STUDIES ON TILAPIA NILOTICA FROM LAKE NASSER

I. Macroscopic Characters Of Gonads

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I. INTRODUCTION

Lake Nasser is being formed on the construction of the High Dam in southern part of the United Arab Republic as a man-made lake. Its length is 500 km., of which about 350 extends in this country, with an average width of 10 km. Data available showed that fish production has progressively increased since 1966. The lake is inhabited by a number of species of which about 15 are of economic importance. *Tilapia nilotica* is the main species produced and in fact it alone comprises more than half of the fish consumed as fresh. The present work represents a contribution in our knowledge in the Biology of this important fish.

II. MATERIAL AND METHODS

Specimens of *T. nilotica* were collected during different months either from the commercial catch at the fish landing site of Asswan or during the exploratory fishing in the lake. Region, date, standard and total lengths as well as weight of the specimens were recorded. On opening the abdominal cavity the sex was indentified. The gonads were collected, weighed and preserved in 10% formalin.

The gonad index was computed as the percentage weight of the gonad to that of the body. Egg diameter was measured by an ocular micro-meter. Scales were adopted for age determination.

III. RESULTS

A. Relation Between Total Weight and Weight Minus Gonads

Data available for examining the relation between these two variables are shown in table (1). Actually the females examined have mature or maturing ovaries and their weight is rather significant. Immature ovaries are usually small and insignificant as compared with the total weight fish.

On the whole, it appears from Fig. 1 A that a direct relationships exists between the total weight and weight minus gonads in the females examined.

B. Relation Between Total And Gutted Weights

Due to the fact that the alimentary canal and the viscera in *T. nilotica* form a considerable part of the body weight, the relation between the total and gutted weights was examined in some females covering a considerable range. The data available are given in table (1) and graphically represented by Fig. 1.B. A straight line relationship between these two variables exists *i.e.* between the total and gutted weights The relation can be described by the equation : $Y = 1.083\text{-}311.8$ (where Y is the gutted weight and X is the total weight in gm.)

On this account the total weight of fish is reliable on relating it with the gonad weight in computation of the gonad index.

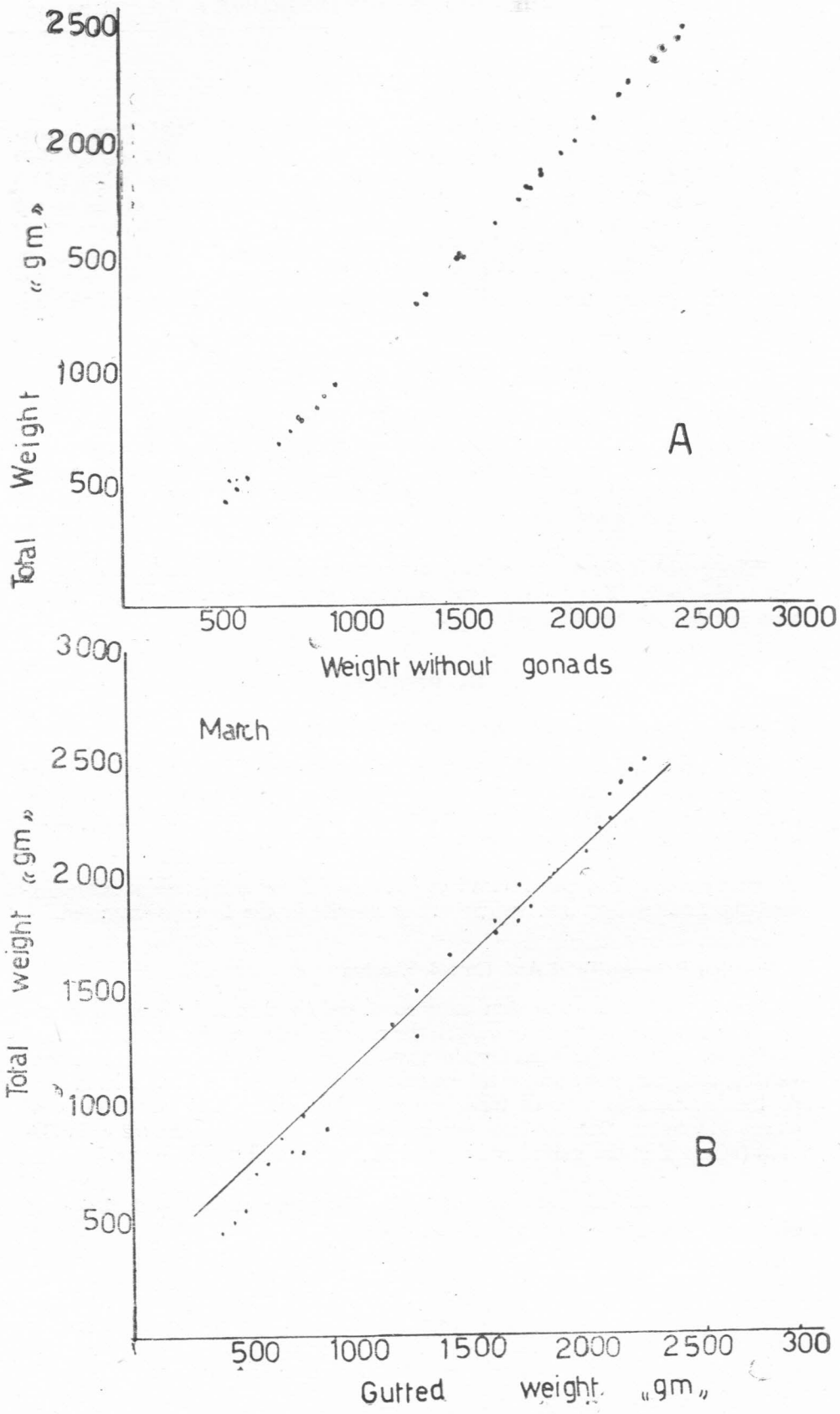

Fig. 1.— (A) Relation between total weight and weight minus gonads in *T. nilotica*.
(B) Relation between total and gutted weights.

TABLE 1— TOTAL AND GUTTED WEIGHTS AS WELL AS WEIGHT MINUS GONADS (IN GMS.) IN SOME SPECIMENS OF *T. nilotica*

Total weight	Gutted weight	Weight withcut gonad	Total weight	Gutted weight	Weight without gonad
1500	1400	1486	850	650	844
1800	1700	1772	800	750	785
2100	2000	2076	950	750	932
2200	2050	2180	1350	1150	1333
1850	1750	1832	700	550	680
2000	1850	1988	550	500	544
1500	1400	1491	900	850	892
1800	1600	1768	1500	1400	1467
1500	1250	1486	1800	1650	1787
2400	2150	2373	1750	1600	1740
1950	1700	1922	1850	1700	1837
750	600	738	800	700	789
2250	2100	2224	450	400	440
2500	2250	2466	500	450	489
2450	2200	2441	1300	1250	1290
2350	2100	2333	1650	1400	1627

C. Gonad Index

The gonad index of females or males which are considered to be sexually mature and 30 cm. long or more was examined for the different months of the year, as shown in table 2 and Fig. 2 This index of the female has two peaks in April and September whence the values recorded are 1.64 and 1.30 respectively. In the male, the average gonad index is much lower and is the highest in March (table 3, Fig. 3.). September shows another peak of gonad index but to a lower extent than that of the afore-mentioned month. On the whole, the gonad index for the different fishes whether males or females is not static but it varies in the different individuals. Thus, the gonad index covers a range whose extent varies in the different months (Figs. 2 and 3).

Furthermore, for finding out how far the sizes of the ovaries vary in different months, gonad indices of each of females or males are assorted into three groups, and the frequency of fishes belonging to each is estimated. Thus, the females (Table 4, Fig. 4) having gonad index less than one are most frequent in January, decreasing progressively in the following months up to April during which members of this gonad group are of least frequency in the whole year. The frequency increased in May, June and further in July during which all females belonged to this gonad index groups but decreasing afterwards in August and September. There is progressive increase for October till the end of the calender year.

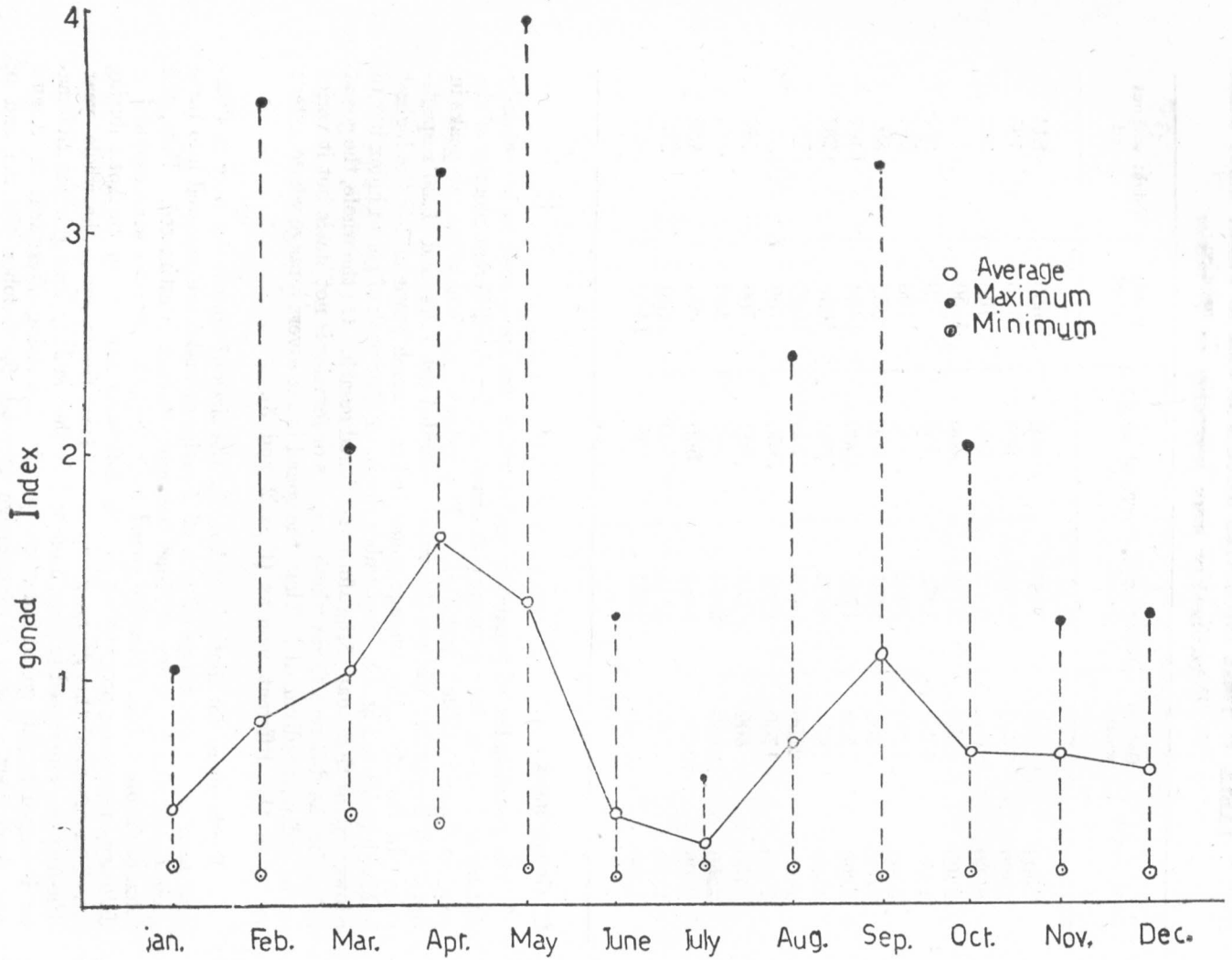

Fig. 2.—Average, maxima and minima of gonad index of females in different months.

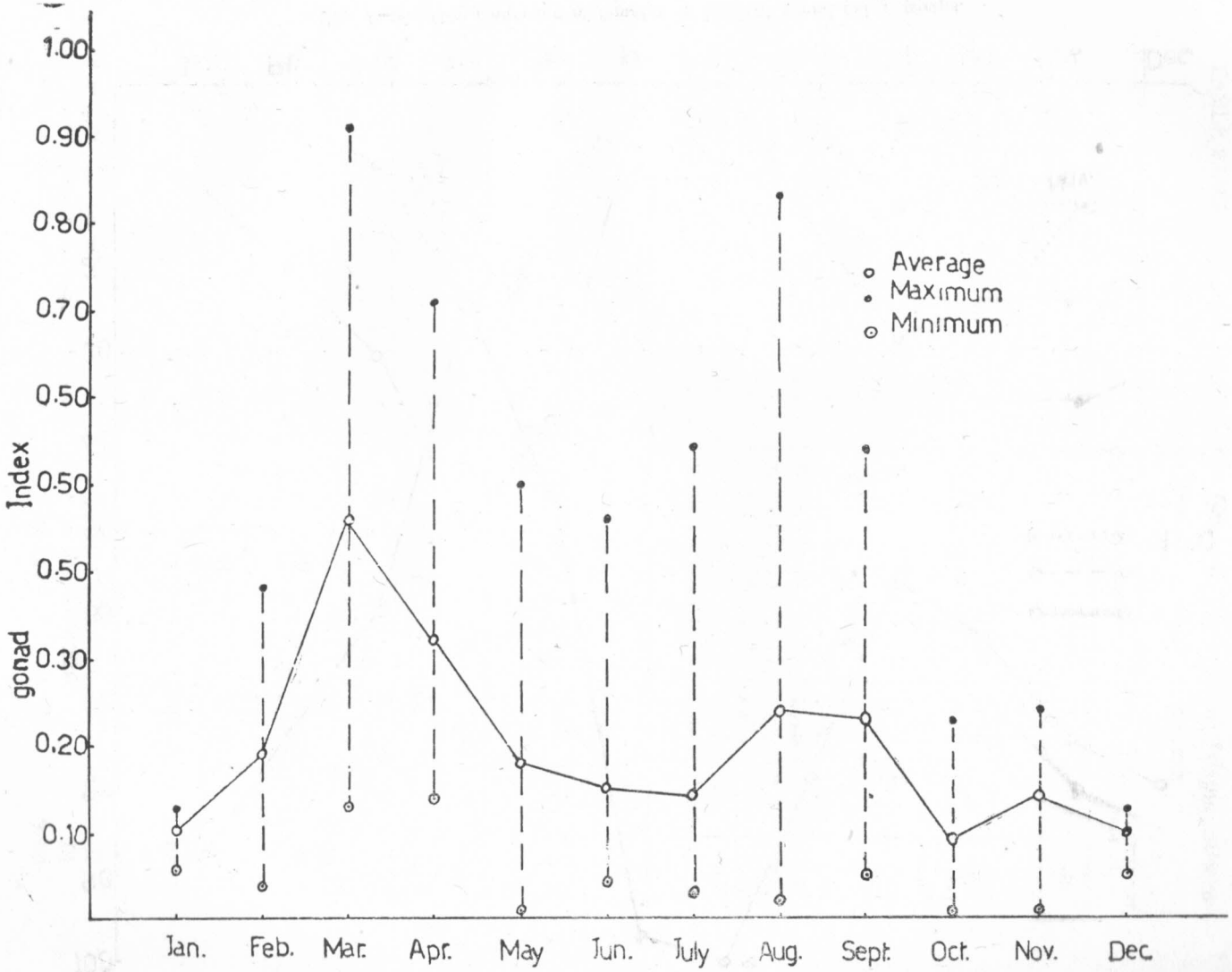

FIG. 3.—Average, maxima and minima of gonad index in males in different months.

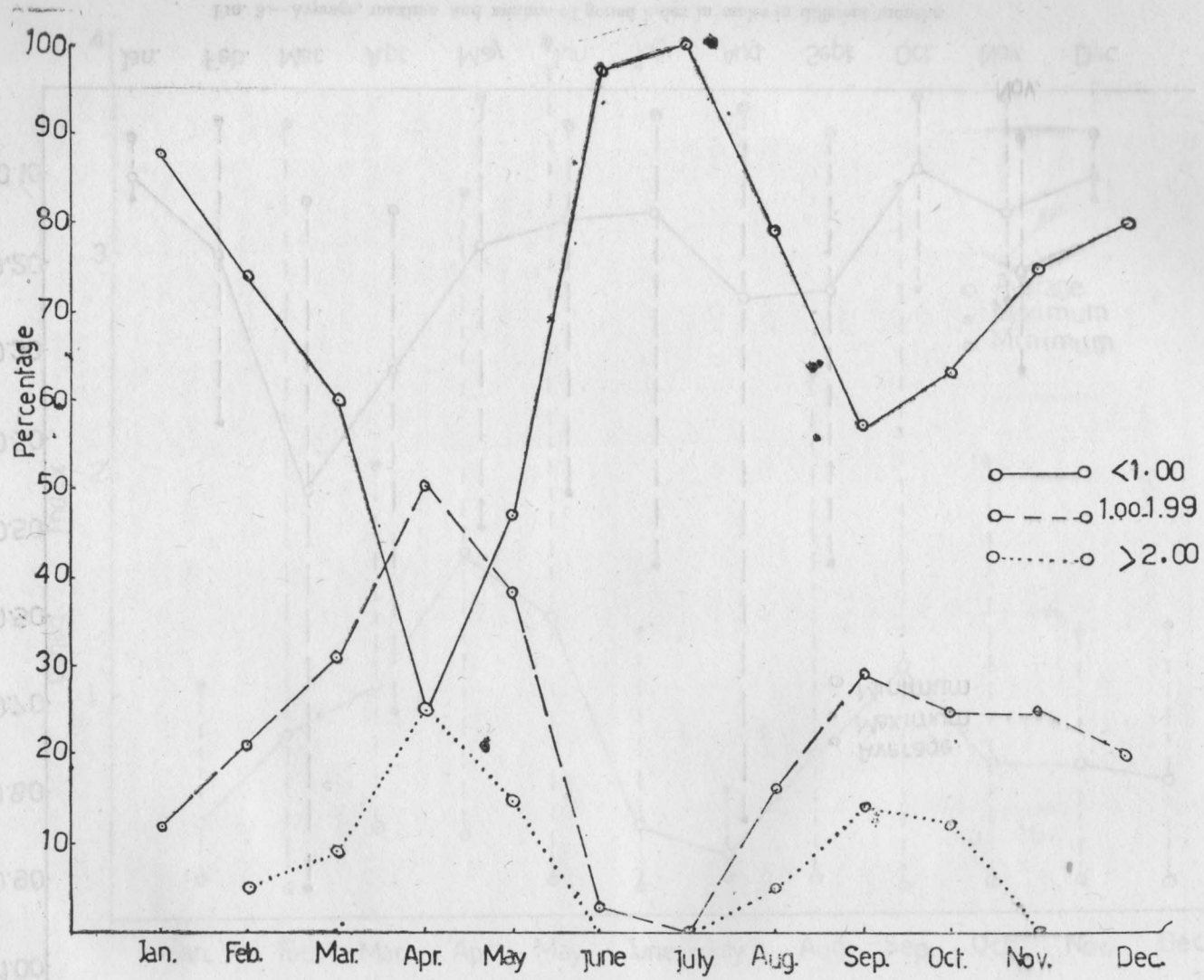

FIG. 4—Mouthly frequency of females of different gonad index groups.

TABLE 2.—GONAD INDEX AND EGG DIAMETER OF FEMALES OF *Tilapia nilotica* MORE THAN 30 CM. LONG DURING DIFFERENT MONTHS

Month	No. of Specimens	Genad Index			Egg diameter (u)		
		Av.	Max.	Min.	Av.	Max.	min.
January	5	0.43	1.05	0.18	1010	1770	500
February	17	0.82	3.58	0.15	1350	2540	800
March	30	1.05	2.04	0.40	1700	2600	1160
April	15	1.64	3.26	0.36	1820	2640	750
May	26	1.35	3.94	0.16	2000	3020	650
June	28	0.40	1.27	0.11	1130	2070	550
July	10	0.27	0.58	0.18	1030	1800	650
August	13	0.73	2.43	0.16	1310	2560	830
September	8	1.30	3.29	0.11	1760	2310	650
October	17	0.68	2.08	0.14	1270	2590	650
November	15	0.67	1.46	0.15	1380	2340	670
December	10	0.60	1.27	0.15	1250	2280	660

TABLE 3.—GONAD INDEX OF MALES OF *T. nilotica* (MORE THAN 30 CM. LONG) DURING DIFFERENT MONTHS

Months	No. of speciments	Gonad Index		
		Average	Max.	Min.
January	7	0.10	0.13	0.06
February	18	0.19	0.38	0.04
March	32	0.46	0.91	0.13
April	21	0.32	0.71	0.14
May	14	0.18	0.50	0.01
June	30	0.15	0.46	0.04
July	9	0.14	0.54	0.03
August	20	0.24	0.83	0.02
September	6	0.23	0.54	0.05
October	11	0.09	0.23	0.01
November	15	0.14	0.24	0.01
December	5	0.10	0.12	0.05

TABLE 4.—MONTHLY PERCENTAGE OF GONAD INDEX GROUPS OF FEMALES OF *T. nilotica*

Month	Gonad Index Groups					
	< 1.00		1.00–1.99		> 2.00	
	No. of fish	%	No. of fish	%	No. of fish	%
January	7	88	1	12	—	—
February	14	74	4	21	1	5
March	23	61	12	31	3	8
April	4	25	8	50	4	25
May	16	47	13	38	5	15
June	29	97	1	3	—	—
July	4	100	—	—	—	—
August	15	79	3	16	1	5
September	4	57	2	29	1	14
October	5	63	2	25	1	12
November	15	75	5	25	—	—
December	8	80	2	20	—	—

The females of the second group of gonad index (1.00-1.99) shows mostly a pattern which is the reverse to that of the first group. Thus, while the former group has the highest frequency in April, the latter is the least frequent in this month.

Females belonging to the third group are mostly the least frequent among gonad index groups examined and are recorded in January, May, July, November and December. In February through May, the trend of this group is comparable to that of the 2nd group. For August/October period, females of this groups are more frequent in September.

On the other hand, the males are assorted into three groups covering the gonad index ranges of < 0.20, 0.20,-0.39 and > 0.40 (Table 5, Fig. 5). Thus, the frequency of the males of the first group is 100% in January and decreasing greatly in February and further in March. The number of males having gonad index less than 0.20 is in April nearly comparable to that of March but much higher in May but decreases in June. In July, all males have gonad index less than 0.20, but only 55% of them in August belonged to this group. In September the frequency is 75% increasing to 83% in both October and November and to 100% in December.

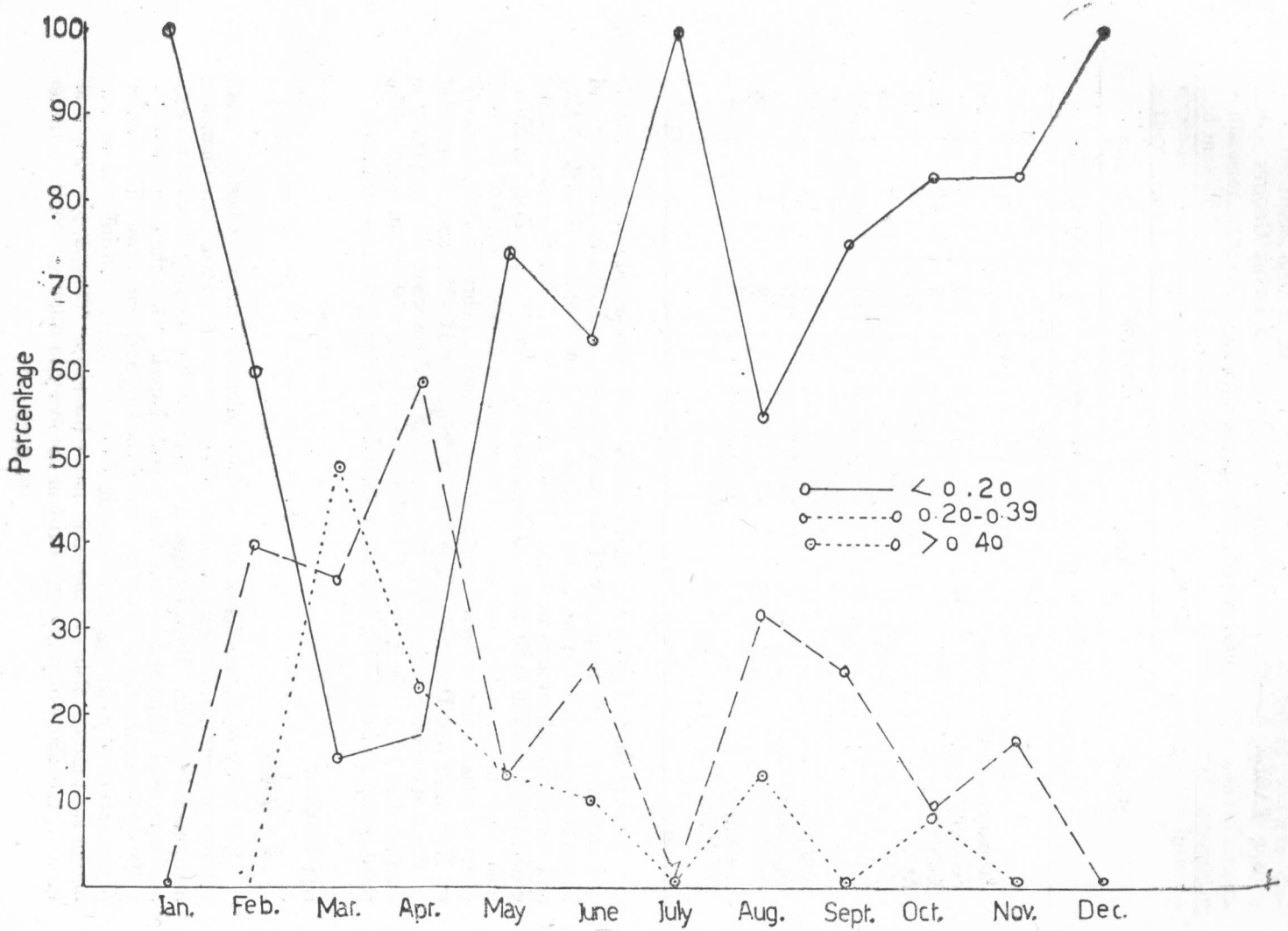

FIG 5.—Monthly frequency of a of differnt gonad ladex griups

TABLE 5.—MONTHLY PERCENTAGE OF GONAD INDEX GROUPS OF MALES OF *Tilapia nilotica.*

Month	Gonad Index Groups					
	< 0.20		0.20–0.39		> 0.40	
	No. of fish	%	No. of fish	%	No. of fish	%
January	8	100	—	—	—	—
February	12	60	8	40	—	—
March	6	15	14	36	19	49
April	4	18	13	59	5	23
May	11	74	2	13	2	13
June	20	64	8	26	3	10
July	9	100	—	—	—	—
August	16	55	9	32	4	13
September	6	75	2	25	—	—
October	10	83	1	9	1	8
November	15	83	3	17	—	—
December	8	100	—	—	—	—

Males of the 2nd group of gonad index are not represented in January, July and December. The frequency of the males is 40% and 36% in February and March respectively but much higher in April (59%) but decreases to 13% in May and decreasing afterwards in June. From August to October the males having gonad index between 0.20 and 0.39 decrease progressively in number. In November these are more frequent than in the preceding Month. Males of the third group of gonad index are not distinguished in Janaury, February, July, September, November and December. The highest frequency is 49% and is recorded in March decreasing successively afterwards up to June when the frequency is estimated as 10%. In August and October, the males with gonad index of the third group comprise 13% and 8% respectively of the specimens examined.

Egg Diameter

A. Yolky eggs

The ovary of *T. nilotica* as was revealed microscopically has besides small microscopic eggs different generations of yolky eggs which vary in their diameters and amount of yolk. Unyolky eggs are spherical but on yolk deposition, eggs aquire an oval shape and become finally pear-shaped. Thus the diameter of the yolky eggs was considered as the average of the long and short axes. The number of generations of yolky eggs in the examined ovaries varies in the different months and in the different fishes of the same month (table 6). Thus, at least 2 and at most 7 generations of yolky eggs exist in the ovary in different months. In the

latter condition, eggs of the oldest generation may be from 1940 to 2950 u in diameter. When 6 generations are present, oldest eggs ranged from 1770 to 2640 u in diameter. Other conclusions can be afferded from table 7. Thus, the minimum and maximum egg diametes of the oldest eggs of different ovaries apparently depended on the ovarian generations of yolky eggs and increases with the increase in their number (Table 7, Fig. 6).

TABLE 6.—NUMBER OF GENERATIONS OF YOLKY EGGS IN DIFFERENT MONTHS

Month	Number of generations	Diameter of oldest eggs (u)	
		Maximum	Minimum
January	2—6	1770	470
February	4—7	2950	1050
March	5—6	2400	1000
April	5—6	2640	1780
May	3—5	2580	950
June	4—6	2150	1400
July	3—5	1000	650
August	6—7	2100	1570
September	2—6	2300	550
October	5—6	1800	1300
November	3—7	1940	1000
December	4—6	2580	990

TABLE 7.—EGG DIAMETER OF THE OLDEST EGGS OF OVARIES OF DIFFERENT GENERATIONS OF YOLKY EGGS.

No. of Generations	Diameter (u) range of oldest eggs
2	470—550
3	650—1000
4	990—1400
5	1000—2580
6	1770—2640
7	1940—2950

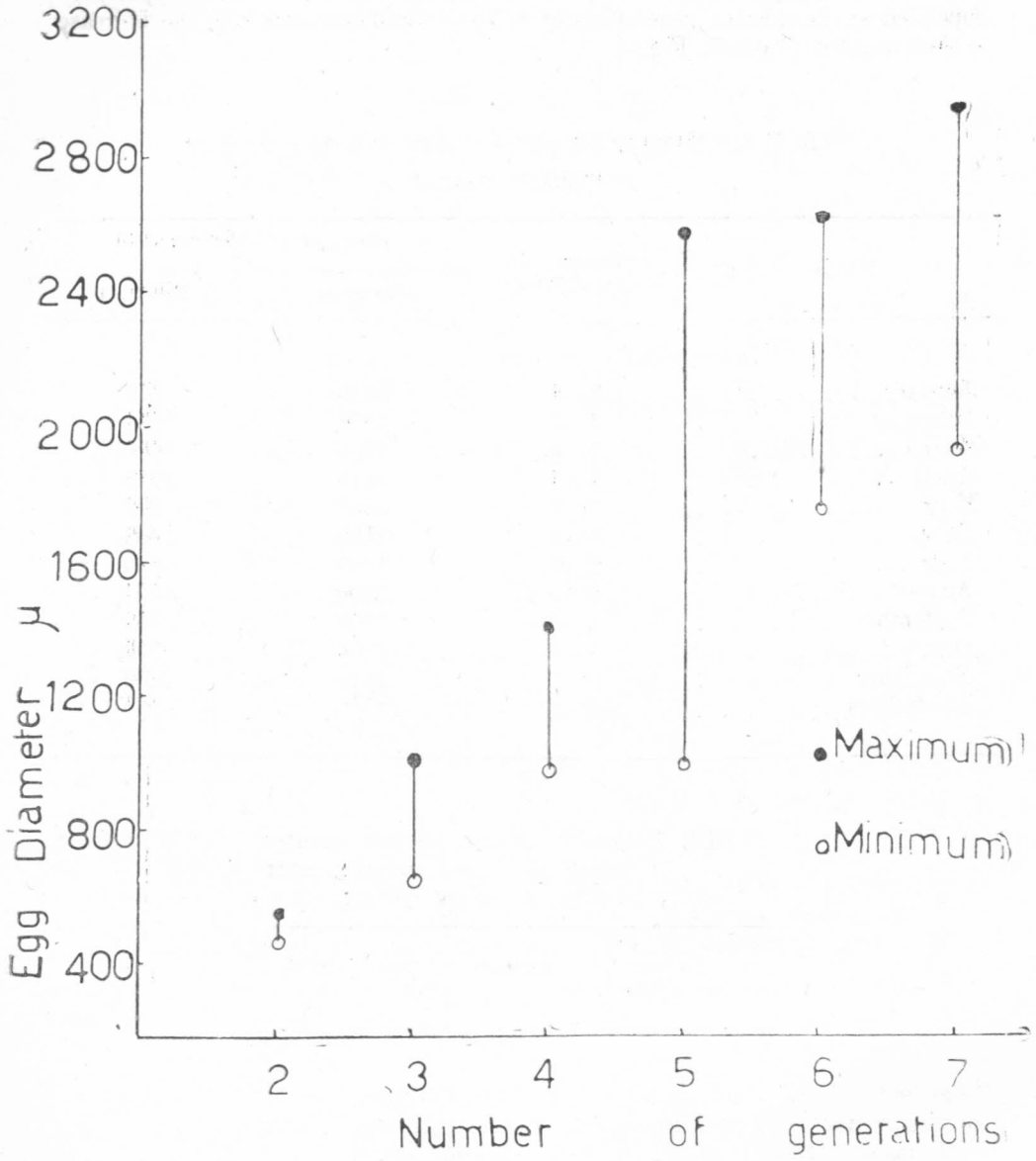

FIG. 6.—Range of diameter of oldest eggs on presence of different generations of yolky eggs.

Table 8 shows diameters of eggs of different generations in some ovaries collected in different months. They include ovaries having 3, 5, 6 and 7 generation of yolky eggs. In general, there is "gradual" decrease in the egg diameter from an older generation to the following one. The average diameter of eggs of different generations when 5, 6 and 7 generations of yolky eggs are shown in table 9 and Fig. 7.

TABLE 8.—EGG DIAMETER (U) OF YOLKY EGGS OF DIFFERENT GENERATIONS

Month	Standard length (cm.)	Number of generations						
		1	2	3	4	6	6	7
		Egg diameter (u)						
February	39	2375	1800	1550	875	700	500	400
March	28	2200	1125	850	550	400		
	34	2375	1025	875	500	400		
	23	2175	1063	875	625	400		
	24	1763	1375	1150	575	400		
	27	2275	975	800	550	400		
	37	1488	1338	975	563	400		
	40	1400	1100	888	588	400		
April	32	1878	1625	1115	625	400		
	43	2642	2150	1163	800	495	350	
June	38	700	605	400				
August	40	2025	1700	975	800	675	575	400
September	30	2312	1850	563	438	300		
October	35	1375	1138	962	638	400		
December	34	1175	950	825	675	575	400	

TABLE 9.—AVERAGE EGG DIAMETER (U) OF DIFFERENT GENERATIONS OF YOLKY EGGS

No. of generations per ovary	Average egg diameter (u)						
	1	2	3	4	5	6	7
7	2200	1750	1260	840	690	540	400
6	1910	1550	995	740	535	375	
5	1925	1260	905	565	390		

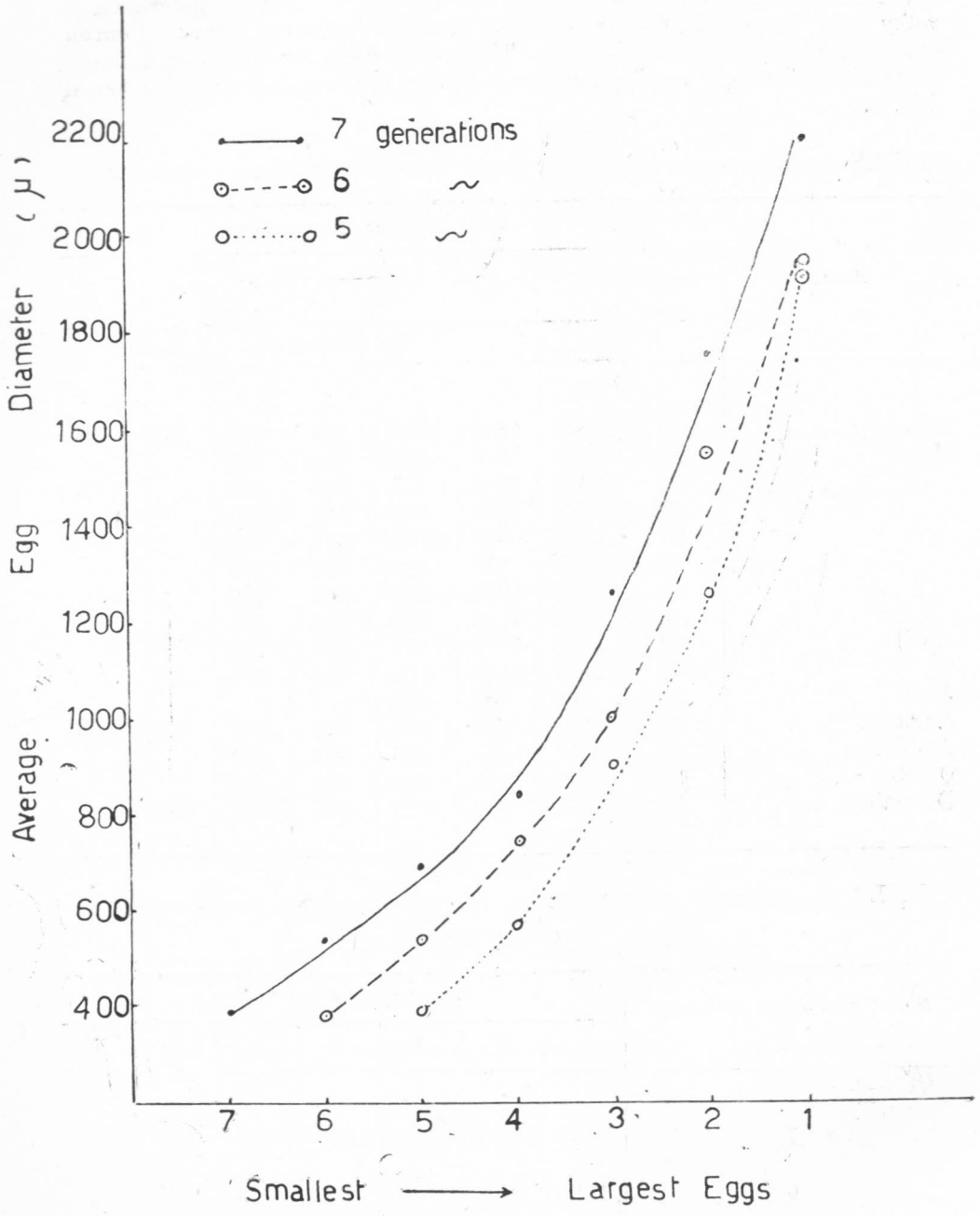

FIG. 7.—Relation between diameter of different eggs on presence of 7, 6 and 5 generations of yolky eggs.

B. *Largest eggs all over the year*

As seen from table 2 and Fig. 8, the average diameter of the oldest eggs has two modes which are distinguished in May and September for the females which are 30 cm. long or more. In turn, within each month, this diameter varies considerably among the different specimens and the widest range of variation is seen in May (Fig. 8).

Moreover, for following the frequency of ovaries with largest eggs of different sizes, the diameters are assorted into three groups<1500, 1500-1999 and>2000 u. Frequency of females belonging to each group were examined for the different months (Table 10). Thus, in January, the frequency of females having the oldest eggs belonging to the first group is 80 % and this decreases progressively to April where the least frequency is recorded. There is a slight increase in frequency in May but large increase is recorded in June and July. The frequency decreases in August and further to September. For October, the frequency of females of the first group is much higher than in preceding month. In November this frequency is comparable but it is higher in December.

TABLE 10:—FREQUENCY OF FEMALES OF DIFFERENT EGG DIAMETER RANGES IN DIFFERENT MONTHS

Months	Range of egg diameter (u)		
	< 1500	1500 - 1999	> 2000
	PERCENTAGE		
January	80	20	—
February	56	38	6
March	36	36	28
April	20	47	33
May	32	32	36
June	71	22	7
July	75	25	—
August	64	27	9
September	20	20	60
October	67	17	17
November	64	18	18
December	80	—	20

For the second group of egg diameter range the frequency of females mostly goes on increasing up to April but again decreases in May and June but shows some increase in July and August. This frequency of females is in September, October and November nearly comparable and it is much lower than that of the first egg diameter group in the last two months.

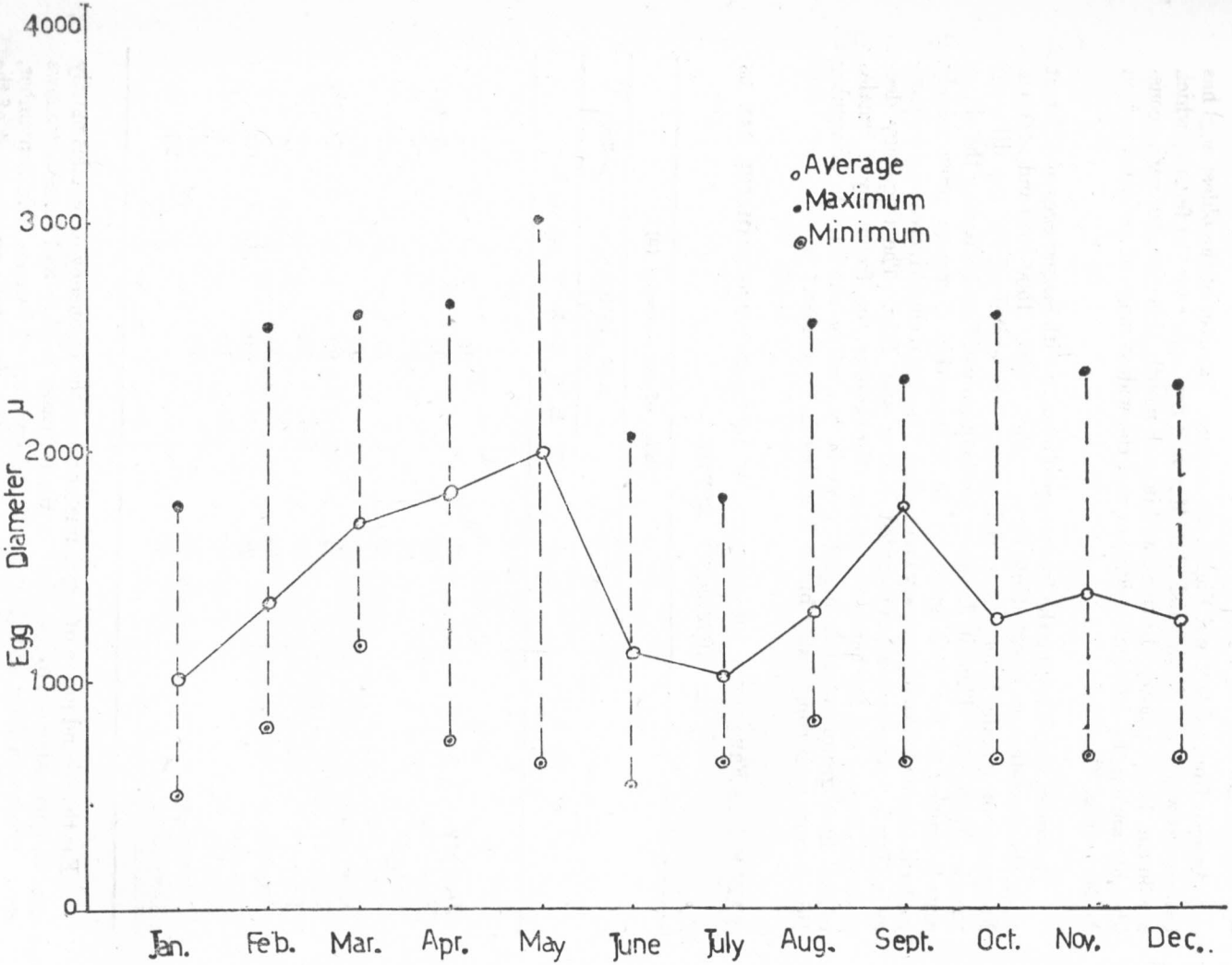

FIG. 8.—Monthly average, maxima and minima of diameter of largest eggs.

Lastly, the females of third egg diameter group are not distinguished either in January or July. Their frequency gradually increases from February to May but decreases in June and August. September shows an abrupt increase and is followed by a sharp decrease in October which has figures nearly comparable to those of November and December.

C. *Relation between weights of eggs and ovary*

This part entails finding out the relationship between the weight of the oldest eggs with that of the ovary and clarifies to what extent the yolky eggs of the other generations contribute in this weight. For this purpose, the weight of largest eggs of varying diameters in 30 different ovaries aws examined. The data available are given in tables (11 and 12). Thus as shown in Fig. 9 the increase in the size of the yolky eggs is accompanied by an increase in their weight. The relation between these two variables is curvilinear. While 100 eggs of about 1100 u diameter have a weight of 40 mgms., the same amount of eggs reaches a weight of 620 mgms on attaining a diameter of about 2700 u.

TABLE 11.– VARIATION IN WEIGHT OF LARGEST EGGS AND THEIR PERCENTAGE WEIGHT IN THE OVARY ON CHANGE IN THEIR DIAMETER

Egg Diameter (u)	Weight of 00 eggs 1 mgm)	% weight of eggs to ovary weight	Egg diam. (u)	Weight of 100 eggs (mgm)	% weight of eggs to ovary weight
1081	40	24.0	1895	240	66.0
1157	50	44.8	1898	200	78.5
1300	40	43.6	1900	170	69.8
1344	60	52.5	1944	240	74.8
1350	90	58.7	2088	310	78.7
1374	80	54.8	2088	290	85.0
1500	70	29.0	2095	240	69.4
1694	160	65 0	2101	330	64 0
1737	190	74 8	2150	200	68.0
1791	200	65.0	2288	370	81.0
1811	220	69.0	2298	400	69.0
1821	200	72.0	2411	460	76.0
1858	240	68.0	2548	480	89.0
1867	210	64.4	5882	580	89.0
1867	220	73.0	2735	620	86.0

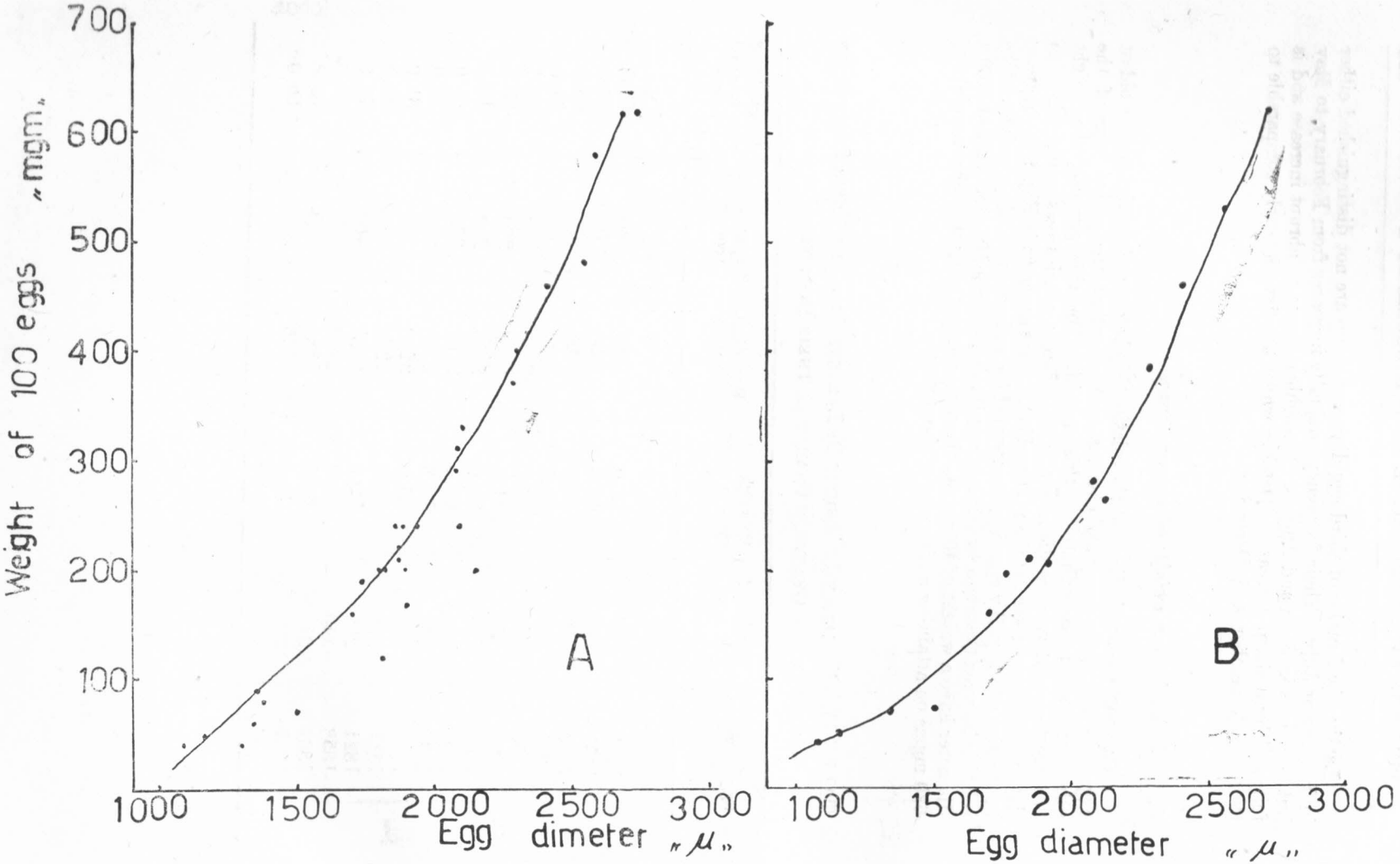

FIG. 9.—Relation between weight and diameter of eggs: (A) Actual (B) Average.

TABLE 12.—Relation Between Diameter And Weight Of Oldest Eggs And Their Percentage Weight In The Ovary.

Ave rage egg diameter (u)	Weight of 100 eggs (mgm)	% weight of largest eggs to ovary weight
1081	40	24
1160	50	45
1340	68	52
1500	70	29
1695	160	65
1765	195	70
1870	218	70
1920	205	72
2090	280	78
2125	265	66
2295	385	75
2410	460	76
2570	530	89
2735	620	86

Moreover, the increase in the diameter of the eggs of the oldest generation causes a subsequent increase in the percentage weight of these eggs in the ovary. Thus, eggs with a diameter more than 2500 u comprise more than 85 % of the ovary weight. This reveals that under these conditions the oldest eggs form most of the mass of ovary. Oldest eggs about 1100 u form only one fourth of the ovary weight. On the whole, the relation between the diameter of oldest eggs and their percentage weight in the ovary tends to be linear (Fig. 10).

IV. DISCUSSION

Tilapia nilotica is the most economic species in Lake Nasser. The present study is a contribution in studying the biology of this fish and entials describing the macroscopic peculiarities of the gonads whether in males or females along the different months.

Thus, the gonad index estimated as the percentage weight of the gonad to that of the body is different in the different months of the year. Whether in male or female, 30 cm. long or more, the average gonad index has apparently two modes. In the former sex, these modes appear in March and August and one month in advance of these modes recorded in the female, However, in the different months, this index is not static but there is a wide range whereby males or females have different indices in one and the same month. One the whole, the ovary attains a weight which is much heavier than that of the testis. Thus, while the maximum ovarian index is 3.94, the maximum testis index is 0.91.

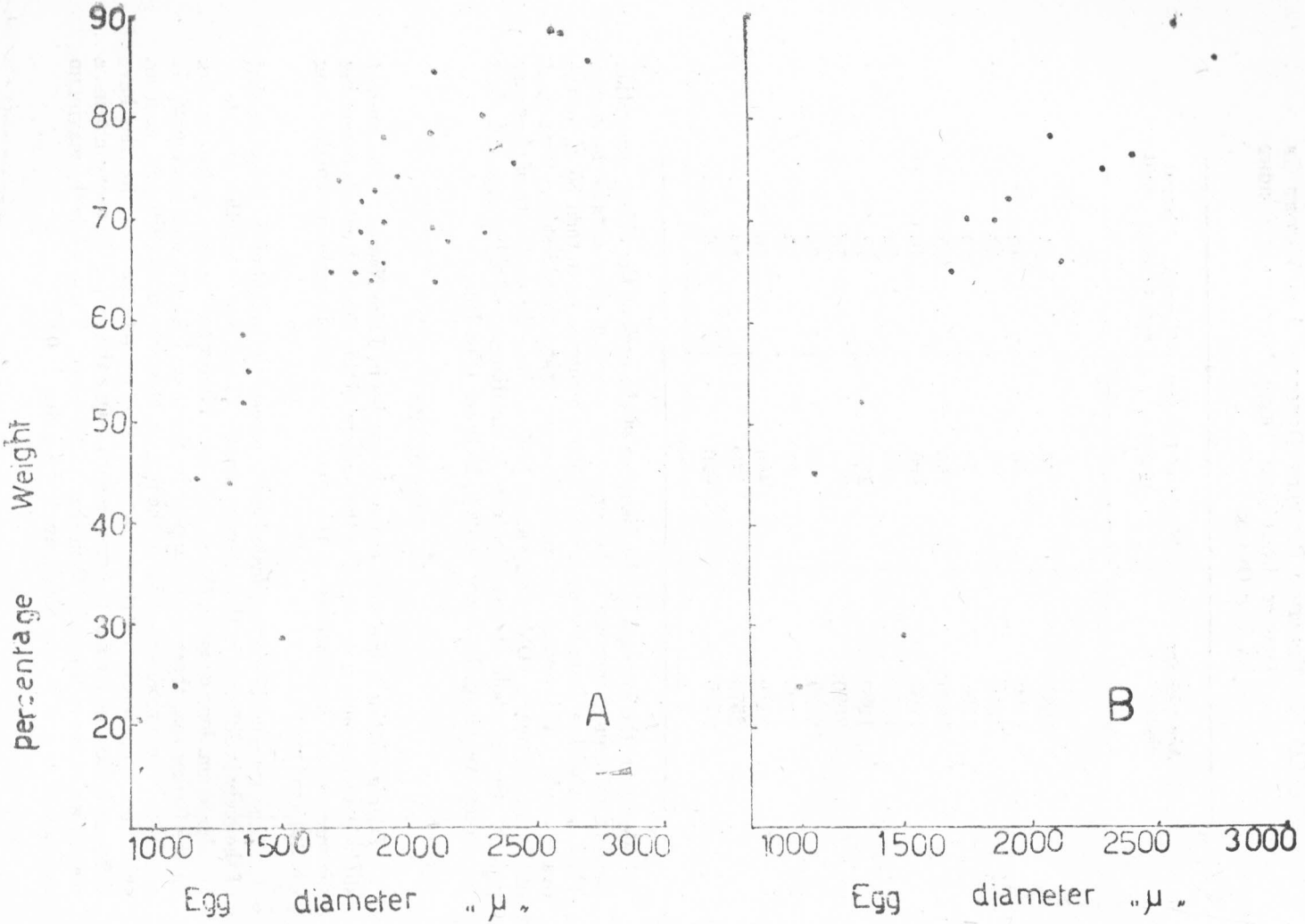

FIG. 10.—Variation in percentage weight of eggs of ovary weight with increase in size of egg: (A) actual (B) Average.

The frequency of females having gonad index less than one decreases from January to April but increases from May till July but redecreases from August and further to September but goes on increasing till the end of the year. A reverse condition is seen with the ovaries whose index is higher and therefore in April when the frequency of the first gonad index group is the lowest, that of the second (1-1.99) and third (>2.00) groups is the highest. On the whole, females having ovary index > 2.00 is not recorded in January, June, July, November and December.

All the males have gonad index less than 0.20 in January, July, and December but they are the least frequent in March. Males having gonad index >0.40 are detected in six months but they are most frequent in March. Males having gonad index 0.20 - 0.39 are detected along February to June and from August to November and are most frequent in April.

Tilapia nilotica of Lake Nasser is a fractional spawning species. Yolky eggs of different sizes can be differentiated in the different months whereby from 2 to 7 generations of these eggs can be assorted. It can be concluded that in Lake Nasser, *Tilapia nilotica* is more "productive" than in the River Nile as in vicinity of Cairo where only 5 generations of yolky eggs were described early in summer (Gohar, Latif and Mohammad, 1972).

Ovaries having the largest eggs more than 2000 u in diameter can be distinguished in most months but their frequency is the highest in May and September whence the highest gonad index is also demarcated. It can therefore be concluded that *T. nilotica* spawns most of the year in Lake Nasser and is therefore different from what prevails in the River Nile where the spawning season extends from May to September in the neighbourhood of Cairo.

Moreover, the average diameter of the largest eggs increases progressively till May decreasing afterwards till July but increases in August and further in September. These eggs vary considerably in diameter in different fishes in one and the same month so that for the different months the diameter of oldest eggs shows a wide range of variation. The mature or ripe egg is pear or egg shaped (Latif & Rasbid, 1971).

In addition the increase in the size of the largest eggs is accompanied by increase in their share in the weight of the ovary. Thus while eggs having a diameter of about 1000 u form only about 1 / 4 of ovary weight these having diameter 2000 u or more form more than 65 % of ovary weight. In other words, under the mature or ripe conditions, the largest eggs form the main mass of the ovary.

V. SUMMARY

1. Individuals of either males or females have monthly different gonad index values, whose average has two modes recorded in April and September in female and in March and August in male.

2. About 80 % or more of females have gonad index less than 1 in January, June, July. August and December and their frequency decreases from January till April, increases till July, redecreases till September but reincreases till end of the year. Frequency of females with higher gonad index showed reverse pattern.

3. Males with gonad index less than 0.20 are least frequent in March and April but 55 % or more of males have this index in the remaining months of the year. All males have this index in January, July and December. Males with higher gonad index show a reverse pattern but those with testis index more than 0.40 are not represented in January, February, July, September, November and December.

4. *Tilapia nilotica* in Lake Nasser spawn portionally and 2 - 7 generations of yolky eggs of different size are distinguished. There is a gradual decrease in the egg diameter from an older generation to the following one.

5. Diameter of largest eggs varies in different females in different months but the average diameter has two peaks appearing in May and September.

6. Spawning takes place in most months of the year and females having yolky eggs more than 2000 u in diameter prevail most of the year.

7. The increase in the size of the egg is accompanied by an increase in its weight. Eggs having diameter 2000 u or more comprise more than 65% of ovary weight.

VI. REFERENCES

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