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Studies on age determination and growth of the ice fish
Chaenocephalus aceratus Lönnberg

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Summary

A method of determining the age of the ice fish Chaenocephalus aceratus Lönnberg is described. Investigations on fishes of different length and comparison with the length distribution curve shows that the age can be determined from the first fin rays of the pelvic fin.

In South Georgia the mean annual growth is about 6.7 cm for males up to four years and females up to six years. Females achieve maturity at age 8 to 11 years and males at age 6 to 10 years. At maturation the length of the females is 57 to 65 cm and that of males is 49 to 57 cm.

1. Introduction

Despite the importance of the ice fish (Chaenichthyidae) for commercial fisheries little has been published hitherto regarding age, growth and age at maturity. To some extent this is due to methodological difficulties in determining the age when studying series of the fish: the ice fish has no scales, and the otoliths must be broken, ground and burnt to determine the age. Since they are very small and fragile this is a difficult and lengthy procedure

and scarcely suitable for routine purposes. Furthermore, the structures are difficult to interpret.

The studies described here were performed on Chaenocephalus aceratus Lönnberg because sufficient fishes of different ages belonging to this species were available.

OLSEN (1955) performed age determinations on Ch. aceratus using exclusively mature animals aged 9 to 17 years. The mean lengths of the females in the different year classes varied between 57 and 65 cm, the males varying between 50 and 55 cm in length. There was no discernible correlation between age and length. No information is available regarding length and age at maturity.

OLSEN used otoliths to determine the age. However, the fact that the ages of 18 out of 52 animals could not be determined indicates that methodological difficulties were encountered.

During our studies the cross section of the first fin rays of the pelvic fin proved suitable for determining the age. A few otoliths were also used for comparison purposes.

2. Material and methods

The material used in our studies was caught between 30 December 1977 and 25 February 1978 in the area of South Georgia.

The lengths of 1 064 animals were measured, and 477 samples were slaughtered for further study. Fish length was measured from the tip of the mouth to the end of the tail fin. The following parameters were determined in addition to length in the slaughtered samples: weight, sex, weight of gonads, diameter of oocytes, stomach content and fullness of stomach. Fin rays and otoliths were taken from 335 specimens, placed in paper bags and dried for age determination.

The age was determined ashore. This was done by grinding the surface of the cut situated near the basis of the fin ray and studying it under a dissecting microscope (magnification 4, 12.5 x ocular) after moistening it with 96 % alcohol. Illumination was from the side, the lamp being shaded so that only the topmost portion of the ray with a width of about 1 mm was illuminated. The rings were counted in the direction shown in Fig. 1.

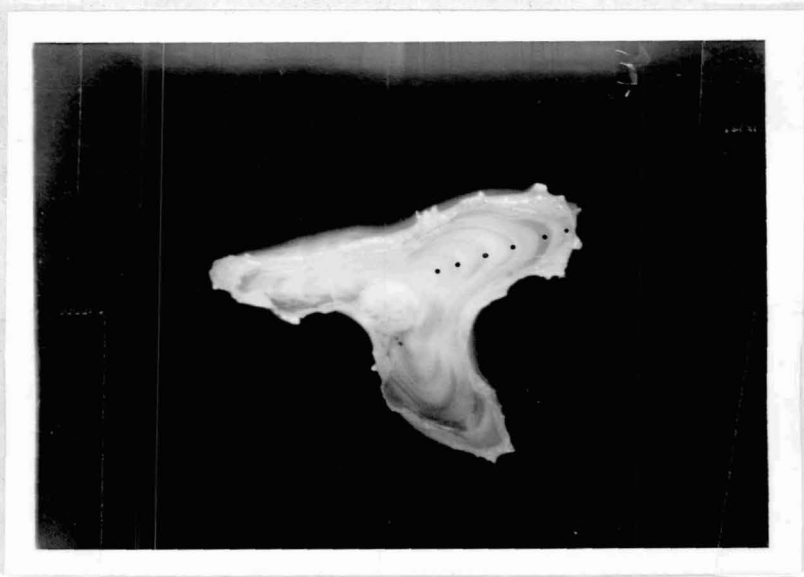
The otoliths were ground down to the middle and burnt (CHRISTENSEN 1964). They were also inspected under a dissecting microscope (magnification 4, 12.5 x ocular) after being moistened with 96 % alcohol. Illumination was oblique from above.

3. Results

3.1 Age determination by means of fin rays

Opaque and hyaline zones were more or less clearly discernible in all cases (Fig. 1).

Fig. 1 Ground cross section through the first ray of the pelvic fin from a female Chaenocephalus aceratus. Length: 49 cm, age: 6 years



It also became evident that fish length and number of rings are clearly related so that age groups can be distinguished.

Fig. 2 shows how the mean length varies with age group. Because no distinct changes in the mean lengths of the different age groups were observed during the studies, the values obtained throughout the study have been united.

There is no appreciable difference between males and females in terms of growth rate until age group 4. The difference reported earlier by OLSEN becomes apparent in older age groups. Mean annual growth ranges between 5.3 and 8.5 cm, with a mean of 6.7 cm up to age group 4 in the males and age group 6 in the females.

The difference between the sexes is also clearly reflected in the length distribution of the specimens caught off South Georgia (Fig. 3). It is also conspicuous that the first peaks of this curve coincide exactly with the mean lengths in the first age groups, a fact which supports the view that the rings really are annual rings.

The second question to be clarified was that of the actual age of the fish. The youngest specimens whose fin rays were studied were between 15 and 17 cm long and had only one hyaline zone at the outside edge (year class 1). The smallest young fish were 71 - 84 mm long and were caught off South Georgia in February.

Ch. aceratus spawns in the second half of March and in April (OLSEN 1955, PERMITIN 1973). According to PERMITIN, the eggs develop until the next summer, and young fish aged 3 - 4 months and with a length of 65 - 105 mm (age group 0) were caught in the subsequent antarctic autumn. In view of this it can be assumed that the fish in age group 1 are actually one year old and that the age groups therefore correspond to the age in years.

Inspection of the otoliths brought no satisfactory results. No clear correlation could be established between the visible ring structures and the number of discernible rings in the fin rays. There was also no clear relationship between the number of rings and the length of the fish.

3.2 Length and age at maturity in the specimens caught off South Georgia

The characters used as criteria for maturity were oocyte diameter and relative gonadal weight (weight of gonads as a percentage of the body weight) for females and relative gonadal weight for males.

Clear signs of ovarian maturity were found in none of the females with lengths of 56 cm or below or aged seven years or less. The relative gonadal weight was always less than unity, and the oocyte diameter was always below 1 mm. These animals must be regarded as juveniles.

In the length range from 57 to 61 cm, 17 % of the females showed a clear increase in relative gonadal weight and an increase in oocyte diameter. The proportion of females with developing gonads increased to 77 % in the animals which were 62 to 64 cm long. All females which were 65 cm long or more showed clear signs of at least a certain degree of gonadal development.

A similar pattern emerged when the relationship between maturation and age was considered. Whereas no clear signs of maturity were found in any of the females aged 7 years and below, more or less pronounced signs of ovarian development were evident in 40 % of the 8-year-old, 48 % of the 9-year-old, 68 % of the 10-year-old and all of the 11-year-old and older females.

The relative gonadal weight in females with clearly developing ovaries varied between 1.0 and 8.3 %, and the oocyte diameter in these animals was 1 ... 4 mm. These substantial differences

found within the different length and year classes are probably due to the fish being in a pre spawning state, a state in which the gonads are not at the same stage of maturity even in adult individuals.

Because the animals were still in the pre spawning state and the gonads even of the adults were relatively undeveloped it was not possible to clearly differentiate between juvenile and adult males. The weight of the gonads varied between less than one gram and 12 g.

Enlargement of the gonads relative to the body weight was observed in males over 48 cm long and more than 5 years old. The weight of the testes was less than 0.5 % of the body weight in all males of 48 cm or less in length and 5 years or less in age. In 20 % of the males with a length of 49 - 50 cm it was greater than 0.5, and it was between 0.5 and 1.0 in 67 % of the males from 51 to 52 cm, 77 % from 53 to 54 cm and 88 % from 55 to 57 cm.

Relative gonadal weight was between 0.5 and 1.0 % in 25 % of the 6-year-old, 30 % of the 7-year-old, 80 % of the 8-year-old, 75 % of the 9-year-old and 100 % of the 10-year-old males. It is impossible to state whether all males with a relative gonadal weight greater than 0.5 % actually achieve spawning maturity in the same year. This question can only be answered with certainty by studies performed during the spawning season.

3.3 Correlation between length and weight

Fig. 5 shows how the mean weight of the fish caught off South Georgia varies with the length. The two sexes do not differ clearly in this respect. The length-weight relationship is expressed by the equation

$$w = 64.5 \times 10^{-5} \times l^{3.59}$$

This equation reproduces the relationship found in our studies better than that given by EVERSON (1977) on the basis of results from DUBROVSKAYA and MAKAROV (1969).

Finally, we must state that initial results from studies on Glansecephalus gunnari, Chaenodraco wilsoni and Pagetopsis macrop-
terus show that the method described in this paper for determining the age can also be used for other species of ice fish.

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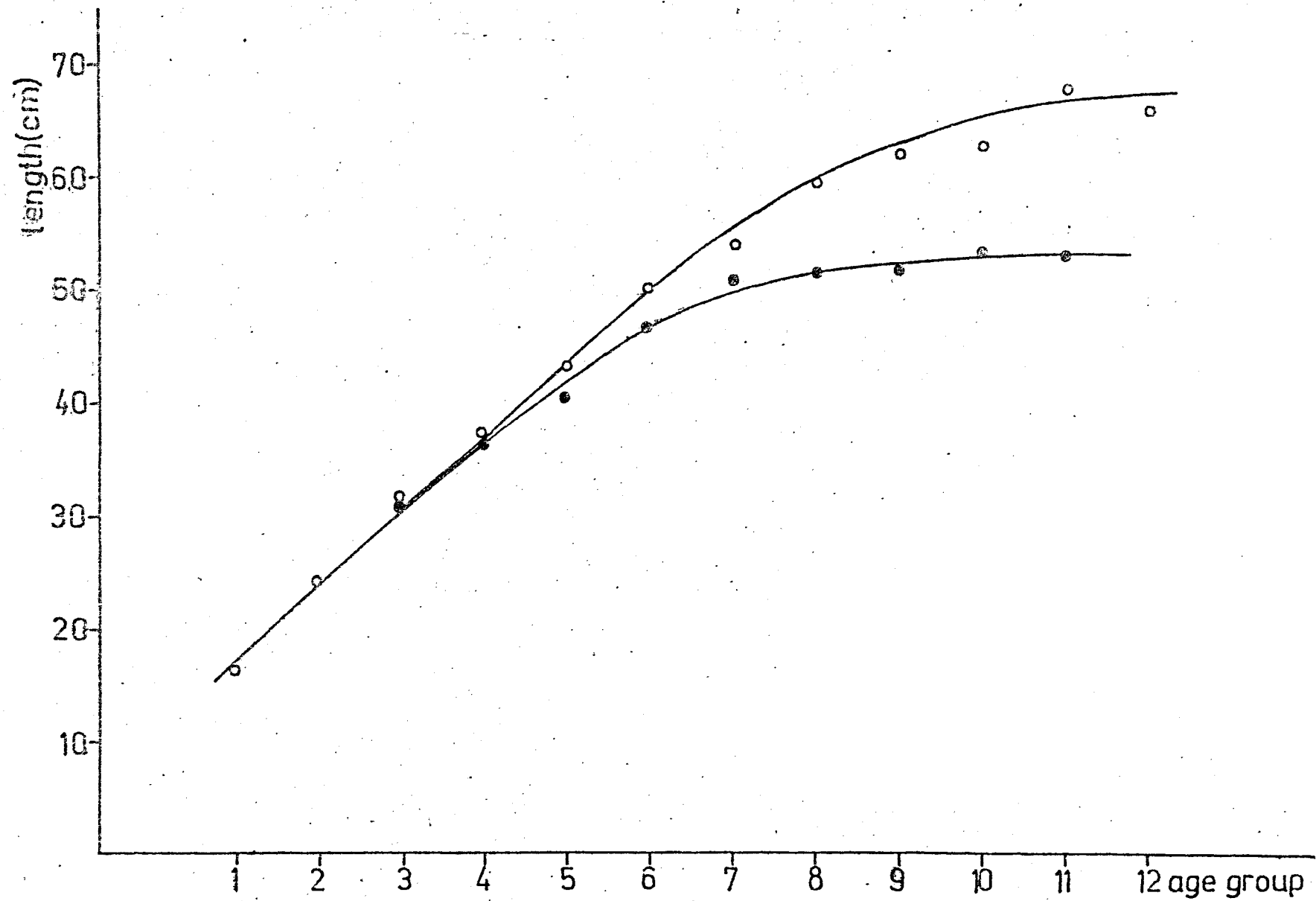


Fig.2 Variation of mean length with age group ○-females ●-males

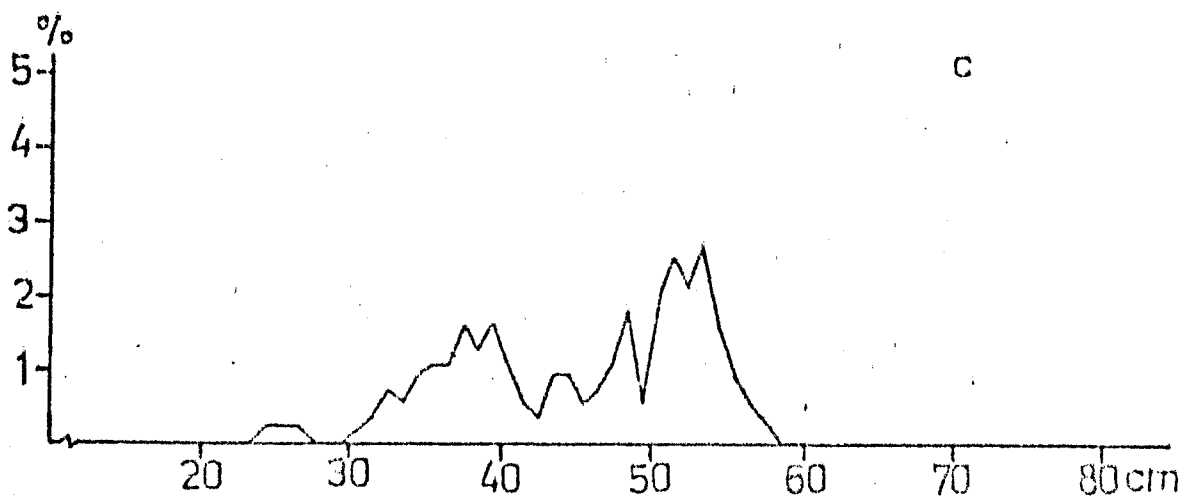
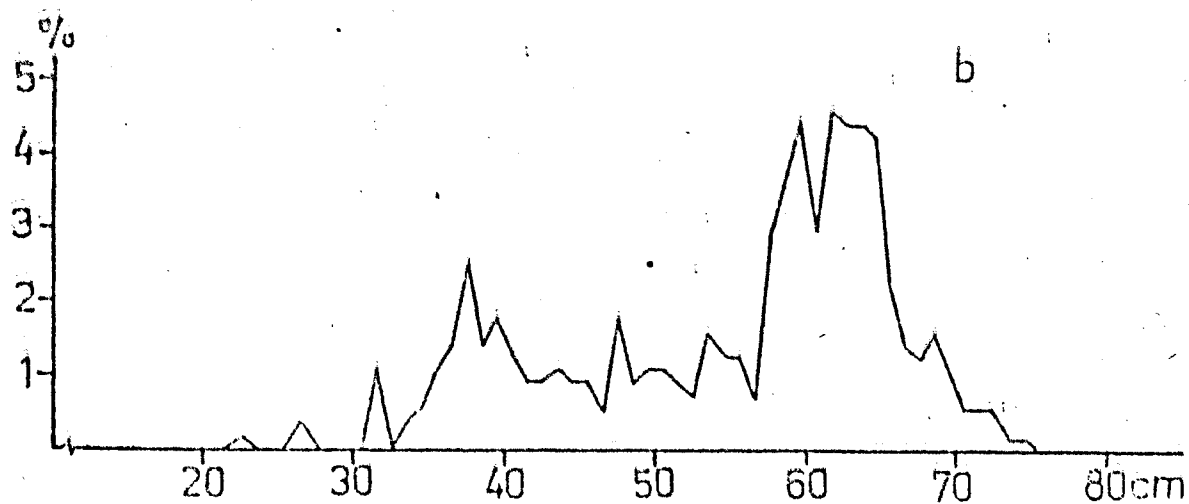
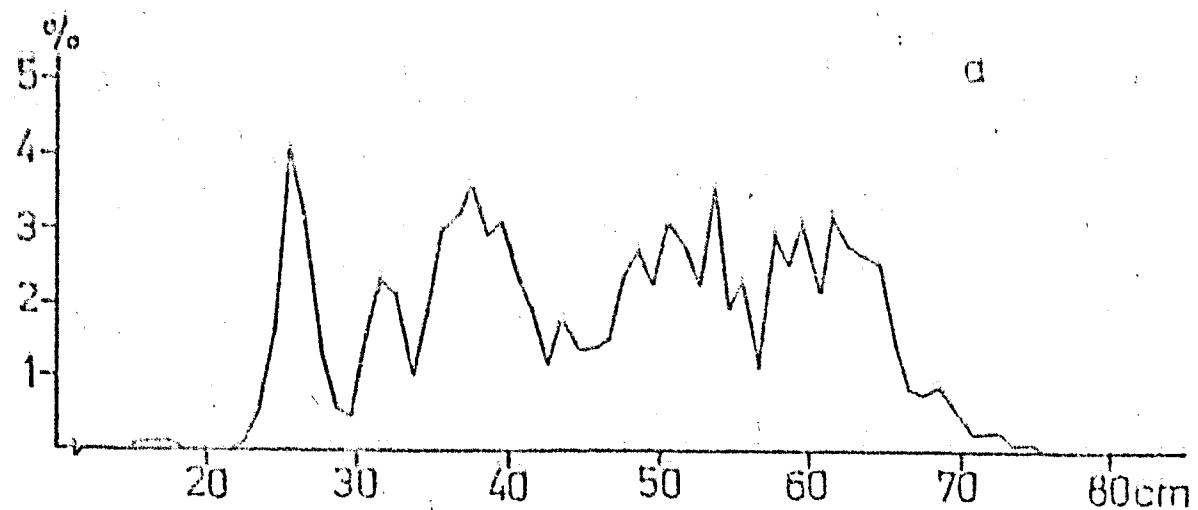


Fig.3

Length distribution of *Chaenocephalus aceratus* caught off South Georgia from December 1977 to February 1978

a—males and females, n=1064

b—females n=392

c—males n=173

The percentages for females and males (b and c) are related to the sum of b+c

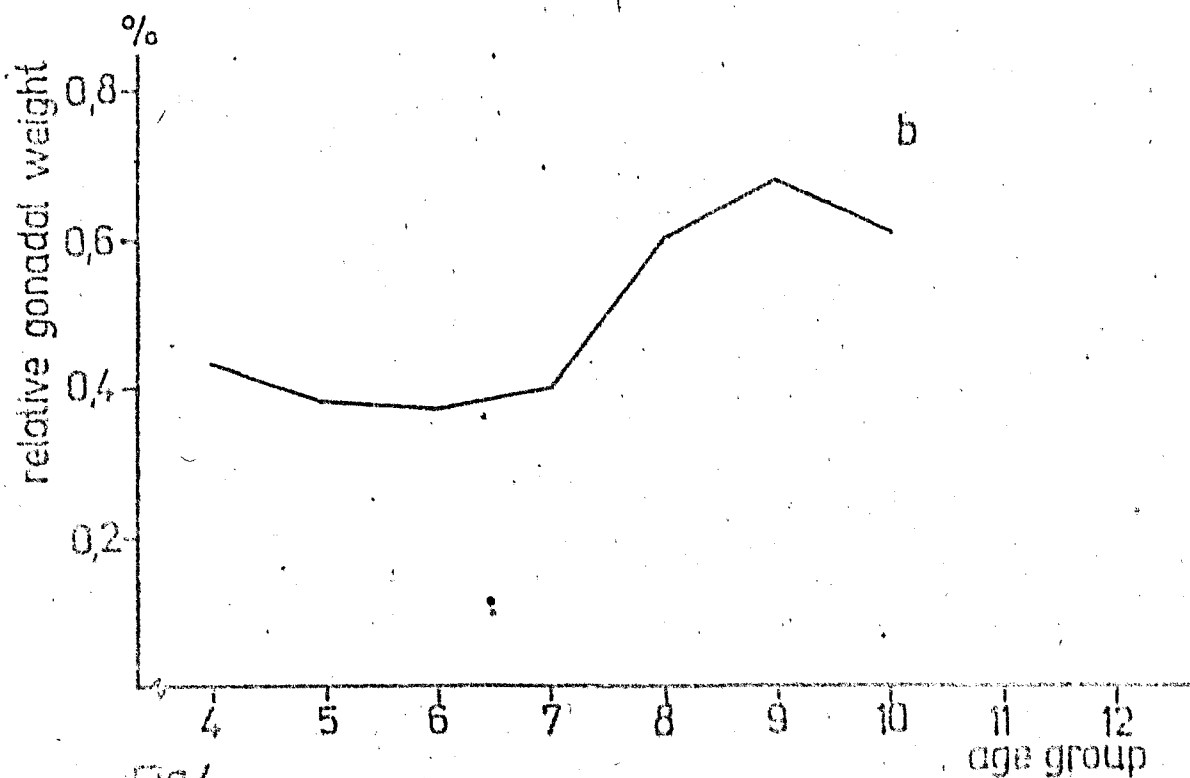
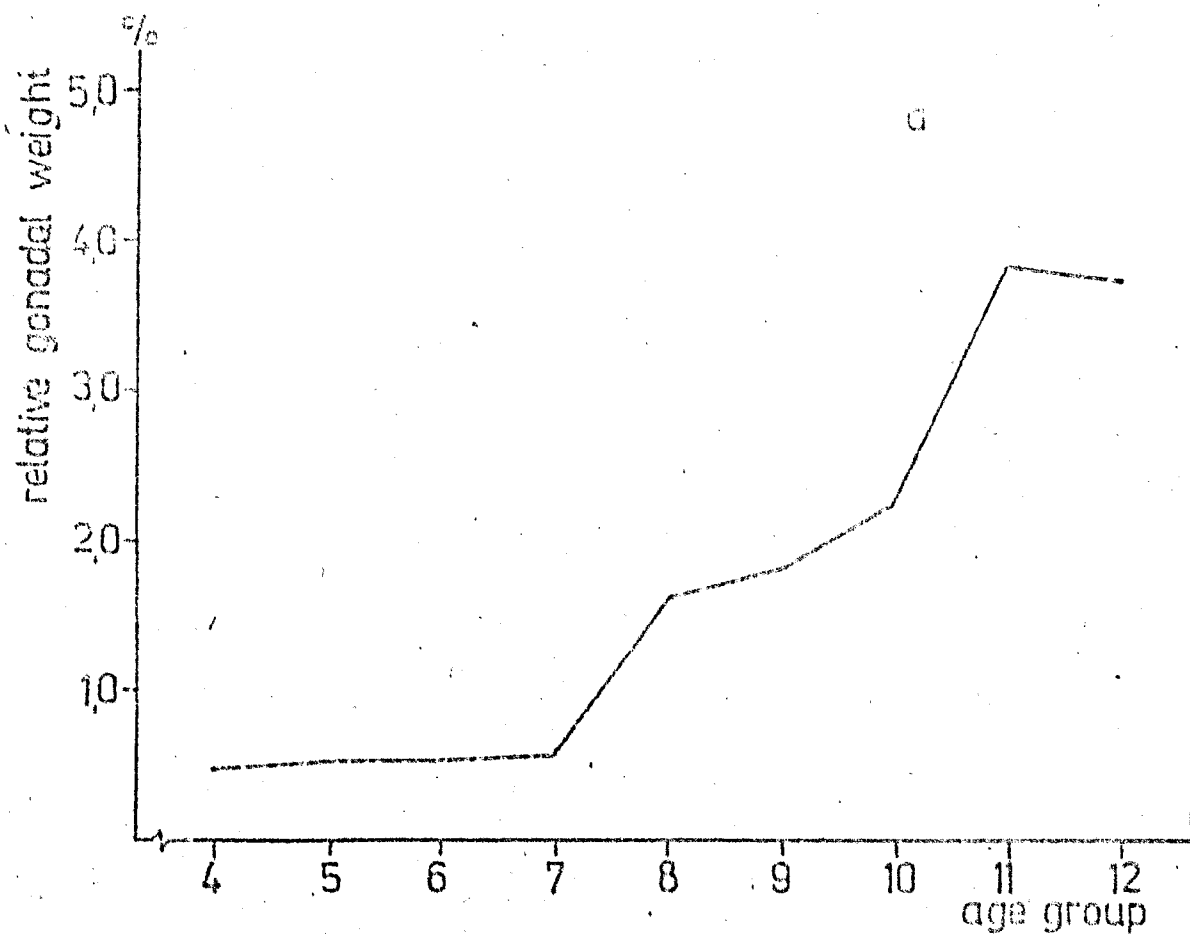


Fig. 4

Variation of mean relative gonadal weight
 (% of body weight) with age group
 a-females b-males

Fig.5

Length-weight relationship of the specimens caught off South Georgia ○-females ●-males

