

**FAT METABOLISM IN TILAPIAZILLII GERV.**

**I. Seasonal Variation in the General Condition and Feeding Activity of  
*Tilapiazillii* from lake maruit.**

*By*

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## INTRODUCTION

The three cichlid species of the genus *Tilapia* namely *Tilapia zillii*, *Tilapia nilotica* and *Tilapia galilae* are economically important fishes supporting the fishing industry of inland and lake waters in Egypt. Of these species, *Tilapia zillii* is perhaps the most common, it is a prolific fish which attains sexual maturity during its first year of life, and is capable of with-standing increasing salinity in its ambient medium up to 29‰. For this reason it has a more wider distribution.

The biology of *Tilapia zillii* in different habitats has been the subject of various studies, particularly its population in lake Quarun and Lake Mariut. (El Zarka, 1962 ; Shaheen, 1969 ; Botros, 1969). It is aimed in this study to outline the fat metabolism in this fish and the biological factors affecting the changes in the fat content of its various organs. These studies are essential for the completion of the physio-ecology of the fish, which would help in the estimation of its economic importance in fish culture.

### Methods and Technique :

Sampling was carried out during the period from May 1966 to June 1967 ; sample of 50-70 fish was taken alive at fortnightly intervals from a fixed area in Lake Mariut where *Tilapia zillii* is considered to be the predominant species. After recording the total and standard lengths and total weight of each fish in the sample, the weights of the gonad, liver and alimentary canal were taken accurately and the gutted weight (i.e. the total fish weight minus the weights of liver gonad and gut) of fish was also recorded.

### Results and Discussion :

(a) The breeding activity as indicated from the gonadosomatic index G.S.I.

The gonadosomatic index (G.S.I.) expressed by

$$= \frac{\text{weight of gonad} \times 100}{\text{gutted weight of the fish}}$$

is taken as an indication of sexual activity in female fish.

The monthly mean values of the G.S.I. for the female and male *Tilapia zillii* are graphically represented in Fig. 1. The mean G.S.I. in the female fish varies between 0.472 in November and 9.48 in June ; it is significantly less in males varying between 0.17 in November and 0.78 in June. In both sexes, the G.S.I. increases significantly in the interval from April to September and shows two pronounced rises, a major one in June and a minor one in September. This means that the fish spawns twice during its breeding season, or in other words, it is a fractional or partial spawner with two spawning sheds separated by a period of gonad reactivation. The first shed which is the major one, occurs in May - June and the second shed takes place in September. The increase of

G.S.I. from April to September is accompanied by high water temperature of over 21°C while the peaks coincide with water temperature over 25°C. Welman (1948) showed that the equatorial climate in Nigeria induced *Tilapia zillii* to spawn all the year with a climax in spring.

(b) Monthly variation of the Hepatosomatic Index or Liver Condition (KL).

The hepatosomatic index H.S.I. is an indication of the liver condition and it is expressed by the equation :

$$\text{H.S.I.} = \frac{\text{weight of the liver} \times 100}{\text{gutted weight of the fish}}$$

The monthly mean values of the hepatosomatic index H.S.I. were calculated for the females and males, are graphically represented in Fig. 2.

The mean values in the females range between 4.17 in April and 1.56 in October, in the males, they range between 3.89 in March and 1.25 in July. The H.S.I. in the female is higher than that in the male all the year round specially prior to spawning in March and April. It is evident that the hepatosomatic index H.S.I. in the males and females reaches its maximum respectively in March and April i.e. the months preceding breeding activity of the fish. It sharply decreases in May and June and this coincides with the first spawning activity of the fish. The H.S.I. increases again in August and shows another peak in September for both females and males. This rise is due mostly to the decrease in the gutted weight due to the exhaustion of the fish after spawning. The increase in liver weight in July and August takes place before the fish performs its second spawning activity.

(c) Monthly Variation in the Gutted Weight and the Condition of Fish Flesh K<sub>b</sub> :

The condition of the fish flesh was studied by two ways :

1. Monthly calculation of the gutted weight of the fish for the most frequent length in the samples (11.5 cm total length) according to the method of Russell (1922).

2. Monthly calculation of the condition of the fish flesh K<sub>f</sub> according to the method of Graham (1923) in which :

$$K_f = \frac{w \times 100}{L^3}$$

where w = gutted weight in gms and L = standard length in cms.

TABLE 1.—MONTHLY VARIATION OF THE GONADOSOMATIC INDEX (G.S.I.) OF FEMALE AND MALE *Tilapia zillii* AND THE MONTHLY WATER TEMPERATURE OF BAB-EL-ABID AREA (LAKE MARIUT).

Month	The average G.S.I. of the female fish	The average G.S.I. of the male fish	Water temperature °C
January . . . . .	0.546	0.29	13.8
February . . . . .	0.556	0.23	13.6
March . . . . .	0.795	0.29	18.7
April . . . . .	4.467	0.42	21.8
May . . . . .	9.101	0.63	25.5
June . . . . .	9.482	0.78	25.7
July . . . . .	3.892	0.41	26.5
August . . . . .	4.962	0.54	28.1
September . . . . .	5.766	0.68	26.0
October . . . . .	1.198	0.26	22.0
November . . . . .	0.472	0.17	20.5
December . . . . .	0.513	0.23	17.4

The monthly variations of gutted weight in females and males are graphically represented in Fig. 3. The gutted weight of the most frequent length group (11.5 cm) varies in both sexes from 21 gm to 30 and 32 gm in the males and females, respectively. It shows two low values one in June and the second in September. These coincide with the time of full ripeness of the fish. The two rises in the gutted weight in March and in August are due to the increase in the rate of feeding and the fat content in the muscles.

Monthly calculation of the condition of the fish flesh Kf for females and males was also done for fishes of standard length 10 cm (or 11.5 cm total length), and are graphically represented in Fig. 4. It is noted from the figure that the condition of the fish flesh Kf shows two peaks one in March and the other August. The two drops occur in June and September respectively. They are more pronounced in the females than in the males. This could be explained as due to the greater draw of females on their somatic tissue during their breeding activity and hence their muscles become more emaciated.

TABLE 2.—MONTHLY VALUES OF THE HEPATOSOMATIC INDEX (H.S.I.) OR LIVER CONDITION, THE AVERAGE WEIGHT OF THE LIVER AND GUTTED WEIGHT FOR FEMALE AND MALE *Tilapia zillii*.

Month	Females			Males		
	H.S.I.	Average weight of liver in grams	Gutted weight in grams	H.S.I.	Average weight of liver in grams	Gutted weight in grams
January . . . . .	2.87	0.67	23.4	2.64	0.66	25.0
February . . . . .	2.77	0.73	26.4	2.67	0.73	27.4
March . . . . .	3.90	1.195	30.6	3.89	1.17	30.1
April . . . . .	14.7	1.13	27.9	3.34	0.92	27.2
May . . . . .	2.29	0.58	25.3	1.84	0.47	25.5
June . . . . .	2.55	0.54	21.2	1.88	0.41	21.8
July . . . . .	2.05	0.61	29.7	1.25	0.30	24.0
August . . . . .	2.29	0.75	32.8	1.76	0.51	28.9
September . . . . .	3.20	0.76	23.8	2.07	0.44	21.3
October . . . . .	1.56	0.39	25.0	1.61	0.40	24.9
November . . . . .	2.36	0.64	27.1	1.72	0.46	26.7
December . . . . .	2.99	0.79	26.5	2.20	0.56	25.5

TABLE 3.—MONTHLY VALUES OF THE GUTTED WEIGHT FOR FEMALES AND MALE *Tilapia zillii* (OF 10 CM STANDARD LENGTH EQUIVALENT TO 11.5 CM TOTAL LENGTH).

Month	Gutted weight of the female (grams)	Gutted weight of the male (grams)
January . . . . .	23.34	25.0
February . . . . .	26.30	27.1
March . . . . .	30.64	30.1
April . . . . .	26.86	27.7
May . . . . .	25.38	25.8
June . . . . .	21.05	21.8
July . . . . .	29.98	24.1
August . . . . .	32.76	29.1
September . . . . .	23.90	21.2
October . . . . .	25.32	25.1
November . . . . .	26.53	27.0
December . . . . .	26.56	25.4

It is obvious that when the fish is preparing itself for a spawning and the gonads are growing to full ripeness, the condition of the fish flesh decreases and the fish becomes leaner. The inverse relation between the condition of the fish flesh and gonad maturity is also quite apparent when a rapid but a short recovery of the fish condition takes place in the time interval separating the two breeding activity of June and September.

## (d) Seasonal variation in the Rate of Feeding in Relation to the Breeding Activity and its Effect on the Fish Condition :

The seasonal variation in the rate of feeding was estimated from the monthly variations of the weight of the gut. The monthly variation in the food index (F.I.) expressed by the formula :

$$= \frac{\text{weight of gut} \times 100}{\text{gutted weight}}$$

is graphically represented in Fig. 5.

TABLE 4.—MONTHLY VALUES OF THE CONDITION OF THE FISH FLESH  $K_f$  FOR FEMALE AND MALE *Tilapia zillii*, WHERE  $K_f = \frac{w \times 100}{l^3}$

Month	Condition of the fish flesh $K_f$ of the female fish	Condition of the fish flesh $K_f$ of the male fish
January . . . . .	2.26	2.43
February . . . . .	2.55	2.63
March . . . . .	2.89	2.89
April . . . . .	2.44	2.66
May . . . . .	2.25	2.51
June . . . . .	1.85	2.12
July . . . . .	2.83	2.37
August . . . . .	3.10	2.85
September . . . . .	2.18	2.10
October . . . . .	2.35	2.45
November . . . . .	2.58	2.64
December . . . . .	2.57	2.48

It is obvious from the graph, that the fish feeds actively throughout autumn and winter. The feeding activity decreases from April and becomes very low in June and September; the fish feeds actively in between these two months as indicated from the increase in the food index.

The monthly variation of the weight of the gut, the condition of the fish flesh (K-), the condition of the liver (H.S.I.) and the condition of the gonads (G.S.I.) are illustrated in Fig. 6.

It is noticed that in March and April, before the full ripeness of the fish, the rate of feeding is high and the fish store reserve material. This is reflected on the high condition of the fish flesh (Kf) and the high condition of the liver (H.S.I.). The decrease of feeding activity just prior to spawning and at the same time the high demand of the fish on its fat and protein reserve necessary for gonad ripeness and breeding activity affects greatly the material stored and leads to the poor condition of both the fish flesh and liver in July and August, before the second breeding activity of September, the fish feeds vigorously, and the condition of both the fish flesh and liver improve.

During winter, the feeding activity (as judged from the small amounts of food in the fish stomach) decreases and this is probably due to low temperature. The relatively high value of gut weight during that time is mostly due to the mesenteric fat which covers the gut.

To sum up it could be said that the improving in the conditions of liver and muscles usually accompanies an increase in the feeding activity of the fish which generally precedes the ripeness of gonad. These conditions drop at full gonad ripeness and also immediately after the fish performs its spawning.

The results obtained from tracing the seasonal variation in the general condition of *Tilapia zillii* as described before are in accordance with those obtained from similar studies on other fishes. Russell (1922), in his study on the cod *Gadus morrhua* L., found that this fish loses weight during the spawning period, while it gains weight outside this period. Graham (1923) found that in *Gadus morrhua* there is a small fall in the flesh condition of the immature fish in autumn, due to a sudden growth in length. The significant drop taking place in the flesh of mature fish in summer, seems to be connected with the maturity and spawning. Hickling (1930) found that the major seasonal changes in the weight and condition of the somatic tissues (body muscles and the liver) of the mature Hake "*Merluccius merluccius* L." are attributed to spawning. Both the conditions of muscles and liver undergo seasonal fluctuation; after reaching an optimum prior to the breeding season, they show a progressive loss which is due to the transference of material from the somatic tissues to the ripening gonads. This is followed by a gradual recovery after spawning until again the optimum condition is retained. Fradu (1947) found from his investigation on more than 600 individuals of the albacore "*Neohyunnus albacore* L" that the ratio  $\frac{\text{weight of the liver}}{\text{weight of the head}} = \text{H.C.I.}$



undergoes an important diminution of about 20 — 25 % as the fish passes to reproduction. Olivereau & Loloup (1950) determined the R.H.S. and R.H.L. in "*Scyllium canicula* L" where  $R.H.S. = \frac{\text{weight of the liver} \times 100}{\text{total weight of the body}}$  and  $R.H.L. = \frac{\text{weight of the liver} \times 100}{\text{length of the animal}}$ .

TABLE 5.—MONTHLY VALUES OF THE WEIGHT OF THE GUT AND THE FOOD INDEX FOR FEMALE AND MALE *Tilapia zillii*.

Month	Male		Female	
	Weight of the gut in grams	Food index	Weight of the gut in grams	Food index
January . . . . .	2.6	1.04	2.36	1.01
February . . . . .	4.0	1.47	3.33	1.27
March . . . . .	3.2	1.06	3.68	1.21
April . . . . .	2.5	0.90	2.25	0.84
May . . . . .	2.0	0.77	2.01	0.79
June . . . . .	1.7	0.77	1.69	0.80
July . . . . .	2.1	0.87	2.77	0.91
August . . . . .	3.4	1.16	3.08	0.94
September . . . . .	2.0	0.93	2.05	0.85
October . . . . .	3.5	1.30	3.37	1.29
November . . . . .	3.6	1.33	3.51	1.32
December . . . . .	2.8	1.10	3.94	1.48

They found that these two ratios are lower in young animals, and slightly higher in adult fish. They decrease with the development of eggs, increasing with the movement of eggs in the oviduct and decrease again after a spawning. Jangaard et al (1967) studied the seasonal variation of K and Kf in the cod "*Gadus morrhua*" from the Nova-Scotian water. He found that their maximum values are in late summer and fall (July to November), they then drop to a low level until spawning is completed in March and the fish resumes its heavy feeding in June.

The relation between the breeding of the fish and the change in the general condition is even more clear in a fish with fractional spawning like *Tilapia zillii*. During the short interval of time separating its two spawns an apparent increase in both the condition of the liver and muscle takes place and this soon disappears by the formation of the genital products of the second spawn.

### SUMMARY

The breeding activity of the *Tilapia zillii* G. was traced by means of studying the seasonal variations of G.S.I. and H.S.I. as well as the rate of feeding. These studies showed that during the autumn and winter months the fish passes a sexually quiescent phase. During the spring and summer time, the fish spawns twice, one in June and the second in September.

The condition of the fish flesh (Kf), shows a minimum which coincides with the climax of the breeding i.e. in June and September. During spawning the fish shows a decrease in its rate of feeding as well. The highest H.S.I. precedes the increase in G.S.I. by one or two months. The lowest H.S.I. values were recorded in October when the fish is in the spent condition.

These studies demonstrate clearly that the fish body undergo a state of exhaustion due to breeding.

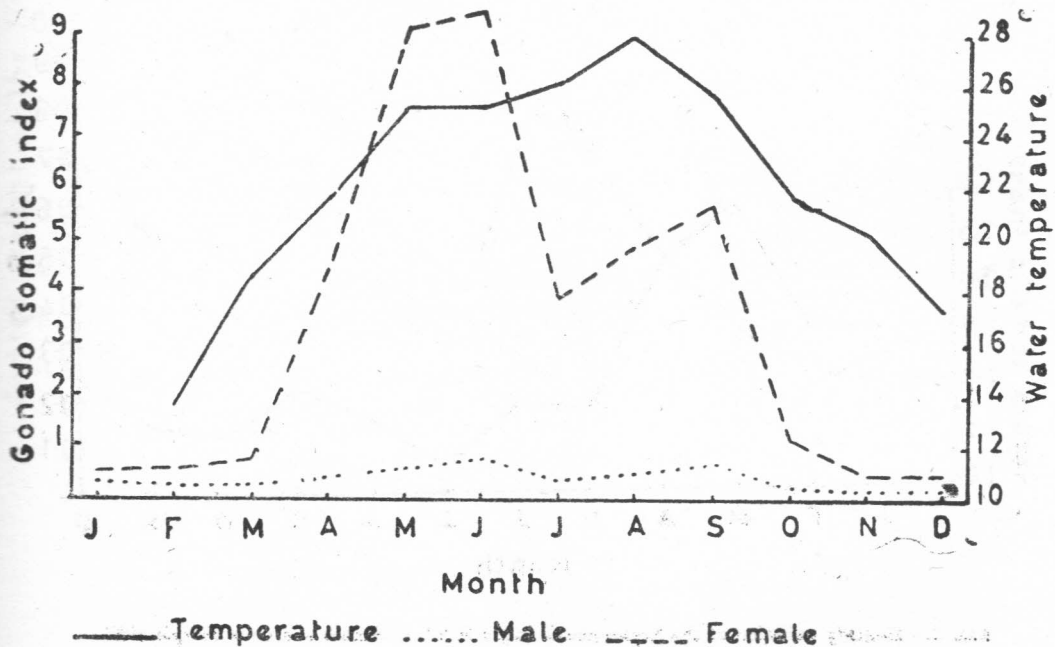


FIG. 1.—Monthly variation of gonadosomatic index G.S.I. in female and male *Tilapia zillii* and water temperature.

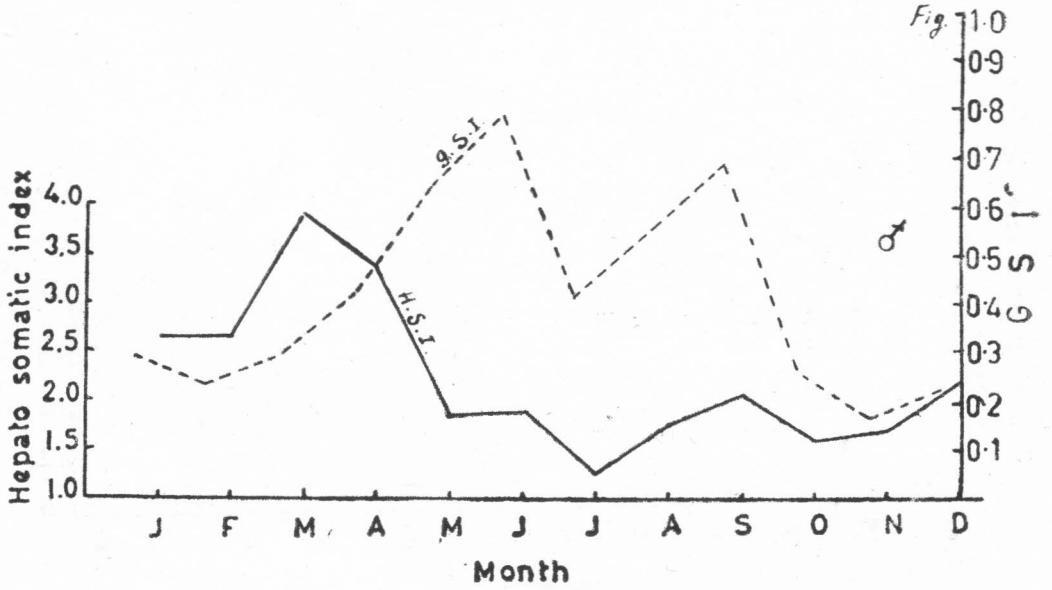
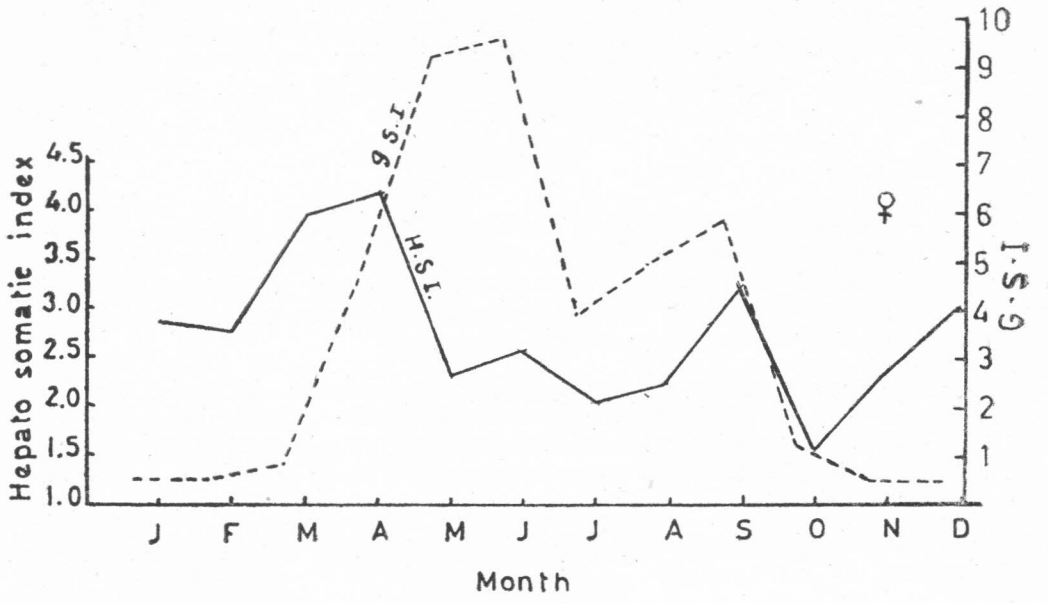


FIG. 2.—Monthly variation of the hepatosomatic index H.S.I. in female and male *Tilapia zillii*.

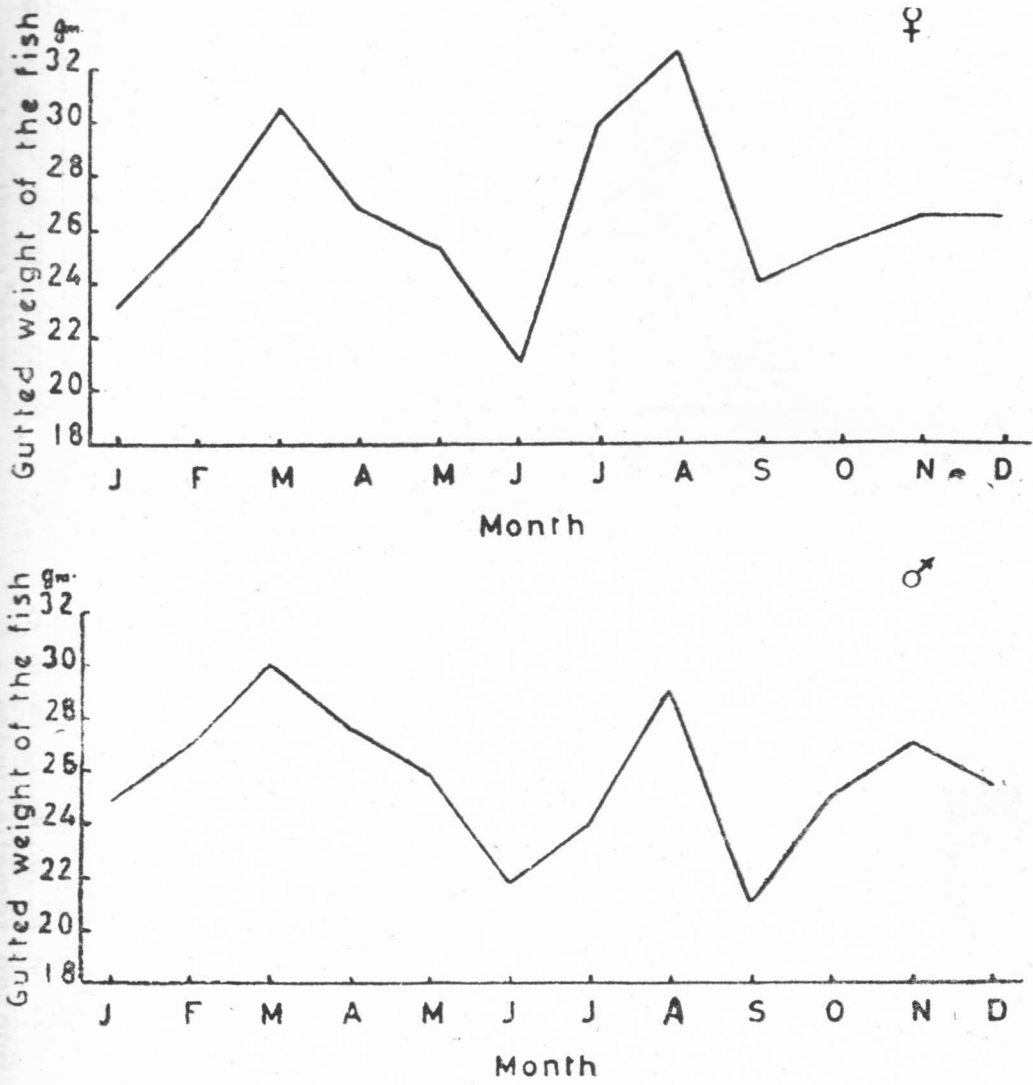


FIG. 3.—Monthly variation of the gutted weight in female and male *Tilapia zillii* (Standard length 10 cms).

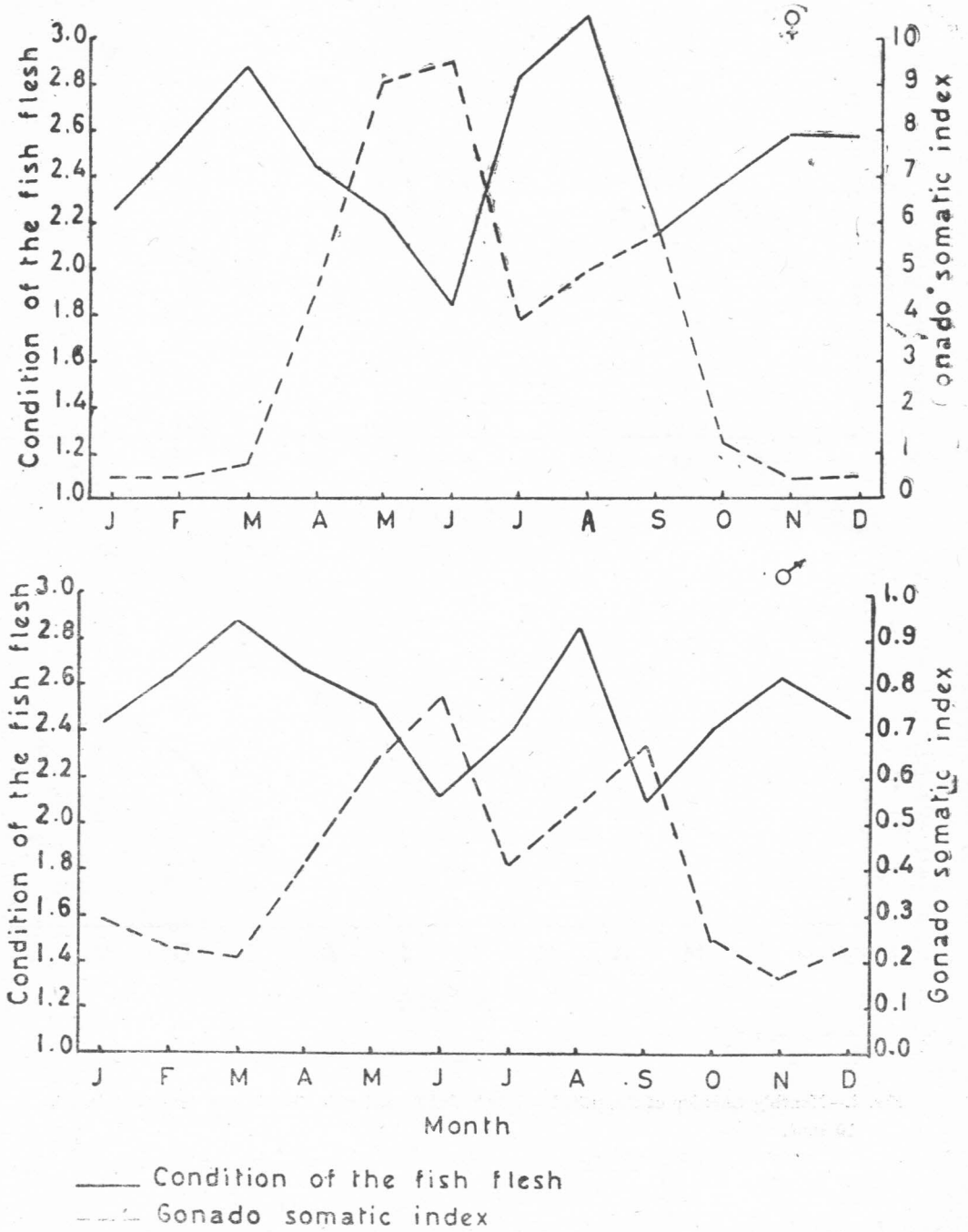


FIG. 4.—Monthly variation of the condition of the fish flesh K- in female and male *Tilapia zillii* (Standard length 10 cms).

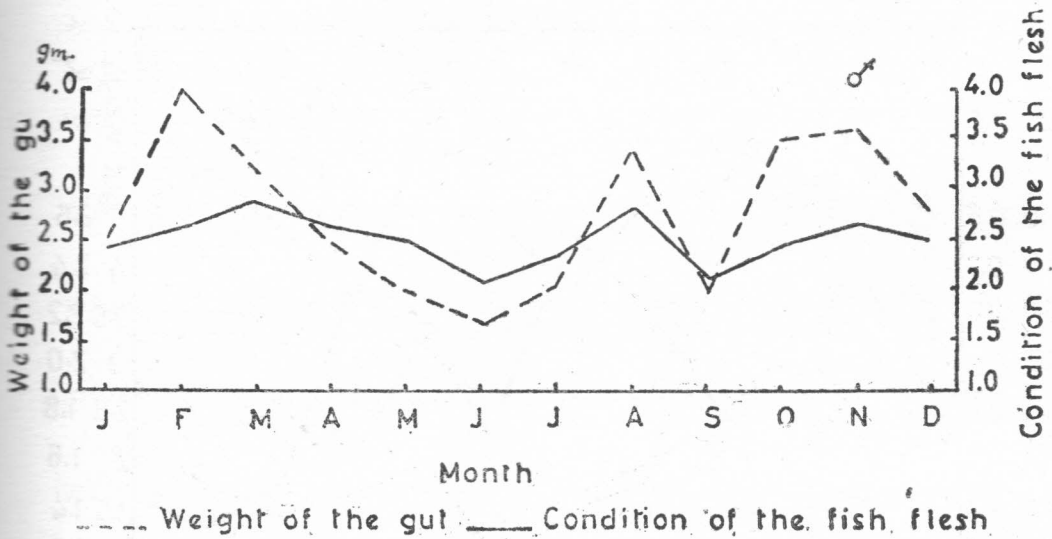
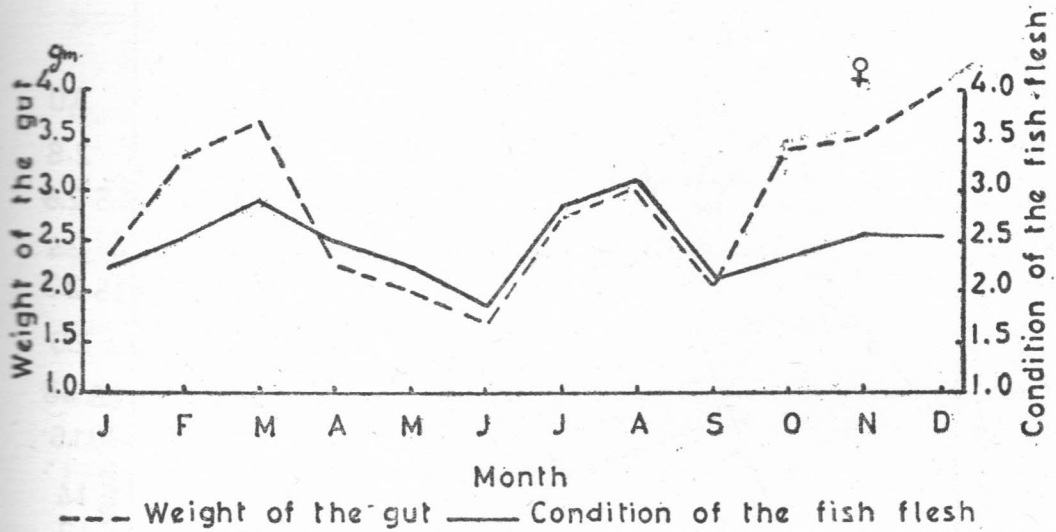


Fig. 5.—Monthly variation of the weight of the gut in female and male *Tilapia zillii* (Standard length 10 cms).

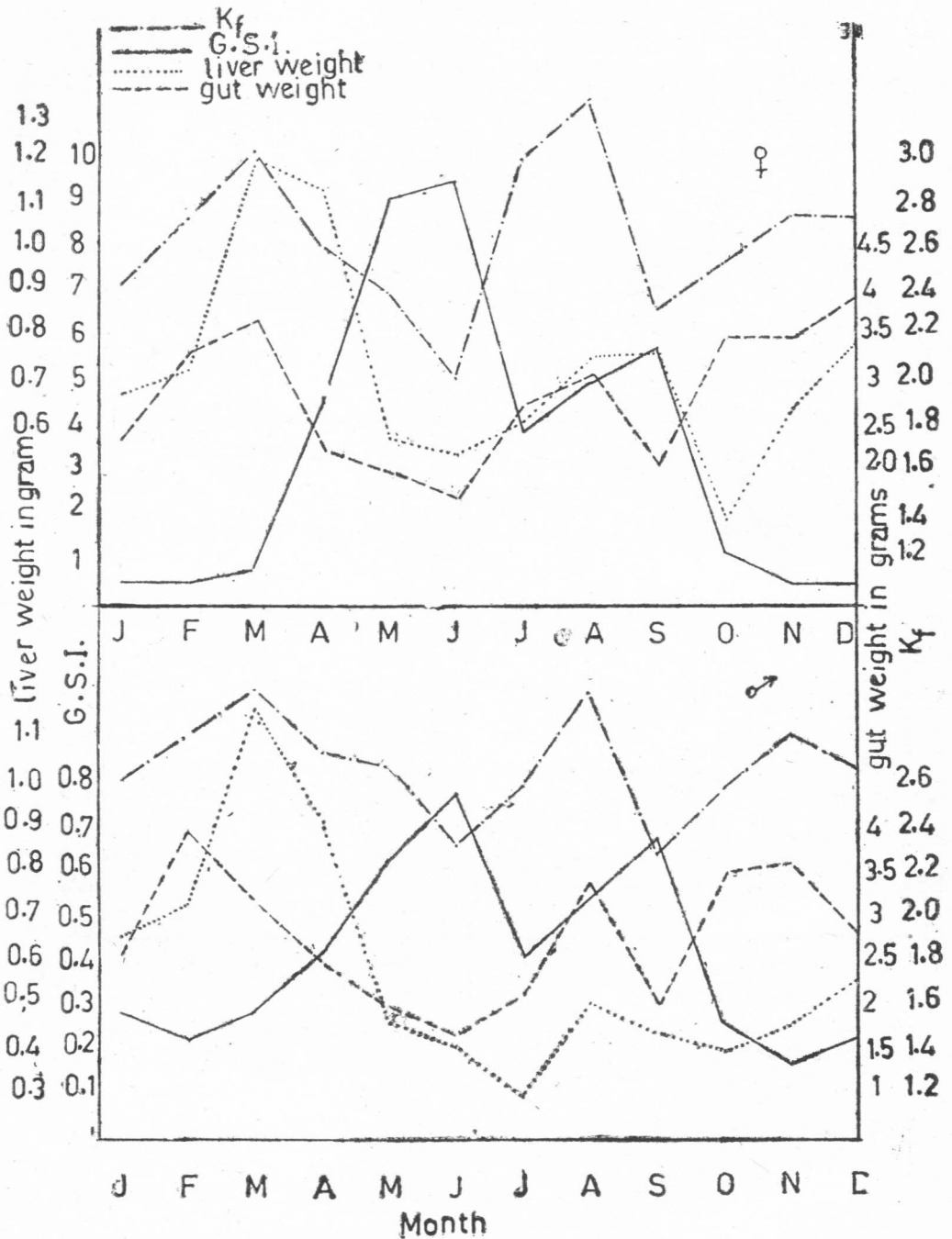


FIG. 6.—Monthly variations of G.S.I., liver weight, K- and gut weight in female and male *Tilapia zillii*.

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