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GROWTH OF THE BARENTS SEA CAPELIN OF THE YEAR-CLASSES 1967-70

by

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ABSTRACT

Otoliths of the 1967-70 year-classes of the Barents Sea capelin have been analyzed. For otoliths with radius < 0,74 mm there was a close, linear relation between fish length and otolith radia. For larger otoliths the correlation was less strong.

Radia of the first hyaline zones, measured in fish 1, 2 and 3 years old showed no significant differences between the year-

classes, although measurements made on 1 year old fish were significantly different if analyzed separately. The radia of the second and third zones were different at the 5 % level.

Back-calculation showed that the 1967 and 1968 year-classes had a similar growth pattern. The 1969 year-class showed faster growth between age 1 and 2 years. The young fish of the 1970 year-class was similar to those of 1967 and 1968.

INTRODUCTION

The Barents Sea capelin is a highly variable species with respect to growth, reproduction and abundance. RASS (1933) divided the stock into three different ecological groups, spring, summer and autumn spawners which spawn at the coast of Finnmark, Murman and Novaya Zemlya respectively.

PROKHOROV (1965), however, compared otolith measurements of spring and summer spawners. He found no reason to divide the Barents Sea stock into different ecological groups, and it is then considered as one population only.

The commercial capelin fishery consists of a winter/spring fishery for the maturing part of the stock approaching the coast for spawning, and a summer/autumn fishery which takes place on the feeding grounds. Only Norway and USSR exploite the Barents Sea stock noteworthy, and more than 1 mill tonnes are caught annualy.

The capelin are distributed over most areas of the Baretns Sea. In early January the mature part of the stock congregates and starts the spawning migration towards the coast. The main spawning takes place in March and April along the Finnmark coast, with a later spawning in June and July in more eastern areas,i.e.

in the Varangerfjord and along the Murman coast. These two spawnings may overlap each other both in time and area. The larvae therefore hatch over a long period and over a wide area. This causes variations in the early growth of the capelin within a year-class, and also between year-classes.

The present paper consider the relationship between otolith size and body length within the year-classes 1967-70 and the growth of these year-classes.

MATERIAL AND METHODS

Samples of capelin were collected during regulary acoustic surveys and from commercially landed catches. The total length was measured to nearest mm and the age determined by the otolith-method described by PROKHOROV (1965) and MONSTAD (1971).

The otolith radia were measured along a line which makes an angle of 90° with the line through center and rostrum of the otolith (Fig. 1). A binocular with 25 times magnification was used. The measurements are expressed as binocular units, with one unit equals 0.04 mm.

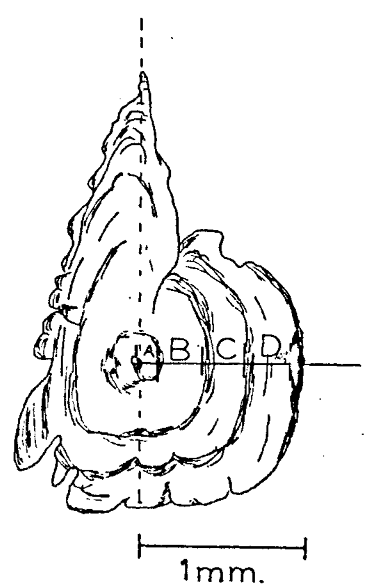

Fig. 1. Otolith of a four year old Barents Sea capelin with growth zones (A-D).

The abundance of the 1967-70 year-classes have not been accurately assessed, but the yearly O-group surveys indicate that the 1970 year-classes was poor, with the three others considered as average to strong (HAUG and NAKKEN 1973). However, later cruises gave the impression that the 1967 and 1969 year-classes were strong, the 1968 was of average strength, while the 1970 year-class was poor (DRAGESUND, GJØSÆTER and MONSTAD 1973).

The statistical methods used, analysis of variance and correlation analysis, is those described in textbooks as SOKAL & ROHLF (1969).

RESULTS AND DISCUSSION

Relation of otolith radius to fish length

A plot of the length and the otolith measurements (Fig. 2) indicated that two stright lines could be fitted to the data, one line for fish with otolith radia < 18.5 binocular units and one for radia > 18.5 units. Both the slope of the lines, and amount of scattering around the lines changed at this point. Transformation of the data to logaritms did not either give continuity.

For R > 18.5 lines were fitted for males and females separately, and the slopes, intercepts and regression coefficients were tested, but no significant difference (5 percent level) was found. therefore males and females were pooled, and a common regression line was used.

The regression lines

$$l = 0.547 \cdot R + 2.182 \qquad (R < 18.5)$$

$$l = 0.784 \cdot R - 2.756 \qquad (R > 18.5)$$

were fitted where l is the length of the fish in cm and R is the otolith radius measured in binocular units. The coefficients of determination (r^2) are 0.940 and 0.737 for R smaller and bigger than 18.5 respectively. For otoliths with radia < 18.5 units, there are a very close correlation with fish length. For longer radia observations are much more scattered around the line, and a sigmoid curve might give better fitt.

The fish used for establishing the regression lines were caught in several areas and at various times of the year, and as pointed out by REAY (1972), the relation between the otolith size and body length may show considerable seasonal variation. This may be partly responsible for the deviation from the stright line for older fish. All the younger fish were caught during summer and this may explain the better fitt for them.

WINTERS (1974) studied the otolith-body relationship for capelin in the Newfoundland area. He did not find a convient matematical function fitting the data. In contrast to our results ha found a pronounced difference in otolith-body relationship between males and females.

Size at one year

The radia of first growth zone measured at different ages are shown in Table 1.

Table 1. Radia of first growth zone of capelin (binocular units), and back-calculated mean lengths (cm).

Age when measured \ Year-class	1967	1968	1969	1970	Mean (bin.units)	$\bar{l}$ (cm)
1	6.18	5.66	5.46	5.14	5.61	5.3
2	5.58	5.62	5.02	5.10	5.33	5.1
3	5.14	5.38	6.58	5.68	5.69	5.3
Mean (bin.units)	5.63	5.55	5.69	5.30	5.54	5.2
$\bar{l}$ (cm)	5.3	5.2	5.3	5.1	5.2	

An analysis of variance was done on the otolith radia. The results showed no significant differnces on the 5 % level between the year-classes or between fish measured at age 1, 2 and 3 years respectively. LEE's phenomenon was observed in all of the year-classes, the 1967 and 1968 showed a positive one, and the 1969 and 1970 showed a negative one.

The most reliable picture of first year growth is probably seen from the fish which are analysed at an age of 1 year. If these are analysed separately, a highly significant difference between the year-classes was found.

Size at two years

Mean radia of the hyaline zones are shown in Table 2.

Table 2. Radia of second growth zone of the capelin (binocular units), and back-calculated mean lengths (cm).

Age when measured \ Year-class	1967	1968	1969	1970	Mean	$\bar{l}$ (cm)
2	14.40	15.06	15.40	14.46	14.83	10.3
3	14.08	14.12	16.00	14.46	14.66	10.2
Mean	14.24	14.59	15.70	14.46	14.74	10.2
$\bar{l}$ (cm)	10.0	10.2	10.8	10.1	10.2	

A highly significant difference on the 5 % level was found between the year-classes, and tests carried out showed that most of this difference was due to difference between the 1967 and 1969 year-classes.

There was no significant LEE's phenomenon.

Size at three years

Mean radia of the 3. hyaline zones are shown in Table 3. A highly significant difference on the 5 % level were observed between the year-classes.

Table 3. Radia of the third growth zone of the capelin otolith (binocular units) and back-calculated lengths (cm).

Year-class	1967	1968	1969	1970	Mean	$\bar{l}$ (cm)
	19.80	19.10	20.64	19.52	19.31	12.4
$\bar{l}$ (cm)	12.8	12.2	13.4	12.6	12.4	

Growth of the year-classes

The 1967 (Fig. 3) and 1968 (Fig. 4) year-classes show similar growth pattern. There is a fast growth till the fish reach an age of 2 years, and until this time there is only a slight difference between males and females. After age 2 years the growth is much slower, and it is slower in females than in males. The LEE's phenomenon is not very pronounced.

The young fish of the 1970 year-class (Fig. 6) also follows the same pattern, but the older ages have not been measured.

The 1969 (Fig. 5) year-class differ from the other in several aspects. It shows a faster growth between age 1 and 2, and from age 2 years it shows a much more pronounced LEE's phenomenon than the other year-classes.

Our data are not suited for an analysis of the causes of the difference in size and growth indicated. It is reasonable to expect geographical variation in growth rate, and for the youngest, time of hatching may also be of importance (HAMRE 1977). The strength of the year-classes may also influence growth rate, although the present data show no correlation between growth and the year-classes strength as ranked by DRAGESUND, GJØSÆTER & MONSTAD (1973).

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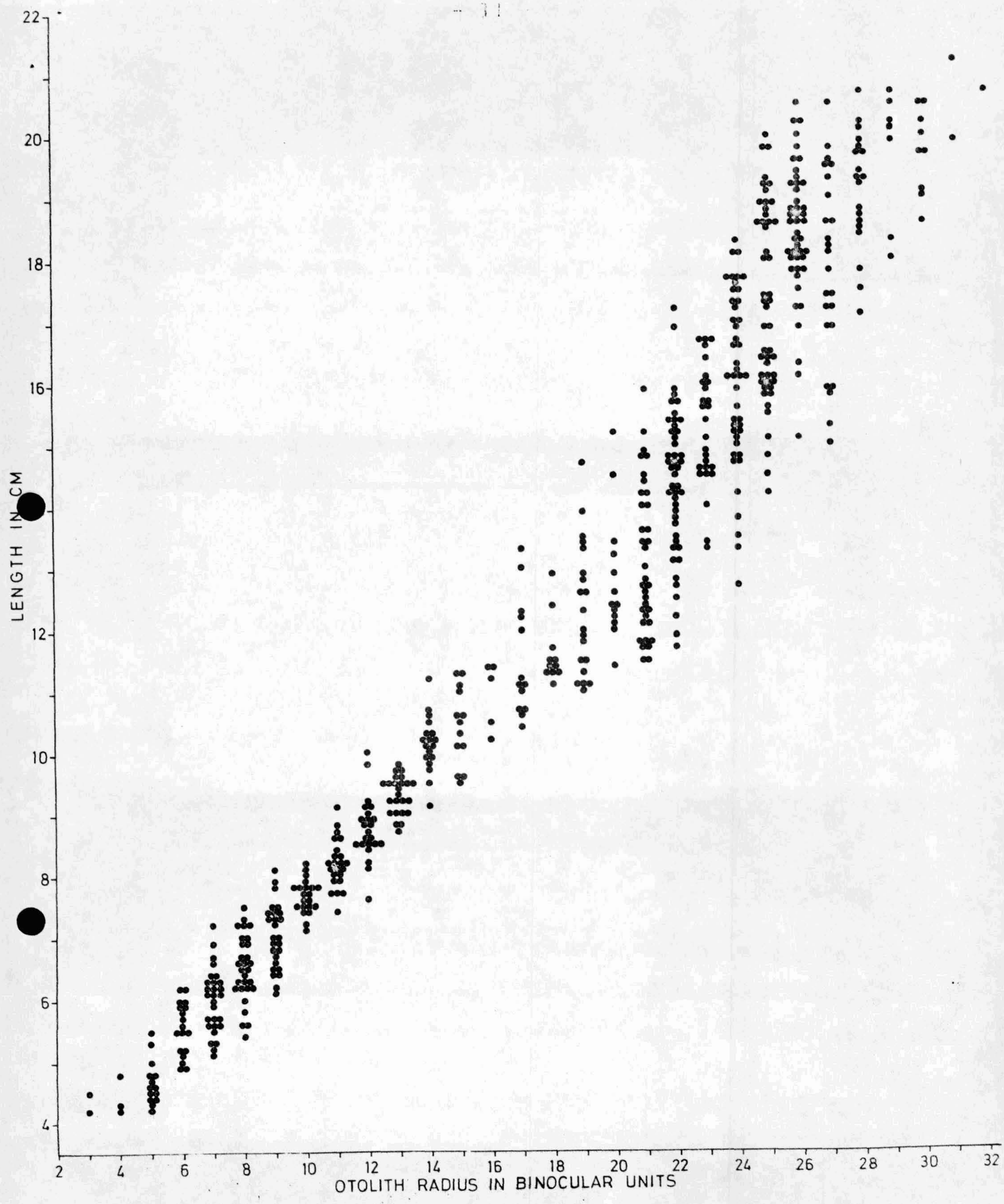

Fig. 2. Relationship between total fish length and otolith radius of Barents Sea capelin.

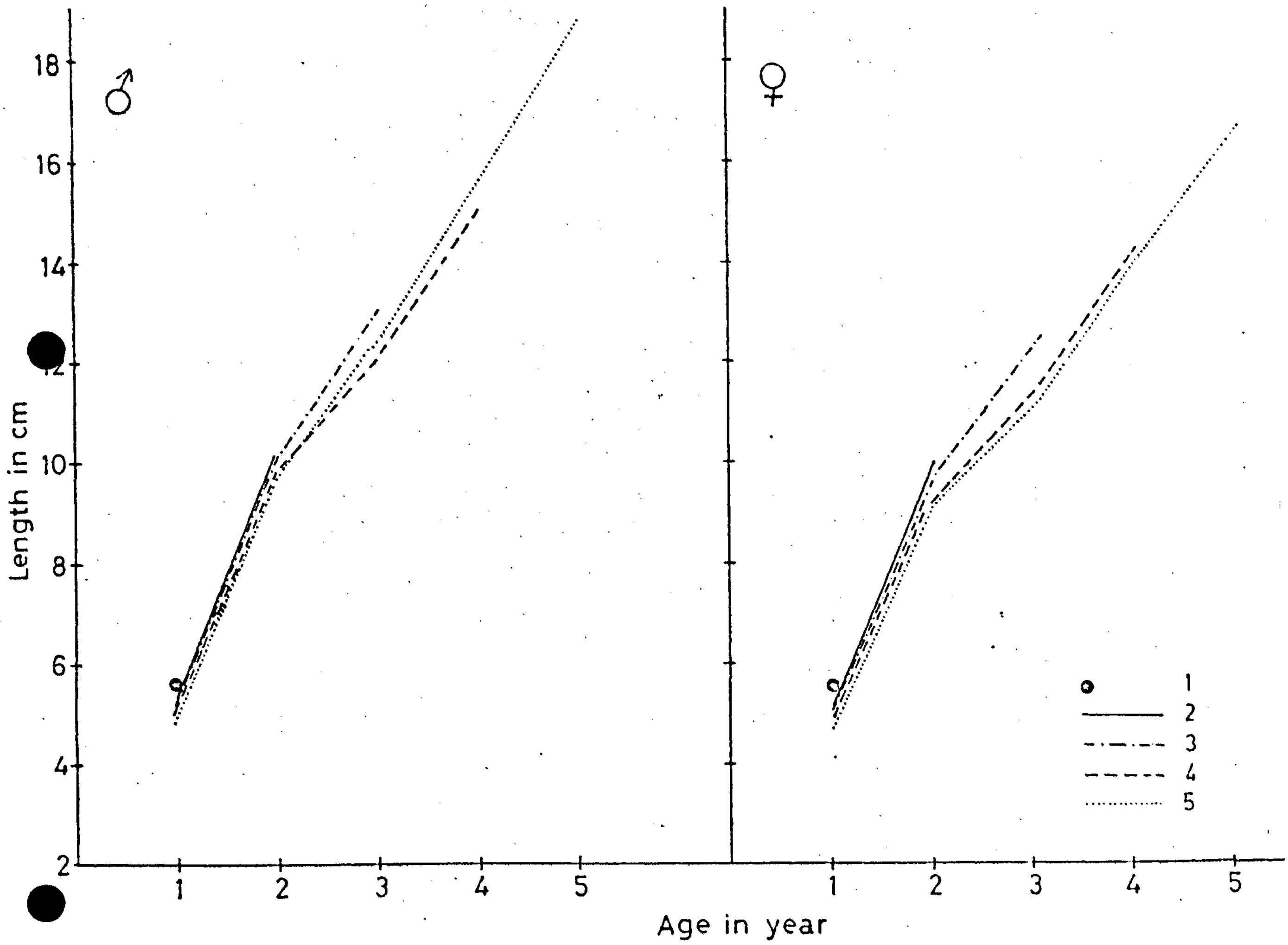

Fig. 3. Growth of the 1967 year-class of Barents Sea capelin. Back-calculated lengths analysed at different ages. 1-5) measurements at age 1,2,3,4 and 5 years respectively.

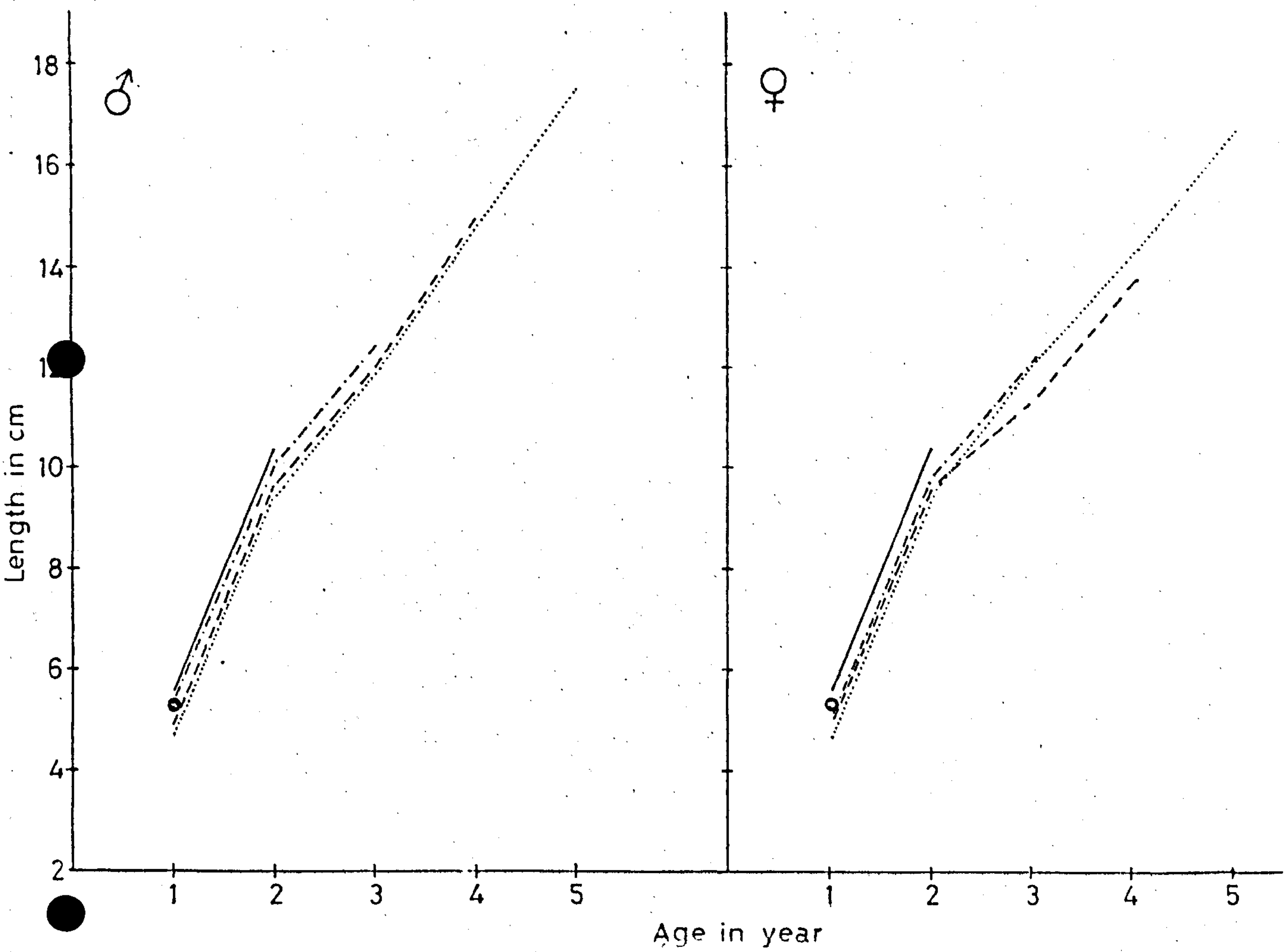

Fig. 4. Growth of the 1968 year-class of Barents Sea capelin. Symbols as in Fig. 3.

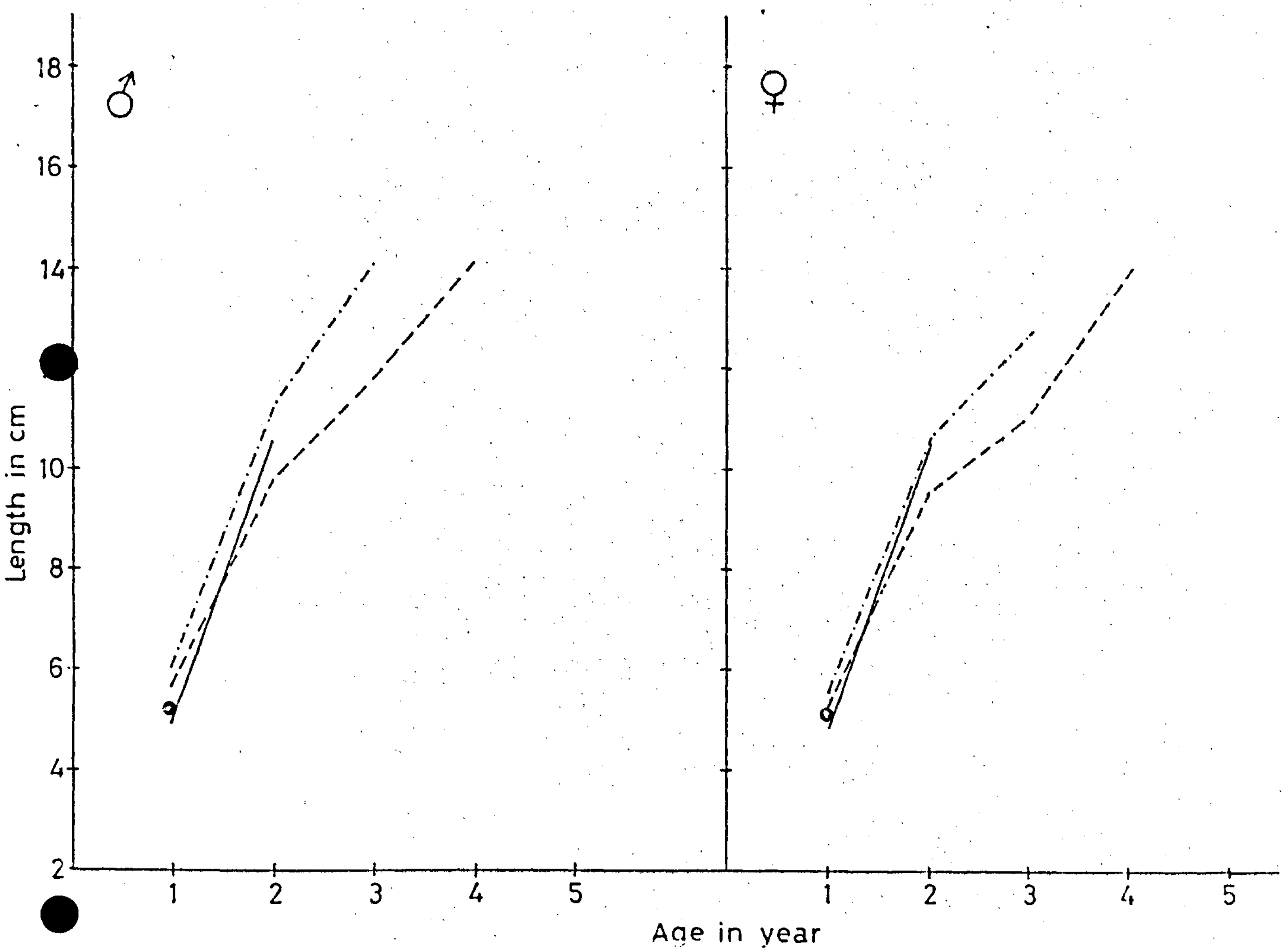

Fig. 5. Growth of the 1969 year-class of Barents Sea capelin. Symbols as in Fig. 3.

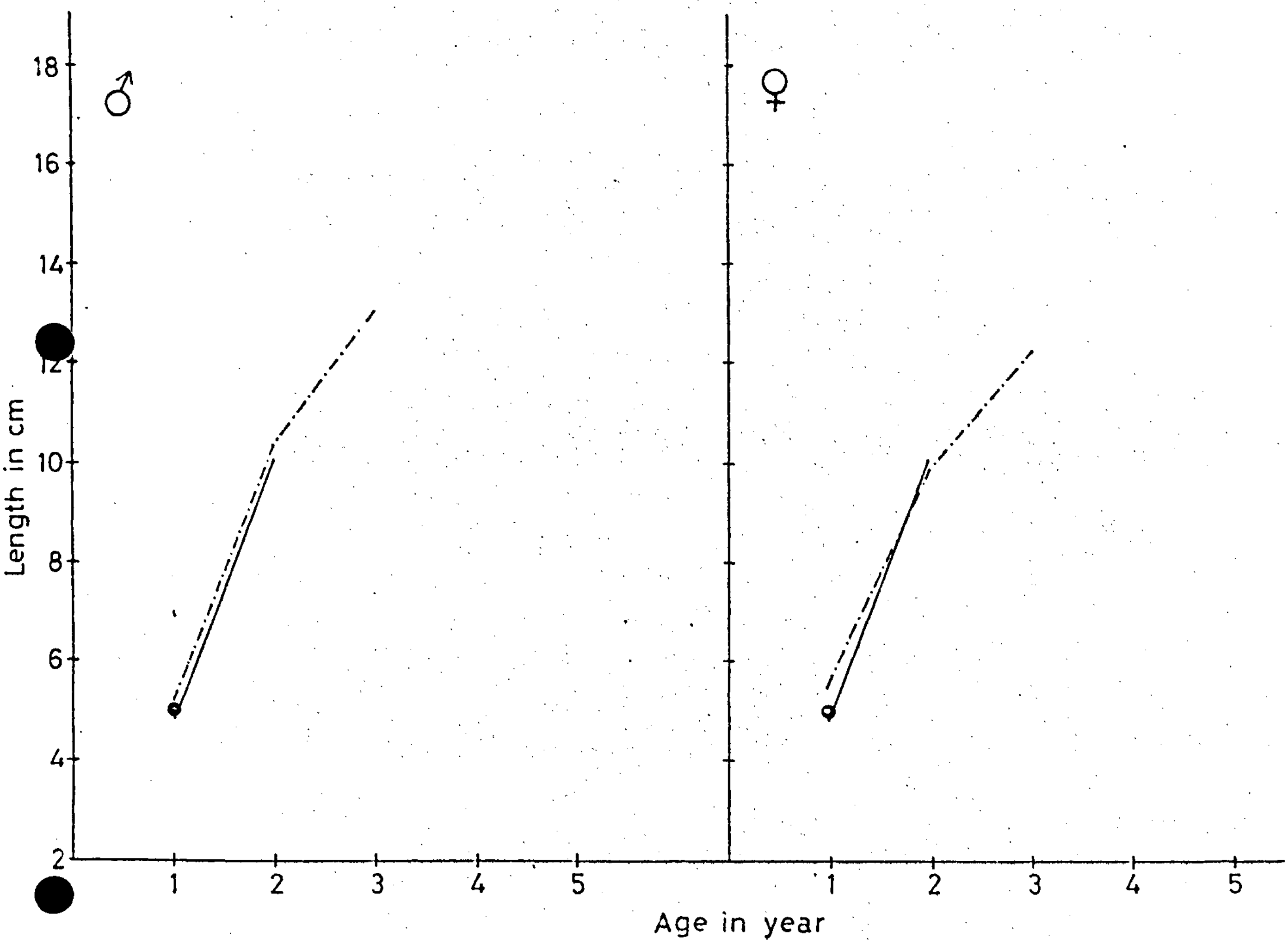

Fig. 6. Growth of the 1970 year-class of Barents Sea capelin. Symbols as in Fig. 3.