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SOME ASPECTS OF THE BIOLOGY AND POPULATION DYNAMICS OF *AMBLYGASTER SIRM* (WALBAUM) FROM THE WEST COAST OF SRI LANKA

P. M. A. JAYASURIYA
National Aquatic Resources Agency, Crow Island, Mattakkuliya, Colombo 15., Sri Lanka.

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Abstract: The spawning of *Amblygaster sirm* was found to occur twice a year in April / May and August / September. The growth rate and the asymptotic length were found to be 2.1 (annually) and 24.4 cm respectively. Growth pattern determined from length frequency distribution, corresponded with the spawning season. Natural mortality coefficient was estimated as 2.54. The sex ratio indicated that more females than males were abundant in the catches. At present about 75 – 85% of the maximum yield is being obtained. The yield per recruit can be increased by increasing the fishing intensity. However, an increase in fishing intensity could lead to a reduction in the spawning stock below the level where the recruitment could be affected.

1. Introduction

About forty percent of the total fish catch in Sri Lanka consists of small pelagic fish species. *Amblygaster sirm* is very delicious and one of the popular fish among the local people. Studies of species composition[4] show that *A. sirm* contributes a high percentage to the total small pelagic fishery. Therefore, having a proper knowledge of the biology and the population dynamics of this species is very important for the rational exploitation of the resource.

Fisheries of *A. sirm* are carried out through out the island but with a greater intensity on the west, north–east and the east coast. This fishery is being operated throughout the year by using gillnets and seventeen feet fibre glass boats with out–board motors. Nets with mesh sizes of 20 mm and 38 mm are commonly used in this fishery. The present study was made at one of the major fish landing centres (Negombo) on the west coast.

Some length frequency studies of *A. sirm* caught by purse seine from the west coast of Sri Lanka have been done by Joseph.[5] Age and growth studies of *A. sirm* and other *Sardinella* species were done by Dayarathne[4] from the same areas.

In the present study an attempt was made to determine the length weight relationships and the length–weight regression coefficient ('b') values, so as to get an idea of the condition of the fish and its relation to spawning seasons.

The sex composition of the catches were also analysed to get an idea of the sex ratio of the species. The yield per recurit estimates and the growth parameters of the species were analysed to get a better knowledge of the existing fishery.

2. Materials and Methods

Samples of *Amblygaster sirm* were collected from March 1979 to April 1981 from the main fish landing centres of Negombo, on the west coast of Sri Lanka. Each sample consisted of about fifty specimens.

The fish were brought to the laboratory and the total length and weight of each individual fish was measured. Length was taken up to the closest mm and weight was taken up to the closest mg. Sex and maturity stages were also recorded. Three stages of maturity were identified by external colour, shape and size of the gonads of both sexes.

They were as follows;

Immature — Gonads small and dark red and occupy less than half of the body cavity. In males they are flattened while in females they are more tubular in shape.

Maturing — Gonads occupy more than half of the body cavity. In males, gonads are flattened along the edges. In females the gonads are thicker and rounded.

Mature — Gonads occupy almost all of the body cavity. In males gonads are yellowish and thicker with a flattened edge. In females eggs can be seen with naked eye. The colour is reddish.

Length—weight relationships $W = a L^b$, (L = lengh in cm, W= weight of fish in g, a and b are constants) were determined for samples taken from February 1980 to January 1981. The variation of factor 'b' was taken to get an indication of the condition of the fish. The sex ratio was studied in samples taken from March 1979 to April 1981. The nullhypothesis that sexes were equally distributed was tested by using a log—likelyhood ratio test[11] $G = 2 \, fi \, In \, (fi/Fi)$; fi = observed number of frequencies, Fi = expected number of frequencies).

Length frequency distribution was drawn from March 1979 to April 1981 for the pooled data of males and females. Growth curves were fitted to the length frequency samples sequentially arranged in time using the "integrated method" as described by Pauly.[6] Growth parameters (L and K) were estimated by using the Ford—walford plot.

Natural mortality coefficient "M" was estimated from the following empirical relationship.

$$\text{Log}_{10} M = 0.0066 - 0.279 \text{ Log}_{10} L + 0.6543 \log_{10} K + 0.4634 \log_{10} T$$

L and K are the parameters of the von Bertalanffy's growth equation and T is the annual mean temperature. The temperature was taken as 28.5^{0}C. The 'M' values obtained from this equation was multiplied by 0.8 to get a reasonable estimate[8] of M.

Pauly's equation was used to calculate the value for t_0

$$\log(-t_0) = -0.3922 - 0.2752 \log_{10} L - 1.038 \log_{10} K$$

Yield per recruit (Y/R) was estimated from the following formula

$$Y/R = Fe^{-M(t_c - t_\lambda)} W_\infty \sum_{n=o} \frac{U_n \; e^{-nk(t_c - t_o)} \; 1 - e^{-(-F+M+nk)t_\lambda - t_c}}{F+M+nk}$$

F = fishing mortality
M = natural mortality
K = growth coefficent
t_λ = highest age caught
t_c = age at first capture
t_o = age at recruitment
W = asymptotic weight
U = summation constant

3. Results

3.1 Length—weight Relationship

Immature males and females did not show much variation in 'b' value throught the period except females in December and March (Figure 1a & b). However, maturing and matured fish of both sexes showed clear peaks in April and May. Maturing fish showed another peak in 'b' value in August / september. During this period very few mature fishes were observed in catches (Table 1).

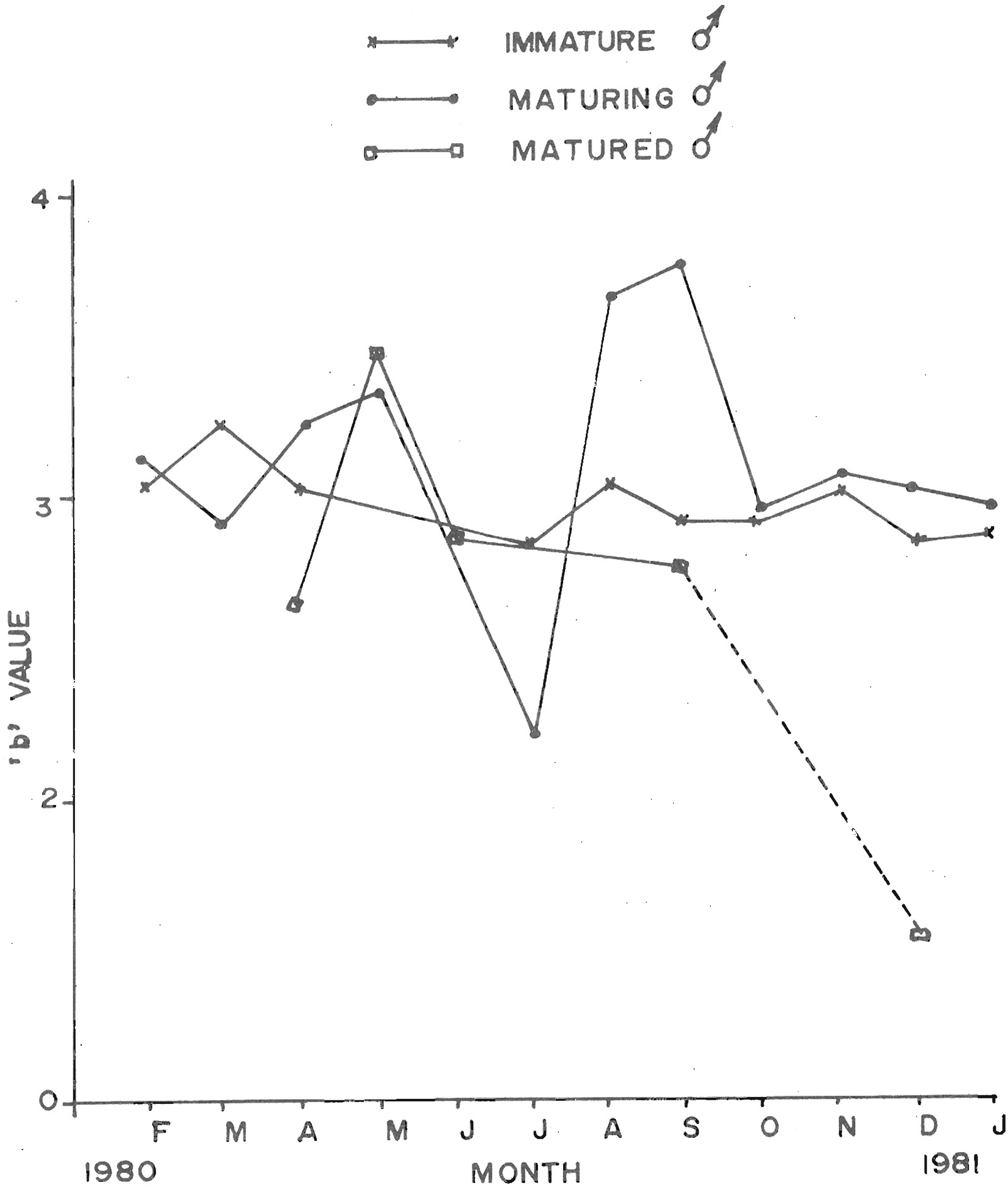

Figure 1a. The monthly variation of regression coefficient ('b') of different maturity stages of males.

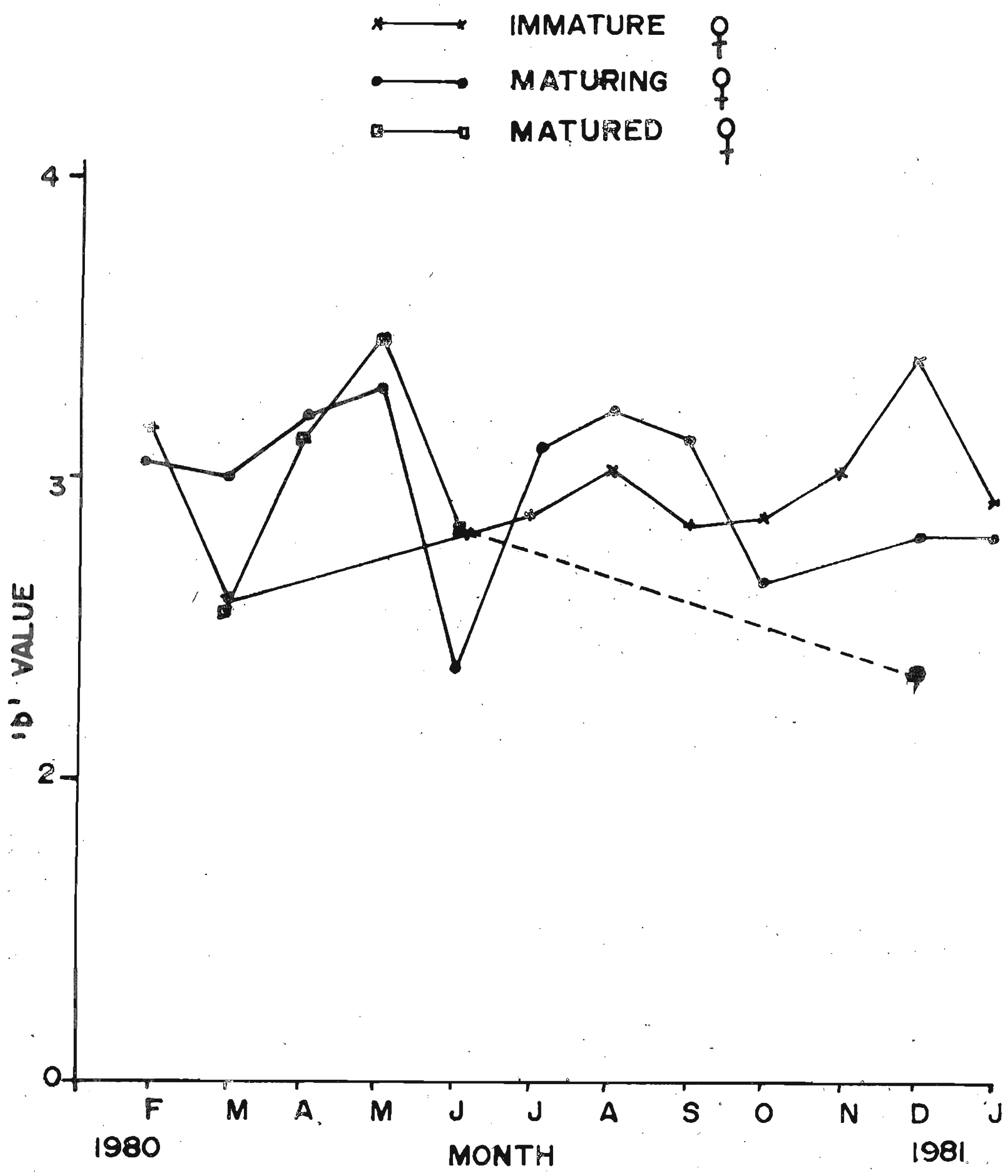

Figure 1b. The monthly variation of regression coefficient ('b') of different maturity stages of females.

Table 1. The number of fish observed in each maturity group

	1980 Feb.	1980 Mar.	1980 Apr.	1980 May	1980 June	1980 July	1980 Aug.	1980 Sep.	1980 Oct.	1980 Nov.	1980 Dec.	1980 Jan.
IMMATURE MALE	55	18	9	–	–	64	76	94	120	61	74	37
MATURING MALE	64	64	64	19	–	12	8	8	52	3	6	28
MATURED MALE	–	–	9	29	17	–	–	3	–	–	5	–
IMMATURE FEMALE	29	44	–	–	–	101	121	104	40	65	57	23
MATURING FEMALE	41	80	97	29	6	36	6	12	64	–	7	31
MATURED FEMALE	–	3	7	42	24	–	–	–	–	–	6	–

3.2 Sex Ratio

The proportion of females was higher than that of males in samples taken during May / October 1979 and March / September 1980 (Fig. 2). Log likelyhood ratio test indicated a significant difference in sex ratios during these months (d.f. = 1, P<0.05). Seventeen months out of twenty—six show-ed a significant difference from the 1:1 ratio (Table 2) of these, eleven months have more females while six have more males. The overall ratio was also significantly different from 1:1 (G value = 32.472, d.f. = 1, P < 0.01) indicating females to be more abundant than males (2416 : 2036, females : males).

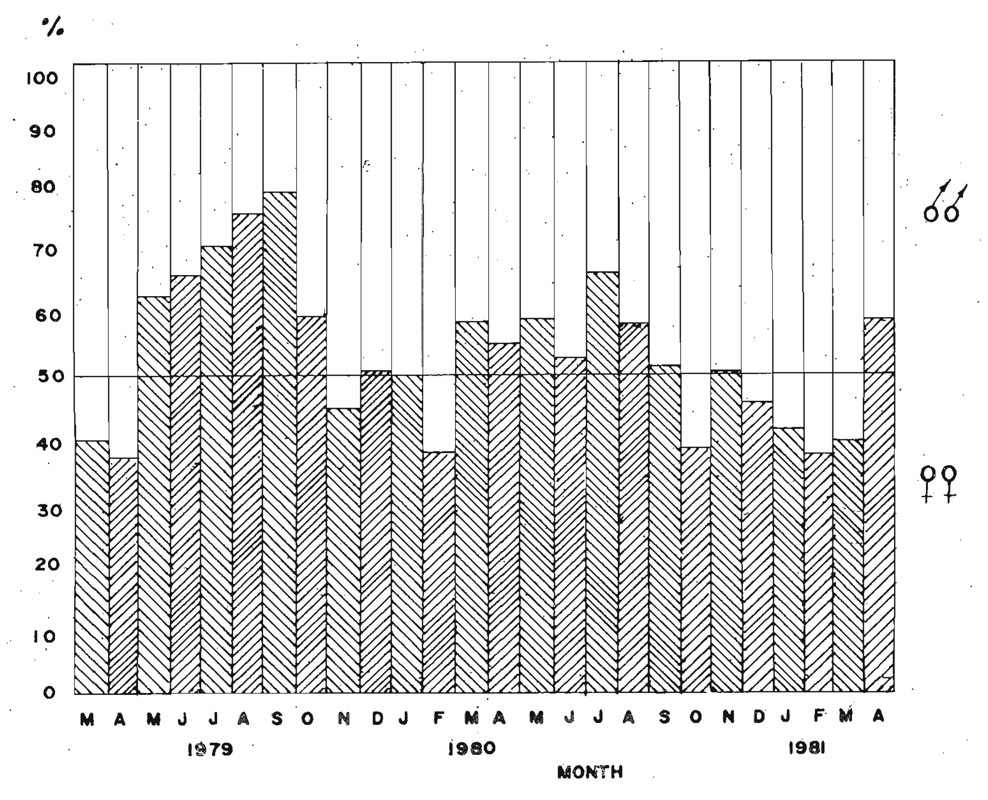

Figure 2. Sex composition of *Amblygaster sirm*

Table 2. Monthly distribution of sex ratio significantly and non significantly different from 1 : 1.

Year	No. of months having sex ratio significantly different from 1 : 1	No. of months having sex ratio not significantly different from 1 : 1	No. of months with more females	No. of months with more males
1981	2	2	6	2
1980	7	5	5	2
1979	8	2	0	2

3.3 Growth Parameters

The total length range was 10.0 to 22.9 cm. In respect of young and old age groups two sets of growth curves were fitted in the length frequency distribution (Fig. 3).

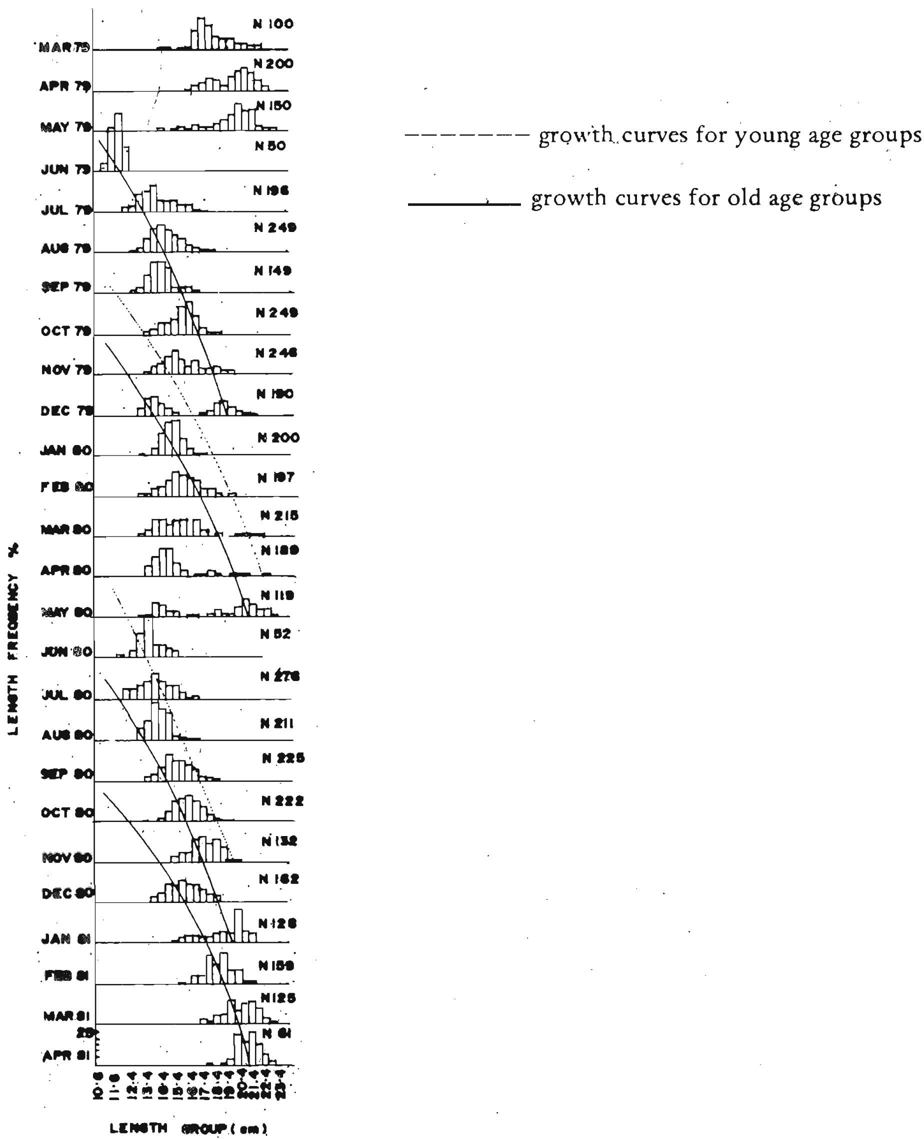

Figure 3. Length frequency distribution of *Amblygaster sirm*

The following growth parameters were derived from the Ford—Walford plot (Fig. 4).

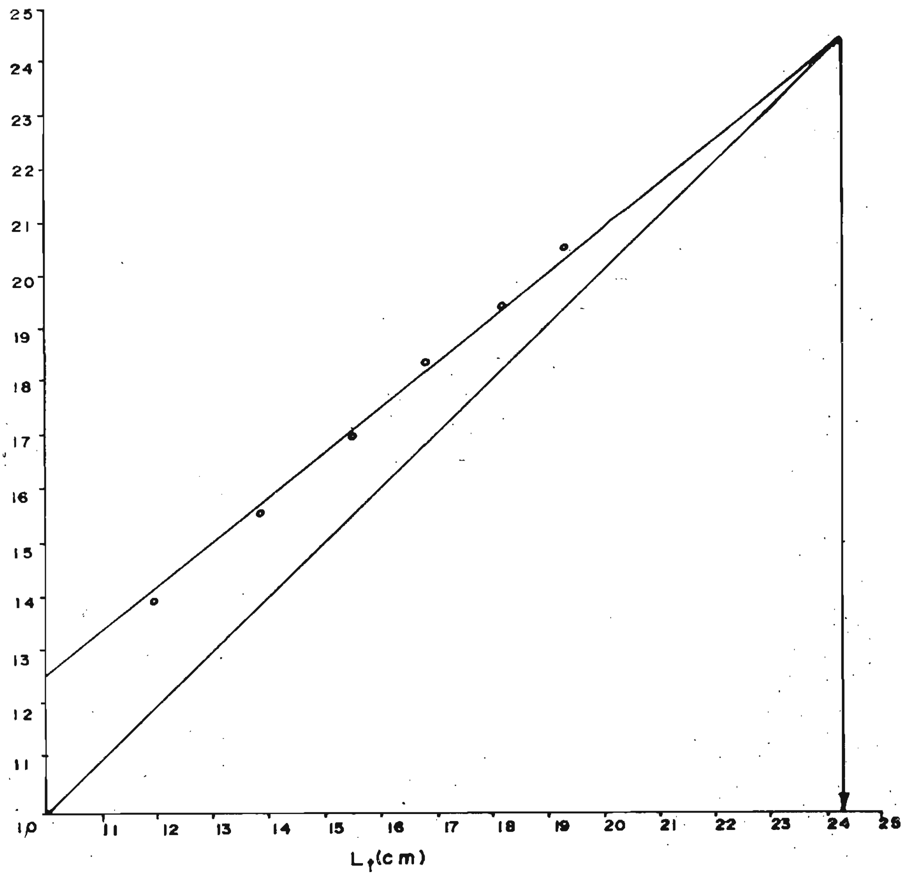

Figure 4. The Ford Walford plot

Asymptotic weight (L) = 24.2 cm.
Growth constant (K) = 2.19 cm.

3.4 Yield per Recruit

Figure 5 gives the yield per recruit in grams for fiching mortality (F) varying from 1 to 10, corresponding to the age at first capture $(t)_c$ from 0.1 to 1.0. Basic data used in computation of yield per recruit (Y/R) are given in Table 3.

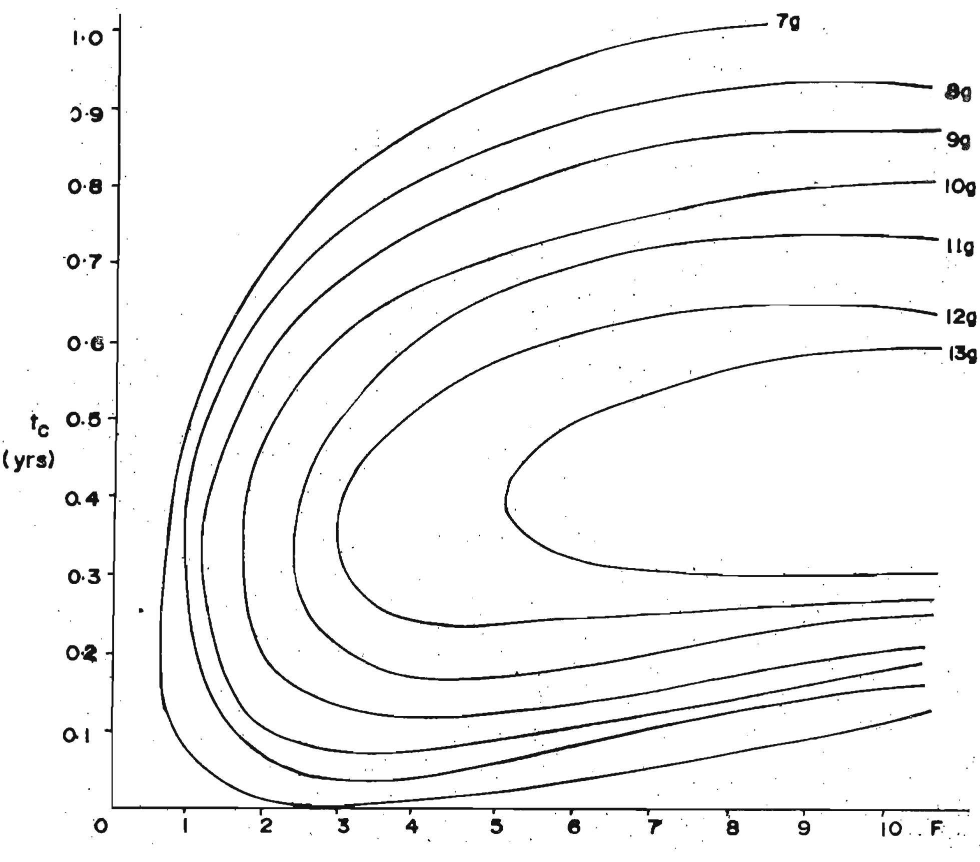

Figure 5. Yield isopleth diagram

Table 3. Parameter values used in computation of Y/R

Parameter	Value
K	2.19
t_o	−0.07
W	126
t_c	0.1
t_λ	5
M	2.54
F	variable
t	variable

Age at recruitment was taken as 0.1 year, corresponding to the smallest fish caught. W was taken as the weight corresponding to L, using the length—weight relationship.

4. Discussion

The 'b' value of the length weight relationship is indirectly correlated with condition factor of a given fish. The variation of a condition factor again uaually related to the spawning cycle.

The peak in December of immature females may be due to the high productivity of water during the south west monsoon period. The drop of 'b' value in March of immature females can be explained due to the low productivity of water during that period. The peaks shown in April/May of the maturing and matured fish are correlated with the south—west monsoonal period (Figure 1a & b). The peaks shown by the maturing fish during August/September correspond with the latter part of the south—west monsoon (Figure 1a & b). The lack of matured fish in this period might be due to spawning migrations. High values of primary production of the Indian ocean have usually been associated with monsoons and consequently with high nutrient concentrations.[1] Therefore, it seems that the spawning pattern of this species is associated with the seasonal pattern of the production in these areas.

The two suggested spawning period of *Amblygaster sirm* occurs in April/May and August/September. These periods are coinciding with the begining and the latter part of the south west monsoons. Weber (1970) also found that the hydrographycal changes associate with these monsoons have some influence on the spawning time of most of the pelagic fish.

The proportion of females was significantly higher during May to October, 1979 compared to other years (Figure 2). In all the years except April 1979, during April / May and August / September the proportion of females are higher than the other months. This may be regarding the active movements of the females during spawning seasons. The sex ratio indicate females to be more abundant than males. The pooled length data for males and females were taken into consideration for the length frequency distribution since there was not much difference of the growth patterns of males and females in this species. Since the small fishes in the catches are highely biased by the gear, the curves fitted for the old age groups can be considered better than the curves fitted for the young ones. (Figure 3).

Since the calculated t_0 is almost equal to zero, the months in which the growth curves begin can be considered as the spawning periods. The growth curves, begining from May / June and Sep. / Oct. are correlating with the suggested spawning periods in this study.

The yield isopleth diagram (Figure 5) indicates that the maximum yield per recruit (13.0 g) can be obtained with a fishing mortality (F) of 5 and age at first capture (t_c) of 0.4.

With the two mesh sizes (28 mm and 30 mm) commonly used, the present t is ranging from 0.4 to 0.54. Considering the surveys conducted by R.V "Dr. Fridtjof Nasen" in 1979 to 1980 in Sri Lanka it is found that the fishing mortality value in that area is equal to 2. According to these values the present yield per recruit is between 10 and 11g (Figure 5). That means about 75%–85% of the maximum yield is being taken with the present F and t_c. If the age at first capture can be reduces to 0.3, even at a fishing intensity of 3, about 90% of the maximum yield can be obtained. Therefore it seems that the present fishing mortality can be increased a little further without taking the risk of growth overfishing.

However, increasing the fishing intensity could lead to a reduction in the spawning stock below the level where the recruitment is affected. According to Cushing[3] and Ulltang[10], pelagic fish stocks are more prone to recruitment overfishing than demersal fish, if not properly managed. The danger in reaching this situation is higher, the nearer the management objective is to the MSY point and the risk of a total collapse in the spawning stock greater if the immature fish are also caught.[10]

According to these factors even though it is possible to increase the fishing mortality a little further, it is better not to encourage it. The present fishing effort can be recommended highly for the rational exploitation of the herring stock.

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