Serial No. 903
(D. c. 2)

Document No. 39

ANNUAL MEETING - JUNE 1961

A STANDARD TERMINOLOGY AND NOTATION FOR OTOLITH AGE READERS

by Albert C. Jensen
Fishery Research Biologist, U. S. Department of the Interior, Fish and Wildlife Service, Bureau of Commercial Fisheries, Biological Laboratory
Woods Hole, Massachusetts

Results of the cod otolith exchange program (Anon., 1959), and the analysis of a questionnaire (Keir, 1960) distributed to biologists engaged in age determination of fishes, indicated some important disagreements between different workers, particularly in the terminology used to report their findings. Because of the fundamental importance of age data to the work of the International Commission for the Northwest Atlantic Fisheries (ICNAF), the Standing Committee on Research and Statistics, at the 1960 Annual Meeting (Anon., 1960) recommended that a working part on ageing techniques be set up to resolve these disagreements, and to draw up a uniform set of terms and symbols.

Dir. Gunnar Rollefsen (Norway) was appointed Convenor, and the author was asked to prepare a set of terms, definitions, and symbols that he would take to Bergen, Norway, in Autumn, 1961, for consideration by the working party. This preliminary listing of terms, definitions, and symbols has been compiled to serve as the basis for comments and suggestions by biologists. The terms have been kept as simple as possible. Preference has been given to terms that have precedence in the literature or have a valid historical basis. Quite often the oldest term is the best term.

Terms that deal with validity of methods (e. g., year-marks), and terms for which the dictionary definition has been replaced by a common usage definition (e. g., annulus) are not considered here. The proposed terms are intended to be descriptive and of a restricted nature. Also, they are terms that will have a similar meaning when translated from English, the official language of ICNAF, into the various languages of the ICNAF members.

Otolith Marks

Term	Alternative	Definition
Zones	Annuli, rings, year marks, bands, winter rings, summer rings, growth rings	Bands of concentric hyaline or opaque material seen in otolith and counted for age determination.
Check	Check mark, check ring, false ring, secondary ring, secondary zone	A zone not counted in age determination. Checks are sometimes indistinct, discontinuous or, in the judgment of the reader, do not meet the criteria established for identification as a year mark. Checks may be hyaline material deposited during the growing period (denoted by opaque material), thus represent a check in growth.
Nucleus	Focus, center, origin, kernel	The whole of the first summer opaque zone. (In most laboratories the center of the otolith is not fully understood, thus many biologists have not yet developed a firm definition for this term.)

Term	Alternative	Definition
Opaque edge	Summer edge, fast-growth edge, dense edge	The otolith periphery composed primarily of opaque material. Beginning of opaque edge frequently best seen at narrow tip of otolith in cross section.
Hyaline edge	Winter edge, slow-growth edge, translucent edge	The otolith periphery composed primarily of hyaline material. Beginning of hyaline edge frequently best seen at narrow tip of otolith in cross section.
Spawning zones	Spawning marks	Hyaline and opaque zones formed in the otolith in the years following the onset of sexual maturity. In general, both hyaline and opaque zones of spawners are uniform in size and form, and the opaque zones are distinctively narrower than those formed during the immature period of the fish's life. The hyaline spawning zones are clear and usually free of opaque material; in many species (e. g., cod) they are frequently broader than the adjacent opaque zones.

Readability of Otoliths

A system of letter notations is proposed to grade the readability of the otoliths. Such notations will also serve as a guide to the reliability of the ages determined for each otolith. Letters are preferred to numbers to avoid confusion with the notation used to indicate the age or the number of zones counted.

Notation and term	Definition
A -- Excellent	The zones are plainly visible and well defined. There are no strong checks. The reader has a high degree of confidence in the resulting age determination.
B -- Good	The zones are plainly visible with generally good definition between hyaline and opaque zones. Any check readily identifiable as such. The reader has a good degree of confidence in resulting age determination.
C -- Fair	The zones are visible but not well defined. There are many checks present. The reader has fair (but still sufficient) degree of confidence in resulting age determination. In many otoliths the zones may form distinct patterns that make reliable age determinations feasible.
D -- Poor	The zones are vaguely marked. Otoliths with zones so poorly defined as to be undecipherable, or where the age is merely estimated, are placed in this category.

Abbreviations and Symbols

It is desirable to keep abbreviations and symbols to a minimum and as simple as possible. Any lengthy comments on the appearance of the otolith and its markings, or on the degree of confidence of the determined age, are best made in an appropriate remarks column on the form used to record the results of the otolith reading.

Asterisks, plus and minus signs, or other addenda to the age notation, serve only to clutter the data. When comparing the results of duplicate otolith readings, the reader's first concern is, "Do the ages agree?" After this, the question may be asked, "Why did the duplicate readings agree (or disagree)?" Symbols and remarks will serve to answer the second question, but they should not clutter the sheet such that, after the otolith has been studied and an age assigned, the data sheet must be studied to find the notation of age.

Type of edge growth

Determining the type of growth (hyaline or opaque) seen at the edge of the otolith can, at times, be difficult and sometimes depends upon the subjective judgment of the reader. Final determination of the type of edge growth is influenced by the manner in which the otolith is cut or broken for reading and at times the beginnings of new growth are best seen at the narrow tip of the long axis of the otolith. These factors must be taken into consideration by the reader when he records his observation of the type of edge growth. Since the type of edge growth is used to translate age determinations from zone counts, recognition of the edge type is essential to the otolith reading process. To help him in this recording, the following abbreviations are proposed:

Nh - narrow hyaline zone at edge	(1)
Wh - wide hyaline zone at edge	(2)
No - narrow opaque zone at edge	(3)
Wo - wide opaque zone at edge	(4)

For card punch systems (IBM, Keysort, etc.), the numerical notation may be substituted for the abbreviation, but care should be exercised to avoid confusing the edge code number with the age or zone-count number.

Checks

$C_{3,4}$ - check in third and fourth zone

Spawning zones

12,4s - total of 12 zones of type counted, 4 of which are spawning zones

Age notation

9 - clearly, nine completed zones of the type counted
9(10) - probably nine, possibly ten completed zones
(8)9(10) - probably nine but possibly eight or ten completed zones
12(?) - best estimate of count from ambiguously marked otolith

Age Assignation

The immediate aim of otolith reading is, of course, to determine the ages of individual fishes. In this proposed standard terminology, I have concerned myself solely with tools with which to report what is seen in the otolith. Many of my respondents, however, suggested that some schedule be set up whereby zone counts may be translated into ages. I have deliberately avoided doing this since I feel it is a problem for the biologists who are directly concerned with the species under study.

The biologist, in his validation of the otolith method of age determination, should, of course, first determine that the zones counted are formed on an annual basis. He should also determine the season of year in which the hyaline and opaque zones are formed; that is, he should develop an otolith calendar. The calendar should be related to the official birthday, based on the peak of the known spawning season. Such a calendar has been devised by Kohler (1958) for haddock from the Lockeport, Nova Scotia, area and is also used at Woods Hole for the Browns Bank haddock. Kohler's otolith calendar is shown below, and might well serve as a model for other workers.

Table 1.--Examples of observed ring counts and edge types on haddock otoliths, and the resulting assignation to age groups.

Time of capture		Number of			
Quarter of year	Months	hyaline zones	Type and width of edge zone		Age group assignation
I	Feb.	5	narrow	hyaline	5
	Mar.	5	wide	hyaline	5
	Apr.	5	narrow	opaque	5
		5	wide	opaque	5
II	May	5	narrow	hyaline	5
	June	5	wide	hyaline	5
	July	5	narrow	opaque	5
		5	wide	opaque	5
III	Aug.	5	narrow	hyaline	4[a]
	Sept.	5	wide	hyaline	5 (4[a] in Oct.)
	Oct.	5	narrow	opaque	5
			wide	opaque	5
IV	Nov.	5	narrow	hyaline	4[a]
	Dec.	5	wide	hyaline	4[a]
	Jan.	5	narrow	opaque	5
		5	wide	opaque	5

[a]--In these cases it is assumed that a new hyaline zone has formed at the edge of the otolith before the birthday of the fish in the following February. Therefore, it is not counted as a year-zone for age-group assignation.

Literature Cited

Anon. 1959. Report of the ad hoc subcommittee on the ICNAF cod otolith exchange program. Report of the standing committee on research and statistics, ICNAF 1959 Annual Meeting. Appendix III, pp. 48-50.

Anon. 1960. Report of subcommittee on ageing techniques. Report of the standing committee on research and statistics, ICNAF 1960 Annual Meeting. Appendix X, p. 37.

Keir, Ronald S. 1960. Techniques for reading otoliths. ICNAF, 10th Ann. Mtg., Ser. 714 (D.c.2), Doc. 4, Appendix I-XII (mimeographed).

Kohler, A. C. 1958. The validity of otolith age determinations for haddock (Melanogrammus aeglefinus) from the Lockeport, N. S. area. J. Fish. Res. Bd. Canada 15(6): 1229-1238.