growth in Length.*

The data on length at capture and calculated length at the end of each year of life of *Clarias lazera* in Serow ponds are given in Table 4 and Fig. IV From the table it is clear that there is a considerable agreement in the average calculated lengt at the end of each year of life in all age groups. It is also shown that *Clarias* growth is most rapid in the first and second year of life. The growth then rises at a lower rate till the fifth year. It slows still down from the fifth to the sixth year of life. The increment of growth in length is also greatest in the first and the second years (192 & 297 mm). They are lower in the following years; being lowest in the sixth year about 59 mm).

In the growth curve Fig. IV, are also given the ranges of calculated lengths in the different age groups. There is a wide ringe in size of fish of the same age. Sometimes, a fish at a certain size may belong to three age groups. However, this is not believed to be indicative of an error in the method of age determination. This case was also recorded by El Bolock & Koura (1960). According to Appelget and Smith (1951); in catfish *Ictalurus punctatus* of known age held in a pond at Fairport, Iowa, one - two - and three - annulus fish had a range in length of 3.1, 4.8 and 5.9 inches respectively.

TABLE 4.—AVERAGE TOTAL LENGTH AT CAPTURE OF *Clarias lazera* FROM SEROW PONDS, AVERAGE CALCULATED LENGTH ATTAINED BY THE AGE GROUPS AT THE END OF EACH YEAR OF LIFE AND ANNUAL INCREMENT IN LENGTH (SEXES COMBINED)

Age group	No. of Fish	Av. T.L. at Capt. mm.	Av. calculated length at end of year					
			1	2	3	4	5	6
0	89	163.7	—	—	—	—	—	—
I	92	265.2	188.6	—	—	—	—	—
II	149	341.9	199.9	308.1	—	—	—	—
III	137	396.3	187.1	285.4	372.0	—	—	—
IV	42	470.0	188.7	284.2	374.1	449.3	—	—
V	17	563.7	198.7	307.1	382.8	469.3	542.5	—
VI	9	631.6	189.2	298.4	378.9	455.8	544.7	602.4
T. No. of Fish	535	Grand Average	192.0	296.6	376.9	458.2	543.6	602.4
Increment of growth in length in mm.			192.0	104.6	80.3	81.3	85.4	58.8
Percentage increase in length.			—	54.4	27.0	21.5	18.6	10.8

From Table 4, we can also notice that comparisons between calculated length at any annulus and empirical length for fish of that age at time of capture show good agreement. This means that age assessment was correct. Of course the agreement will not be exact, since fish caught during the growing season will be longer than the length at the time of formation of the last annulus.

The data on growth of *Clarias* males and females separately are shown in Table 5 and Fig. V. Growth for sexes separate and combined is represented in Fig. VI. The same trend in growth for sexes combined can also be traced here when the sexes are separated.

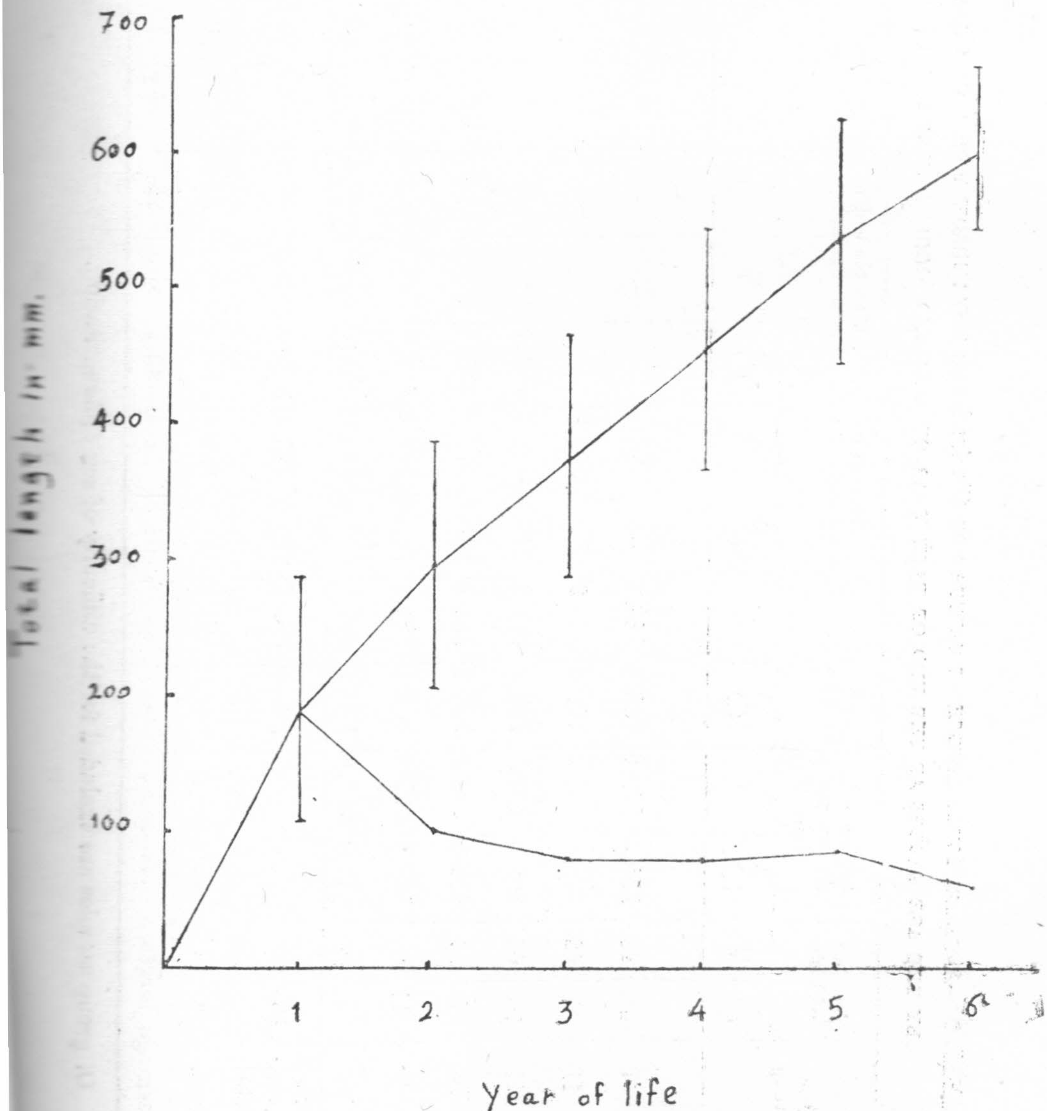


Fig. IV—Calculated length, grwoth range at each annulus and annual increments of *Clarias lazera* in Serow ponds.

TABLE 5.—AVERAGE TOTAL LENGTH AT CAPTURE OF *Clarias lazera* FROM SEROW PONDS, CALCULATED LENGTH ATTAINED BY THE AGE GROUPS AT THE END OF EACH YEAR OF LIFE AND ANNUAL INCREMENTS (SEXES SEPARATE).

Age Group	Number of Fish		Av. Total l. at Capture (mm)		Average calculaled l. at the end of each year of life (mm)											
					1		2		3		4		5		6	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
I	46	46	259.6	270.9	188.8	188.4	—	—	—	—	—	—	—	—	—	—
II	80	69	348.5	335.4	199.5	200.3	313.5	302.7	—	—	—	—	—	—	—	—
III	75	62	391.5	401.1	182.9	191.3	279.5	291.3	364.7	379.4	—	—	—	—	—	—
IV	17	26	493.2	446.8	194.5	183.0	297.1	271.3	397.2	351.1	473.7	425.3	—	—	—	—
V	11	6	570.0	557.5	203.1	194.4	296.4	317.9	384.3	381.3	469.9	468.8	551.9	533.1	—	—
VI	6	2	646.0	616.6	176.7	201.7	288.8	308.0	377.8	380.1	459.0	452.7	556.0	533.5	614.2	590.7
Grand Averg. Total	235	211	—	—	190.9	193.1	295.0	298.2	381.0	372.9	467.5	448.9	553.9	533.3	614.2	590.7
Increm. of growth in lenght (mm)					190.9	193.1	104.1	105.1	86.0	74.7	86.5	76.0	86.4	84.4	60.3	57.4
Percentage Increase					—	—	54.5	54 4	29.1	25.0	22.7	20 3	18.4	18.8	10.8	10.8

O. group samples are excluded for the difficulty of sex differentitation.

Comments on the comparison of the growth in length of the sexes, were best made from Table 6 which was obtained from Table 5. From the table, it is clear that *Clarias* females are slightly bigger in size than the males in the first and the second year of life. The size advantage, however, does not exceed 3.2 mm. In the successive years of life, the males grow more rapidly than the females The size advantage of males over females increases progressively to 23.5 mm. in the sixth year.

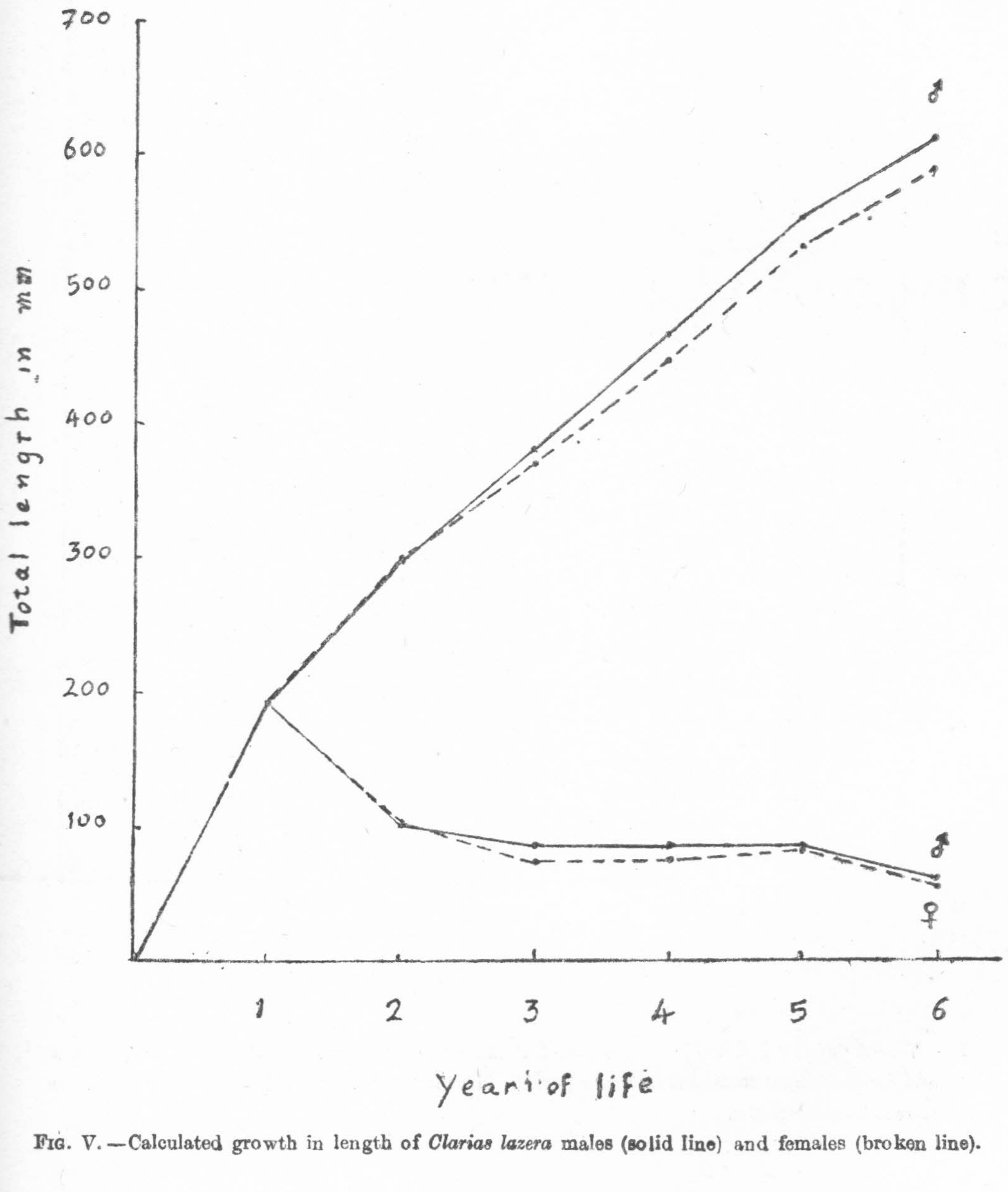


FIG. V.—Calculated growth in length of *Clarias lazera* males (solid line) and females (broken line).

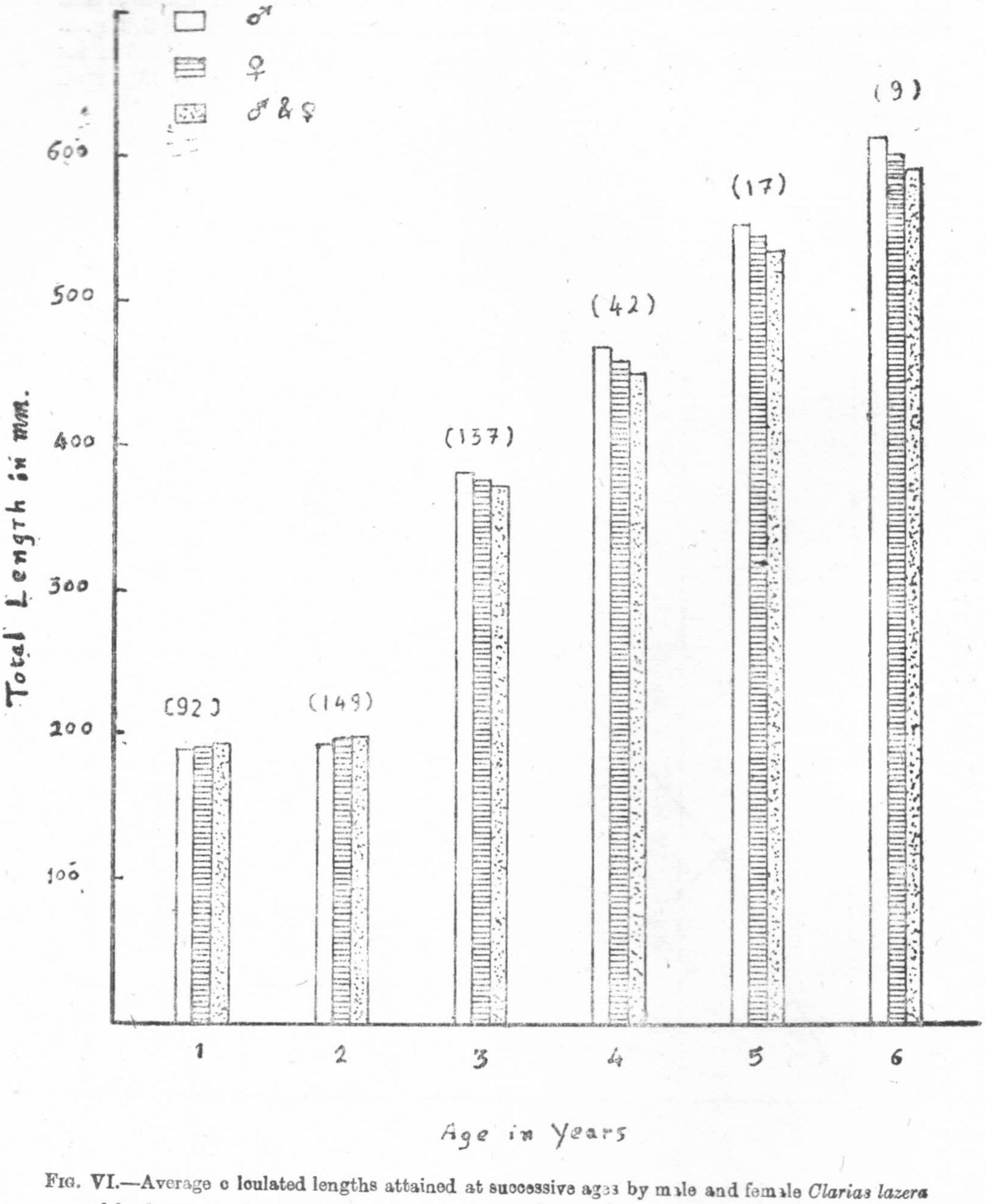


FIG. VI.—Average c loulated lengths attained at successive ages by male and female *Clarias lazera* and by both sexes combined in Serow ponds. Number of fish included in each age group are shown in parentheses.

The percentage increase of growth at different years of life is also given in Table 6. As a reflection of the growth, the percentsge increase is also greatest in the first year, and lowest in the sixth year. The percentage increase is also slightly higher in the case of femles for the first and second year of life. The case is then reversed and the percentage is more pronounced in case of of males than fmales till the sixth year of life.

TABLE 6.—CALCULATED TOTAL LENGTH (MM.), LENGTH INCREMENTS AND PERCENTAGE INCREASE OF *Clarias lazera* IN SEROW PONDS.

Year of life	Males			Females			Size Advantage	
	Calcul. l. (mm.)	Increm.	% Incr.	Calcu. l. (mm.)	Increm.	% Incr.	Males	Females
1	190.9	190.9	31.1	193.1	193.1	32.7	—	2.2
2	295.0	104.1	16.9	298.2	105.1	17.8	—	3.2
3	381.0	86.0	14.0	372.9	74.7	12.6	8.1	—
4	467.5	86.5	14.1	448.9	76.0	12.9	18.6	—
5	553.9	86.4	14.1	533.3	84.4	14.3	20.6	—
6	614.2	60.3	9.8	590.7	57.4	9.7	23.5	—

3. *Calculated Growth in Weight.*

Estimates of growth in weight of *Calarias lazesa* in Serow ponds were obtained from calculated weights (computed from the equation $W = 1.944 \times 10^{-5}\ L^{2.8155}$ 2.8155) equivalent to the grand average of caluclated lengths attaine st the end of each year of life (Table 7). The calculated weights and the annual increments of growth in weights for sexes combined are shown in Table 7 and Fig. VII. Those for males and females separately are shown in Tabel 8 and Fig. VII also.

In contrast to length, the weight increased slowly in the first year (52.4,) and then rapidly till the sixth year. The increments were also lowest in the first yesr and then increased till the end of the fifth year (372.Ig). From the fifth to the sixth year the increment was smaller than the fifth year (327.6 g).

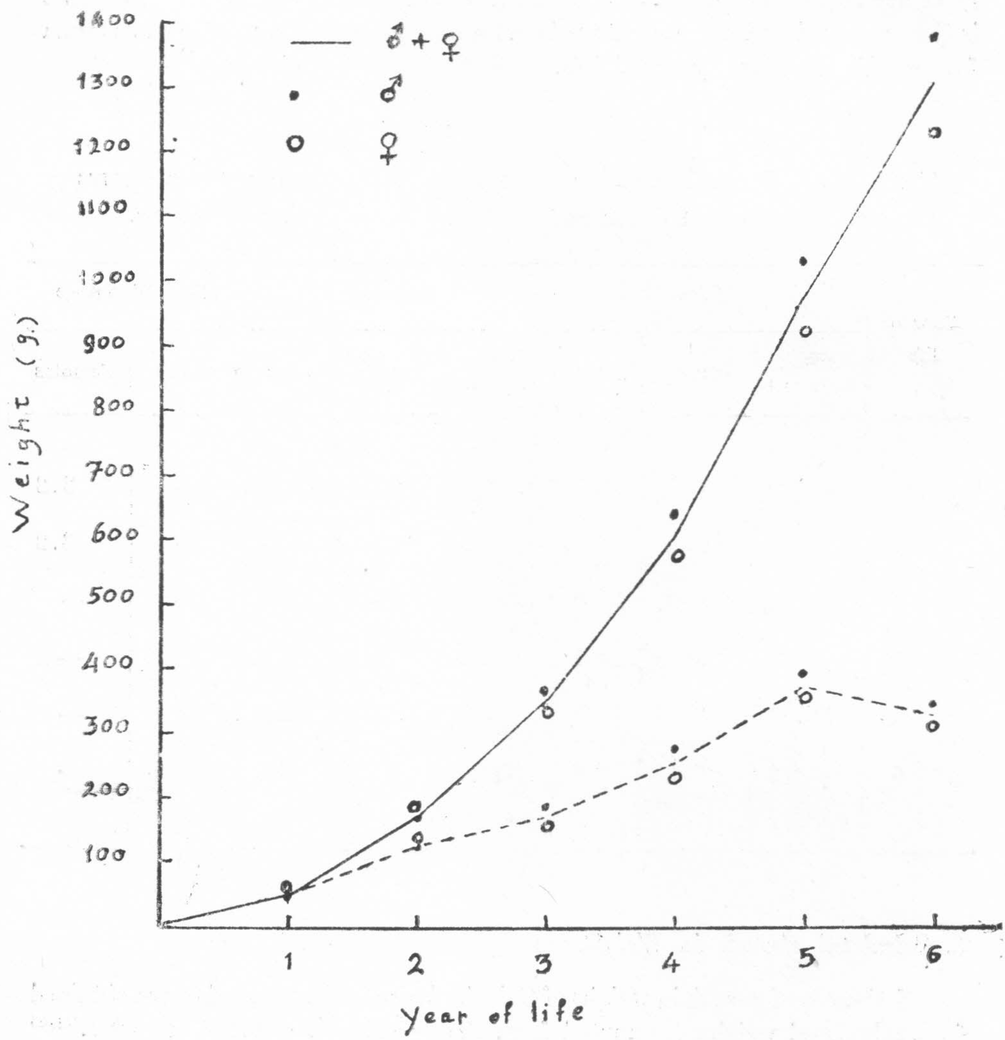


FIG. VII.— Calculated growth in weight of *Clarias lazera* in Serow ponds and annual increments.

TABLE 7.—CALCULATED WEIGHT AT THE END OF DIFFERENT YEARS OF LIFE OF *Clarias lazera* IN SEROW PONDS (SEXES COMBINED).

Age group	No. of Fish	Calculated weights (grams) at end of year					
		1	2	3	4	5	6
I	92	49.6	—	—	—	—	—
II	149	68.4	197.6	—	—	—	—
III	137	48.5	159.3	336.1	—	—	—
IV	42	49.8	158.1	344.5	576.3	—	—
V	17	57.5	196.4	363.7	646.2	972.2	—
VI	9	50.6	180.9	353.6	595.0	983.7	1305.5
Grand Av . & Total	446	52.4	178.5	349.5	605.8	977.9	1305.5
Increase of growth in weight		52.4	126.1	171.0	256.3	372.1	327.6
Percentage increase in weight		—	240.6	95.7	73.3	61.4	33.5

The comparisin of growth in weight of males and females can be shown in Table 9, which was obtained from Table 7. From Table 9 it is clear that the females are slightly heavier than the males in the first and second years, the difference being 1.6 & 6 grams respectively. The males grew much faster in weight than the females in the successive years. The size advantage of mals over females reched 143 grams in the sixth year.

The percentage increase in length and weight are given in Table 10 and Fig. VIII. From the table it clear that the maximum increase in length for the sexes combined was attained in the first year. The percentage increase was about 32% The same case was found for the males and females sparately.

TABLE 8.—CALCULATED WEIGHTS AT THE END OF DIFFERENT YEARS OF LIFE OF *Clarias lazera* IN SEROW PONDS AND ANNUAL INCREMENTS OF GROWTH IN WEIGHT (SEXES SEPARATE)

*Age group	Number of Fish		Calculated weight (grams) at end of year											
			1		2		3		4		5		6	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
I	46	46	49.8	49.4	—	—	—	—	—	—	—	—	—	—
II	80	69	58.1	58.7	207.3	187.9	—	—	—	—	—	—	—	—
III	75	62	45.5	51.6	150.1	168.6	317.4	354.9	—	—	—	—	—	—
IV	17	26	54.1	45.6	178.2	138.0	403.7	285.2	663.0	489.5	—	—	—	—
V	11	6	61.1	54.0	177 1	215.7	367.7	359.7	648 5	643.9	1020.0	924.5	—	—
VI	6	2	41.6	59.9	164.6	197.3	350.5	356.7	606.6	583.4	1041.0	926.4	1377.0	1234.0
Grand Av. & Total	235	211	51.6	53.2	175.5	181.5	359.8	339.1	639 3	572.2	1030.5	925.4	1377.0	1234.0
Increm. of growth in weight .			51.6	53.2	123.9	128.3	184.3	157.6	279.5	233.1	391.2	353.2	346.5	308.6
Percentage annual increase in weight			—	—	240.1	241.1	105.0	86.8	77.6	68.7	61.1	61.7	33.6	33.3

* O group samples are excluded for the difficulty of sex differentiation.

In contrast to length, the minimum percentage increase of growth in weight was noticed in the first year. The value was 3.7 and 4.3% for males and females respectively. The maximum percentage increase in weight was attaind in the fifth year for both sexes combined and for males and females separately.

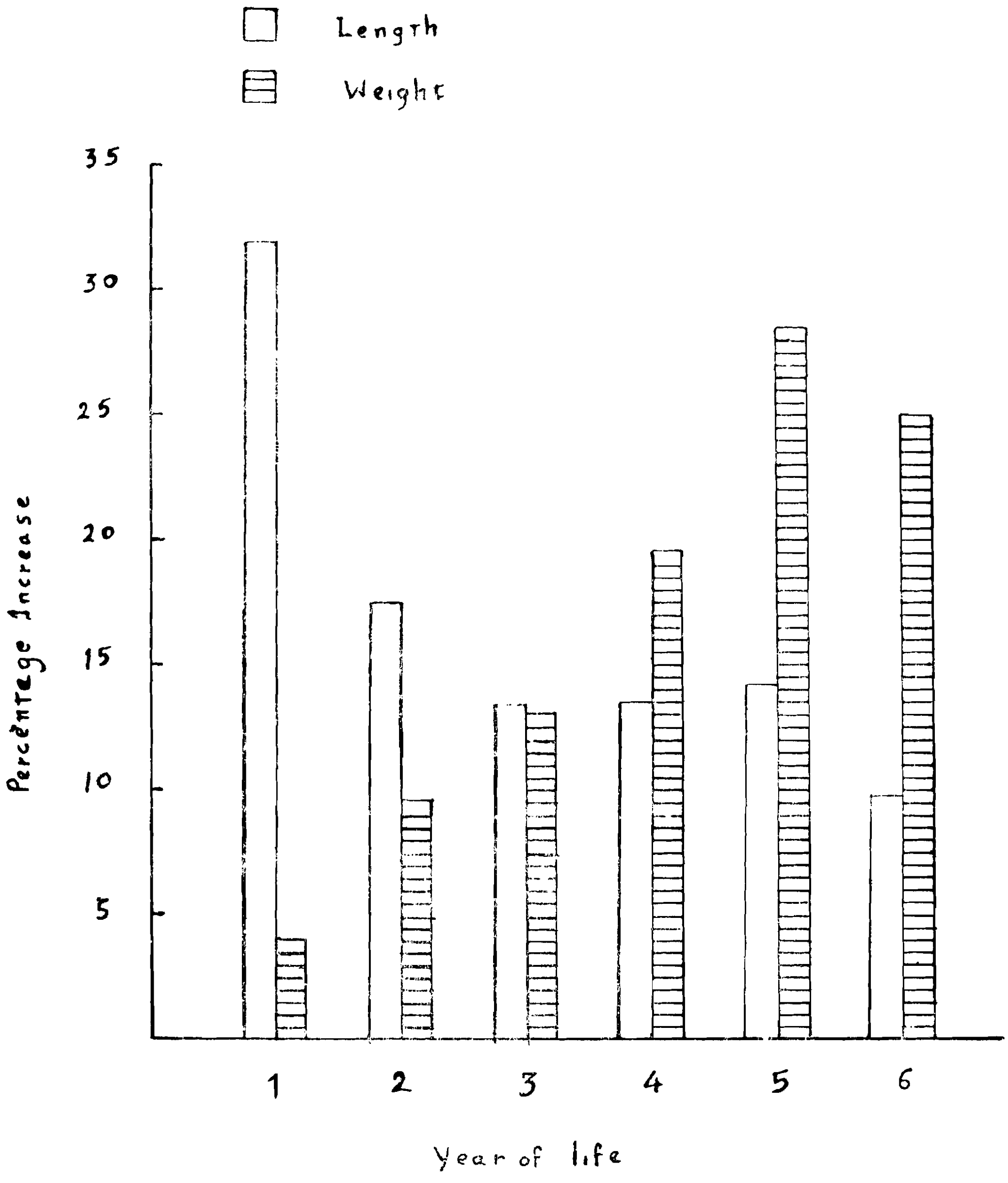


FIG. VIII.—Percentages increase of growth in length and weight of *Clarias laezra* in Serow ponds.

TABLE 9.—CALCULATED WEIGHTS (GRAMS), WEIGHT INCREMENTS, PERCENTAGE INCREASE IN TOTAL GROWTH AND SIZE ADVANTAGE OF *Clarias lazera* IN DIFFERENT YEARS OF LIFE

Year	Males			Females			Size Adv.	
	Calc. wgt.	Increm.	% Inc.	Calcul. weight	Incerm.	% Incerm.	Males	Females
1	51.6	51.6	3.7	53.2	53.2	4.3	—	1.6
2	175.5	123.9	9.0	181.5	128.3	10.4	—	6.0
3	359.8	184.3	13.4	339.1	157.6	12.8	20.7	--
4	639.3	279 5	20.3	572.2	233.1	18.9	67.1	--
5	1030.5	391.2	28.4	925.4	353.2	28.6	105.1	—
6	1377.0	346.5	25.2	1234.0	308.6	25.0	143.0	--

4. *Comparison of Growth in Length and Weight in Serow and Barrage Ponds.*

The average calculated lengths and corresponding calculated weights of *C larias lazera* in Serow and Barrage ponds are shown in Table II and Fig. IX & X. The equations by means of which the calculated weights in both regions are found can be shown at the foot of Table 11.

As regards calculated growth in length, *Clarias* from Serow ponds are less than those from Barrage ponds in the first and year second of life. The differences being 5.0 and 11.4 mm. respectively. From the third till the sixth year of life the case is reversed and *Clarias* from Sorow ponds are longer than those from Barrage ponds. The maximum difference (23.6 mm.) was attained in the fifth year. The minimum difference (2.4) mm. was attained in the sixth year.

The same observation was noticed in case of growth in weight, where *Clarias* from Serow ponds are heavier in wieght than those from Barrage ponds in the first, second and third Year. The differences being 8.6, 29.5 and 13.5 mm. From the third till the six th year the case is reversed. The discrepances being + 37.8 + 97.9 and + 270.5 respectively.

5. *Comparison of Length-frequency Distribution Modes with Modes of Distribution in Each Age Group.*

When the peaks in length-frequecny polygon of the entire sample aged are compared with the modes of length-frequency in each assigned age group, a considerable agreement in the first, second, third and fourth age group (Table 12 and Fig. XI) was found. In the following age groups, the range of zise and scarsity of material resulted in enough overlapping, and no clear coincidence of the modes could be detected. However, the agreement is good enough to give support to the vertibral method of aging this species.

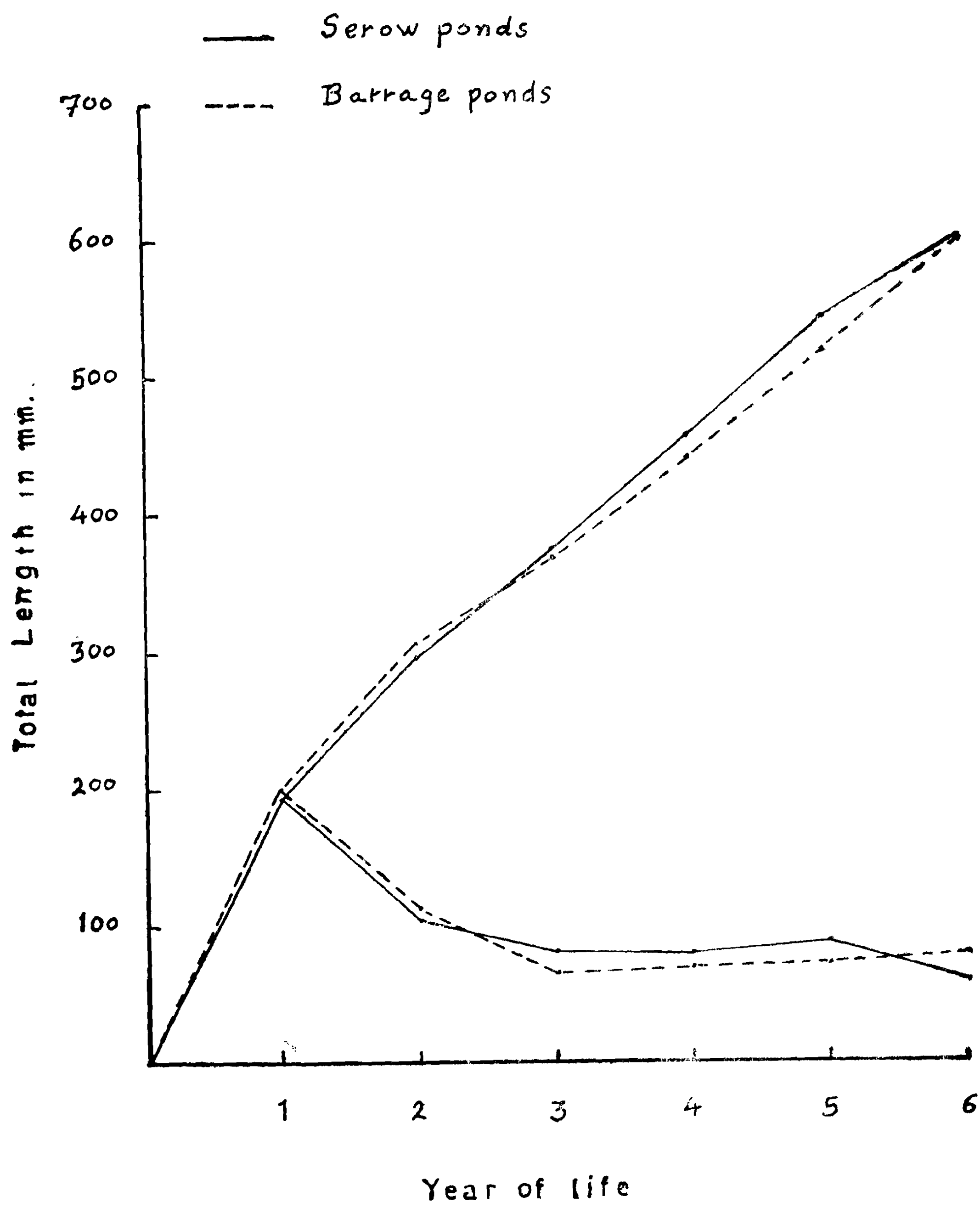


FIG. IX.—Calculated growth in length of *Clarias lazera* in Serow and Barrage ponds.

TABLE 10.—PERCENTAGE ANNUAL INCREASE IN LENGTH AND WEIGHT OF *Clarias lazera* FROM SEROW PONDS IN DIFFERENT YEARS OF LIFE

Year	% increase in length			% increase in weight		
	Males	Females	Sexes combined	Males	Females	Sexes combined
1	31.1	32.7	31.9	3.7	4.3	4.0
2	16.9	17.8	17.4	9.0	10.4	9.7
3	14.0	12.6	13.3	13.4	12.8	13.1
4	14.1	12.9	13.5	20.3	18.9	19.6
5	14.1	14.3	14.2	28.4	28.6	28.5
6	9.8	9.7	9.7	25.2	25.0	25.1

TABLE 11.—AVERAGE CALCULATED LENGTH IN MILLIMETERS AND THE CORRESPONDING CALCULATED WEIGHTS IN GRAMS AT THE END OF EACH YEAR OF LIFE OF *Clarias lazera* IN SEROW AND BARRAGE PONDS

Locality	Item	1 Average calculated length and weight at end of year					
		1	2	3	4	5	6
Serow ponds	Length (mm.)	192.0 (192.0)	296.6 (104.6)	376.9 (80.3)	458.2 (81.3)	543.6 (85.4)	602.4 (58.8)
	2 Weight (g.)	52.4 (52.4)	178.5 (126.1)	349.5 (171.0)	605.8 (256.3)	977.9 (372.1)	1305.5 (327.6)
Barrage ponds	Length (mm.)	197.0 (197.0)	308.0 (111.0)	373.0 (65.0)	443.0 (70.0)	520.0 (77.0)	600.0 (80.0)
	3 Weight (g.)	61.0 (61.0)	208.0 (147.0)	353.0 (145.0)	566.0 (213.0)	880.0 (314.0)	1035.0 (155.0)

1 : Increment in parentheses.

2 : Calculated by means of the equation $W = 1.944 \times 10^{-5} L^{2.8155}$

3 : Calculated by means of the equation $W = 2.980 \times 10^{-5} L^{2.7505}$

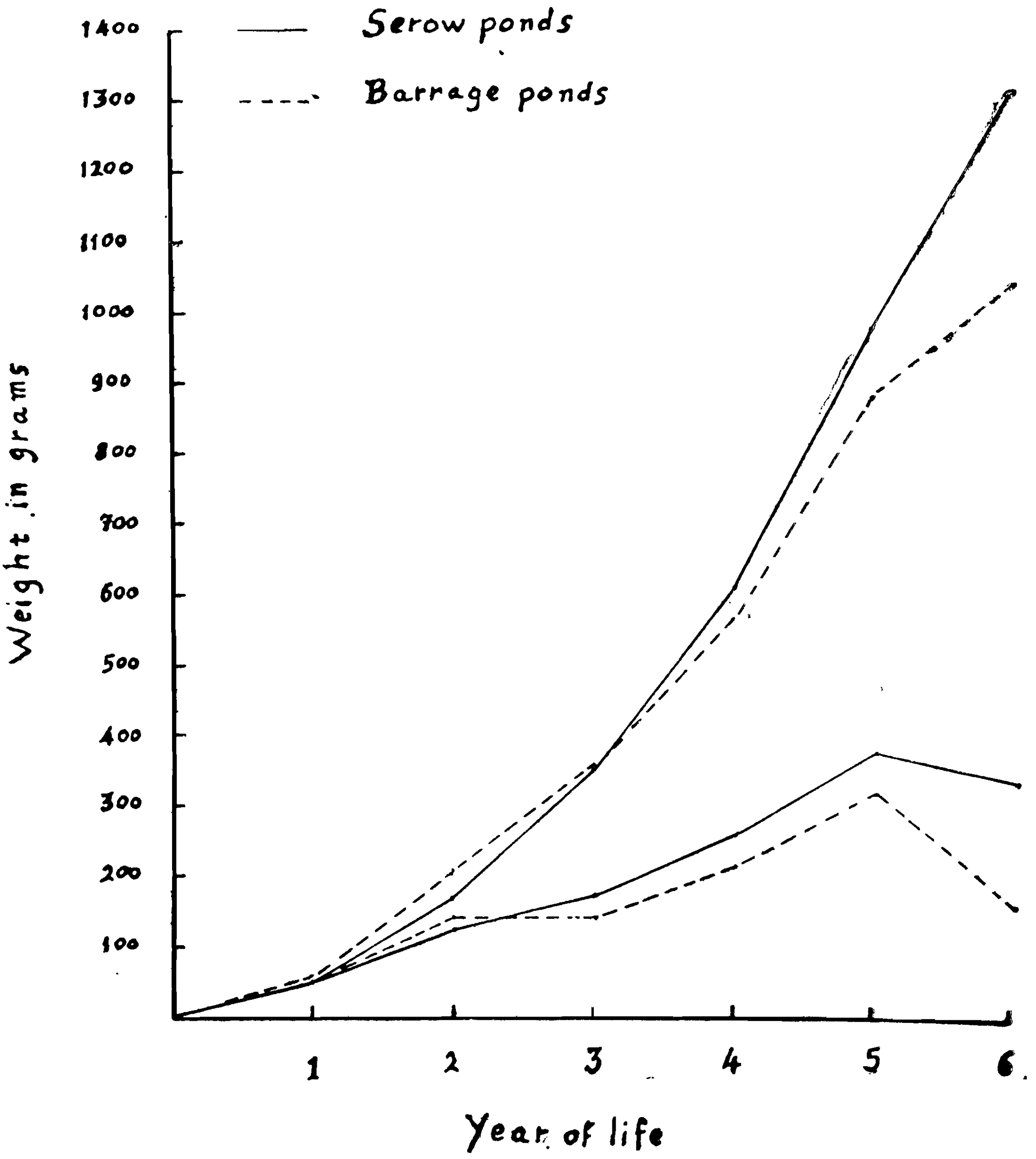


FIG. X. —Calculated growth in weight of *Clarias lazera* in Serow and Barrage ponds.

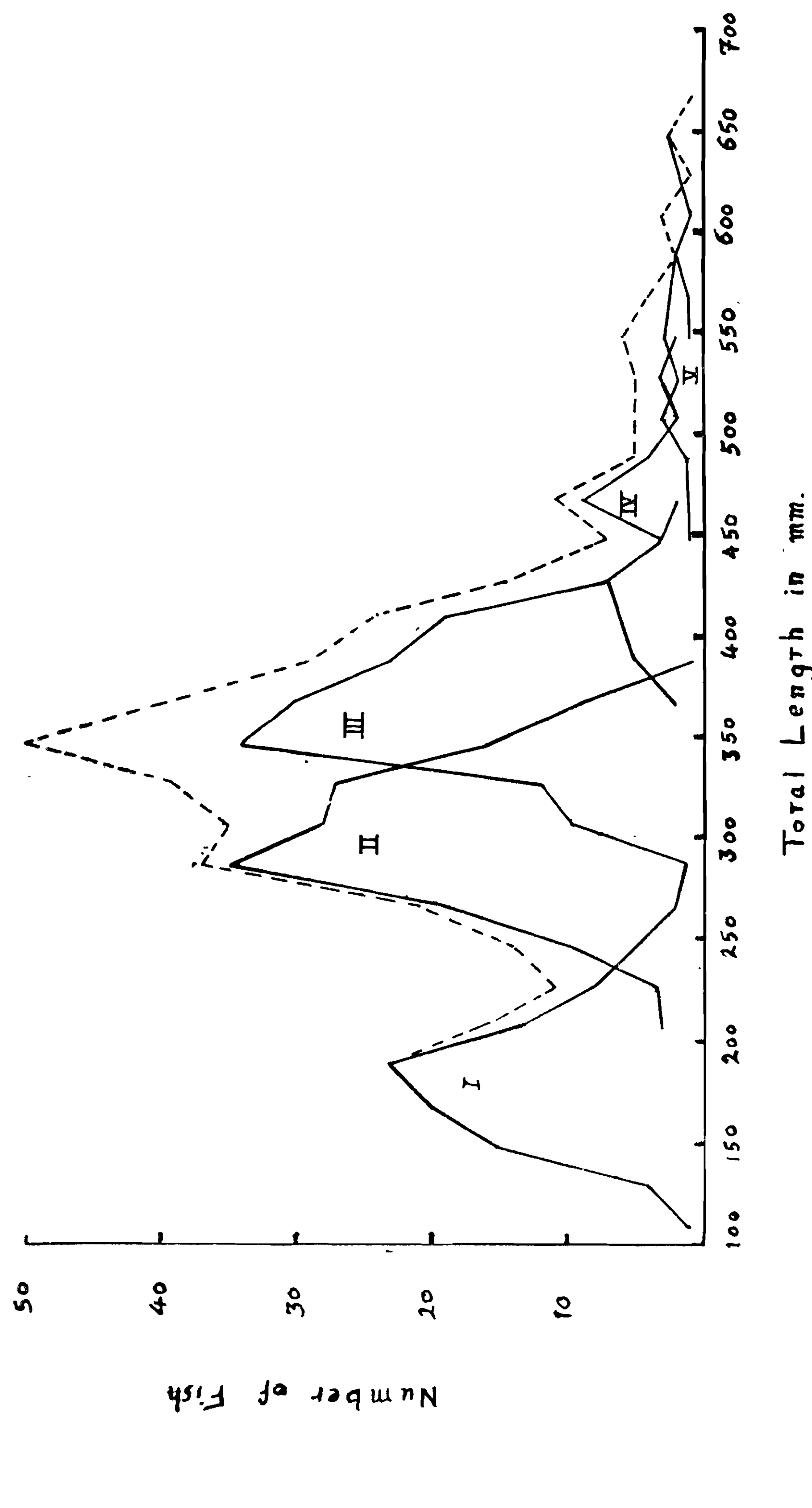


FIG. XI.—Length frequency of *Clarias lazera* form Serow ponds (broken line) compared with length frequencies of fish assigned to each age group (solid line). Roman numeras indicate age classes.

TABLE 12.—NUMBER OF FISH IN EACH AGE GROUP (SEXES COMBINED) OF *Clarias lazera* FROM SEROW PONDS EXPRESSED BY 2-CENTIMETERS INTERVALS

Total Length (mm)	Age Group						No. of Fish	%
	I	II	III	IV	V	VI		
100 — 119	1	—	—	—	—	—	1	0.2
120 — 139	4	—	—	—	—	—	4	0.9
140 — 159	15	—	—	—	—	—	15	3.4
160 — 179	20	—	—	—	—	—	20	4.5
180 — 199	23	—	—	—	—	—	23	5.2
200 — 219	13	3	—	—	—	—	16	3.6
220 — 239	8	3	—	—	—	—	11	2.5
240 — 259	5	9	—	—	—	—	14	3.1
260 — 279	2	19	—	—	—	—	21	4.7
280 — 299	1	35	1	—	—	—	37	8.3
300 — 319	—	28	7	—	—	—	35	7.8
320 — 339	—	27	12	—	—	—	39	8.8
340 — 359	—	16	34	—	—	—	50	11.2
360 — 379	—	8	30	2	—	—	40	9.0
380 — 399	—	1	23	5	—	—	29	6.5
400 — 419	—	—	18	6	—	—	24	5.4
420 — 439	—	—	7	7	—	—	14	3.1
440 — 459	—	—	3	3	1	—	7	1.6
460 — 479	—	—	2	8	1	—	11	2.5
480 — 499	—	—	—	4	1	—	5	1.1
500 — 519	—	—	—	2	3	—	5	1.1
520 — 539	—	—	—	3	2	—	5	1.1
540 — 559	—	—	—	2	3	1	6	1.3
560 — 579	—	—	—	—	3	1	4	0.9
580 — 599	—	—	—	—	—	2	2	0.4
600 — 619	—	—	—	—	2	1	3	0.7
620 — 639	—	—	—	—	1	—	1	0.2
640 — 659	—	—	—	—	1	3	3	0.7
660 — 679	—	—	—	—	—	1	1	0.2
Number of Fish. .	92	194	137	42	17	9	446	100.0

6. *Comparison of Clarias Calculated Growth with Growth of Experimentally Reared Fish with Additional Feediug.*

For this comparison, the results obtained by El Bolock (Unpublished work) from 2 experiments conducted in Barrage ponds in 1969-1970 were used. In

2 ponds measuring 926 & 952 square meters, *Clarias* fingerlings (40 mm. in length) were stocked at a rate of 2500 and 3000 per ponds. The fish were reared for 251 and 266 days respectively During this period the fish in each pond were fed with 720 kilogrmas of chicken bowels and 640 kilograms of rice bran mixed with fresh animal blood. At the end of the experiment, the fish attained 320 and 300 mm. in length and 250 and 200 grams in weight respectively. By comparing these sizes with those obtained in this work (Table 4 & 7 and Fig. IV & VII), the average lengths were found to fall within the ranges of the second and third year life, while average weights fall inbetween the second and third year of life. The average coefficient of conditions' K' calculated for the sizes obtained from the ponds where additional feed was given were found to be 0.76 and 0.74 respectively, compared with 0.67 for the unfed fish. This comparison, however, gives good evidence of the better condition of the fish given additional feed over the unfed ones.

VI. SUMMARY

Claria lazera, Cuv. & Val., an important indigenous species, has recently attained great care as a pond culture fish. All the material for this study was taken from samples collected from Serow fish farm ponds (Near Lake Manzallah) from 1964 to 1969 For age determination 535 specimens were used while for lengthweight relationship 2183 samples were taken.

The vertebrae were chosen for age determination since they are easy to secure, prepare, examine and the centrum shows all the essential markings needed in aging fish. True year marks are clear complete and concentric with the rim of the vertebra, while the accessory rings are faint and not complete.

The length-weight relationship is expressed satisfactorily, by the equation.

$$W = 1.944 \times 10^{-5} L^{2.8155}$$

The value of the coefficient of condition 'K' varied from 0.97 to 0.56, the average being 0.67 which is a little less than that found in Barrage ponds, (0.71). However, in both Serow and Barrage ponds the coefficient of condition K decreased with increase in age which means bad condition of the fish at big sizes.

Body vertebra relationship was shown as a straight line inter-septing the length axis at a value of 40.4 mm. The direct proportion calculated lengths were corrected by the formula

$$L_n = V_n \frac{L - 40.4}{V} + 40.4 \quad (\text{R. Lee } 1920)$$

Clarias growth in length as well as the increment of growth in length are most rapid in the first year and second years of life. There is also a big range of size in fish of the same age so that sometimes a fish of a certain size may belong to three age groups. However, this is not due to any error in the method of age determination. Comparisons between calculated lengths at any, annulus and empirical lengths for fish of that age at time of capture show good agreement which means that age assessment was correct.

Calculated lengths of the *Clarias* females are very slightly longer than the males in the first and second years (The difference being only 2.2 and 3.2 mm.). Then the males increased in length more than the females till the sixth year. The maximum size advantage which is 23.5 mm. was reached in the sixth year.

In contrast to growth in length, the *Clarias* growth in weight was slowly on the first year (52.4 gram) and then rapidly in the following years. The maximum increment of growth in weight was reached in the fifth year, the minimum was in the first year. The *Clarias* females are slightly heavier than the males in the first and second year (The difference being only 1.6 and 6 0 gram respectively). In the following years the males exceeded the females in weight. The size advantage reached 143 gram in the sixth year.

Comparison of growth in length and weight of *Clarias lazera* from Serow and Barrage ponds showed no significant discrepancies which is an indication of the correctness of age determination by means of vertebrae.

Another support for the vertebral method of aging *Clarias* can be shown when the peaks in length-frequency polygon of the entire sample aged are compared with the modes of length frequency in each assigned age group as a result considerable agreement was found between these peaks especially from the first till the fourth year. In later years the coincidence of the modes could not be detected due to big ranges of size and scarcity of material.

The growth of *Clarias lazera* given additional feed composed of chicken bowels and rice bran mixed with fresh animal blood in Barrage experimental ponds greatly exceed that of the unfed fish obtained in this work. In the same time the average coefficient of condition from the first case was also higher (0.76) than that of the second case (0.67) which is a good evidence of the better condition of the fed fish than the unfed ones.

ACKNOWLEDGMENT

I would like to express my gratitude to Prof. Dr. A. Al Kholy for kindly, reading, criticising and accepting this paper for publication.

LITERATURE CITED

ALEEN, K.R. 1938.—Some observations on the biology of the trout *Salmo trutta* in Windermere. J. Amer. Ecology. 7 : 333–349.

APPELGET, J. AND L. SMITH JR. 1951.— The determination of age and rate of growth from vertebrae of channel catfish *Ictalurus lacustris punctatus*. Trans. Amer. Fish. Soc. Vol. 80 (1950) pp. 119–139.

BOULENGER, G.A. 1907.—Zoology of Egypt. The Fishes of the Nile. Publ. Hugh. Rees Ltd., London.

BECKMAN. W.C. 1948.—The length-weight relation, factors for conversions between standard and total lengths and coefficient of condition for seven Michigan fishes. Trans. Amer. Fish. Soc. Vol. 75 (1945) pp. 238–256.

CURRIER, J. 1951.—The use of pectoral fin rays for determining age of Sturgeon and other species of fish. Canad. Fish Cult. No. 11, pp. 10-18.

CHUGUNOVA, N.I. 1959.—Age and growth studies in fish. Academy of Sc. of the U.S.S.R. Inst. of Animal Morphology in A.N. Severtsov.

DAHL, K. 1910.—The age and growth of Salmon and Trout in Norway as shown by their scales. 141 pp. Salmon and Trout Assoc. (1911), London.

EL ZARKA, S. 1959.— Fluctutions in the population structure of yellow perch (*Perca flavescence* M.) in Saginaw Bay, Lake Huron, University of Michigan (Ph. D. Thesis).

————, 1961.—Tilapia fisheries investigations in Egyptian lakes. II. A biological study of the fisheries of *Tilapia Zillii* Gerv. in Lake Quarun, Egypt, U.A.R. Inst. Ocean. and Fish. Notes and Memoirs No. 66.

EL BOLOCK, A.R. AND R. KOURA. 1960.—Observations on age growth and feeding habits of *Clarias lazera* Cuv. & Val. in Barrage Experimental ponds. Ibd. Notes and Memoirs No. 56.

————, 1960.—Age, growth and breeding season of *Tilapia zillii* Gerv. in Egyptian experimental ponds. Ibd. Notes and Mem. No. 49.

EL ILA, A. AND EL BOLOCK 1972.—On the Biology and Culture of *Clarias lazera* Cuv. & Val. in Egyptian Ponds. Spawning and developmental Stages. (Under publication).

FRASER, C. MCLEAN 1916.—Growth of the spring Salmon. Trans. Pacific Fish. Soc. pp. 29-39.

HILE, R. 1936.—Age and grcwth of cisco, *Leucichthys artedi* (Le Sueur), in the lakes of northeastern highlands. Wisc. Bulletin U.S. Bur. Fish. Vol. 48, pp. 211-317.

HILE, R. AND F.W. JOBES 1941.—Age and growth of the yellow perch, *Perca flavescens* (Michell), in Wisconsin Waters of Green Bay and Northern lake Michigan. Pap. of Michigan Acad. Sc., Art and Lett. Vol. 27 pp. 241-266.

HILE, R. 1948.—Standardization of methods of experssing length and weights of fish. Trans. Amer. Fish. Soc. Vol. 75 (1945), pp. 157-164.

LEA, EINAR 1910.On the methods used in the herring investigations. Conseil perm. inter. pour L'explo. de la mer. Publ. de circon. No. 53, pp 7-174.

LEE, ROSA 1920 —A review of the methods of age and growth determination in fishes by means of scales. Mins. Agr. and Fish. Fish investig., second Series, Vol. 4. No. 2 pp. 1-32.

LE CREN, E.D. 1947.—The determination of the age and growth of the perch (*Perca fluviatilis*) from the opercular bone. Jour. of Animal Ecology. Vol. 16, No. 2, pp. 188-204

————, 1951 —The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). Jor Anim. Ecology, Vol. 20, No. 2, pp 201-21.

LEWIS, W.M. 1949 —The use of vertebrae as indicators of the age of the northern black bullhead *Ameiurus m. melas* (Rafinesque) Iowa State College Journ of Sci. Vol. 23, No. 2, pp. 209-218.

MARTIN, W.R. 1949 —The mechanics of environmental control of body form in fishes. Univ. Toronto Stud. Biol. 58 (Publ. Ont. Fish. Res. Lab. 70) pp. 1-91.

O 'CONNELL, C.P. 1953 —The life history of the cabezon *Scorpaenichthys marmoratus* (Ayres) State of Calif Dep. of Fish. and Game Fish. Bulletin No. 93.

ROUNSFELL, G. AND W.H. EVERHART 1960 —Fishery Science, its methods and applications. John Wiley and Sons Inc. New York. London.

SIDTHIMUNKA, A *et al* 1966 —The culture of catfish (*Clarius* spp.) in Thailand Proc. F.A.O. World Symp. on Warm-water pond Fish Culture Vol. 5, No. 44.

THOMPSON, W. 1942.—On growth and form. New Ed. Cambridge.

VAN OOSTEN, JOHN 1942 —The age and growth of fresh-water fishes Proc of a Symp. on Hydrob University of Wisc. Press : 196-205.

————, 1942 —The age and growth of the lake Erie white Bass, *Lepibema chrysops* (Raf) Pap. of Michigan Acad. of Sciences, Arts and Lett., Vol. XXVII.