Bull. Nat. Inst. Oceanogr. & Fish., ARE, 16, 1990: 103 - 124

THE BIOLOGY OF LETHRINUS ELONGATUS, VAL. 1830 (TELEOSTS: LETHRINIDAE) IN THE RED SEA.

ELHAM A. WASSEF* AND F. BAWAZEER

Girls College, Jeddah, Saudi Arabia.
*. To whom correspondence should be addressed.

ABSTRACT

A thorough investigation on the biology of longnose emperor **Lethrinus elongatus** Val. in the Red Sea off Jeddah waters was carried out Age and growth was determined by means of scales interpretation. Back-calculated lengths and weights at age were obtained up to the tenth year of life. Both sexes gave virtually identical results in their growth rate. Fish length (L) and scale radius (S) were closely correlated (r=0.99), the relationship can be written as: L = -3.8357 + 3.8555 S. Conditions factor (K) values varied from 1.01 to 1.07 (Av. = 1.1) and have not shown to be influenced with the change in fish size. Breeding started in May and ended in July, with peak activity in June when water temperature was around 30°C. Feeding intensity was relatively higher in February (filling index = 3.65) and August (FI = 3.30) than in other months of the year and lower in May (F.I = 2.27), coincided with fish spawning, and September (F.I =2.35). The von Bertalanffy's growth equation was fitted to the age/ length data and the following parameters were estimated: L = 54.69 cm, W = 1641.2 g, K = 0.2163 & t_o = 0.0995 yr for L.elongatus.

INTRODUCTION

The Red Sea which accounts for 77% of the total Saudi Arabian line, produced 67.4% of the total landings of marine fishery. The rest, 32.6%, had been recorded from the Saudi Arabian Gulf area (Chakraborty et al., 1987). Lethrinid fishes or emperors are abundant in coastal waters of Saudi Arabia Red Sea around rocky outcrops and coral reefs where they form small schools (Wray, 1979). They are also abundant in the coastal waters of tropical and subtropical Indo-Pacific, where they represent an important fishery of the region (Indian waters, Toor, 1968; Great Barrier Reef, Australia, Walker, 1978; New-Caledonia lagoon, Meunier et al., 1979, Loubens, 1980 & Morales, 1988 and Tikehau lagoon, Tahiti, French Polynesia, Caillart et al., 1986).

Ten lethrinid species are identified from the Red Sea, namely: **Lethrinus elongatus; L.lentjan; L.nebulosus L.mahsena; L. mahsenoides; L.harak; L. ramak; L.xanthochilus; L.variegatus & Monotaxis grandoculis** (Randall, 1983). The first three species and L.kallopterus were also reported from the Arabian Gulf as well (Daghestani et al., 1988). Emperors (locally known as 'Shaour' or

'Sheiry') are of considerable economic importance, and form a valuable food fish on the markets of Saudi Arabia. They constituted about 19% of the total captures of 1986 (Chakraborty et al., 1987). Despite their commercial significance there is little available information on their biology in the area. Kedidi and Bouhleil (1985) stated that "More information need to be collected on lethrinids for a better knowledge of the stock and consequently optimum exploitation". The main objective of the present work was to study some biological aspects of the longnose emperor **Lethrinus elongatus**, to provide the basic information required for the planned development of lethrinids fishery in Saudi Arabia. The species is associated with other species of the same family in its environment and within the catch. Previous reports: Salem (1971 & 1976); Aldonov and Druzhinin (1978); Hashem and Shakour (1981) and Kedidi and Bouhleil (1985) are the only ones for the Red Sea. Other studies relevant to the subject along the Saudi coast of the Arabian Gulf was confined to the unpublished work of El Dussary (personal document, 1987). It may be worthy mentioning here that, the Indo-Pacific species **Lethrinus miniatus** (Bloch and Schneider) and **L.chrysostomus** (Richardson) of the south west Pacific are another synonyms for the Red Sea species, **L.elongatus** (Randall, 1983 & FAO, 1983).

MATERIAL AND METHODS

Fresh samples of **Lethrinus elongatus**, were collected, at random, from the commercial fish landing center of Jeddah (Al-Bangalah) at almost bimonthly intervals from December 1988 to December 1989.

They were caught mainly by hooks and lines off Jeddah waters of the Red Sea. On this way, 527 specimens of **L.elongatus**, ranging in length between 16.8 & 50.5 cm and weighed between 70 & 1325 g, were examined shortly after being captured. Small 'shaour' (< 20 cm) were very rare on the market and smaller sizes (< 15 cm) were totally absent. For each individual fish, the following data were collected: total length (mm), total and gutted weights (g), sex and stage of gonad maturity (visually recognised according to an arbitrary VI-stages scale) & gut and gonad weights (0.001 g). Scales were sampled from the pectoral area for age determination. They were cleaned with water and mounted dry between slide glasses and then examined with a dissecting microscope (X 20). Age was assigned counting the growth checks, annuli, on the scales. Detailed measurements of the scale radius and radii of annuli were undertaken, from the scale center along the anterior diagonal line, with the aid of eye piece micrometer.

In data processing, all fishes ranging between (X - 0.5) and (X + 0.4) cm were considered as representing (X) cm length group, total length was used and sexes were kept separate.

RESULTS

i- Age Determination

Microscopic scale examination of L.elongtus revealed the presence of growth checks or annuli as light and dark zones, which were cyclic in nature. A true annulus was distinguishable as a light transluscent line just followed a rather dark band of closely laid preceding circuli and could be traced around the scale (Fig. 1). Besides, the scales sometimes showed accessory marks as breaks or interuptions in the general pattern of circuli, but not complete or continuous all round the scale center. The so called 'fry ring' and 'spawning ring' (Salem, 1971 & 1976; Hashem and Shakour, 1981 and El Dussary, 1987) were frequently detected. The first type was observed on the central part of the scale, not far from the focus. Conspicuous fry ring may cause confusion with first true annulus and resulted in a rather low estimated length of fish at first year of life. The formation of such checks probably relate to important events which happened during young stages (Toor, 1968; Salem, 1971 and Meunier et al., 1979). On the other hand, the spawning ring was usually seen followed a true annulus by short distance and sometimes forming together one broad or double ring. Moreover, crowded annuli on the periphery of older fish scales may by encountered among the difficulties met with for accurate ageing. Nevertheless, ages up to ten years were estimated in the present investigation. About 75% of fish examined belong to age groups II^+ (29%), III^+ (29%) & IV^+ (17%), whereas younger or older fishes were of relatively minor occurrence.

ii-Fish Length/Scale Radius Relationship

The plotting of the average fish lengths 'L' against corresponding scale radii 'S' (Fig. 2) showed a strong linear relationship (r= 0.998). By applying the method of least squares, the following regression equation was derived for L.elongatus:

$$L = -3.8357 + 3.8555\ S \ ....(1)$$

where L is the total fish length in centimeters and S is the anterior scale radius in micrometer divisions (1 m.d = 0.5 mm). The values of L/S ratio were found to be nearly constant (= 6.9), i.e the rate of fish length to scale size evidently exhibited no trend of variation with the increase in fish length.

For the purpose of back-calculation the value of 'a' in equation 1 (= -3.8357), however was used for correcting the direct proportional Lee's formula (1920):

$$L_n = S_n / S (L - a) + a$$

where L_n = fish length at the 'n' th year of life.
L = fish length at capture
S_n = scale radius to the 'n' th year of life
S = total scale radius
& a = correction factor, previously obtained in equation 1.

iii- Growth in Length

Back-calculated size of the fish, for separately males and females were calculated using the corrected formula of Lee (1920) mentioned above. Both sexes gave virtually identical results up to age group X. Minor differences, if present, were tested (T-test) to be insignificant (at both levels of 1 & 5%) (Table VI). Accordingly, growth rate was estimated for sexes combined (Table 1). The average length at capture at successive ages correspond fairly closely with the back-calculated (Table III), which validate the use of scale reading as an ageing technique for such a tropical fish, L, L.elongatus. Highest growth took place during the first year of life (about 12.3 cm), after which the annual increment gradually and progressively decreased with further increase in age (Table I). It seems that growth rate was rather constant from the fiveth to the sixth year of life (about 4 cm for both years). Relative growth (to the length reached at the end of life span) showed also the same trend of variation (Fig. 3) as annual increment.

iv- Length / Weight Relationship And Condition Factor

The most frequent sizes were between 26 & 36 cm constituting about 77% of fish examined (Table II). It was noticed that females have usually higher weights than males of the same length group, except for fish (less than 25 cm). Therefore, sexes were treated separately in length 'L' / weight "W' computations which were based on the well established power equation ($W = cL^n$), where c & n are constants. The length / weight formulae can be written as follows:

$$W_m = 0.02616\ L^{2.75} \quad ..... \quad (2) \text{ For males}$$

$$W_f = 0.01670\ L^{2.8826} \quad ..... \quad (3) \text{ For females}$$

$$W_{mf} = 0.0224\ L^{2.7993} \quad ..... \quad (4) \text{ For sexes combined}$$

The equations can be used to convert fish length to weight or vice versa. It is noticed that the value of the exponent 'n' in the preceding formulae was slightly higher for females (2.88) than that for males (2.75).

Another formula for expressing the length / weight relation is the condition factor (K), which reflects the state of well-being of fish. Estimates of average 'K' ranged from 1.01 to 1.07 for males and from 1.03 to 1.16 females, if the values based on one or two specimens had not considered. However, the grand average 'K' for either sex was identical (=1.1). These values are considered characteristic to L.elongatus off Jeddah water of the Red Sea. It is obvious also that values of 'K' did not vary with the increase in fish length (Table II).

Maximum condition values were attained, for both sexes, during the period from April to July (Av. K = 1.1), during which females had comparatively higher condition values (Av. K = 1.15) than males (Av. K = 1.07). Another peak of condition was also noticed in October (Av. K = 1.13 & 1.15 for males and females respectively). On the other hand, the lowest values were seen in January (Av. K = 1.0) for both sexes (Fig. 4).

v- Growth in Weight

Estimates of growth rate in weight were obtained (Table III) by applying the length / weight equation (4) to the calculated length given in Table 1. Growth in weight was much slower at younger ages and the annual increased with age, being a maximum value (172 g) during the sixth year of life. Percentage gain was approximately constant during the sixth, seventh & eighth years of life (about 14%), after which a marked decline was noticed for the oldest ages (Fig. 5).

vi- Theoretical Growth Rate

By fitting the vonBertalanffy growth equation (Gulland, 1969) to the data obtained by back-calculations from scale readings (Table I), the sizes of the fish at age were estimated (Table III), and the following growth parameters were calculated for L. elongatus: L = 54.69 cm; K = 0.2163 & t_o = -0.0995 yr. Infinity weight was also determined to be = 1641.17 g. by converting the theoretical lengths into weights, using the length / weight formula (4). The agreement seems to be close, in both cases (Table III) and it can be said that the vonBertalanffy growth equation describes the growth rate of this fish in a good way.

vii- Spawning Season

In this study, the percentage of gonad weight to gutted fish weight is referred to gonad index (G.I) and is used to indicate gonad condition and identify breeding season. When G.I values are less than unity this means that gonads are in a rest stage, and when such values exceed one it means that gonads start developing for the forthcoming spawning. Maximum values of G.I indicate the onset of breeding. Monthly variations of average G.I for L. elongatus (Fig. 6) illustrate peak in May and June for males and June and July for females, after which a sharp drop was noticed in August for both sexes. It is observed also that gonad indices for females were than those of males (Fig. 6). L. **elongatus** seems to have a rather prolonged spawning season, from May to July, with peak of activity in June when water temperature was around 30° C. It may be worthy mentioning that running individuals were never obtainable within the catch investigated. Gonad weights recorded in this study are those of maturity stage just preceding the running stage.

viii- Size And Age At First Sexual Maturity

The smallest size of a mature fish was 24 cm for males and 25 cm for females. This was determined as the size at which 50% of the fish examined were mature during the current spawning period. Referring these lengths to age (Table I) means that fish became mature during their third year of life.

ix- Sex Ratio

Throughout the period of study, females always outnumber males within each monthly sample. However, the overall sex ratio when related to age (Table IV) revealed that females predominate in the catch up to age class IV, and the reverse is true for older ages. The same observation could be taken from Table II, that frequency of males only exceed that of females in size classes over 34 cm, aged 4^+ years . During the whole year the overall sex ratio was 1: 1.3 in favour of females (Table IV).

x- Feeding Intensity

The filling index 'F.I' (Berhaut, 1973) was used in the present work as indicator to feeding intensity of fish. Monthly variations of average filling indices were followed for separately males, females and sexes combined (Table V). Higher feeding activity was noticed in February and August (F.I = 3.7 & 3.3 respectively). Whereas, a relatively lower rate was observed in May (F.I = 2.3) coincided with the start of fish breeding Another decline in feeding intensity was also noticeable in September (F.I = 2.4).) On the other hand, fish feed moderately in other months of the year. When taking the seasonal variations into account, it seems that fish actively feed in winter (F.I = 3.1) and summer (F.I =2.9) than in spring or autumn (F.I = 2.6) It is also obvious sex did not influence feeding rate i.e both males and females have very similar filling indices (Table V).

DISCUSSION

The possibilities of various skeletal structures being useful as age indicators in lethrinids, as tropical fish, have been previously demonstrated. Some authors have aged a variety of lethrinids by means of scales (Toor, 1968; Salem, 1971 & 76; Aldonov and Druzhinin, 1978. Hashem and Shakour, 1981; Kedidi, 1984; Kedidi and Bouhleil, 1985 and El Dussary, 1987). Otoliths were also used (Toor, 1968; Meunier et al., 1979; Caillart et al., 1986; Baddar, 1987 and Morales, 1988). Although some observations on the usefulness of vertebrae (Edwards et al., 1985) or dorsal fin spines (Meunier et al., 1979) in ageing L.nebulosue have been made, previous ageing and growth studies by scale reading were all successful. Despite the limited range in temperature variation at Jeddah waters (about 10 ^{o}C), the formation of annual rings on the scales of L.elongatus is indeed possible and evidenced on the scales of 527 fish examined in this study. Age was validated by the close correlation between the length at-age- determined by scale reading and back-calculated (Table III). Furthermore, the similarity of estimates of mean length at age from 1-10 of the species in the Gulf of Aden (Aldonov and Druzhinin, 1978 and Kedidi and Bouhleil, 1985), strengthened the validity of scale interpretation for ageing the species. However, the work of Caillart et al., (1986) suggested much higher growth rate in Tikehau lagoon, Tahiti, French Polynesia, than observed in this study. It is likely that this variability is merely a reflection of the different environmental conditions experienced by longnose in the different habitats. It is equally possible that growth achieved in different years with the same region could vary for the same reasons.

Previous determinations of vonBertalanffy's growth constants were also higher, $L = 82$ cm; $K = 0.213$ & $t_o = 0.26$ yr (Kedidi and Bouhleil, 1985) and $L = 63$ cm; $K = 0.55$ & $t_o = 0.184$ yr (Caillart et al., 1986). It is well documented that these parameters are not constant values but vary according to fish age considered in computing these values.

The absence of 0-group individuals from the catch may point out that smaller fish were not vulnerable to capture by the gear used. however, Hashem and Shakour (1981), observed the same phenomenon for **L.mahsena** and **L.xanthochilus** and stated that young fish do not live in the same area with moderate and old-age fish.

The distinct peak of condition factor in October signifies the best time for exploitation and processing, since the weight of edible flesh per fish would be at its maximum. Whereas, the elevation of condition values noticed during the breeding season (May - July) (Fig. 6) denote the additional weight of ripe gonads. It appears that breeding had caused a rather low feeding activity (Table V). Detailed report on food and feeding habits was given by Walker (1978).

Knowledge of length and age at first maturity may has its practical application in determining the size or age needed to protect an adequate spawning stock, and to ensure at least one spawning for mature individuals.

The predominance of females over males at younger ages, while the reverse is true for older ages suggests sex reversal from female to male during the fiveth year of life. Histological examination of gonads was carried out to, results are not included herein, but evidenced this assumption. Further support has also given by Young and Martin (1982), who described the species as protogynous hermaphrodite.

CONCLUSION

1-The validity of ageing L.elongatus by means of scale interpretation was assessed, despite the high frequency of accessory checks.

2-Regression of fish length (L) on scale radius (S) was computed to be: L = -3.8357 + 3.8555 S, when L is in centimeters and S in micrometer divisions (1 m.d = 0.5 mm). L/S ratio was constant with the change in fish length.

3-Growth rate in length, for sexes combined, appeared to be highest during the younger ages (1-3 yr) and slows down as age progresses. On the contrary, growth in weight being much slower at earlier ages and considerably increased reaching a maximum during the sixth year of life. Senelity stage seems to be reached after the eighth year of life, when growth rate noticeably decreased.

4-The constants in the power curve relationship of whole weight against total length were determined as: b= 2.75; 2.88 & 2.80 for males, females and sexes combined respectively, when weight is in gram and length in centimeter.

5-Both males and females have similar condition factor (K) values, which do not fluctuated much with the increase in fish length. Out of spawning season, a peak of condition factor was attained in October.

6-Spawning is shown to occur between April and July and the mean age at first sexual maturity to occur at 2^+ years.

7-Feeding rate seems to be comparatively higher in winter and summer than in spring or autumn. Fish slows down their feeding rate during breeding period.

8-Sex ratio at ages suggested sex reversal from female to male during the fiveth year of life.

9-The estimates obtained for the vonBertalanffy's growth constants are:

$$L = 54.7 \text{ cm}; K = 0.216 \ \& \ t_o = -0.0995 \text{ yr.}$$

REFERENCE

Aldonov, V.K. and A.D Druzhinin, 1978. Some data on Scavengers (Family Lethrinidae) from the Gulf of aden region. J.Ichthyol., 18 (4): 605-614.

Baddar, M.K., 1987. A preliminary study of the population dynamics of a Sheiry, the starry pigface bream, Lethrinus nebulosus. Kuwait bull. Mar. Sc., 19: 215-220.

Berhaut, A., 1973. *Biologie des stades juveniles de Teleosteens Mugilidae, Mugil auratus, Risso* (1810), M.capito, Cuv. (18
29) et M.saliens, Risso (1810). Reprinted from Aquaculture, 2: 251-266.

Caillart, B., M. Franc de ferriere, and E. Morize, 1986. Croissance de deux especes de poissons du lagon de Tikehau: Lethrinus miniatus (Schneider) et Lutjanus fulvus (Schneider), evaluee par la lecture des otolithes. In: Contribution a l' etude de l'atoll de Tikehau, III, Orstom, Tahiti, Notes et Doc. Oceanogr. 30: 1-44.

Chakraborty, D & Others, 1987. Marine fish production from the traditional fisheries in the Kingdom of Saudi Arabia during October'85 - September'86 (1410 H). Report prepared by Min. Agric. Fish. Res. Centre, Jeddah, Saudia Arabia, 52 p.

Daghestani, F., T. Abu Shusha, and M. Kalantan, 1988. Fishes of Saudi Arabia Kingdom from the Red Sea and Arabian Gulf. Report, Min. Agic. Fish. Res. Cent. Jeddah, 114 p (In Arabic).

Edwards, R.C., A. Bakhader, and S. Shaher, 1985. Growth, mortality, age composition and fisheries yields of fish from the Gulf of Aden. J. Fish. Biol., 27: 13-21.

El Dussary, N., 1987. Biological studies on some fishes of Family Lethrinidae. M.Sc. Thesis, Fac. Sc. Girls College, ElDammam, 431 p.

FAO, 1983. Species identification Sheets for Fishery Purposes. Fishing Area 51, West Indian Ocean. United Nations Fish and Agric. Organ. Rome.

Gulland, J.A., 1969. Manual of methods for fish stock assessment. part I. Fish population analysis. FAO Manual FRS / M 4, 154 p.

Hashem, T. and A. Shakour, 1981. Age determination and growth studies of Lethrinus mahsena and L.xanthochilus. Jed.J.Mar.Res., 1:11-21.

Kedidi, S.M., 1984. Biology and stock assessment of the redspot emperor, Lethrinus lentjan from waters adjacent to Tuwwal, Saudi Arabia. Project for development of fisheries in areas of the Red Sea and Gulf of Aden. FAO, RAB/ 81/002/15, 21 p.

Kedidi, S. and M. Bouhleil, 1985. Stock assessment of the longface emperor, Lethrinus miniatus, from the Djiboutian waters, Red Sea -Gulf of Aden. Project Develop. Fish. Red Sea and Gulf of Aden. FAO, RAB/ 83/ 023/ 12, 19 p.

Lee, R., 1920. A review of the methods of age and growth determination in fishes by means of scales. Min. Agic. Fish. Invest., II, 4 (2): 1-32.

Loubens, G., 1980. Biologie de quelques especes de poissons du lagon neo-caledonien. III-Croissance. Cahiers de L'Indo-Pacifique,2 (2): 101-153.

Meunier, F.J.; M. Pascal, and G. Loubens, 1979. Comparison de methods squelettochronologiques et considerations fonctionelles sur le tissu osseux acellusire d'un osteichthyen du lagon neo - caledonien, Lethrinus nebulosus (forskal, 1775). Aquaculture, 17: 137-157.

Morales, Nin B., 1988. Age determination in a tropical fish Lethrinus nebulosus (Forskal, 1775), (Teleosteii: Lethrinidae) by means of otolith interpretation. Inv. Pesq., 52 (2): 237-244.

Randall, J.E., 1983. Red Sea Reef Fishes. Publ., London: 76-79.

Salem, S., 1971. Biological studies on Lethrinid fishes from the Red Sea. M. Sc. Thesis, Fac Sc. Cairo Univ., 275 p + illust.

Salem, S., 1976. On the Biology of two Lethrinus species (from the Red Sea). Ph. D. Thesis, Fac. Sc. CAiro Univ., 261 p + illust.

Walker, M.H., 1978. FOod and feeding habits of Lethrinus chrysostomus, Richardson (Piscas, Perciforms) and other lethrinids on the Great Barrier Reef. Aust. J. Mar. Fresh water Res., 29 (5): 623-630.

Wray, T., 1979. Commercial fishes of Saudi Arabia. Min Agric. & water Res. Riyadh, Kingdom of Saudi Arabia, White Fish Authority, U.K.,: 81-87.

Young, P.C., and R.B. Martin, 1982. Evidance for protogynous hermaphroditism in some lethrinid fishes. J. Fish Biol., 21: 475-484.

Table (I) : Growth rates and annual increment in length for Lethrinus elongatus, (increment in parenthesis).

Age group	FRQ %	L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	L_9	L_{10}
I	17 4.9	13.37	—								
II	100 28.6	13.12	22.69 (9.57)	—							
III	103 29.4	12.06	20.79 (8.73)	27.04 (6.25)	—						
IV	58 16.6	11.68	20.34 (8.66)	26.36 (6.02)	31.61 (5.25)	--					
V	36 10.3	11.35	19.94 (8.59)	26.03 (6.09)	30.83 (4.80)	35.15 (4.32)	—				
VI	18 5.1	11.88	20.89 (9.01)	27.32 (6.43)	31.63 (4.31)	35.63 (4.00)	39.00 (3.37)	--			
VII	10 2.9	11.95	19.97 (8.02)	26.00 (6.03)	[illegible] (5.06)	35.62 (4.56)	39.33 (3.71)	42.27 (2.94)	--		
VIII	5 1.4	12.09	21.01 (8.92)	27.67 (6.66)	33.01 (5.34)	37.54 (4.53)	41.70 (4.16)	43.85 (2.15)	45.91 (2.06)	--	
IX	2 0.6	12.02	21.79 (9.77)	28.07 (6.28)	33.23 (5.16)	37.59 (4.36)	41.04 (3.45)	43.88 (2.84)	45.80 (1.92)	47.43 (1.63)	--
X	1 0.3	9.49	18.20 (8.71)	25.26 (7.06)	30.47 (5.21)	35.09 (4.62)	39.09 (4.00)	42.49 (3.40)	45.24 (2.75)	47.00 (1.76)	48.30 (1.35)
Grand av. calculated lengths		12.27	21.17	26.71	31.42	35.57	39.58	42.90	45.80	47.29	48.35
Increment of Av.		12.27	8.90	5.54	4.71	4.15	4.01	3.32	2.90	1.49	1.06

Table (II) : Length/Weight relationship and Condition Factor (K) of *Lethrinus elongatus*.

Total Length (cm.) (L)	Av. emperical weight (g) (W) Male	FRQ.	Condition Factor (K)*	Av. emperical weight (g) (W.) Females	FRQ.	Condition Factor (K.)
17	70.0 ± 10.0	(1)	1.42	-		-
18	82.0 ± 0.0	(1)	1.41	78.0 ± 2.0	(2)	1.34
19	95.0 ± 0.0	(1)	1.39	-		-
21	104.5 ± 4.5	(2)	1.13	110.0 ± 0.0	(1)	1.19
22	122.0 ± 0.0	(1)	1.15	122.0 ± 7.7	(6)	1.15
23	150.0 ± 0.0	(1)	1.23	146.0 ± 6.0	(2)	1.20
24	161.0 ± 1.4	(3)	1.16	155.5 ± 8.9	(6)	1.12
25	182.5 ± 7.4	(4)	1.17	170.6 ± 4.9	(14)	1.09
26	194.7 ± 5.0	(10)	1.11	203.8 ± 9.9	(17)	1.16
27	206.0 ± 6.6	(5)	1.05	213.2 ± 10.8	(18)	1.08
28	235.5 ± 6.8	(12)	1.07	242.2 ± 9.9	(22)	1.10
29	269.0 ± 9.1	(12)	1.10	273.4 ± 10.2	(34)	1.12
30	290.7 ± 13.1	(12)	1.08	287.5 ± 14.6	(33)	1.06
31	318.2 ± 11.4	(14)	1.07	327.5 ± 9.8	(31)	1.10
32	345.4 ± 12.1	(26)	1.05	370.5 ± 11.3	(27)	1.13
33	374.8 ± 15.5	(16)	1.04	390.8 ± 11.3	(15)	1.09
34	403.3 ± 18.1	(15)	1.03	403.4 ± 14.3	(14)	1.03
35	432.3 ± 15.3	(19)	1.01	440.5 ± 12.1	(10)	1.03
36	488.9 ± 14.7	(27)	1.05	500.7 ± 18.4	(11)	1.07
37	528.5 ± 12.2	(11)	1.04	577.9 ± 16.8	(7)	1.14
38	599.8 ± 13.4	(8)	1.09	633.8 ± 17.1	(4)	1.16
39	621.7 ± 14.3	(3)	1.05	642.0 ± 15.9	(4)	1.08
40	685.0 ± 18.3	(4)	1.07	711.3 ± 20.9	(2)	1.11
41	738.3 ± 20.9	(3)	1.07	748.3 ± 20.1	(3)	1.09
42	758.3 ± 20.6	(6)	1.02	791.7 ± 6.2	(3)	1.07
43	871.3 ± 16.1	(4)	1.10	870.0 ± 0.0	(1)	1.09
44	923.5 ± 6.5	(2)	1.08	-	(-)	-
45	957.5 ± 17.5	(2)	1.05	1040.0 ± 0.0	(1)	1.14
46	1075.0 ± 0.0	(1)	1.10	-	(-)	-
48	-	(-)	-	1192.5 ± 0.0	(1)	1.08
49	-	(-)	-	1300.0 ± 0.0	(1)	1.10
50	-	(-)	-	1325.0 ± 0.0	(1)	1.06
51	1280.0 ± 0.0	(1)	0.96	-		-
Total No. of Fish		227	Av.=1.104		290	Av.=1.104

± Standard deviation .

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

Table (III) : Comparison between calculated and theoretical (Bertalannfy's equation) lengths and weights at different years of life of <u>Lethrinus elongatus</u>.

Age (yr)	Av. Length (cm)			Annual increment	Av. weight (g)		Annual increment
	at capt.	calc.	theor		calc.	theor	
1	23.22	12.27	11.57	12.27	25.22	21.22	25.22
2	27.29	21.17	19.96	8.90	115.93	97.68	90.71
3	30.47	26.71	26.72	5.54	220.88	221.00	104.95
4	33.70	31.42	32.16	4.71	348.23	371.26	127.35
5	36.65	35.57	36.54	4.15	492.66	330.77	144.43
6	40.97	39.58	40.07	4.01	664.96	687.10	172.30
7	44.21	42.90	42.91	3.32	832.40	832.28	167.44
8	48.23	45.80	45.20	2.90	998.85	926.67	166.45
9	49.35	47.29	47.05	1.49	1092.36	1077.07	93.51
10	50.50	48.35	48.53	1.06	1162.46	1174.62	70.10

Table (IV) - Variation of sex ratio with age of _L._ _elongatus_.

Age (yr.)	Males %	Males FRQ.	Females %	Females FRQ.
1	41.2	7	58.8	10
2	38.0	38	62.0	62
3	36.9	38	63.1	65
4	44.8	26	55.2	32
5	55.9	19	44.1	15
6	57.9	11	42.1	8
7	77.8	7	22.2	2
T.number of fish		146		194
Ratio		1		1.3

NB. Ages older than 7 yr. are represented by small number of fish from both sexes.

Table (V) - Monthly variations of average filling indices (F.I) for *Lethrinus elongatus* .

Month	Average filling index (F.I)*		
	Males	Females	Sexes Combined
Dec. 88	2.72 ± 1.5 (12)	2.36 ± 0.7 (20)	2.70 ± 1.2 (32)
Jan. 89	2.97 ± 1.9 (17)	2.73 ± 0.9 (27)	2.81 ± 1.4 (44)
Feb. "	3.23 ± 1.0 (16)	3.86 ± 1.5 (21)	3.65 ± 1.2 (37)
March "	2.25 ± 1.1 (26)	2.74 ± 0.9 (27)	2.60 ± 1.0 (53)
April "	2.85 ± 1.6 (36)	2.87 ± 1.0 (30)	2.85 ± 1.3 (66)
May "	2.20 ± 0.7 (26)	2.40 ± 0.7 (36)	2.27 ± 0.7 (62)
June "	2.86 ± 1.3 (16)	2.80 ± 0.8 (12)	2.83 ± 1.1 (28)
July "	2.45 ± 1.6 (15)	3.0 ± 1.3 (13)	2.70 ± 1.5 (28)
Aug. "	3.13 ± 1.6 (13)	3.32 ± 1.5 (21)	3.30 ± 1.5 (34)
Sept. "	2.03 ± 0.4 (35)	2,64 ± 0.7 (27)	2.35 ± 0.7 (62)
Oct. "	2.93 ± 0.7 (13)	2.85 ± 0.5 (12)	2.87 ± 0.6 (25)
Nov. "	2.40 ± 0.4 (12)	2.67 ± 0.8 (34)	2.60 ± 0.8 (46)

Between brackets are the number of fish examined .

± Standard deviation .

* $F.I. = \frac{\text{gut weight}}{\text{gutted fish weight}} \times 100$ (Berhaut , 1973) .

Table

T- test analysis of average length at capture (L_i) and back-calculated lengths (L_o) for males, females and sexes combined aged from 1-10 years.

BACK CALCULATED LENGTHS

RELATION	Li	Lo1
M.MALE	22.571	12.433
M.FEMALE	23.600	14.031
M.COMBOD	23.224	13.373
T.TEST	1.344	1.325

RELATION	Li	Lo1	Lo2
M.MALE	27.988	13.367	22.963
M.FEMALE	27.373	12.983	22.544
M.COMBOD	27.586	13.116	22.690
T.TEST	1.217	.854	.784

RELATION	Li	Lo1	Lo2	Lo3
M.MALE	31.424	12.532	21.549	27.985
M.FEMALE	29.918	11.779	20.348	26.494
M.COMBOD	30.474	12.057	20.791	27.044
T.TEST	3.304	1.865	2.519	3.304

RELATION	Li	Lo1	Lo2	Lo3	Lo4
M.MALE	33.696	11.875	20.529	26.261	30.474
M.FEMALE	33.709	11.521	20.179	26.437	20.724
M.COMBOD	33.703	11.679	20.336	26.358	30.612
T.TEST	.025	.838	.587	.312	.432

RELATION	Li	Lo1	Lo2	Lo3	Lo4	Lo5
M.MALE	36.768	11.611	20.332	26.226	30.607	34.205
M.FEMALE	36.507	11.014	19.433	25.785	30.437	34.087
M.COMBOD	36.653	11.347	19.935	26.031	30.532	34.153
T.TEST	.328	1.069	1.049	.537	.235	.154

RELATION	Li	Lo1	Lo2	Lo3	Lo4	Lo5	Lo6
M.MALE	40.836	11.775	20.819	27.353	31.761	35.758	38.573
M.FEMALE	41.150	12.011	20.976	27.277	31.446	35.483	38.536
M.COMBOD	40.968	11.875	20.885	27.321	31.629	35.629	38.557
T.TEST	.227	.403	.207	.077	.286	.236	.038

RELATION	Li	Lo1	Lo2	Lo3	Lo4	Lo5	Lo6	Lo7
M.MALE	44.014	12.057	19.714	26.132	31.211	35.200	39.279	41.422
M.FEMALE	44.900	11.553	19.534	25.521	30.548	34.539	39.409	42.521
M.COMBOD	44.311	11.945	19.674	25.996	31.063	35.121	39.325	41.660
T.TEST	.509	.737	.157	.485	.397	.472	.138	.614

RELATION	Li	Lo1	Lo2	Lo3	Lo4	Lo5	Lo6	Lo7	Lo8
M.MALE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
M.FEMALE	40.225	12.005	21.011	27.674	33.000	37.530	41.776	44.052	46.909
M.COMBOD	40.225	12.005	21.011	27.674	33.000	37.530	41.776	44.052	46.909
T.TEST	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

RELATION	Li	Lo1	Lo2	Lo3	Lo4	Lo5	Lo6	Lo7	Lo8	Lo9
M.MALE	50.500	11.939	22.456	29.467	36.470	39.903	43.408	45.242	46.994	48.747
M.FEMALE	48.967	12.051	21.569	20.446	33.405	36.790	40.229	42.619	44.474	46.904
M.COMBOD	49.350	12.023	21.791	20.701	34.233	37.580	41.044	43.275	45.104	47.425
T.TEST	1.017	.395	.727	.514	2.770	2.252	1.962	3.060	4.031	1.410

RELATION	Li	Lo1	Lo2	Lo3	Lo4	Lo5	Lo6	Lo7	Lo8	Lo9	Lo10
M.MALE	50.500	9.405	17.197	25.260	29.467	34.735	39.903	43.409	45.242	46.994	48.74
M.FEMALE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00
M.COMBOD	50.500	9.405	17.197	25.260	29.467	34.735	39.903	43.409	45.242	46.994	48.74
T.TEST	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00

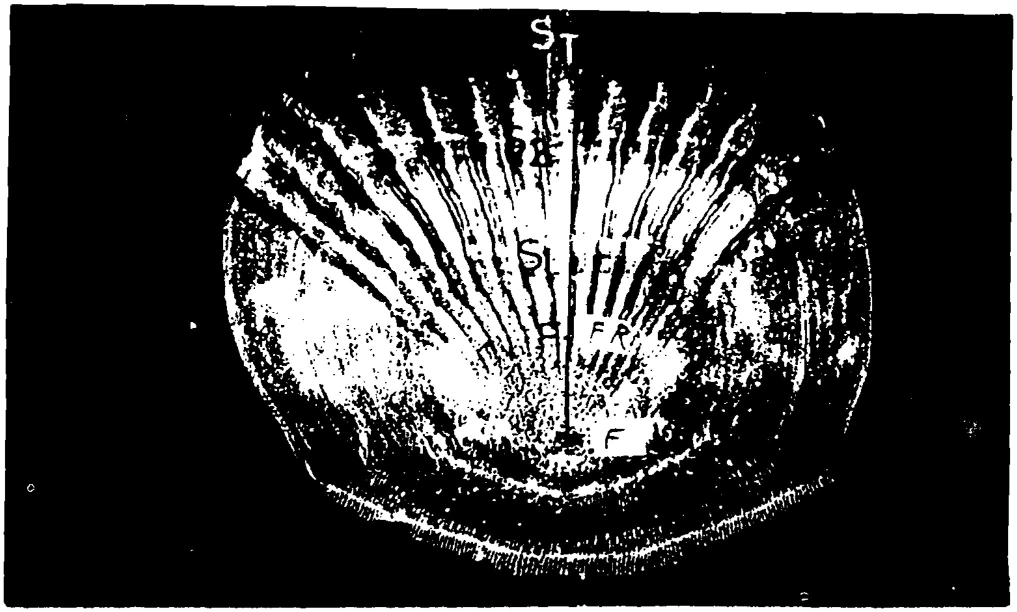

Fig. 1 : Scale of L. elongatus, 31 cm in length, caught in 23 July, 1989, showing line of measurement and 3 growth checks (F = focus , F.R = fry ring, S_1, S_2 & S_3 are scale radii to 1 st, 2 nd & 3 rd annulus respectively.

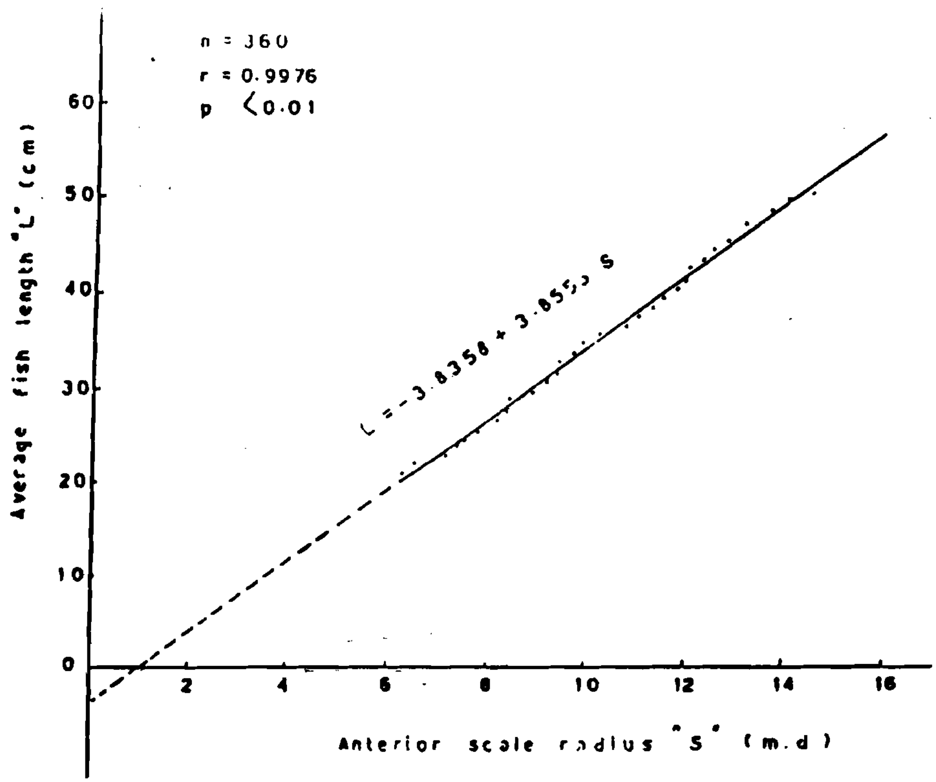

Fig. 2 : Fish-length / scale-redius relationship for <u>Lethrinus elongatus</u>

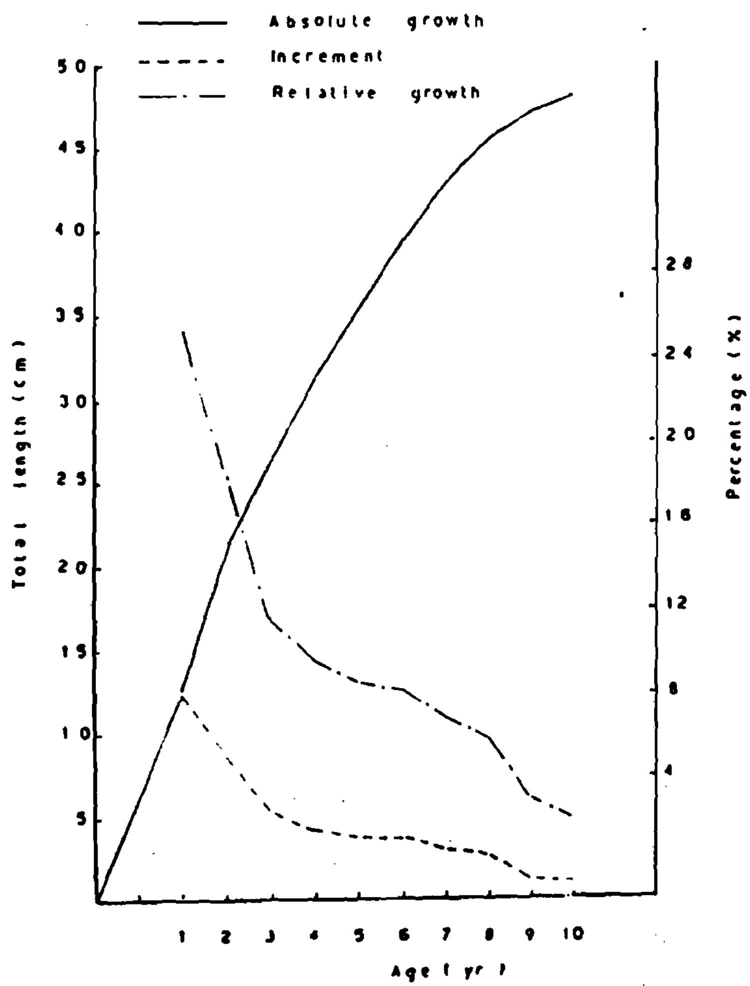

Fig. 3 : Growth in length with age for Lethrinus elongatus

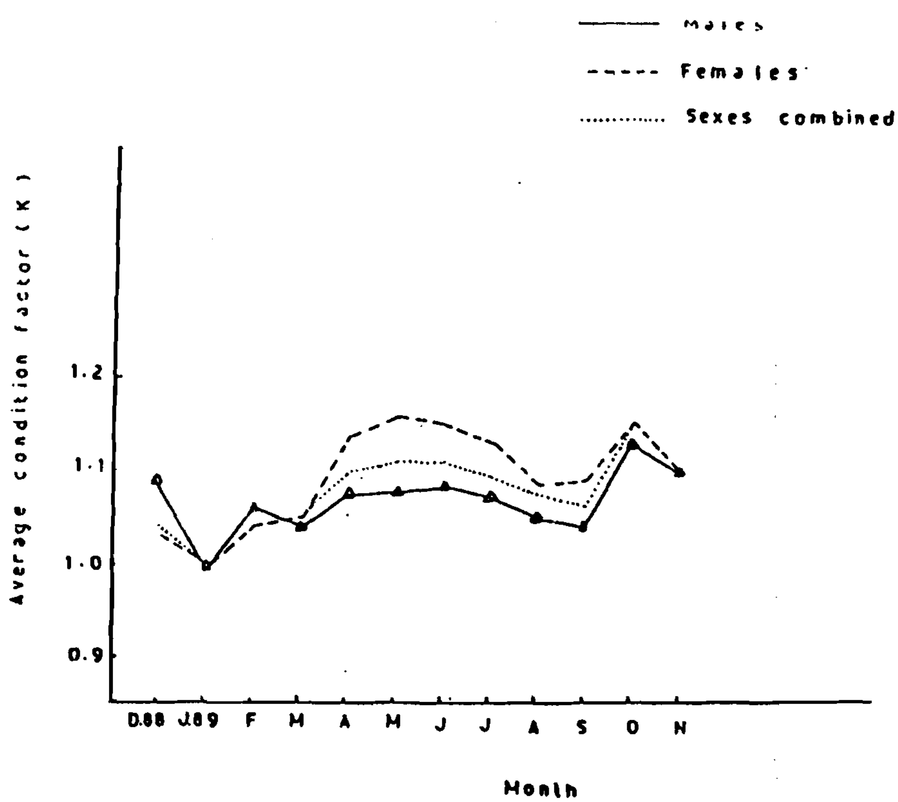

Fig. 4 : Monthly variation of average condition factor of Lethrinus elongatus.

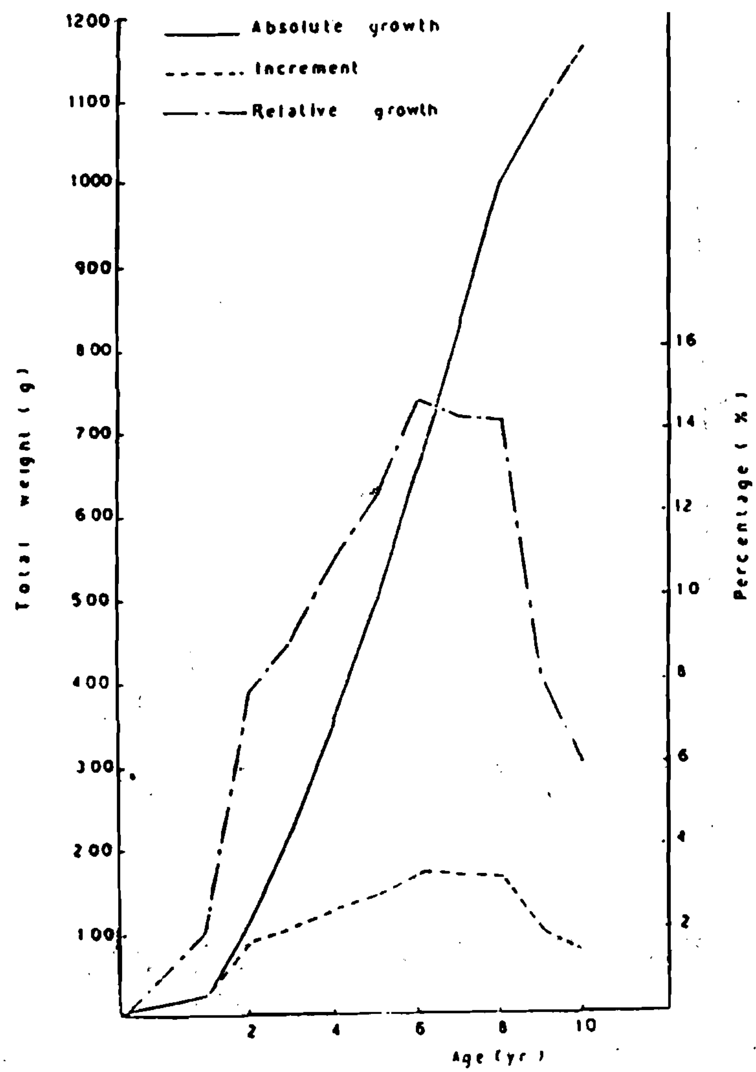

Fig. 5: Growth in weight wigh age for Lethrinus elongatus.

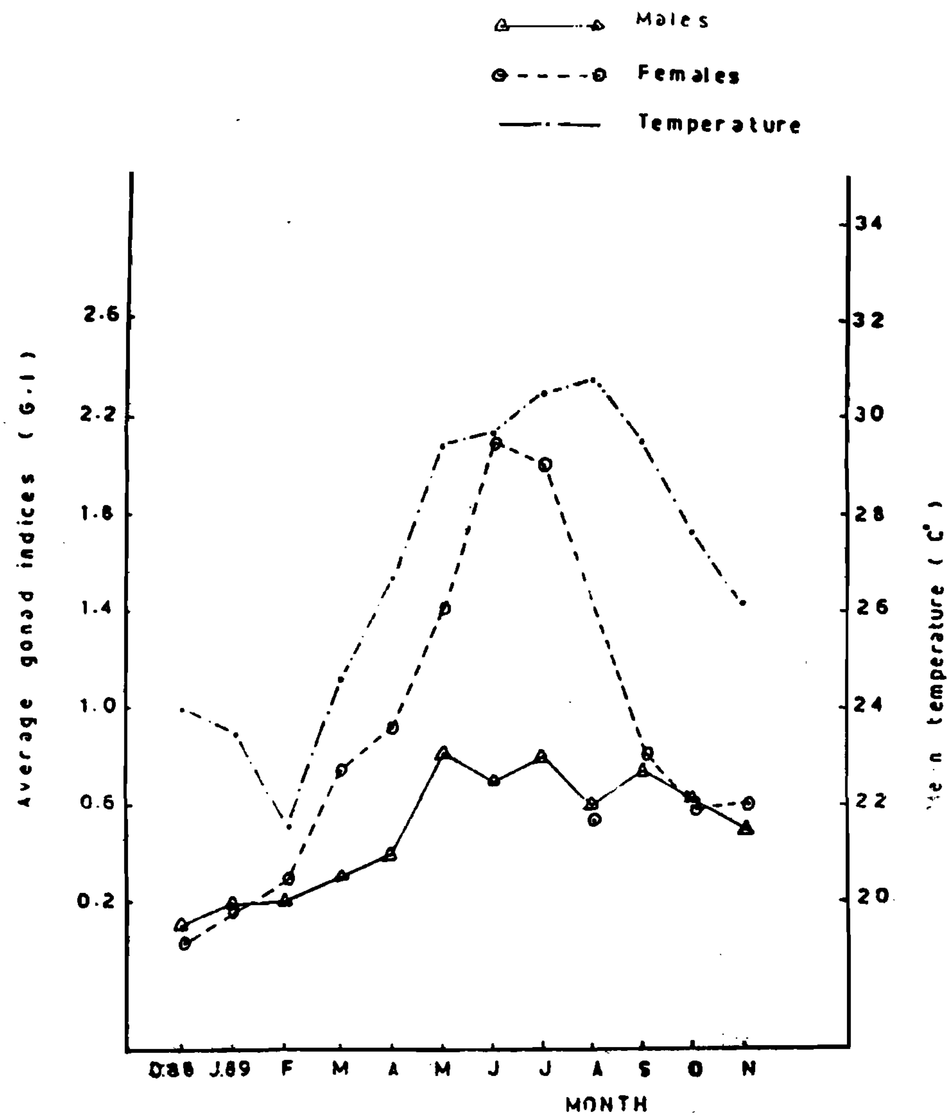

Fig. 6 : Monthly variation of average gonad indices of Lethrinus elongatus.