The Periodic Growth of Scales in Gadidæ and Pleuronectidæ as an Index of Age.

By

J. Stuart Thomson,

Lecturer on Biology, Municipal Technical Schools, Plymouth.

(With Plate V.)

THE first part of a lengthened and detailed statistical paper on the structure and seasonal growth of Gadoid and Pleuronectoid scales will shortly be issued from the Marine Laboratory.

The forthcoming paper will show by means of tabulated statistics that scale growth is accelerated during the warmer season of the year; but diminished during the colder season in such a methodic manner as to cause the formation of annual rings. The formation of these annual rings results from the fact that the lines of growth on the scale surface are comparatively widely separated from one another in that portion of the scale formed during the warmer season of the year; but much less widely separated in that part built up during the colder season. Thus by following the arrangement of the lines of growth on scales, it is a simple matter to observe the starting place of any year's growth by the comparatively wide separation of the growth-lines at that portion of the scale, and in this way the surfaces of scales appear mapped out by annual rings. These annual rings supply us with an index as to the age of the fish, and may be roughly compared to the rings in many trees. The annual rings in the stems of trees are due to seasonal nutritive conditions, and the rings on the scales of fishes are probably the result of seasonal environmental conditions such as food, temperature, etc. In more detail, the alternate occurrence of comparatively rapid and slow areas of growth in scales is probably the result of the variations in food, temperature, etc., which are associated with the alternation of summer and winter. For example, the abundant supply of food (plankton, etc.) during the warmer season of the year probably has much connection with the comparatively rapid growth of the scale at that time as compared with the slow increase during the colder season, when there is a decrease in the supply of food.

These facts appear to possess both scientific and economic importance,

since they permit the extension to marine fishes of a new system of age determination by means of these annual rings on scales, a system which has recently been shown and demonstrated by Dr. Hoffbauer for the carp.*

I hope to illustrate clearly the mode of formation of annual rings in Gadoid scales by the aid of the figure on the accompanying plate.

The figure (Plate V., Fig. 1) represents the scale of a pollack, 28·5 centimetres (11½ inches) in length, captured towards the end of October. A minute translucent area (see Fig. 1, C) devoid of any lines is situated towards the narrower and more internal end of the scale; and around this area, which is the first portion of the scale to be formed, are grouped numerous excentric lines of growth similarly disposed to the excentric layers in the starch grains of the potato.

The excentric lines of growth on this scale, however, are arranged in such a manner (see figure) as to map out its surface into two main regions, namely, an internal area, which is the entire growth of the first year, and an external part, the summer growth of the second year. One understands how these two areas appear so distinctly if one follows the lines of growth outwards from the translucent area to the broader and more external part of the scale. One may firstly observe that there are nineteen lines comparatively widely separated from one another, which indicate the growth of the first summer, and secondly, ten lines less widely separated, indicating growth of the first winter. External to these, there follows an area showing much more widely separated lines of growth, which indicate the scale growth of the second summer.

The difference between the lines of growth formed during the second summer and those of the preceding winter is so apparent as to clearly define the termination of the first year's growth. The widely separated lines of the second summer number nineteen, and as the pollack from which this scale was taken was captured in October, it appears that in this scale the number of lines formed during the second summer exactly agrees with the number formed during the first summer.

In most cases, however, the growth of the scale in the pollack's second year appears to be greater than that of preceding and succeeding years. As the statistics of the forthcoming paper are too detailed for the purposes of this note, I select a few tabulated figures relating to *Gadus pollachius* and *Gadus minutus*, which will in some measure show the general bearing and object of this work. The following tables commence with fish about an inch in length, the scales of which show a small translucent area without any lines of growth (excentric lines),

* "Die Altersbestimmung des Karpfen an seiner Schuppe," von Dr. HOFFBAUER; *Jahresbericht des Schlesischen Fischerei-Vereins für das Jahr 1899.*

PLATE V.

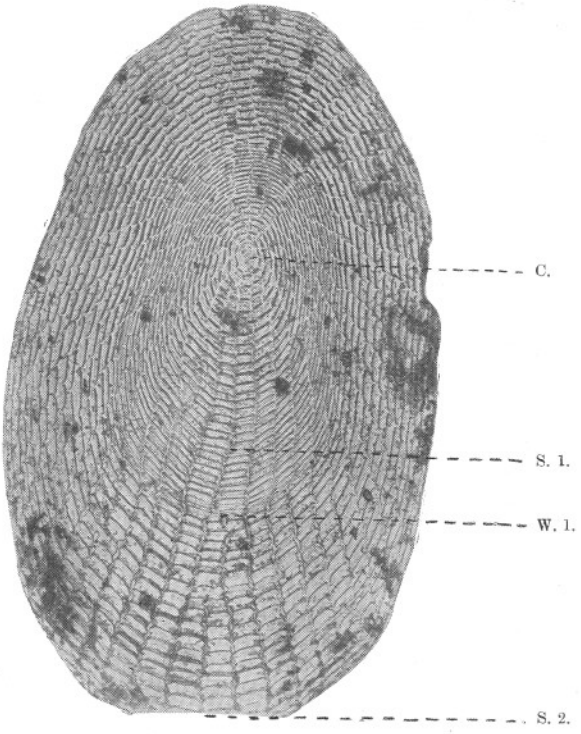

FIG. 1. Microphotograph of pollack scale at end of second summer.
(Magnified 45 diameters.)

C. = Centre of growth.
C.—W. 1. = Growth of first year.
C—S. 1. = Growth of first summer.
S. 1.—W. 1. = Growth of first winter.
W. 1.—S. 2. = Growth of second summer.

and terminate with a pollack apparently at the commencement of the ninth summer. By means of these tables a comparison may be made as to the number of lines of growth (excentric lines) formed during successive years.

GADUS POLLACHIUS.

No. of fish.	Length of fish.	Date (month of capture).	No. of annual rings.	No. of lines of growth (excentric lines) in years. I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
2	2·3 cm.	May	0	0	—	—	—	—	—	—	—	—
4	4–6 ,,	July	,,	2–4	—	—	—	—	—	—	—	—
3	6–7 ,,	,,	,,	3–5	—	—	—	—	—	—	—	—
6	9–10 ,,	Oct. to Dec.	1st forming	13–16	—	—	—	—	—	—	—	—
9	10–11 ,,	,,	,,	15–19	—	—	—	—	—	—	—	—
2	11–12 ,,	December	,,	15–19	—	—	—	—	—	—	—	—
2	35–39 ,,	April to June,	2 complete	23–24	30–31	7	—	—	—	—	—	—
1	45 ,,	April	3 ,,	21	29	18	2	—	—	—	—	—
1	60 ,,	,,	4 ,,	24	24	18	22	3	—	—	—	—
1	84 ,,*	June	8 —	26	25	12	12	11	9	11	10	3

* In this case the majority of the scales showed much disintegration.

GADUS MINUTUS.

No. of fish.	Length of fish.	Date (month of capture).	No. of annual rings.	No. of lines of growth (excentric lines). Year I.	Year II.	Year III.
1	3·3 cm.	June	0	0	—	—
8	3·4–5 ,,	,,	,,	2–7	—	—
17	5–6 ,,	,,	,,	3–9	—	—
8	6–7 ,,	,,	,,	6–10	—	—
3	11–12 ,,	July	1 complete	27–33	6–10	—
6	12–15 ,,	,,	1 ,,	23–32	9–12	—
2	19–20 ,,	Not known	2 ,,	19–25	20–25	10–15

From the preceding tables the age-indices of these varied sizes of *Gadus pollachius*† and *Gadus minutus* may be tabulated as follows:—

GADUS POLLACHIUS.

Length of fish.	Age of fish.
2–7 cm.	First summer
9–12 ,,	First winter
35–39 ,,	Third summer
45 ,,	Fourth spring
60 ,,	Fifth spring
84 ,,	Ninth spring (?)

GADUS MINUTUS.

Length of fish.	Age of fish.
3·3–7 cm.	First summer
11–15 ,,	Second summer.
19–20 ,,	Third summer

In conclusion, I would express my indebtedness to the officials of the Marine Biological Association, more especially to Mr. Walter Garstang, Naturalist in Charge of the Fishery Investigations.

† Compare CUNNINGHAM, *Marketable Marine Fishes*, 1896, p. 295.