Northwest Atlantic Fisheries Organization

Serial No. N422

NAFO SCR Doc. 81/IX/116

THIRD ANNUAL MEETING - SEPTEMBER 1981

Larval Fish Surveys on Flemish Cap, 1980

by

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ABSTRACT

Ichthyoplankton surveys were carried out on Flemish Cap during 6-13 April, 20-26 May and 22-28 July, 1980. Larval redfish were the dominant ichthyoplankton during all three surveys, abundance being estimated as 7.9×10^{11} larvae in April, 2.20×10^{12} larvae in May and 1.11×10^{11} larvae in July. Peak extrusion was determined to have occurred between 24 April - 1 May, 1980, based on a growth rate of 0.146 mm/d estimated from changes in length-frequency data, May-July. Both population increase and decline approximated on exponential relationship on Flemish Cap, based on data from 1978, 1979 and 1980. In 1980 it was estimated that over 99% mortality had occurred between April and July, 1980. Comparison of abundances of larval *Sebastes* sp. in July 1978, 1979 and 1980 indicated a decrease across all three years.

Cod eggs and larvae on Flemish Cap were extremely low in abundance in 1980, as they were in 1979.

INTRODUCTION

As a continuation of the Flemish Cap Project in 1980, several research cruises were made to sample ichthyoplankton, zooplankton, chlorophyll, nutrients, temperature and salinity on Flemish Cap. The distributions and abundances of redfish larvae, *Sebastes* sp., and cod, *Gadus morhua*, eggs and larvae on Flemish Cap in 1980 are reported.

MATERIALS AND METHODS

Three research cruises were made to Flemish Cap during 6-13 April, 20-26 May and 22-28 July 1980 to sample for ichthyoplankton. In each case a 42 station grid survey was carried out at 20 nmi station spacing using a 61 cm Bongo sampler with paired nets of .333 mm mesh sizes. Standard tows were done to 200 m or within 5 m of the bottom following the basic procedures outlined by Smith and Richardson (1977). Processing of samples and calculations of abundance estimates followed the procedure of Anderson and Akenhead (1981).

RESULTS

REDFISH

As in 1979 (see Anderson and Akenhead 1981), redfish larvae (Sebastes sp.) were the most abundant larval fish sampled on Flemish Cap in 1980. During the period 6-13 April 1980 values ranged from 0.2-252.5 larvae m^{-2} in the survey area, with the total abundance estimated to be 7.98 x 10^{11} larvae (Table 1). The distribution of larvae was similar to April 1979 (Anderson and Akenhead 1981) in that highest values (>100 larvae m^{-2}) were observed over depths >200 m, in this case mostly to the north of shoal waters (Fig. 1a). Similarly, only low values (<5 larvae m^{-2}) were observed over waters <200 m depth. At the upper range of sizes, distribution of larvae 8 mm in length was highly irregular with highest values tending to be over depths >400 m. Larvae were observed range from 4 to 8 mm standard length, the mean value being 6.45 mm (Fig. 2a).

During the survey 20-26 May, 1980, total redfish larval abundance for the area was estimated to be 2.20 x 10^{12} larvae (Table 1), with station values ranging from 0.1 to 447.0 larval Sebastes sp. m^{-2}. Highest abundances at this time occurred over shoal waters and extending to the northeast (Fig. 1b). The lowest values were confined to the extreme northwest corner of the survey area. Distributions of larvae ≥9mm was not markedly different from that for all lengths combined. However, larval abundances 6 and 7 mm in length were distinctly high east and west of shoal waters >200 m depth on Flemish Cap. Larval Sebastes sp. were 5-14 mm in length, with an average length of 8.93 mm (Fig. 2b).

Larval abundance was very much reduced by the 22-28 July survey, 62 days later. Station values ranged from 0.0 - 10.1 larvae m^{-2}. The total estimated abundance for the survey area was approximately 1.11 x 10^{11} larvae (Table 1). Larval Sebastes sp. were most abundant over shoal waters of Flemish Cap and extending north beyond the 200 m contour (Fig. 1c). Larvae were observed from 4-27 mm in length, with three model values at 6, 10 and 18 mm (Fig. 2c). The average length of larvae 12-27 mm standard length was 17.97 mm. A breakdown of abundance distributions for larvae 4-8 mm, 8-12 mm and 12-27 mm indicated the 12-27 mm group was concentrated over Flemish Cap, similar to the distribution in Fig. 1c. However, larvae of the smallest size group were exclusively concentrated in waters >200 m immediately west and north of shoal waters. Larvae of the middle size group were scattered irregularly throughout the survey area, abundances being too low to discern any concentrations in distribution.

Comparison of the mean length of larval Sebastes sp. 12-27 mm in length during July (17.97 mm) with that of the May survey (8.93 mm) indicated a larval growth rate of 9.04 mm in 62 days. This is equivalent to a growth rate of 0.146 mm/d during this period.

Larval redfish abundances from surveys in 1978, 1979 and 1980 have followed a similar trend (Fig. 3). Larval extrusion begins in March and increases exponentially with time until late April-early May. Population decline following peak extrusion also appears to be exponential through to the July period. The intersection of the ascending line from early 1979 data with that of post-peak extrusion in 1980 (Fig. 3) indicates an extrusion peak at Julian Day 119. Observations from 1978 and 1980 during the pre-peak extrusion period both fell below the line connecting the early 1979 observations.

Observations during July for 1978-80 indicated a trend of decreasing larval abundance from 1978 through to 1980 (Fig. 4 and Table 2a). Comparing 1978 with 1980 this was true for both size groups, 4-12 mm and 13-27 mm. In 1979 the 4-12 mm size group was slightly higher than 1978, but absence of larger larvae resulted in a lower total abundance of Sebastes sp. larvae. Total abundance estimated for 1980 larvae was 40% of the 1978 estimate.

COD

Catches of cod eggs and larvae were extremely low during 1980 on Flemish Cap. A total of 53 cods eggs were caught during the April survey, 2 eggs in the May survey and none in July. A total of 14 cod larvae were caught during the three surveys on Flemish Cap, 3 in April, 8 in May and 3 in July 1980. These larvae averaged 4.5 mm, 7.0 mm and 35.0 mm, respectively. Cod eggs in April were distributed towards the outside of the survey area in all but the S-W corner, while numbers of larvae were too low to determine any distributions.

DISCUSSION

REDFISH

In April 1980 distribution of larval Sebastes sp. was similar to that of April 1979 (Anderson and Akenhead 1980). Larvae were most abundant north of central Flemish Cap, in waters >200 m depth, while in areas <200 m depth abundances were quite low. In contrast, 1980 surveys in May and July indicated larval redfish were abundant in a broad area over shoal waters and extending to the north and east. Thus, the distribution of larvae as observed in 1978 and 1979 was not the same in 1980 throughout the spring-summer period (cf. Anderson and Akenhead 1981).

Distributions of larvae at different sizes and times, gives some indication of where extrusion took place and the fate of earlier extruded larvae. For instance, larval distribution in April was most abundant north of the 200 m contour and 6 mm and 7 mm larvae during 20-26 May 1980 were most abundant on either side of Flemish Cap >200 m depth. Similarly, during 22-28 July 1980 4-8 mm larvae, which are less than 1 week old (Penney and Anderson, MS 1981), were most abundant west of the 200 m isobath. As it is unlikely local currents will significantly alter their location in just a few days, it appears extrusion is taking place in these areas, >200 m depth. The abundance of larger larvae over shoal waters on Flemish Cap during May and July 1980 indicates larvae extruded in deeper waters during April 1980 are now concentrated more to the centre of Flemish Cap. Such a central concentration of larvae has also been described by earlier workers (e.g. Serebryakov, 1978).

The extent to which physical circulation is concentrating larvae in the central region is not known. Abundance estimates from our surveys vary from 1 to 2 orders of magnitude. Given the large fluctuations in abundance about the time of peak extrusion, variation in growth and mortality of larvae in different areas of Flemish Cap would have a marked effect on abundance distributions. We are presently examining growth rate differences for these larvae to determine if variable growth rates can account for such differences. A detailed analysis of water circulation during this period would be necessary to properly describe such a mechanism.

Larval redfish abundance estimates in 1980 followed a similar pattern to that observed for 1978 and 1979 (Fig. 3). These data indicate extrusion increases exponentially, beginning sometime in March, and rising to a maximum during late April. The maximum is then followed by an exponential decline in population abundance, at least from May through to July. The rate of population decline from the estimated date of peak extrusion in late April through to July is dramatic. For instance, estimating peak abundance to be 9.2×10^{12} larvae on 28 April 1980 (Fig. 3), then by 20-26 May 1980 there has been 77.7% total larval mortality, and by 22-28 July 1980 99.2% mortality. Similarly, comparing survey results from May to July 1980 corresponds to 96.6% mortality through this period and an estimated mortality coefficient of 0.0493 (Z).

Such rapid declines in population size of larval fish are common. For example, larval surveys for North Sea plaice through several years indicated mortalities from 94.8% to 99.6% over days, and mortality coefficients of 0.052 to 0.082 (Bannister et al. 1974). Similarly high mortality rates have been observed by Georges Bank larval herring where the mortality coefficient ranged from 0.0320 to 0.0538 over 120 days from 1971-1977 (Lough et al. 1979). Small shifts in the mortality rate can result in substantial differences in larval abundance after several months.

Comparison of larval redfish data from 1978, 1979 and 1980 indicates peak extrusion on Flemish Cap took place at approximately the same time each year. The time of peak extrusion can be estimated from July length-frequency data and growth rates. In 1980, using an estimated growth rate of 0.146 mm/day, a starting length of 6.45 mm and an average size of 11.97 mm for July redfish, then these larvae had grown an average of 11.52 mm. This corresponds to an estimated time of peak extrusion on Julian Day 118 (28 April 1980). Growth rate estimates based on otoliths indicated the same date for peak extrusion (Penney and Anderson MS 1981). Similarly, for 1978 using a growth rate of 0.155 mm/d estimated from otoliths (Radtake MS 1980) compared to July 1978 length frequency data (Anderson and Akenhead 1981) indicates peak extrusion occurred on Julian Day 117. However, Radtke's (MS 1980) growth estimate is based on total length, versus standard length. It is likely an adjusted growth rate corrected to standard length would be lower and therefore estimate peak extrusion would be earlier. Based on 1 mm size groups, variations in the above estimates for peak extrusion would be ±3-4 days.

Extrapolation of abundance estimates from the ascending line of 1979 data and the descending line of 1980 data (Fig. 3) indicates an intersection at Julian Day 119. While time of peak extrusion can only be indirectly inferred from this observation it does correspond very closely with the above estimates for peak extrusion, using the only 1979 data available. From these observations peak redfish extrusion on Flemish Cap appears to occur as a very discrete event and at a very specific time. The consistent timing of peak spawning has been documented for a number of species (Cushing 1969).

If one assumes that the time of peak extrusion occurred around day 118 ± 4 days in 1978, 1979 and 1980, then two observations are apparent from Fig. 3. The first is that peak abundance of larval redfish on Flemish Cap in 1978 and 1980 would have been less than in 1979. Secondly, July abundances were different in all three years. While these abundances are different, there is little infomation on variation in larval redfish abundances in different years. While July 1980 redfish abundance was only 40% of that in 1978, this difference may or may not be significant from the long term mean. Larval herring abundances on Georges Bank varied from 15% to 218% of the mean during 1972-76, before the collapse of that stock, and these differences were not related to estimates in recruitment (Lough et al. MS 1980). To determine if such differences in larval redfish abundances on Flemish Cap are significantly related to recruitment must wait until these fish enter the fishery 10 years later. On the other hand, the complete absence of large redfish in July 1979 is significant. Present work is underway to determine if there were differences in feeding, growth and condition related to the observed abundances during these years.

COD

Cod eggs and larvae were present in such small numbers that few, if any, conclusions can be drawn from the data. It remains that cod eggs and larval abundance was extremely low on Flemish Cap in 1980, as it was in 1979.

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Table 1. Abundance estimates of larval Sebastes sp. based on a 42-station sampling grid for Flemish Cap, 1978, 1979 and 1980.

Date	Mid-date (Julian Day)	Abundance	In abundance	Source
18-30 April 1978	114	$3.26 \times 10^{12*}$	28.8127*	Grimm et al. 1980
16-23 July 1978	201	2.73×10^{11}	26.3327	Anderson and Akenhead 1981
20-24 March 1979	80	1.13×10^{11}	25.4507	"
23-27 April 1979	115	6.94×10^{12}	29.5683	"
10-14 July 1979	193	$1.12 \times 10^{11**}$	25.4418**	"
6-13 April 1980	101	7.98×10^{11}	27.4054	This paper
20-26 May 1980	145	2.20×10^{12}	28.4915	" "
22-28 July 1980	207	1.11×10^{11}	25.4328	" "

* Abundance estimate based on a 56-station grid (Grimm et al MS 1980).

** Estimated from 20 stations sampled as representing 86% of larvae that would have been sampled by a 42 station grid. This was based on comparisons with 1978 and 1980 data (see Table 2).

Table 2. Summary of July abundances of larval Sebastes sp. on Flemish Cap for a) 20 stations over the center of Flemish Cap (see Anderson and Akenhead 1981) and b) the complete 42 station grid.

Date	Size group 4-12 mm	Size group 13-27 mm	Total
a)			
July 1978	8.28×10^{10}	17.28×10^{10}	25.56×10^{10}
July 1979	9.62×10^{10}	0.0	9.62×10^{10}
July 1980	1.22×10^{10}	7.49×10^{10}	8.71×10^{10}
b)			
July 1978	9.86×10^{10}	17.43×10^{10}	27.30×10^{10}
July 1980	2.68×10^{10}	8.21×10^{10}	10.89×10^{10}

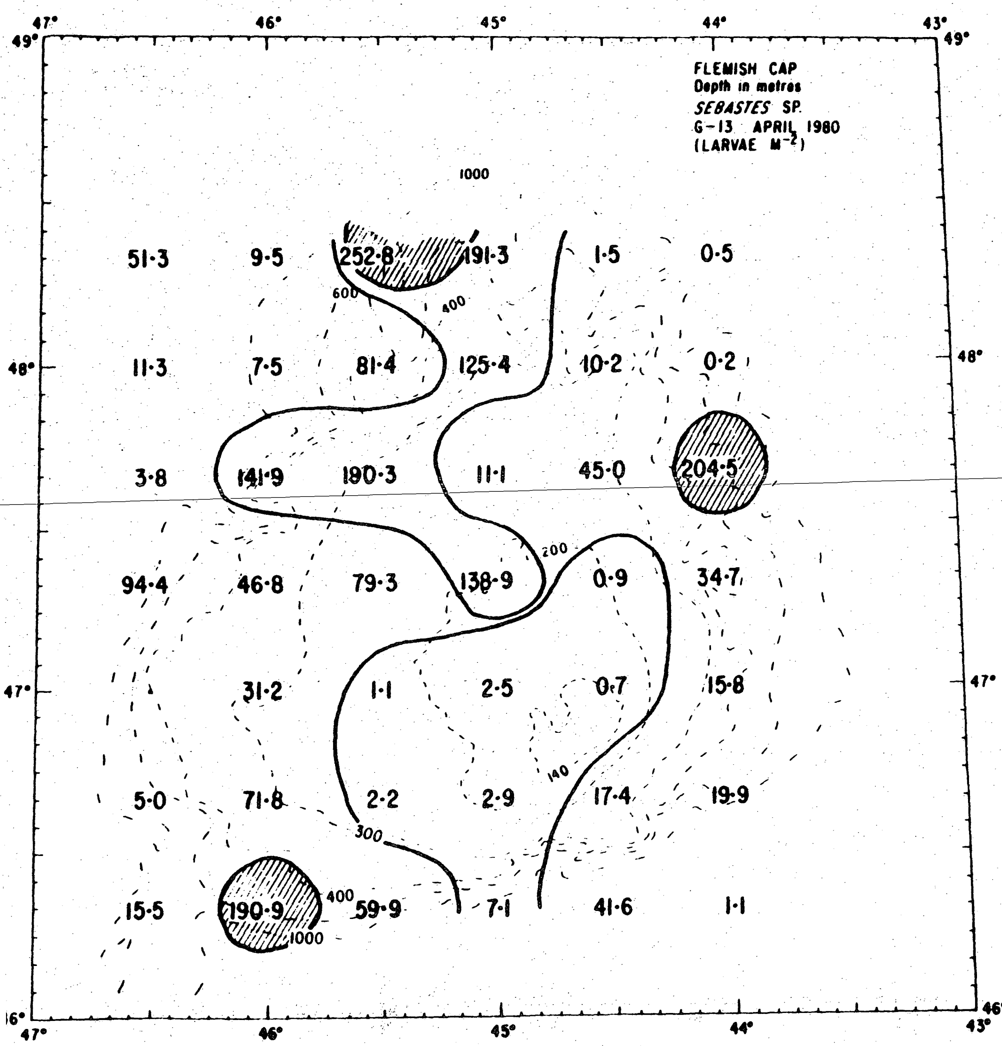

Fig. 1A: Distribution and abundance of redfish larvae (number/m^2) on Flemish Cap during 6-13 April 1980.

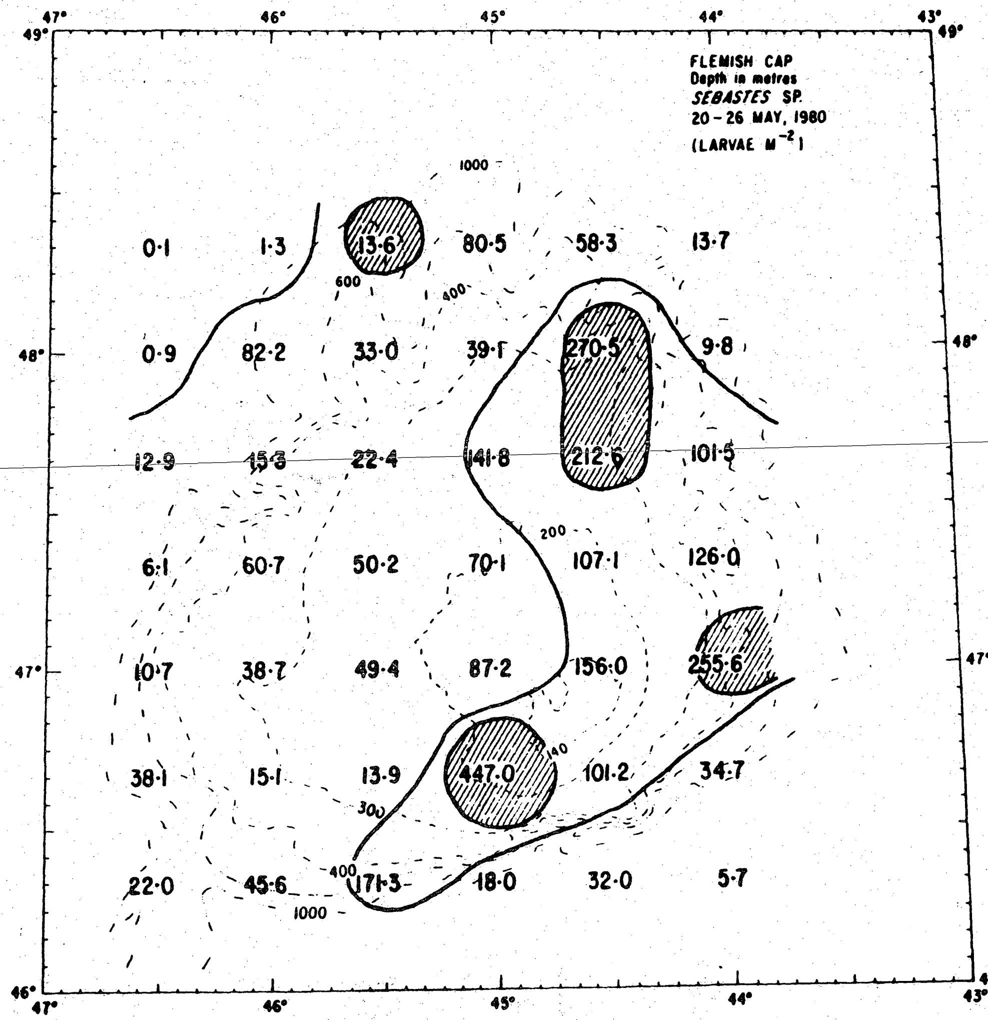

Fig. 1B: Distribution and abundance of redfish larvae (number/m^2) on Flemish Cap during 20-26 May 1980.

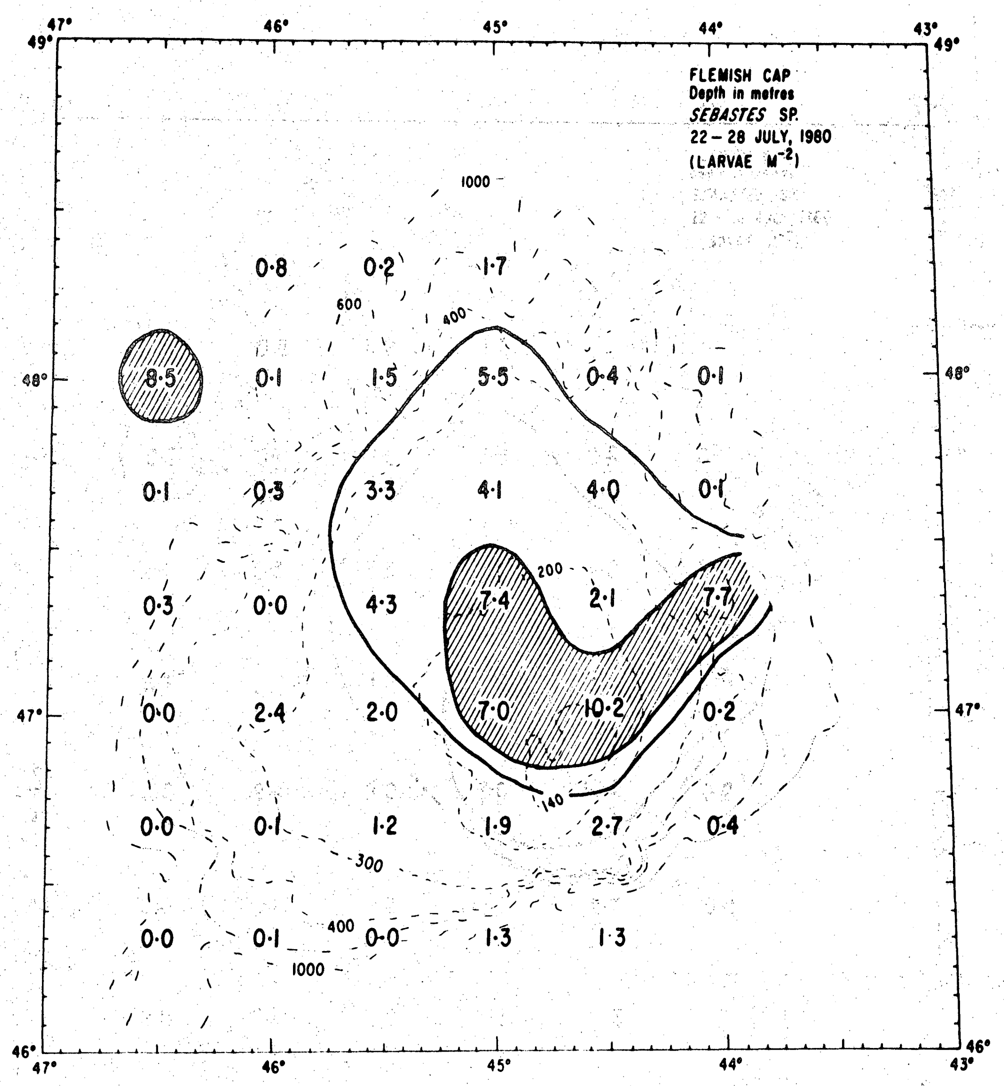

Fig. 1C: Distribution and abundance of redfish larvae (number/m²) on Flemish Cap during 22-28 July 1980.

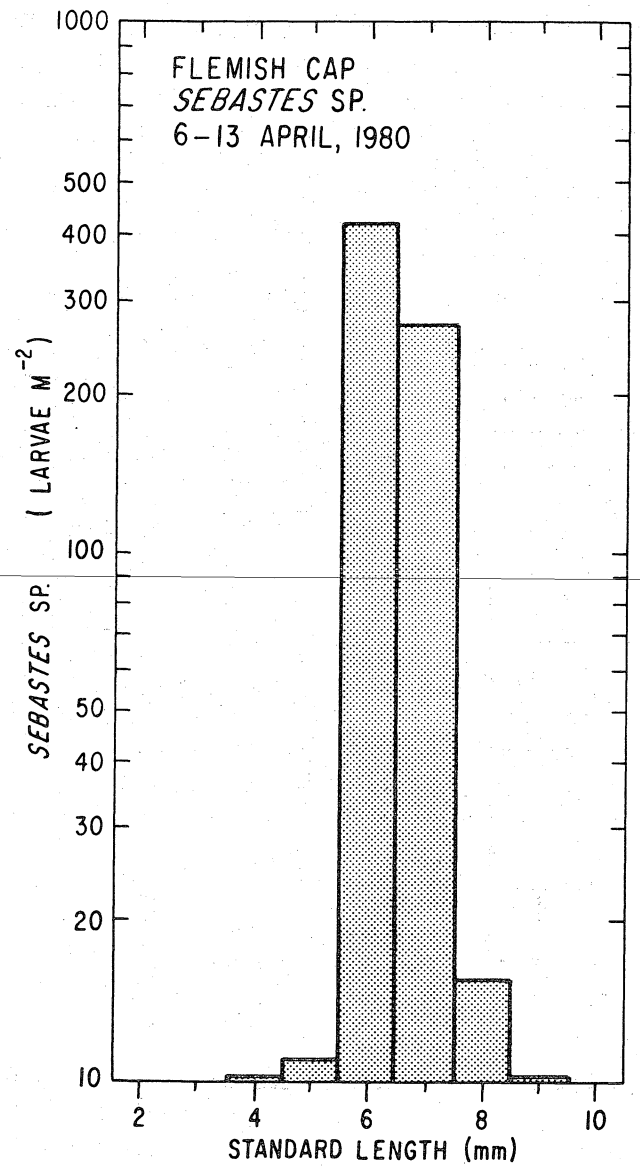

Fig. 2A: Length composition of redfish larvae on Flemish Cap during 6-13 April 1980.

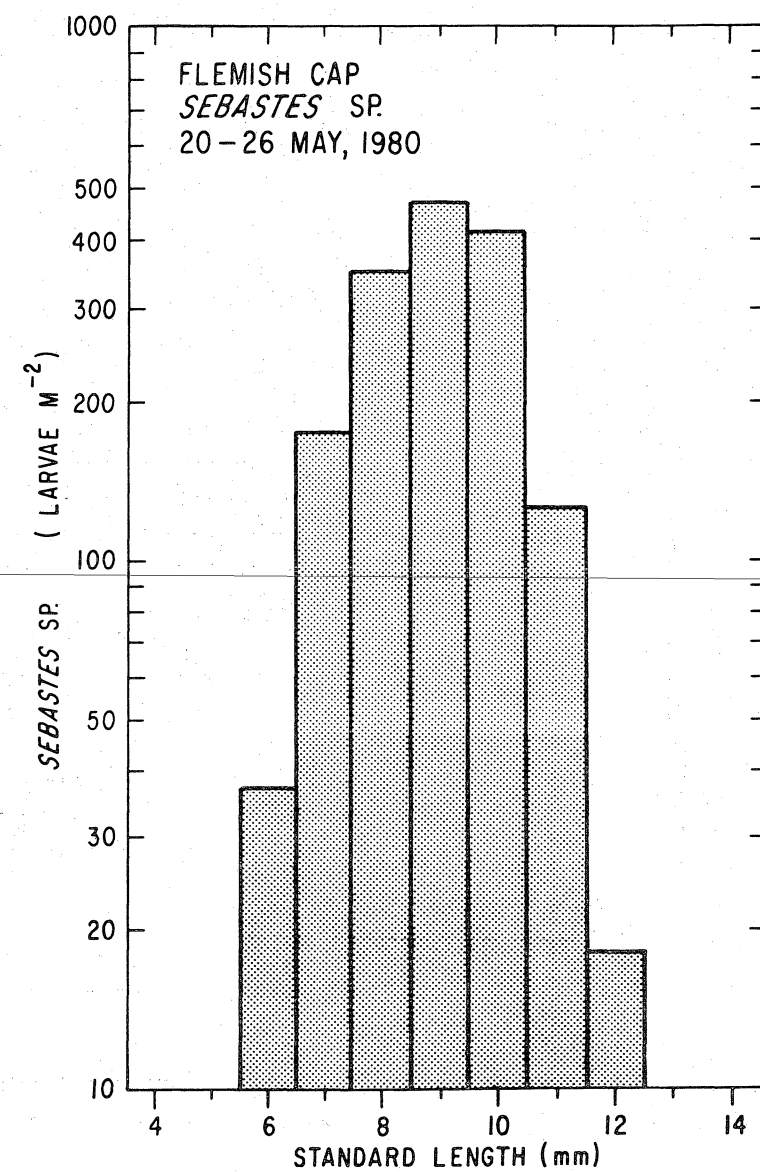

Fig. 2B: Length composition of redfish larvae on Flemish Cap during 20-26 May 1980.

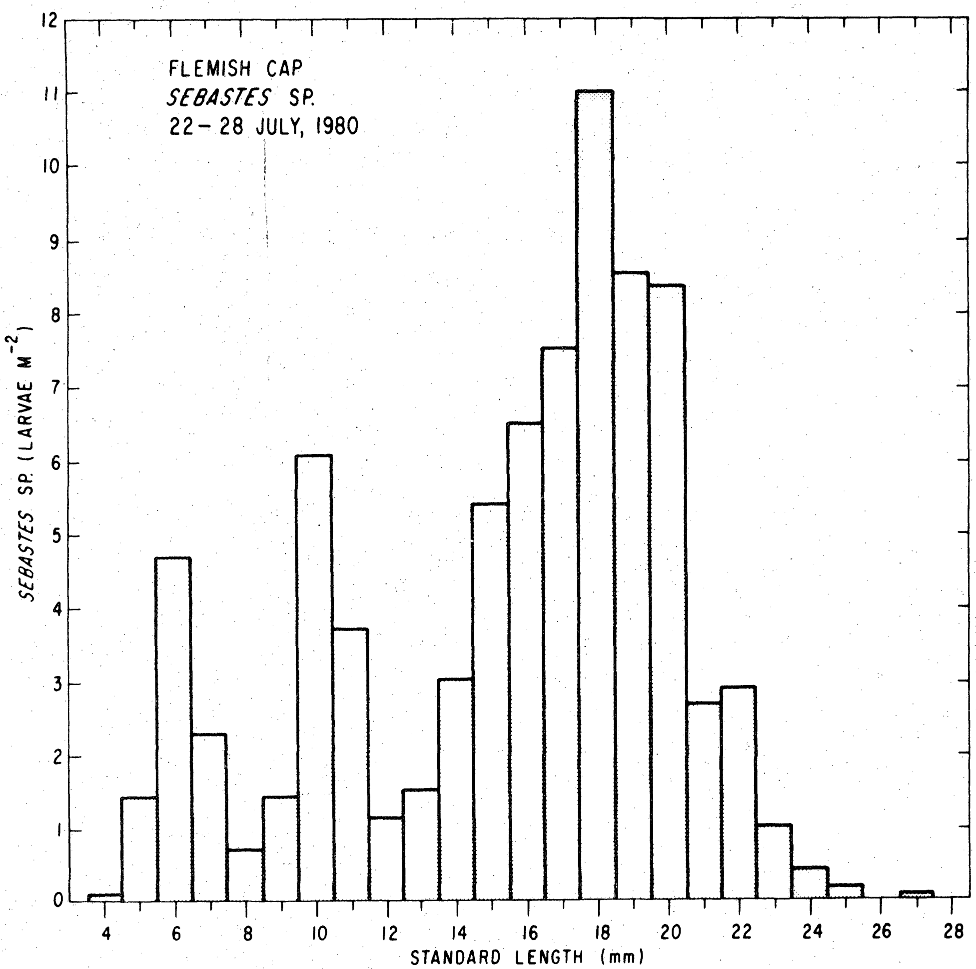

Fig. 2C: Length composition of redfish larvae on Flemish Cap during 22-28 July 1980.

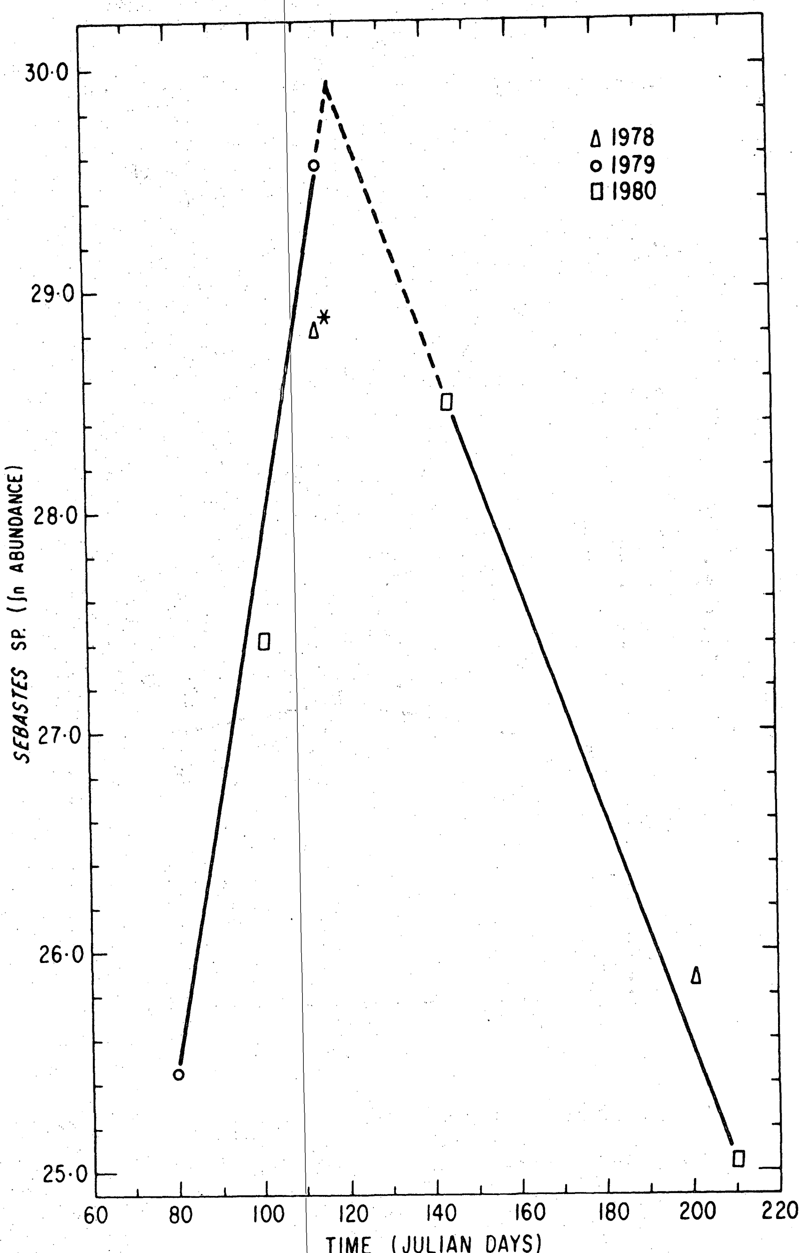

Fig. 3: Abundance estimates of larval Sebastes sp. on Flemish Cap during 1978, 1979 and 1980. (*abundance for 56 stations, Grimm et al. MS 1980).

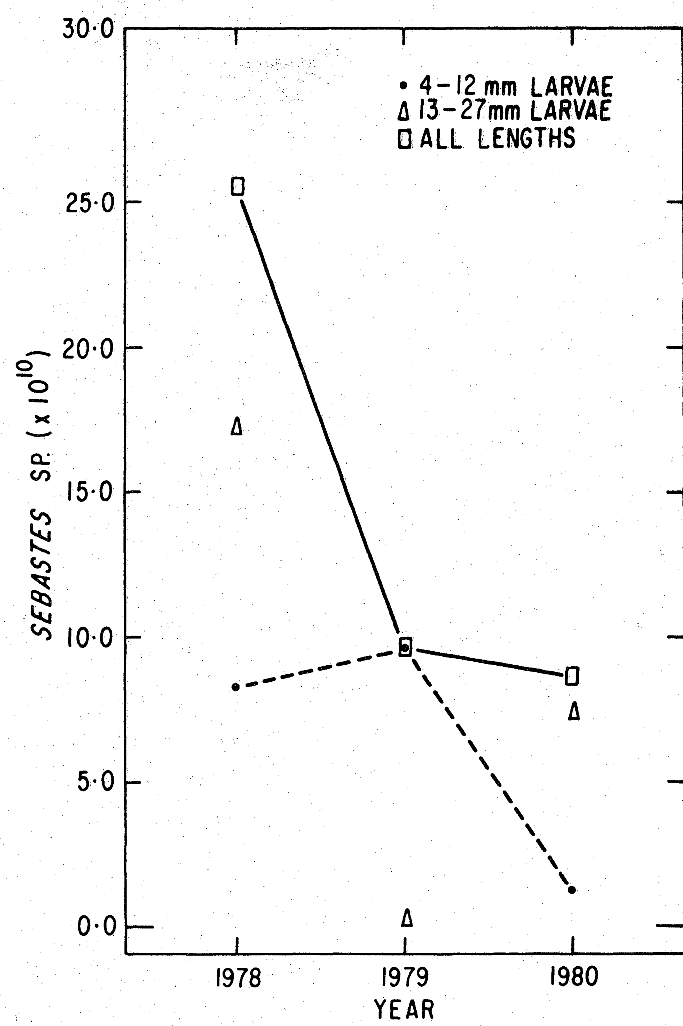

Fig. 4: Abundance estimates of larval Sebastes sp. on Flemish Cap during July 1978, 1979 and 1980. (Data for 20 stations).