Fol. 41 H

International Council for the
Exploration of the Sea

C.M.1970/H:5
Pelagic Fish (Northern) Committee

Age, Growth, Reproduction, and Feeding of Benthosema glaciale (Myctophidae) from Western Norway

by

Jakob Gjøsæter[x)]

Introduction

Benthosema glaciale (Reinhardt, 1837) is the most common member of the Myctophidae in the North Atlantic and the Norwegian Sea. It is mesopelagic, and most records are from areas outside the 400 m depth contour, or from fjords where the depth is 300 - 500 m or more (Johnsen, 1922). A diurnal vertical migration is shown to occur (Halliday, 1970).

This paper gives some preliminary results from an investigation on Benthosema glaciale from Byfjorden in the Bergen area, western Norway.

Material and methods

The main part of the material was collected in 1969 by R/V "Fritjof Nansen" of the Biological Station, University of Bergen. A collection of B. glaciale taken during investigations on euphausiids in 1967 and 1968 was also placed at my disposal by Dr. Kr.Fr.Wiborg.

x) Institute of Marine Research, Bergen,
and
Biological Station, University of Bergen.

Most of the fish were collected by an Isaacs-Kidd three-foot midwater trawl, but a Beyer low speed midwater trawl with an opening about 1 m^2 was also used.

Standard length was measured to the nearest 0.5 mm. The fish collected in 1969 were measured immediately after capture, and then preserved in about 4 % formalin. The otoliths were removed within a few hours. Fish from 1967 and 1968 were preserved in formalin and measured in this condition. To make these length measurements comparable, the formula $l_{fresh} = 1.050\ l_{pres.} - 0.574$ was used.

Age and growth

Otoliths were used for aging. They were placed in absolute alcohol, transfered to creosote, mounted in Canadabalsam or Eukitt, and viewed by binocular microscope using reflected light. Age was determined by counting the hyaline zones.

To confirm the assumption that the zones were laid down annually, record was kept of the seasonal formation of the edge zones. On some otoliths a gradual transition from opaque to hyaline zones and vice versa was observed. In these cases the character of the rand zone was often difficult to classify, and they were noted as "undetermined". The hyaline zones were mainly laid down in summer and the opaque in winter. (Fig. 1)

As an additional check on the age determination, the age groups were compared to the peaks in the length-frequency distribution, and a good correspondence was found.

The material from 1967 and 1968 was preserved in formalin, and the otoliths were partly dissolved. Therefore, only the 0- and I-groups which could be aged from their lengths, were used in the growth calculation.

In Fig. 2 is shown the age distribution of B. glaciale collected in 1969. Calculated from these data, the estimated average annual mortality in the I-, II-, III-, and IV-groups are about 70%. But as the number of specimens included in the calculation is small, and little is known about the selectivity of the gear, this estimate is probably not very reliable.

Fig. 3 shows the mean length and standard deviation for the months when data were available. Data from 1967, 1968, and 1969 are combined, as the difference in growth between years seems to be small. Halliday (1970) showed that there is no sexual dimorphism in growth, both sexes are therefore combined.

The constants of the von Bertalanffy growth equation were determined by graphical methods (Ricker, 1958). To make the results easily comparable to those of Halliday (1970), age was calculated from 1 April.
The resulting equation was:

$$l_t = 74.0\ (1 - \exp[-0.46(t + 0.05)])$$

This is shown graphically on Fig. 3.
In the Nova Scotia area Halliday (1970), who also used otoliths for age determination, found:

$$l_t = 68.28\ (1 - \exp[-0.36(t + 0.49)])$$

based on measurements from preserved specimens.
L_∞ may be converted to fresh length by using the formula $l_{fresh} = 1.050\ l_{pres.} - 0.574$. This gives $L_\infty = 71.14$ while K and t_o are not altered.

This indicate that B. glaciale grows faster and attains a slightly greater size in the Bergen area than off Nova Scotia. The latter conclusion is also supported by the fact

that the largest specimens in Halliday's material were 67 and 68 mm (converted to fresh length 69.8 and 70.8 mm), while the largest in my collection were 72 and 77 mm. An equally high or higher maximum length is recorded from other Norwegian fjords (Bernhoft-Osa, 1935 ; Lid, 1967 ; Gjøsæter, unpubl.).

Reproduction

The maturity of the gonads was classified according to a scale from 1 to 5, where 1 is immature and 5 spent. The scale is based on macroscopic characters, and for the females also on egg-diameter measurements. The resulting figures are presented in Table 1. (p. VIII).

The spawning probably occur between May and July. Juveniles were found from September, when they had reached a length of 15 - 16 mm. Smaller specimens were not found, probably because they were not caught by the net. Specimens 9.5 - 14.0 mm in length have previously been caught in the Bergen area in September (Johnsen, 1944). Off Nova Scotia post-larvae are found in May and July (Halliday, 1970), and off Iceland larvae and post-larvae are taken i May, June, and August (Magnusson, Magnusson and Halgrimsson, 1965; Magnusson, 1966). This may indicate a somewhat later spawning period in western Norway than in the other areas.

A part of the population in Byfjorden spawns at age 2 and probably all at age 3 and subsequent ages. The same is found by Halliday (1970) off Nova Scotia.

Eggs were counted in 19 specimens. The results are shown in Fig. 4. From these data the regression line

$$\lg N = 3.18 \lg l - 2.74$$

was calculated (N is number of eggs and l standard length in mm.)

Food

The stomach contents were studied in about 400 specimens. The fullness was classified according to the following scale (Lie, 1961):

0	empty
1	very little contents
2	some contents
3	full
4	expanded stomach

The mean fullness in the different seasons were:

spring (March - May)	2.35
summer (June - Aug.)	2.16
autumn (Sept.- Nov.)	1.69
winter (Des.- Febr.)	1.68

15 % of the fishes had empty stomachs. This may in part be due to a regurgitation of the food as they were captured. Therefore, the figures indicating mean fullness are minimum values only.

The degree of fullness through the year is given in Fig. 5, showing that B. glaciale feed all the year, but most through spring and summer.

Fish with food in their stomachs were found both day and night, but the highest values for mean fullness occurred in the first hours after sunset. The contents were also least digested in fishes taken at this time.

In the stomachs Copepoda and Euphausiacea were found. Representatives of other groups were not found, but many stomachs had contents toomuch digested for identification. Euphausiacea were most common in fish of age 3 and 4. Table 2 gives the frequency of occurrence of the main food groups. (Table 2, see page VIII).

Summary

Benthosema glaciale from western Norway attains a maximum age of at least five years and a maximum length of about 75 mm. The growth is a little faster than in the north-western Atlantic.

Spawning occurs between May and July. Part of the population spawns for the first time at age 2 and all at subsequent ages. Mean egg count is about 800.

Benthosema feed all the year, but most through spring and summer. The main food is copepods, but much euphausiids are also eaten.

References

Bernhoft - Osa, A. 1935. Bidrag til Rogalands fiskefauna. Stav. Mus. Årb. 1933 -34 : 75 - 109

Halliday, R. G. 1970. Growth and vertical distribution of glacier lanternfish, Benthosema glaciale, in the northwestern Atlantic. J. Fish. Res. Bd. Canada 27 : 105 - 116

Johnsen, S. 1923. Remarks on the distribution and the biologi of Myctophum glaciale (Reinh.). Bergen Mus. Årb. 1921 -22 (6): 1 - 50, 1 pl.

- 1944. Studies on variation in fish in North - European waters. I. Variation in size. Bergen Mus Årb. 1944 (4): 1 - 129

Lid, G. 1967. Fiskeobservasjoner fra rekefeltene i Oslofjordens indre del. Fauna, Oslo. 20 : 96 - 106

Lie, U. 1961. On the growth and food of 0 - group coalfish, Pollachius virens in Norwegian waters. Sarsia 3: 1 - 36

Magnusson, J. 1966. On capelin larvae (Mallotus villosus O.F.Muller) in Icelandic waters during the years 1960 - 1964, with some notes on other fish larvae. Rit fiskideildar 4 (4): 1 - 35

Magnusson, J., J. Magnusson and J. Hallgrimsson. 1965. The "Egir" redfish larvae expedition to the Irminger Sea in May 1961. Rit fiskideildar 4 (2): 1 - 86

Ricker, W. E. 1958. Handbook of computation for biological statistics of fish populations. Bull. Fish. Res. Bd. Canada 119. 300 pp.

Table 1

Maturity of Benthosema of age 2, 3, and 4.

Maturity stage	Jan, Febr.	March	April	May	July	Sept.	Oct. Nov. Des.
1	9	3				1	5
2	10	3	2	3		5	7
3	15	6	5	1			3
4			2	10			
5				1	3	19	1
Total	34	12	9	15	3	25	16

Table 2

Stomach contents. Frequency of occurrence.

	Spring	Summer	Autumn	Winter	Total
Copepods	59	72	32	19	182
Euphausiids	3	0	18	12	33
Undetermined	21	7	55	30	113
No. of stom. examined	91	86	119	80	376

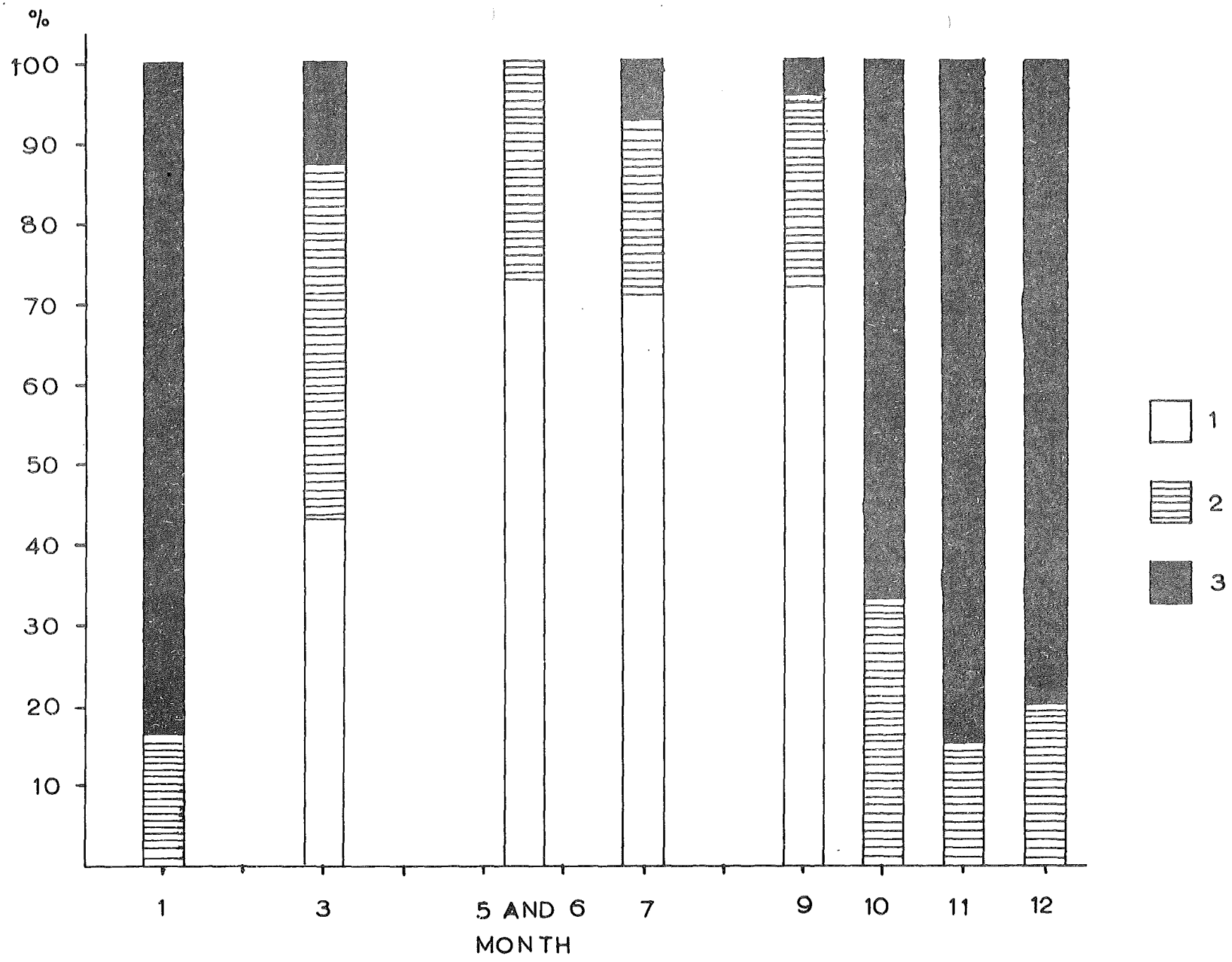

FIGURE 1. DISTRIBUTION OF THE MARGINAL CHARACTER OF THE OTOLITHS.
1: HYALINE 2: UNDETERMINED 3: OPAQUE

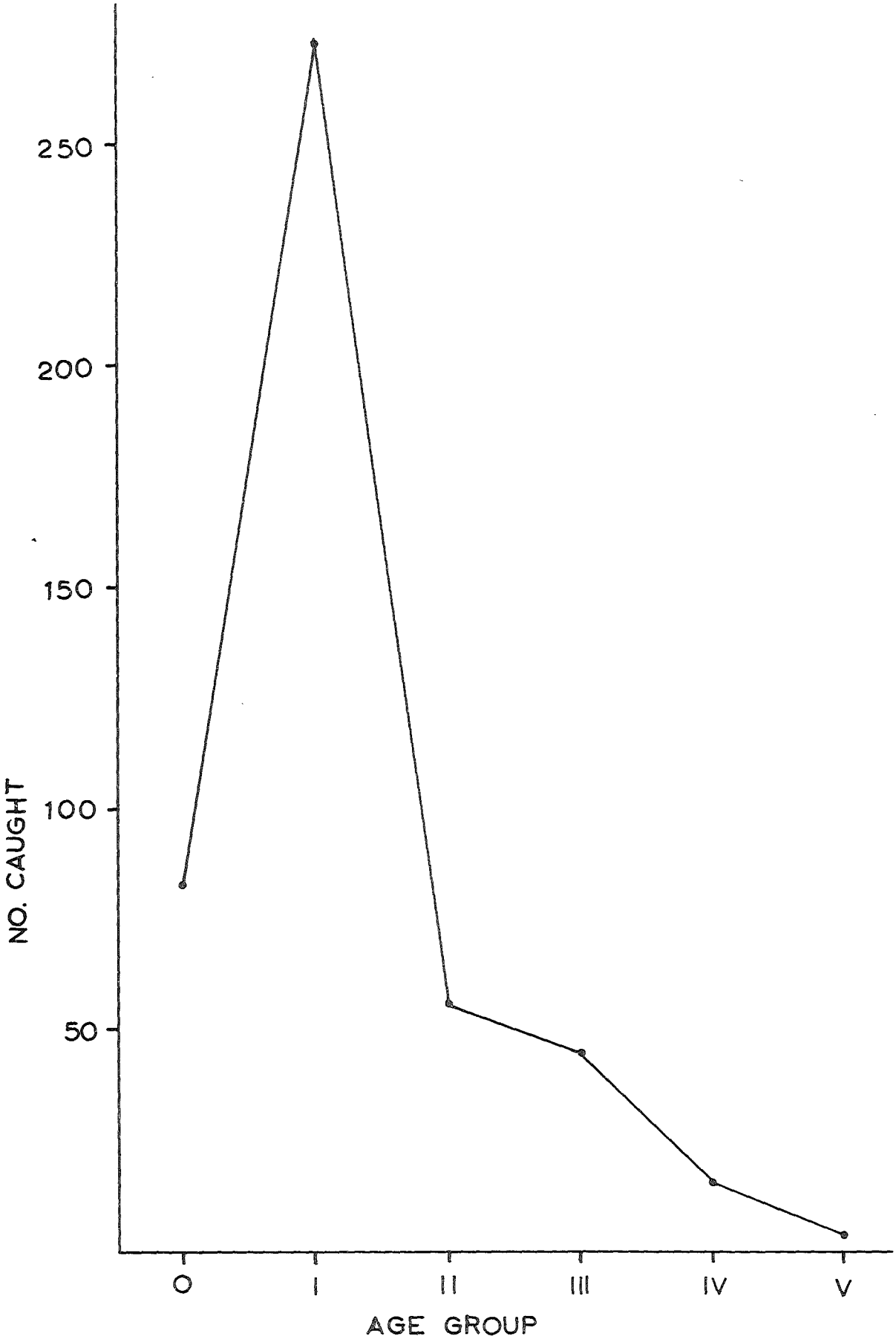

FIGURE 2. AGE DISTRIBUTION OF BENTHOSEMA COLLECTED IN 1969.

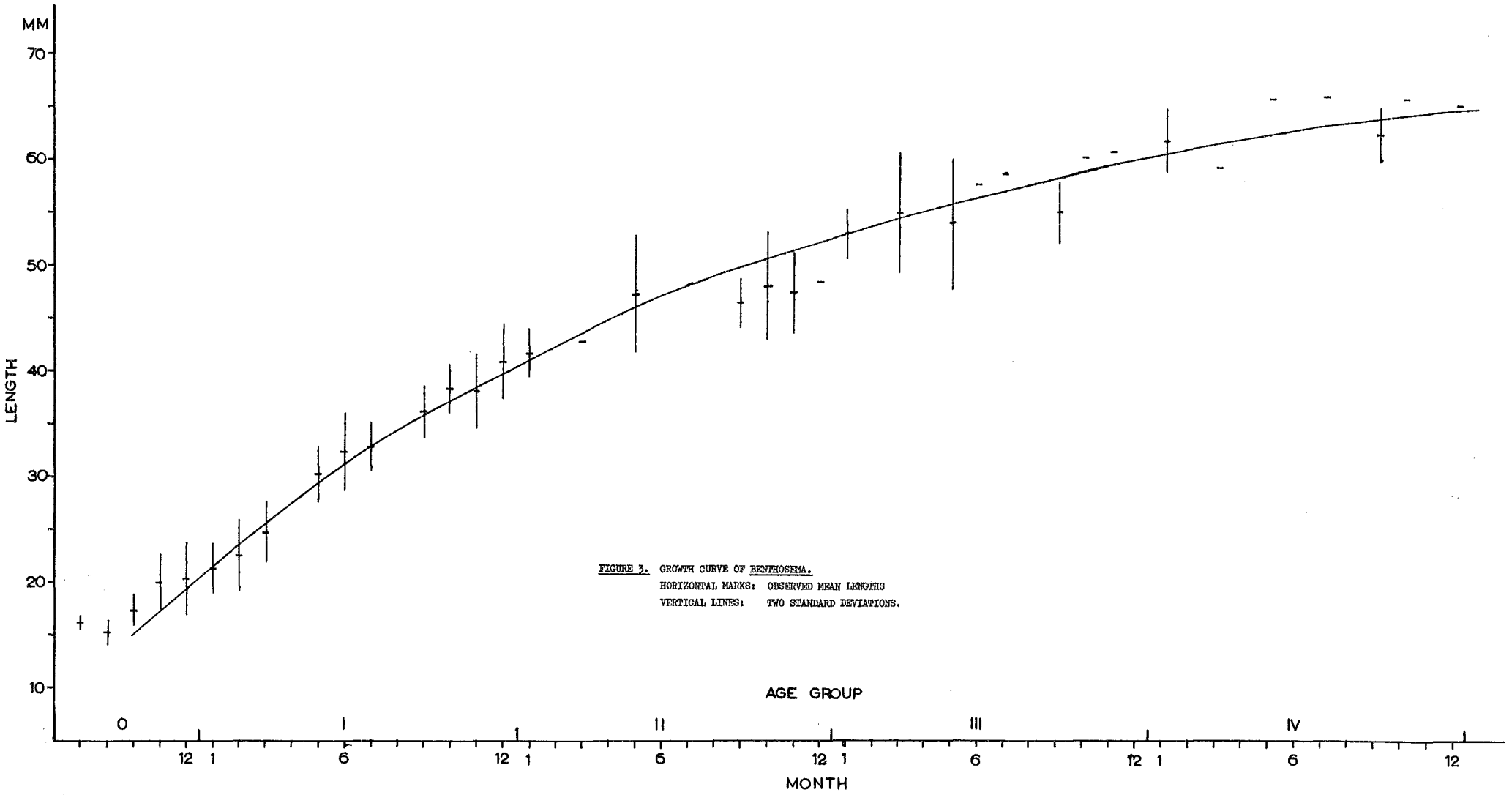

FIGURE 3. GROWTH CURVE OF BENTHOSEMA.
HORIZONTAL MARKS: OBSERVED MEAN LENGTHS
VERTICAL LINES: TWO STANDARD DEVIATIONS.

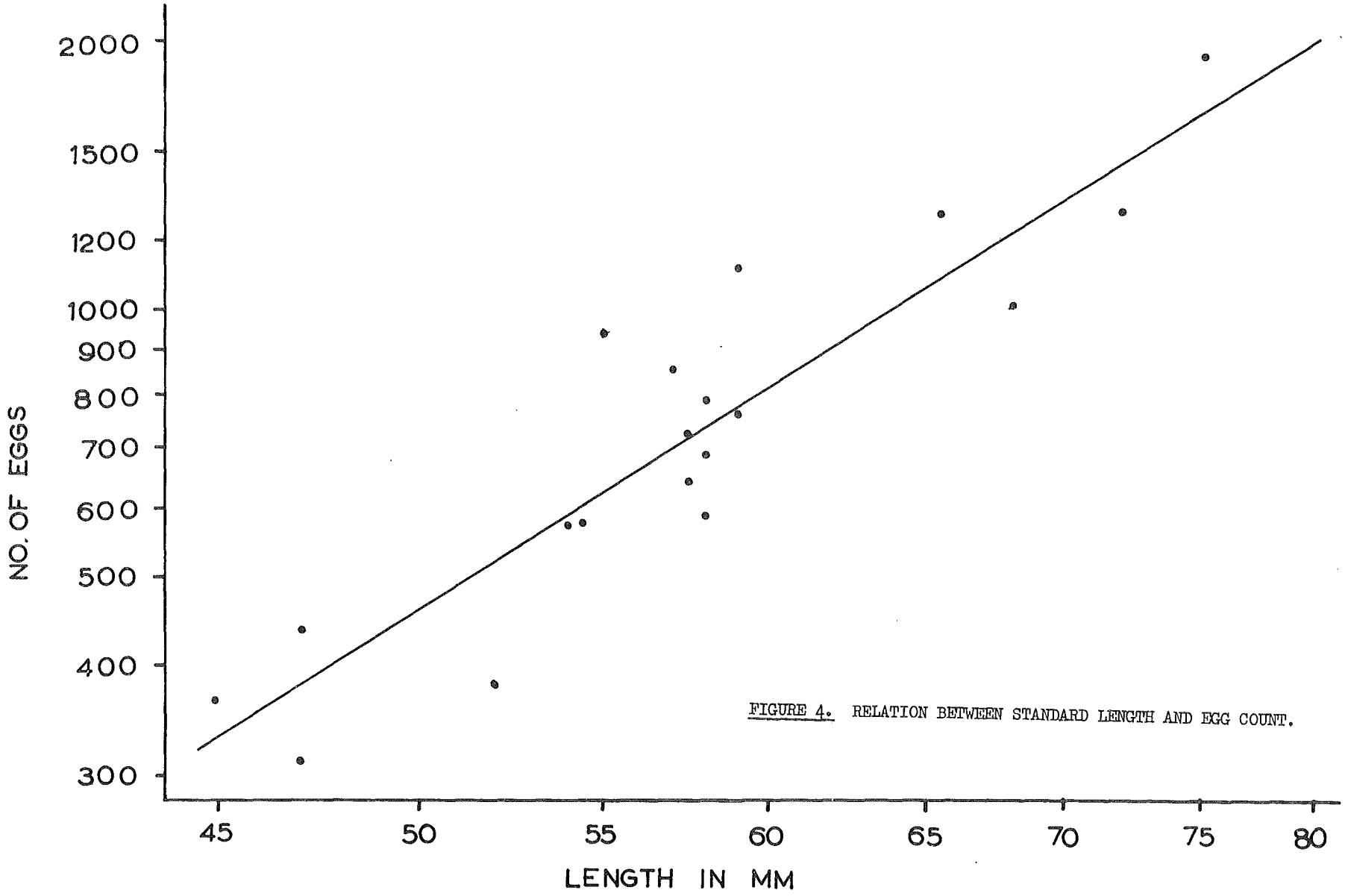

FIGURE 4. RELATION BETWEEN STANDARD LENGTH AND EGG COUNT.

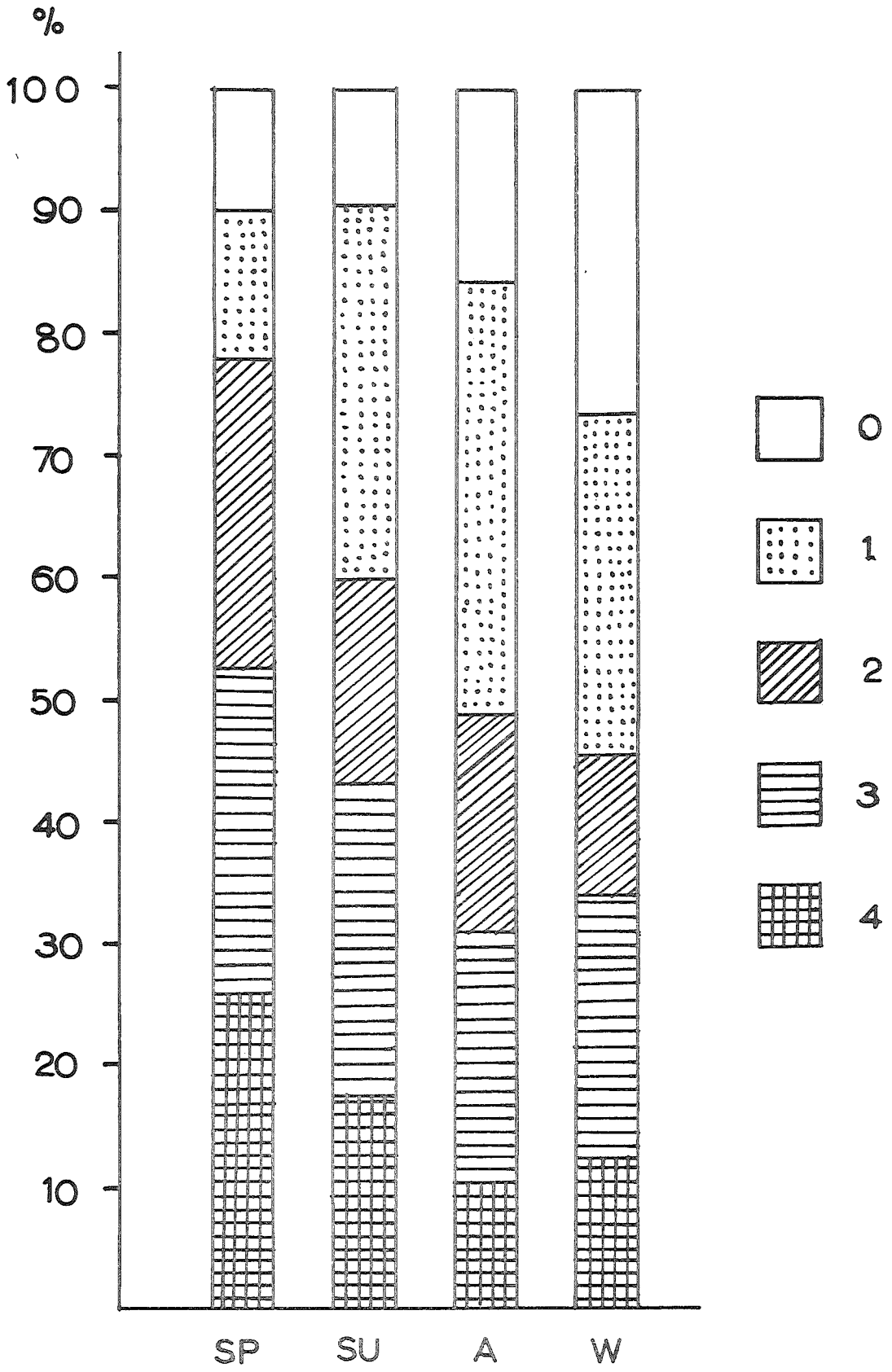

FIGURE 5. DEGREE OF FULLNESS OF STOMACHS.

SP: SPRING SU: SUMMER A: AUTUMN W: WINTER