RESTRICTED

INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES

ICNAF Res. Doc. 66-22

Serial No. 1630
(D.c. 2)

ANNUAL MEETING - JUNE 1966

Otolith Age Validation in Labrador Cod

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Abstract

Examination of seasonal changes in otolith edge deposits, and comparison of otolith ages with modes in the length distributions, show that otoliths are reliable for age determination of cod from Labrador. The opaque zone is formed mainly from September to November; the hyaline zone mainly from January to June. The opaque zone appears first in the youngest individuals.

Introduction

The importance of a critical approach to methods of age determination in fish has frequently been stressed (Dannevig, 1933; Saetersdal, 1953; Kohler, 1964; May, 1965). Determination of age from skeletal structures usually involves interpretation of zone patterns rather than straightforward counting. Validation of methods provides criteria for such interpretation. Procedures for testing the reliability of age determination are reviewed by Parrish (1956).

Previous validity studies of otolith ageing of northwest Atlantic cod have been reported by Fleming (1960) for the Newfoundland area, Kohler (1964) for the southwestern Gulf of St. Lawrence, Williamson (MS, 1965) and May (1965) for the southern Grand Bank. The only previous data from Labrador were those of Fleming (1960) who reported on appearance of otolith edges in samples taken in July and August.

Material and Methods

Otolith samples were available from research vessel surveys offshore and from sampling of commercial catches inshore. The offshore material was almost entirely from the C.G.S. A.T. Cameron, using a No. 41-5 otter trawl having the codend either lined or covered with small-meshed netting to prevent the escape of small fish. Fishing was usually done in a series of depths on lines of stations across the offshore banks, from the shallowest depths available to that where the cod catch became very small. Inshore sampling was from shallow water close to the coast. Small fish were not taken in the inshore gears, but some were obtained by fishing with hook and line from the shore. All the material was from Division 2J.

Otolith ages were read by the author. The technique is described in the summary by Keir (MS, 1960). The type of edge deposit (opaque or hyaline) was recorded for all otoliths. Length measurements were of fork length. All samples were random samples of the catch.

The material offered two avenues of approach in testing the validity of otolith ages, i.e. through recognition of seasonal changes in appearance of the otolith edge, and by comparison of otolith ages in small fish with modes in the length distribution of the samples.

Seasonal Changes in Otolith Edge

Material covering 8 consecutive months was obtained by combining collections from Division 2J (mainly Hamilton Inlet Bank) for the period 1958-64 (Table 1). This was entirely offshore material except for July, when no offshore data were available. Collections from codtraps inshore in Division 2J were made almost entirely during the latter half of July and these were included to complete the picture.

The percentage of otoliths having opaque edge deposits is plotted for each month in Fig. 1A. A few fish show opaque edges as early as April, and they are present in more than 80% of the material from September to November. It is evident that only one opaque (and one hyaline) zone is formed each year. Age was estimated by counting hyaline zones. Beginning in September some fish show a narrow hyaline zone at the otolith edge. This is regarded as the beginning of the next annual hyaline zone, but would not be counted for ageing purposes until January 1 of the next year. A few otoliths, even in November, exhibit no opaque material at the otolith edge. These are invariably from very old fish, which typically have very much reduced opaque zones. These are so narrow in fact that they often appear as seemingly paper-thin separations between broad hyaline zones, and are almost impossible to

Table 1. Numbers of fish examined for otolith edge appearance, Division 2J, April-November, 1958-64. The July collections were from the inshore commercial fishery.

Month	Year	Depth range (m)	No. fish	Total fish
April	1963	174-452	1,081	
	1964	238-362	302	1,383
May	1963	205-329	901	
	1964	201-220	292	1,193
June	1958	177	132	
	1962	277	44	176
July	1959	15-26	608	
	1960	11-24	1,061	
	1962	11-22	811	
	1963	17-26	803	
	1964	14-17	137	3,420
August	1958	271	160	
	1960	163-558	567	
	1962	159-278	969	1,696
Sept.	1959	214-293	21	
	1962	176	120	
	1963	223-318	222	363
Oct.	1963	141-229	589	
	1964	148-183	139	728
Nov.	1964	161-320	417	417

recognize unless followed by a hyaline zone. This is typical in old mature fish and follows Rollefsen's (1933) description of "spawning zones".

The dorsal edge of cod otoliths is thinner than the ventral, and it is in this pointed edge (in cross-section) that opaque material first occurs. It is not until several months later that it appears all round the otolith.

Opaque edge deposits occur much sooner in the year in young fish. This is illustrated by a more detailed analysis of the material for August (Fig. 1B), when about 50% of the offshore sample exhibited opaque edges. Scanty offshore material for ages 1 and 2 was supplemented by the addition of 177 fish of age 1 and 388 of age 2 from inshore collections. The opaque edge deposits by age (Fig. 1B) range from 100% of the fish at age 1 to zero at age 14. When these values are plotted the result is a double reverse sigmoid. The interruption between ages 5 and 6 is due to the attainment of maturity by many fish at these ages (Fleming, 1960). As a result of the spawning process the onset of body growth and formation of the opaque zone are delayed, resulting in wider hyaline zones than in immature fish, again conforming to Rollefsen's (1933) description.

Length Distributions of Small Fish

Cod from Labrador grow very slowly (May et al, 1965). Thus Petersen's method, which requires recognition of separate modes in length frequency distributions, cannot be applied for much of the data since length distributions for each age overlap widely and catch length distributions tend to be unimodal. It can however be applied to the special collections of small fish inshore and to data from certain offshore collections where small fish were plentiful. Examination of length distributions of small cod taken inshore in Division 2J in August of 1959 to 1963 (Fig. 2A) reveals two fairly consistent modes, one at 13-16 cm and the other varying between 19-22 cm. Otoliths of fish in the first mode typically show an opaque central area, one narrow hyaline zone and a substantial amount of opaque material at the otolith edge. These were regarded as having completed one year of growth plus a good deal of the second year's growth. The next mode should thus consist of fish which have completed 2 years of life, and otolith ages agree with this interpretation. Modes in the offshore data of Fig. 2B are ill-defined, but extension of the method would result in age assignations to each mode as shown in the figure. These are in substantial agreement with age interpretation from otoliths, as indicated by the length distributions of each age group from otolith ages, though it will be noted that because of overlap of the length distributions the method would be of little use beyond age 5.

Discussion and Conclusions

From examination of seasonal changes in appearance of the otolith edge, it is clear that in general one opaque and one hyaline zone are formed each year. While complete monthly data were not available, it appears that there is considerable overlap in the population in time of formation of each type of zone. The period of opaque zone formation extends at least from April to November, and probably to December, but is mainly September to November. This is undoubtedly the period of fastest body growth. Some fish exhibit narrow hyaline zones at the otolith edge as early as September, but the period of main hyaline zone formation is probably January to June. It would appear that the growing season in this area is short. The decline in incidence of opaque edge deposits with age in August (Fig. 1B) suggests that the annual period of body growth is particularly short in old individuals.

Secondary or "check" zones often occur in otoliths from this area, especially during the second and third years of growth. These may cause difficulty in age interpretation, particularly if they are present at the otolith edge. However they can usually be recognized as such on the basis of their appearance (less distinct than "annual" hyaline zones and often incompletely formed) and atypical spacing. A knowledge of the typical zone pattern, acquired through experience in age interpretation of otoliths from the area, is indispensable to accurate age assignation for those otoliths which exhibit check zones or otherwise anomalous appearance.

References

Dannevig, A. 1933. On the age and growth of the cod (Gadus callarias L.) from the Norwegian Skagerak coast. Rept. Norweg. Fish. Mar. Investig., 4(1): 145 p.

Fleming, A. M. 1960. Age, growth and sexual maturity of cod (Gadus morhua L.) in the Newfoundland area, 1947-1950. J. Fish. Res. Bd. Canada, 17(6): 775-809.

Keir, R. S. MS, 1960. Answers to the questionnaire on age reading. Annu. Meet. int. Comm. Northw. Atlant. Fish., Doc. No. 4, Ser. No. 714.

Kohler, A. C. 1964. Variations in the growth of Atlantic cod (Gadus morhua L.). J. Fish. Res. Bd. Canada, 21(1): 57-100.

May, A. W. 1965. The validity of otolith ages of southern Grand Bank cod. Res. Bull. int. Comm. Northw. Atlant. Fish., No. 2, p. 19-24.

May, A. W., A. T. Pinhorn, R. Wells and A. M. Fleming. 1965. Cod growth and temperature in the Newfoundland area. Spec. Publ. int. Comm. Northw. Atlant. Fish., No. 6 (in press).

Parrish, B. B. 1956. The cod, haddock and hake. In Sea Fisheries. Their Investigation in the United Kingdom, p. 251-331. Edward Arnold (Publishers) Ltd., London, 487 p.

Rollefsen, G. 1933. The otoliths of the cod. Rept. Norweg. Fish. Mar. Investig., 4(3): 14 p.

Saetersdal, G. 1953. The haddock in Norwegian waters. II. Methods in age and growth investigations. Rept. Norweg. Fish. Mar. Investig., 10(9): 46 p.

Williamson, G. R. MS, 1965. Age, growth, sexual maturity and mortality of cod on the Grand Bank of Newfoundland and St. Pierre Bank during 1946-62. London University, Ph.D. thesis, 140 pp.

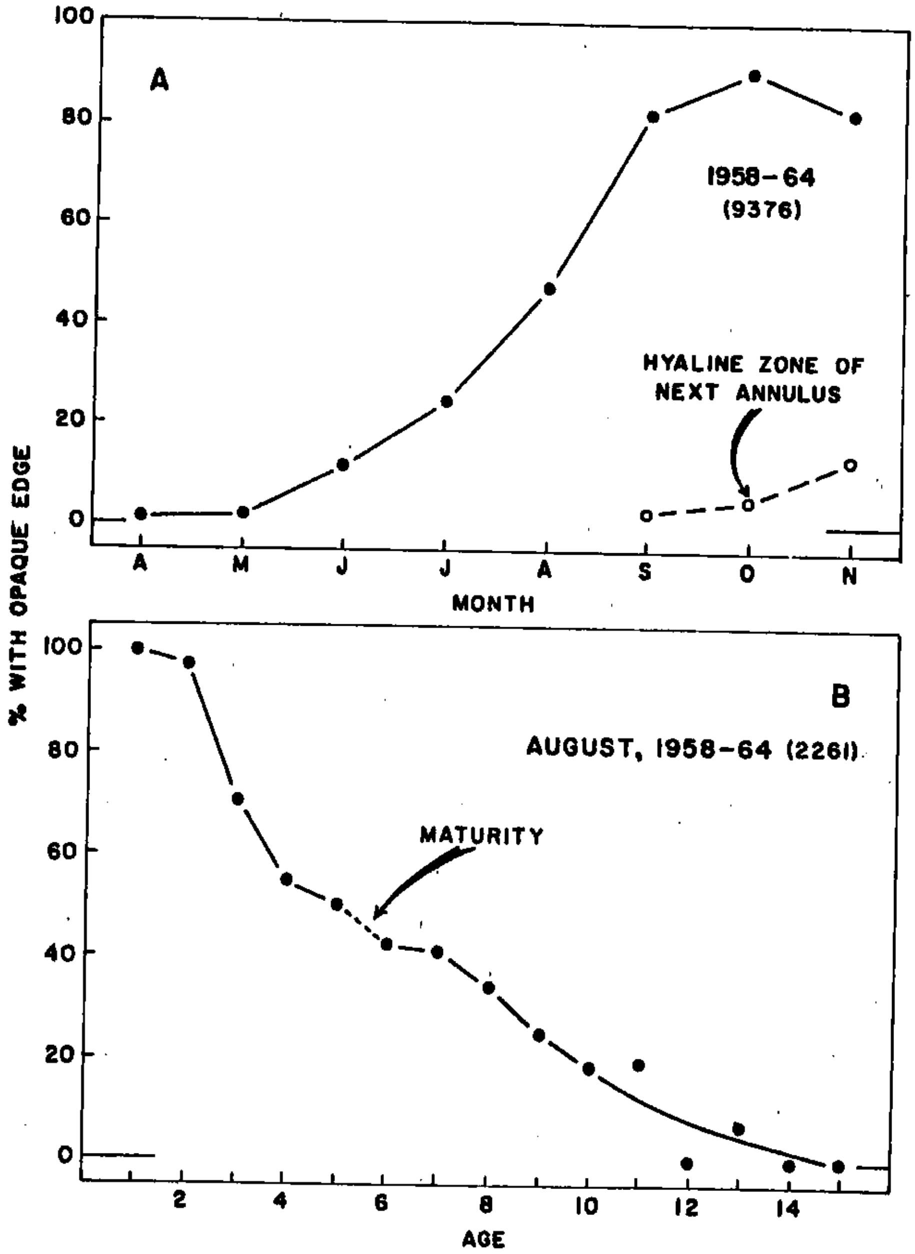

Fig. 1. A. Monthly incidence of opaque edge deposits on otoliths from Division 2J.

B. Incidence of opaque edge deposits by age for August. Numbers of fish are in brackets.

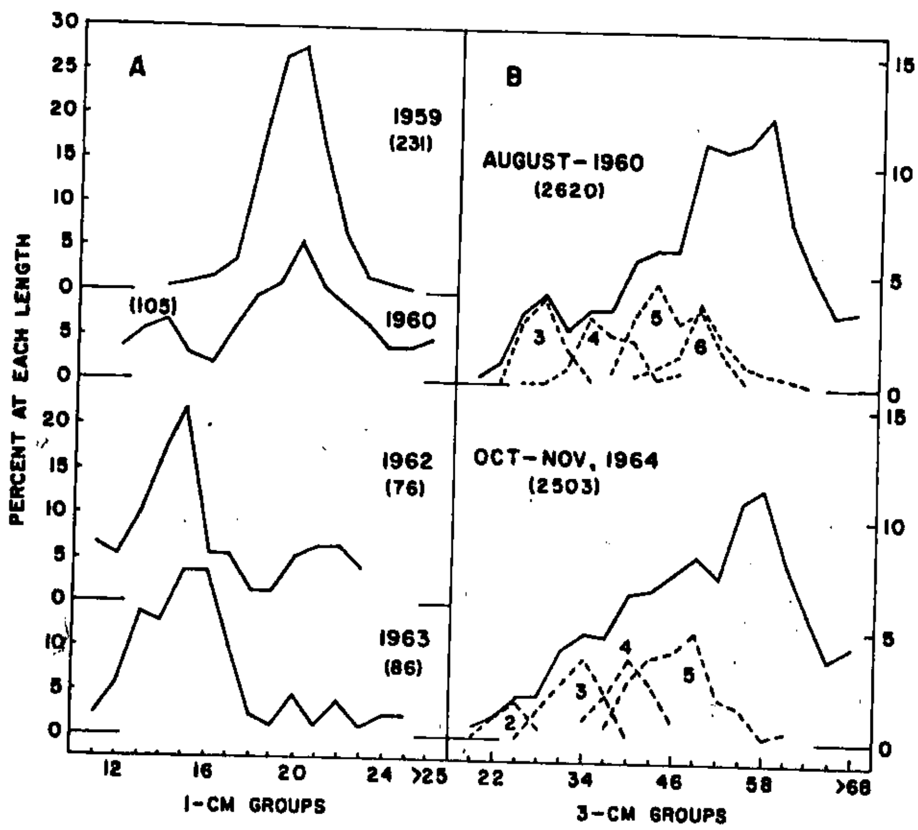

Fig. 2. A. Length distributions of small cod taken inshore in Division 2J in August of each of the years indicated.

B. Selected length distributions from research vessel surveys offshore showing also length distributions of the youngest age groups. Numbers of fish are in brackets.