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Short note

Age structure of *Chionodraco hamatus* (Teleostei, Channichthyidae) samples caught in Terra Nova Bay, East Antarctica

M. Vacchi, M. Romanelli, and M. La Mesa

ICRAP – Via L. Respighi, 5-00197 Rome, Italy

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Summary. The age composition of *Chionodraco hamatus* samples caught by fixed nets in Terra Nova Bay during the Austral summer 1987/88 was determined by examination of thin otolith sections. Individual ages were estimated by counting the number of annuli seen in the sections, since we postulated that annuli were laid down yearly. Fish were estimated to be 5–10 years old. Although our "apparent ages" were not confirmed by other independent estimates, our data seem to compare well with the values reported for other Antarctic fishes. Females in our samples were on average larger than males of the same age and grow somewhat faster, at least over much of the sampled size range.

Introduction

As in temperate species, many Antarctic fishes show year-rings (annuli) in their otoliths, scales and bones. This has been confirmed by length-frequency analysis (e.g. Kock, 1980, 1981; Pankhurst 1990), counts of sclerites related to total lengths (TLs; Freytag 1981) and from frequent sampling at sea to monitor the formation of the opaque/hyaline zones in otoliths (North 1988) or fast/slow growth areas in scales (Scherbich 1975).

These studies suggest that Antarctic fish may be aged by careful examination of suitable hard structures. Otolith and scale readings have been extensively used to define both the growth rates and length/age keys of many fish species of commercial interest (North and White 1987).

Little data are available on other fishes which could play an important role in the food web of some Antarctic subareas. In this paper, we report on the age composition (defined as the number of annuli counted in otolith sections) of the unexploited Channichthiid *Chionodraco hamatus* for which no similar data have been previously reported. Although our data remain unconfirmed (i.e. the concordance of annuli with year classes has not yet been separately checked), they presumably describe the true age structure of the virgin stock from which the fishes were drawn.

Thus, our data may be regarded as a baseline to monitor future changes in the population under examination and can be compared with the age composition of other Channichthiid stocks which are extensively fished.

Correspondence to: M. Vacchi

Material and methods

The area sampled was in Terra Nova Bay stretching between 74°41′S/164°49′E and 74°49′S/164°08′E. The specimens were obtained both by a trammel-net (length = 108 m, height = 1.80 m, mesh opening = 64 mm) and a gill-net (length = 123 m, height = 4.60 m, mesh opening = 64 mm) set in the 77–175 m depth range. A total of 23 fishing operations were carried out from January 13th through February 13th 1988, of which 19 (11 for trammel-net and 8 for the gill-net) caught *C. hamatus* specimens.

The fishes were measured, the total and eviscerated weights recorded (TL and weights being approximated, respectively, to the lower millimetre and gram), the gonads staged (Everson 1977) and the Gonado Somatic Index (GSI) values calculated. In most fishes (118 out of 180), sagittae were taken and stored dry for further study. However, 14 specimens were not "worked" at all.

In the laboratory, the resulting sagittae were brittle and almost completely opaque if observed as a whole, so we adopted the sectioning technique developed by Bedford (1983) on gadoid otoliths. In short, the sagittae were embedded in a polyester casting resin, cut in 0.5 mm thick slices, and then mounted on slides (see Bedford, loc. cit., for further details).

The otolith sections (one for each specimen aged) were then observed at low magnification (up to 50x) both in reflected and transmitted light. The slides were read separately on two occasions by two different readers.

In some cases, numbers differed by one (rarely more) unit(s), because the very central part of the sections appeared opaque so that one or more annulus/i could hardly be seen (Fig. 1). Problems in numbering the annuli of the inner part of the otoliths are apparently rather common when dealing with Antarctic fishes (e.g. Tomo and Barrera Oro, 1986). These "difficult" sections were jointly re-examined. Afterwards, if readings still differed by more than two units, these were discarded.

Since no systematic differences were observed between readers, we assumed that both the higher/lower value of each pair had about

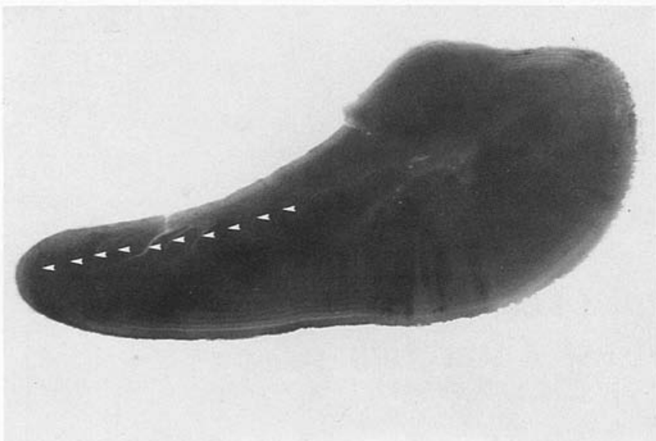

Fig. 1. Otolith section from a ten-year-old female of *Chionodraco hamatus*

equal probabilities of being correct. A "good" estimate of the mean lengths at age could be obtained by entering approximately the same number of "high" and "low" individual ages. However, when readings differed by two units, we adopted the intermediate integer. On the whole, 32 out of 39 females and 70 out of 79 males were aged.

Results

Forty specimens (ten of which were excluded) of *C. hamatus* were captured during 13 fishing operations by trammel-net and 140 during 10 fishing operations by gill-net. The gill-net's higher efficiency was probably linked to the fact that it stood higher on the sea bottom (the Channichthyidae are indeed semipelagic) rather than to different mesh size and/or selectivity. Most *C. hamatus* specimens were caught by entanglement, which is relatively independent of the body size and mesh size.

Even if no proper chi-square test for heterogeneity between the nets could be done because of the low number of fishes captured by the trammel-net, the two length frequencies appeared to be relatively similar. Consequently, they were lumped together for further analysis. Figure 2a, b shows the resulting length frequency of females and males, respectively. The size difference between sexes can be clearly appreciated (median TL of females = 398.5 mm, median TL of males = 358.5 mm).

Figure 3a, b depicts the log-transformed regression lines calculated on our length and weight data for females and males, respectively. In detail, the two regression lines are :

$$LnEWt = 3.0064\ LnTL - 12.1911 \text{ (females, } R = 0.84)$$
$$LnEWt = 3.5858\ LnTL - 15.5125 \text{ (males, } R = 0.83)$$

where LnTL are the logarithms of total lengths and LnEWt the logarithms of weights drawn from the same specimens once they had been eviscerated. Original measures were expressed in millimetres and grams.

As total weights vary throughout the year in connection with the maturation cycle of the gonads, we believed that eviscerated weights could be better compared with future data from other periods and/or areas.

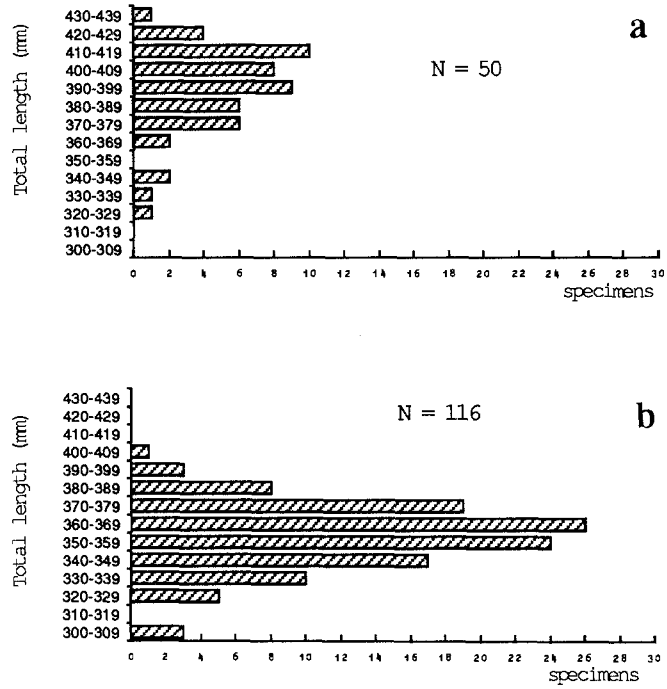

Fig. 2a,b. Length frequency of *Chionodraco hamatus* females (above) and males (below) caught in Terra Nova Bay in 1988

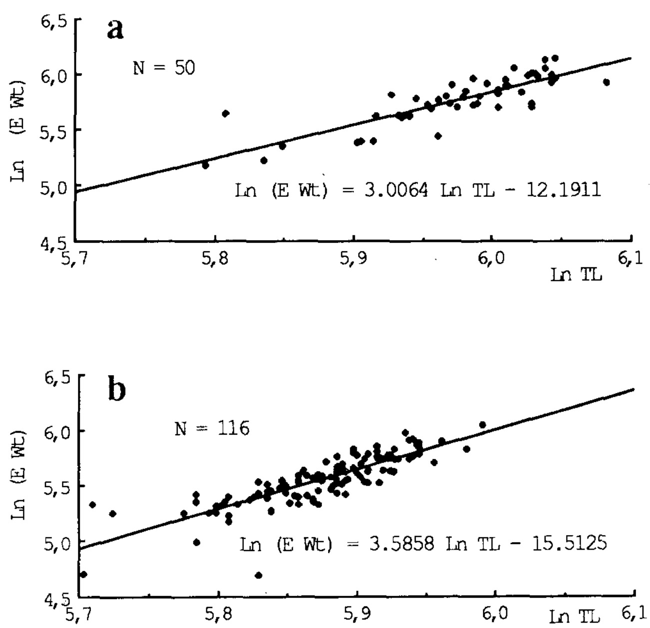

Fig. 3a,b. Regression line, logarithm of weights vs logarithm of total lengths (Ln EWt vs Ln TL), of *Chionodraco hamatus* females (above) and males (below) caught in Terra Nova Bay in 1988

Table 1 shows the age at length values estimated from our specimens by counting the annuli of single otolith sections. The classic Von Bertalanffy growth function was not fitted to the experimental data because we were dealing only with relatively old animals; such a fitting would probably have "smoothed" the extrapolation curve.

Table 1. Age composition of *Chionodraco hamatus* samples caught in Terra Nova Bay in 1988

	FEMALES				MALES						
AGE	Total Length (mm)			Average TL $\pm$ SE	Total Length (mm)						Average TL $\pm$ SE
	333				300						
5 years	342			340.7 $\pm$ 4.1	350						325.0 $\pm$ 25.0
	347										
	328				302	325	346	351			
6 years	366			353.7 $\pm$ 12.8	322	330	347	355			336.5 $\pm$ 4.7
	367				325	332	348	355			
	378				331	340	350	358	367		
	379				333	342	350	360	368		
7 years	390			386.6 $\pm$ 3.4	335	343	354	360	370		351.9 $\pm$ 2.5
	391				339	345	355	364	370		
	395				340	349	356	366			
	382	399			325	362	368	374	380	388	
	392	400			356	362	371	374	381		
8 years	393	407		399.8 $\pm$ 3.3	358	363	372	376	382		369.6 $\pm$ 2.5
	396	414			360	364	372	379	382		
	398	417			361	365	373	379	382		
	388	415	421		362	390					
9 years	405	419		411.7 $\pm$ 4.4	367	395					380.8 $\pm$ 6.4
	414	420			372	399					
	385	422									
10 years	415			409.5 $\pm$ 8.3							
	416										

Our *C. hamatus* samples were comprised mainly of breeders (Everson' stages 4 and 5) which consequently attained large TLs. Lack of young individuals was probably due more to bathymetric/geographic distribution than to our fishing gears, as the same fishing gear also caught some small specimens (less than 250 mm TL) from other Channichthyidae species very similar to *C. hamatus* in their body shape and maybe swimming behaviour (e.g. *Pagetopsis macropterus* and *Chaenodraco wilsoni*).

Discussion

The sagittae sections showed a clear sequence of opaque/hyaline bands which complied well with Everson's description of annuli, so we assumed they expressed regular switches in the growth rate of fishes and were deposited a year apart. The annuli appeared in the sections with a very regular shape as well as with decreasing width from the nucleus to the external border as described by Everson (1980) and expected on the grounds of a positive correlation usually existing in fishes between TL and otolith size.

However, the individual ages obtained by examination of the otolith sections must be regarded simply as "apparent ages" since we could not really know which was the first true annulus among those located in the proximity of the nucleus. Furthermore, we do not have proof that annuli are laid down yearly, as we had no means of comparison with other age estimates, e.g. correlating them with prominent peaks in the length frequencies of large samples composed of young year classes too.

The age data listed in Table 1 match well the report by Gubsch (1982) in which samples of *Chionodraco rastrospinosus* collected near both the South Orkney Islands and King George Islands were composed of year classes IV/VII in the length range 340–470 mm.

Our data show, if correct, that both sexes grow very slowly in the sampled length range, but females are on average larger than males of the same age and increase their TL at a greater rate. Moreover, the females seem to grow less as they get older (the growth rate passes from 33.2 mm/year between age classes VII/VIII to, paradoxically, negative growth for classes IX/X), whereas males follow a linear growth curve (approx. 11/18 mm per year).

In the end, the observation that most specimens present in our samples were breeders (Everson' stages 4 and 5) and males were somewhat younger (and smaller) than females (mean ages of males = 7.31 $\pm$ 0.96 years, mean age of females = 7.84 $\pm$ 1.46 years, $p < 0.001$, Student's test) could imply (even if other explanations are possible) that, in the area sampled, males come to maturity earlier than females.

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References

Bedford BC (1983) A method for preparing sections of large numbers of otoliths embedded in black polyester resin. J Cons Int Explor Mer 41:4–12

Everson I (1977) The living resources of the Southern Ocean. FAO/GLO/SO/ 77/1, 156 pp

Everson I (1980) Antarctic Fish Age Determination Methods. BIOMASS Handbook 8, 24 pp

Freytag G (1980) Length, age and growth of *Notothenia rossii marmorata* Fischer 1985 in the West Antarctic waters. Arch FischWiss 30:39–66

Gubsch G (1982) Zur Verbreitung und Biologie der Eisfische (Chaenichthyidae) im atlantischen Sektor der Antarktis. Fischereiforsch 20:39–47

Kock KH (1980) Graphical analysis of length-frequency distribution of *Champsocephalus gunnari* Lonnberg (Channichthyidae) from South Georgia. Cybium 3e serie 8:33–42

Kock KH (1981) Fischereibiologische Untersuchungen an drei antarktischen Fischarten: *Champsocephalus gunnari* Lonnberg, 1905, *Chaenocephalus aceratus* (Lonnberg, 1906) und *Pseudochaenichthys georgianus* Norman, 1937 (Notothenioidei, Channichthyidae). Mitt Inst Seefisch Hamburg (32):1–226

North AW, White MG (1987) Reproductive strategies of Antarctic fish. Proc V Congr Europ Ichthyol Stockholm 1985:381–390

Pankhurst NW (1990) Growth and reproduction of the Antarctic Nototheniid fish *Pagothenia borchgrevinki*. Polar Biol 10:387–391

Scherbich LV (1975) Method for determining age and onset of sexual maturity in the marbled cod *Notothenia rossii marmorata*. J Ichthyol 15:82–87

Tomo AP, Barrera-Oro E (1986) Age and length growth of *Champsocephalus gunnari*, Lonnberg 1905 (Pisces, Channichthyidae), in the area of Elephant Island, West Zone, Antarctica. Contrib Inst Antart Argentino 319:1–14