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Primary growth rings in Blue Whiting otoliths

by

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Abstract

To approach the problem of ageing blue whiting, acetat prints of the otoliths have been studied through a microscope. Primary growth rings have been counted, and provided that these are formed daily, the hatching time could be estimated

The growth rate was found to reach a maximum when the fish is about two months old, and the results of the analysis further suggest that the blue whiting may reach a size of 20-25 cm within its first year of life.

Introduction

Blue whiting (Micromesistius poutassou) is distributed from the Mediterranean to the Spitsbergen area and in the Barents Sea. A major spawning area is west of the British Islands, and spawning has also been observed in Bay of Biscay and south of Iceland (Andersen and Jakupsstovu 1978). Findings of blue whiting larvae (Bjørke, pers.com.) and analysis of fish samples show that spawning also takes place in some Norwegian fjords during spring time.

The incubation time of the blue whiting eggs is found by Seaton and Bailey (1971) to be 4 days at a temperature of 10-11°C, and by Flüchter and Rosenthal (1965) to be 11-12 days at 8°C. Ageing of the blue whiting is difficult and there are diverging views on the interpretation of the zones in the otoliths. According to the interpretation of Raitt (1968) the blue whiting has a very fast growth and reach a length of 18-20 cm in the spring of their first year of life. Bailey (1970) re-examined some of the otoliths originally assigned to fish younger than one year, and he found that some of them has an inconspicious zone and a larger width in the dorsoventral plane that the others. He interpreted these otoliths as comming from I-group fish. Jakupsstovu (1979) on the other hand argue that the zones referred to by Bailey (1970) are Bowers zones and he therefore supports the interpretation of Raitt (1968).

To elucidate this problem we have tried to count primary rings in the otoliths. During the last few years such rings are studied in many fish species, and there are strong evidence that they are formed daily, at least during periods of growth (e.g. Pannella 1971, 1974, Le Guen 1976, Taubert and Coble 1977). But there is also evidence that during periods with extreme

environmental conditions and slow growth the formation of rings may be supressed. Timola (1977) found that smelt, Osmerus eperlanus from the Bothnian Bay, formed 170 rings during their second summer and only 100 during their third. He did not count the number of rings formed during the first year of life.

Blue whiting otoliths have been studied using scanning electron microscope, and rings were observed (Jakupsstovu unpubl.). This method is, however, time consuming and we therefore used light microscopy to count number of rings and to measure the increment between the rings. At present it has not been proved that the primary growth rings are formed daily on blue whiting, but based on experience from other species this interpretation seems reasonable.

The purpose of this paper is therefore to assess the growth of blue whiting during its first year of life based on the assumption that the primary growth rings are formed daily.

Material and methods

The fish used for this study were caught on the North Sea, off the Norwegian coast and in the Norwegian Sea. Most fish selected for this study were smaller than 25 cm long, although a few larger fish were used. The otoliths used were dissected out and stored in small envelopes.

Several procedures were used to prepare them for counting the zones. The most easy method, and often the most satisfactory one, was a modification of the acetat print method described by Pannella (1971): The otolith is broken through the nucleus. One of the halves is ground and polished using a dentist drill

or a grinding stone, until the surface has become even. Then it is etched by 1 % HCL for approximately 60 seconds. The even surface of the otolith is thereafter pressed against an acetat paper placed on a glass slide. Before the printing the acetat paper is softened by aceton. The otolith is left for about half an hour. When the paper has dried, the otolith is removed leaving a permanent print in the paper. Then the paper is covered with a glass slide.

Another method also applied was grinding the otoliths from the medial and the lateral side till a thin section through the nucleus was left. This section was cleared by creosote and mountened in Canadabalsam between glass slides.

Counting of the zones were either made directly through a microscope or at pictures taken through the microscope (Fig. 1). The magnification used was 200 to 400 times. Measurements were taken using an ocular micrometer.

Results and discussion

Otoliths of 70 fishes were studied and most of these showed clear rings of the type usually interpreted as daily growth marks (Fig. 1). Otoliths of 64 fishes had less than 360 rings, indicating an age of less than one year.

Only 13 of these fishes had no hyaline zone while 37 had one and 14 had two or more hyaline zones (Table 1). Many of these zones were of the type referred to as Bowers zones by Jakupsstovu (1979), but some were previously interpreted as true annual zones.

The otoliths without hyaline zones had a significantly (5 % level) lower number of rings than those with such zones (Table 1). Provided that the rings are formed daily, the fish without hyaline otoliths zones were hatched during summer (Fig. 2), while those with hyaline zones show a bimodal hatching curve with one mode between November and March and one from March to June. The material is, however, to sparce to decide wether the two modes are significantly separated, and if they are, wether they represent two spawning areas or two spawning periods in the same area.

The material at hand suggests that in some fish one hyaline zones may be formed before the first true winter zones. A similar conclusion was reached by Jakupsstovu (1979).

The width of the primary growth zones were measured in one area near the nucleus, one area about midway between the nucleus and the edge, and in the area as near the edge as possible. Fourteen specimens, all caught during November 1976 were used for these measurements.

The mean width of the zones near the nucleus was 3.0 µm (range 2.4 - 3.6). In the middle part of the otolith, which in most of the fish studied correspond to an age of about 2 months, the mean width was 4.4 µm (range 3.6 - 4.9). Near the edge the mean width was 3.6 µm (range 3.2 - 4.9). These widths fits well with 0.5 - 4 µm which Pannella (1979) refer to as common in temperate fishes.

If there is a linear relationship between otolith growth and fish growth, which seem to be the case in adult blue whiting (Jakupsstovu 1979), this suggests a sigmoid growth curve. The growth rate then reach a maximum when the fish is about 2 months

and slow down towards the first winter.

If the interpredation of the primary growth rings is correct the blue whiting may reach a size of 20-25 cm within one year of life (Fig. 3). This is a surprisingly fast growth for a fish reaching a maximum size of only about 40 cm.

All these conclusions are based on the presumption that the primary growth zones in blue whiting otoliths are formed daily during its first year of life. Based on results obtained for other temperate fish species (e.g. Pannella 1974) this seem reasonable, but it has not been proved.

The conclusions are, therefore, tentative, and further studies have to be carried out before final conclusions can be drawn.

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Table 1. Number of hyaline zones, mean number of primary growth rings ($\bar{N}$) and mean length ($\bar{l}$) in cm of the blue whiting studied.

Hyaline zones	Primary growth rings $\bar{N}$	SD	range	Length of fish $\bar{l}$	SD	Nos. of fish
0	132.3	30.9	90-200	17.2	3.1	13
1	227.3	71.6	120-357	23.5	2.1	37
2	268.2	54.0	280-350	25.5	1.0	11
3	344					1
4	287					2

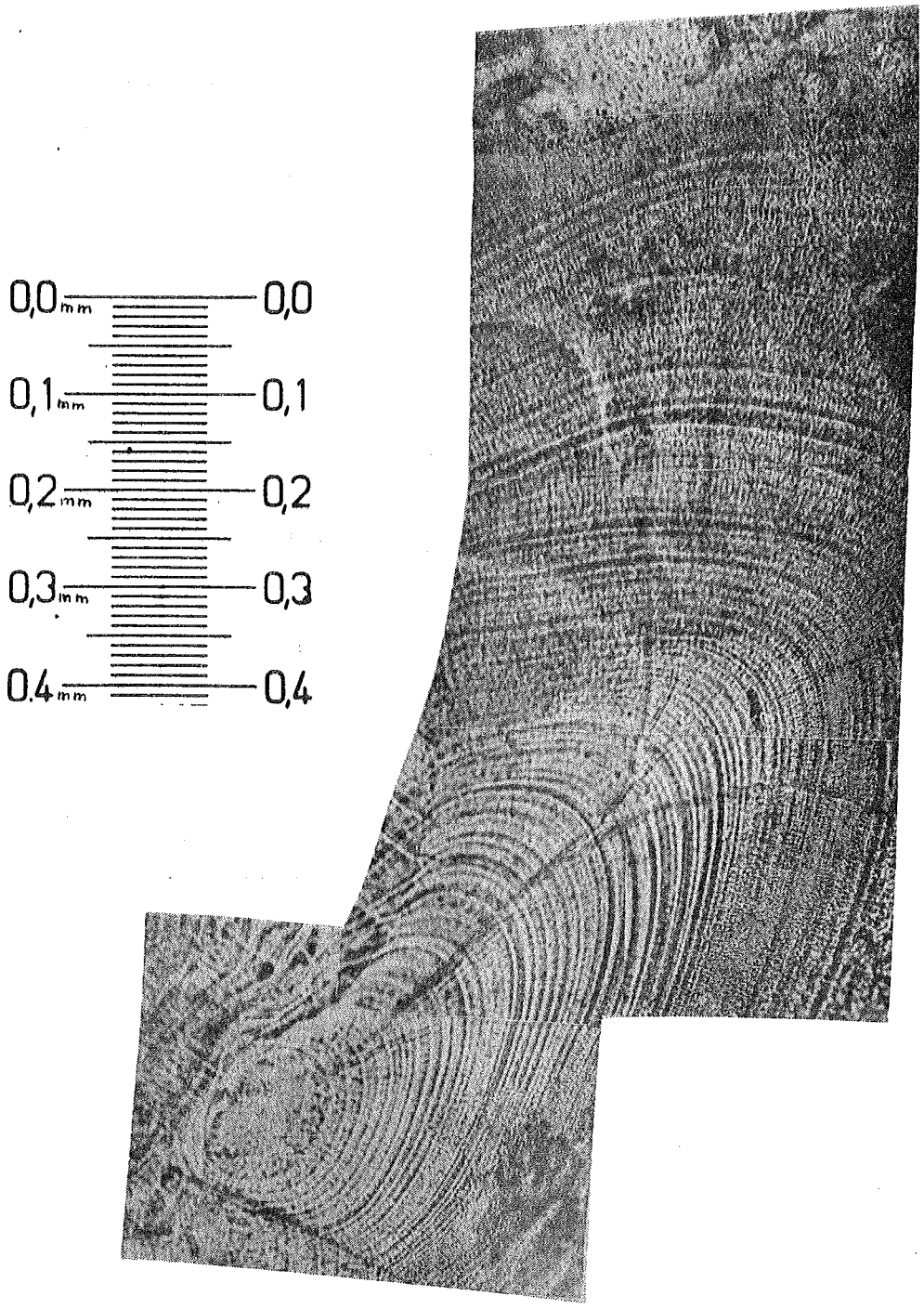

Fig. 1. Picture taken through a microscope of a sectioned blue whiting otolith, showing primary growth rings. The scale is showed by picture of the ocular micrometer.

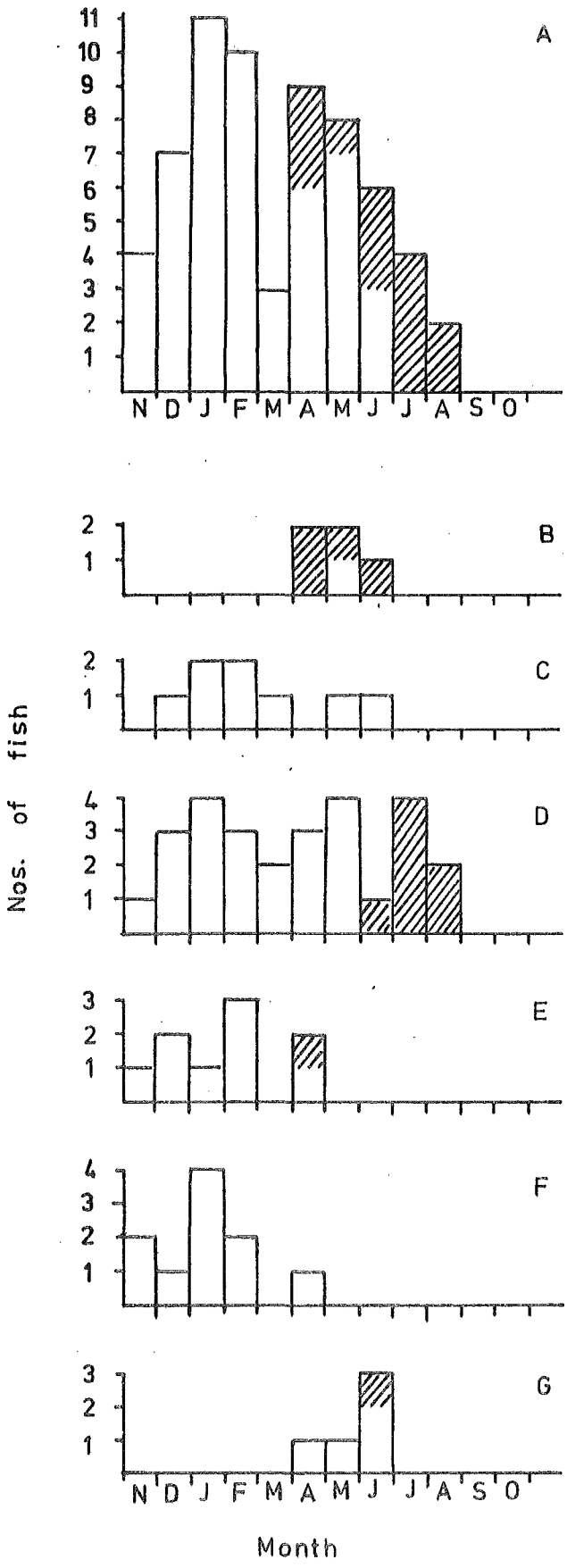

Fig. 2. Calculated hatching months of blue whiting in different samples.
A) All of the fish studied. B) From the Norwegian Sea in September 1975.
C) From east of Shetland in November 1976. D and E) From the North Sea (W. of Bergen) in November 1976. F) From the Norwegian Sea in August 1978, G) From the North Sea in September 1975.
The marked symbols represents otoliths without hyaline zones.

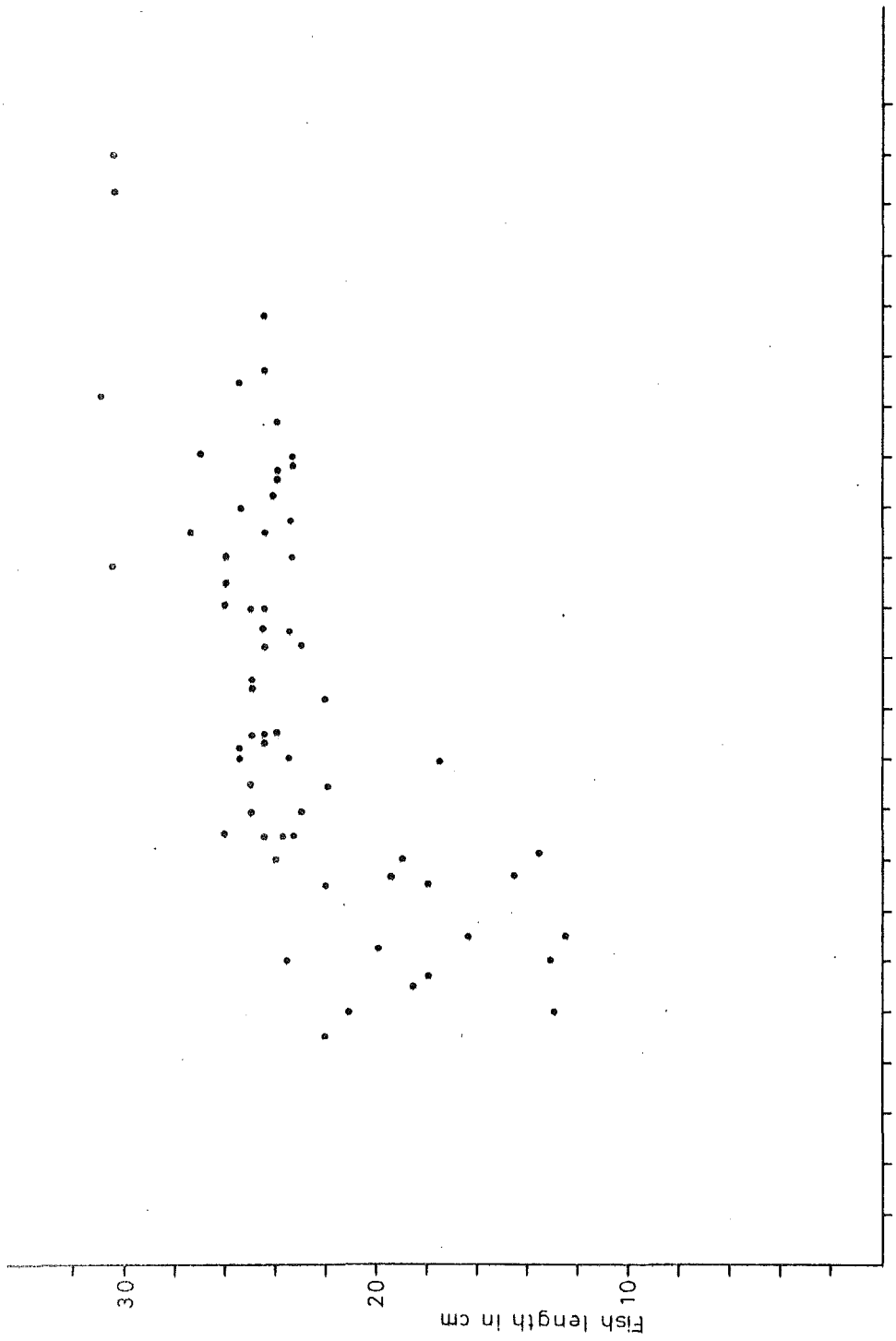

Fig. 3. Relationship between total length of blue whiting and numbers of primary growth rings in the otoliths.