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An interpretation of the otolith structures of some cod from the central Baltic Sea

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Abstract

Otoliths of cod from the central Baltic Sea have been labelled with an antibiotic (Oxytetracycline-dihydrate). This enabled a tentative identification of otolith structures of recaptured fish.

Kurzfassung

Über die Interpretation von Otolithenstrukturen des Ostseedorsches

Otolithen von Dorschen der eigentlichen Ostsee wurden mit dem Antibiotikum Oxytetracycline-dihydrate markiert. Dadurch war eine vorläufige Identifikation der Otolithenstrukturen von wiedergefangenen Dorschen möglich.

1 Introduction

In many fishery studies knowledge of the growth rate of fish species is important. In such studies age determination is necessarily empirical. Since the periodicity of the structures in the hard tissues do not always correlate with the annual periodicity and may vary from fish to fish, in every case it must be established annually that certain structures represent the annuli. For example, in the otoliths of cod from the central Baltic Sea there are some otolith types from which age determination is rarely possible, because in these otoliths the "typical" annual growth bands are not clearly distinguishable. To interpret these structures the otoliths of cods are labelled with an antibiotic. In the studies of MILCH et al. (1957, 1958), BEVELANDER et al. (1959, 1960) and BEVELANDER (1964) it was demonstrated that tetracyclines and their fluorine-derivatives were preferentially incorporated in new bones of different animals. This antibiotic can be injected by intramuscular, intraperitoneal or subcutaneous methods (HARRIS 1960).

2 Sampling of material

During a journey of the fishery research vessel FFK "Solea" to the central Baltic Sea (Bornholm region) 242 cod (*Gadus morhua* L.) were marked and released between September 14–27, 1974. In the present study I used "Uvomycin" (Oxytetracycline-dihydrate corresponding to Oxytetracyclin-hydrochloride) for the labelling of cod otoliths and injected from this stabilized solution approximately 1000 µl per gram fish weight into

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the abdominal cavity. The cod were also tagged with the so-called spaghetti-tag. From these 242 tagged fish, 42 individuals were recaptured and the sagittal otoliths of 18 of the recaptured fish were found to be undamaged (Fig. 1 and Table 1).

These otoliths were embedded in polyester and, with the help of a sawing machine developed by RAUCK (1975), it was possible to obtain discs of 0.2 mm thickness from the otoliths at the level of the nucleus. These discs were glued on slides. All the preparations were photographed for further examination. Due to the fact that tetracyclines have a characteristic yellow-gold fluorescence when excited by ultraviolet (UV) light, the localization of the drug was readily ascertained by UV-microscopy (Fig. 2). The fluorescent ring was superposed on other photographs obtained through simple light microscopy.

3 Otolith structures and their interpretation

As emphasized above, the determination of age is accompanied by certain difficulties in the interpretation of structures. An example is given in figure 3. This fish was caught on September 22, 1974 in the region of Bornholm (55° 17′ N; 15° 00′ E). It was released after tagging and tetracycline injection. The recapture of this specimen occured on February 21, 1975, 15 nautical miles to the south east of Nexø (55° 55′ N; 15° 35′ E). In the time between September 1974 and February 1975 this fish had grown from 58 cm to 63 cm which amounts to a growth of approximately one centimeter per month during autumn and winter. The examination of the tetracycline-labelled otolith of this fish also indicated an increase in radius, and the tetracycline mark lies in the last opaque zone. All the other otolith specimens also appeared to show the tetracycline mark in the last opaque zone. If one subjectively classifies the opaque zone in which the tetracycline mark is observable as "strongly opaque", "slightly opaque" or "undefined", then we obtain a "strongly opaque" appearence at least in 72 % of the undamaged fish otoliths (Table 2).

Thus, it may be concluded, that cod in the Bornholm region experienced the deposition of an opaque zone (in reflected light) in autumn and winter and a hyaline zone in the main growing season. This leads one to assume that the outer hyaline band represents a

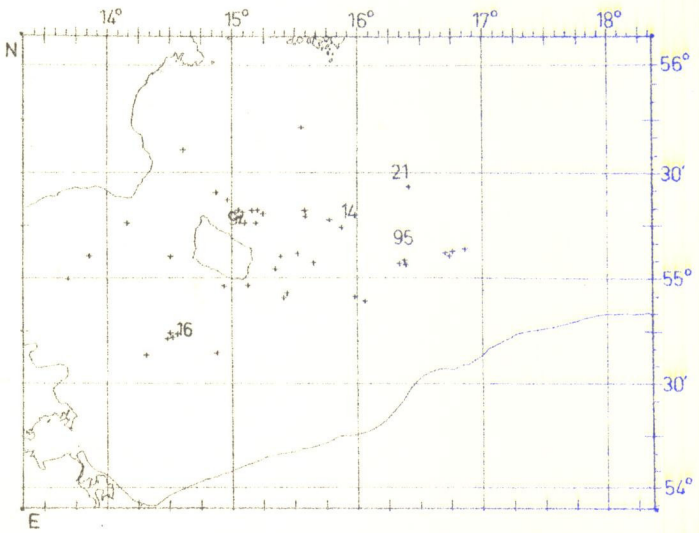

Fig. 1. Release and recapture locations of cod. Numbers show the location and quantity of released fish. + signs indicate the locations of recapture of individual fish

spawning zone. We observe two kinds of growth bands: Those which are the "spawning zones" detectable as clear distinct growth bands in the marginal section, and those which were formed before the first spawning zone, detectable as numerous diffuse rings in the inner section. Probably these rings, which occur in the neighbourhood of the nucleus region, and which have been very difficult to interpret are in fact the true annual rings.

Table 1. Data on recaptured cod for which otoliths were available

Release		Recapture		
Date	Length (cm)	Date	Length (cm)	Time periode (days)
15. 9. 1974	36	5. 11. 1974	37	60
17. 9. 1974	51	14. 5. 1975	54	240
18. 9. 1974	39	25. 11. 1974	39	60
18. 9. 1974	48	6. 3. 1975	49	165
18. 9. 1974	81	22. 2. 1975	81	150
19. 9. 1974	39	14. 12. 1974	40.5	90
19. 9. 1974	39	20. 4. 1975	42	210
19. 9. 1974	45	1. 2. 1975	48	135
19. 9. 1974	48	26. 2. 1975	48	150
22. 9. 1974	34	24. 3. 1975	38	180
22. 9. 1974	37	21. 2. 1975	31	150
22. 9. 1974	58	21. 2. 1975	63	150
23. 9. 1974	31	12. 1974	32.5	~ 80
23. 9. 1974	36	23. 2. 1975	39	150
23. 9. 1974	38	7. 2. 1975	39.5	135
23. 9. 1974	57	10. 2. 1975	60	135
25. 9. 1974	31	5. 2. 1975	33	135
25. 9. 1974	42	18. 4. 1975	45	210

4 Concluding remarks

The above description implies that the age determination of cod from the central Baltic Sea before spawning is to be guessed from the true annual rings and thereafter from the spawning marks in the otoliths. In addition to the above general conclusions table 2 leads one to suppose that the cod in the central Baltic Sea do not live under conditions of food

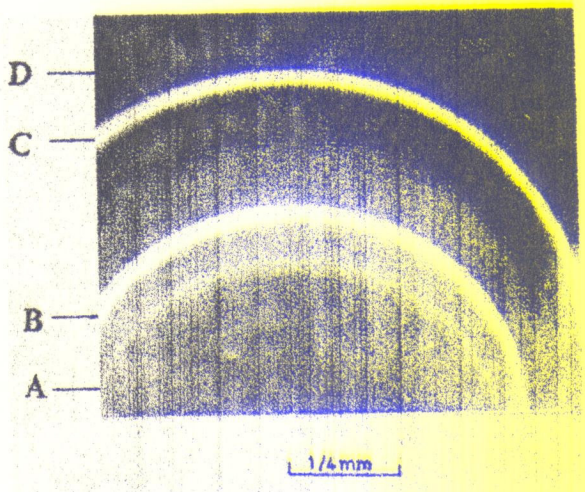

Fig. 2. Tetracycline fluorescence rings in an otolith of a cod which was kept in the aquarium of the Institut für Meereskunde in Kiel. Filter II/47 Zeiss, diaphragm 2.8; exposure 20 minutes. Tetracycline marks are golden

A: 1st Tetracycline mark 04.04.1974, l = 18 cm. B: 2nd Tetracycline mark 15.05.1974, l = 22 cm. C: 3rd Tetracycline mark 10.10.1974, l = 33 cm. D: death 21.02.1975, l = 37 cm.

Table 2. Classification of cod otolith structures deposited in autumn and winter 1974/1975

Period	Number of cods Appearence of last opaque zone in otolith			Sum
	strongly opaque	slightly opaque	undefined	
Before the mark	13	2	3	18
After the mark	14	1	3	18

scarcity even in winter time. STRZYZENSKA (1962), LISHEV and UZARS (1967 and ZALACHOWSKI et al. (1976) have shown that the food of cod consists of more than 50 % of clupeids. Shoals of sprat and herring are present in the winter which may provide food for cod. This may therefore explain how an opaque zone can be formed between September and February. This view is consistent with the observation that the fish live under constant temperature conditions by living in deeper water during the winter (KÄNDLER 1944).

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