G. P. FARRAN
NOTE ON THE GROWTH-RATE
OF HERRINGS IN THE IRISH SEA

EXTRAIT DU JOURNAL DU CONSEIL INTERNATIONAL
POUR L'EXPLORATION DE LA MER
VOL. III. NO. 3. 1928

Note on the Growth-rate of Herrings in
the Irish Sea.

By

G. P. Farran.

Ministry of Fisheries, Dublin.

In a recent paper on Herring Investigations at Plymouth (Journ. Mar. Biol. Assoc. N. S. Vol. XV, No. 1) Mr. E. FORD has called attention to the importance of taking into account the sizes of herrings at the commencement of a year's growth when comparing the increments made by them during the year, and has published figures showing the average growth made in their second and following years (t_2 etc.) by fish at each successive centimetre length (l_1 etc.) at the commencement of each year, the figures being taken from Sussex and Plymouth samples.

Samples of herrings from the East Coast of Ireland have, with a similar end in view, been examined for some years past by the Department of Fisheries of the Irish Free State and a preliminary summary of the results is given here as a contribution towards the determination of a standard growth rate, in the form of tabulated increments made by fish of successive lengths, which could be used to compare with that from other areas. If such a standard could be established for a large number of localities it would, as Mr. FORD has pointed out, be of great assistance in identifying cases of abnormal migration such as undoubtedly occur from time to time.

As the available samples were small and fish with extreme values of l_1 and l_2 comparatively few it seemed best to group together a number of samples with different numbers of year rings in order to arrive at an average over a series of years.

The herring in these samples were measured, according to the Norwegian method, from the snout to the vertical between the tips of the flukes of the caudal fin in their natural position. The scales were examined either by direct measurement with a squared eyepiece or, more usually, with a projection apparatus, the radial distance from the centre of the

scale to each successive year ring and to the edge of the scale in the middle line being regarded as directly proportional to the length of the fish when they were formed. The growth before the first ring is laid down is, as is usual, referred to as l_1 and no distinction has been made, nor would it be possible to do so, between fish which may have been hatched in late autumn and passed through the winter without forming a winter ring and those hatched in the spring and summer of the following year. The winter ring is assumed, for statistical purposes, to be laid down on 31. December in each year and consequently herrings landed on 1st January would be credited with one more ring than if they had been landed on the previous day.

In estimating the second year's growth two sets of samples were examined. The first set, consisting mainly of fish over three years old, was as follows:—

Date	Locality	No. of Specimens	Year rings per cent									
			I	II	III	IV	V	VI	VII	VIII	IX	X
14. 7. 21	off Howth	51	..	22	22	35	18	4	..	..	..	..
11. 7. 23	—	119	..	16	55	23	6	..	..	..	..	..
24. 7. 23	—	149	..	36	47	10	2	3	2	1	..	..
11. 8. 23	—	154	..	..	3	14	37	25	14	6	1	..
13. 2. 24	Dublin Bay	113	..	2	25	57	12	3	..	..	..	..
23. 7. 24	off Howth	144	..	3	6	23	24	25	8	5	3	..
20. 8. 24	—	175	..	17	9	10	13	22	15	9	4	1
30. 7. 25	—	59	..	3	7	2	24	27	24	8	2	3
14. 8. 25	—	187	..	8	5	10	24	24	15	10	3	..
13. 7. 26	off Arklow	222	..	17	55	15	6	5	1	1	..	..
21. 7. 26	off Howth	194	1	61	23	7	3	4	1	..	..	..
5. 8. 26	—	150	5	70	13	4	1	3	1	1	1	..

The Howth fish were taken E. to NE. of Howth, ten to thirty miles off.

Only fish having three or more year rings have been tabulated from these samples as it seemed probable that younger fish would be exposed to selection from two causes, one, that the gill-nets used were not adapted to the capture of two ringed fish of slow growth, and the other, that the more rapidly growing fish with less than three winter rings may perhaps separate themselves from the smaller of equal age and attach themselves to shoals of older fish.

In the following table the total number of fish with three or more winter rings examined from these samples are grouped together according to their l_1 lengths, as calculated from their scale measurements, in 1 centi-

metre groups and the actual number of fish at each centimetre length of l_2 is given for each group. The original records are made to the nearest millimetre and all fish bearing the same centimetre number are grouped under their central value, thus all fish from 20.0 to 20.9 cm. are grouped under 20.5 cm.

l_1 cm	Second season's growth = l_2 Numbers at each cm. length															Numbers	Mean l_2	Increment = t_2
	12.5	13.5	14.5	15.5	16.5	17.5	18.5	19.5	20.5	21.5	22.5	23.5	24.5	25.5				
7.5	1	3	1	10	5	10	2	..	..	..	..	..	..	..	32	16.16	8.66	
8.5	..	..	6	3	17	25	10	1	..	..	..	..	..	..	62	17.03	8.53	
9.5	..	1	2	5	18	27	24	8	1	..	..	..	..	..	86	17.56	8.06	
10.5	..	..	1	6	17	22	51	36	8	1	..	..	..	..	142	18.34	7.84	
11.5	..	..	..	1	4	12	35	52	16	3	..	..	..	..	123	19.07	7.57	
12.5	..	..	..	..	..	7	32	66	32	9	5	1	..	..	152	19.65	7.15	
13.5	..	..	..	..	..	3	19	47	59	24	3	..	..	..	155	20.09	6.59	
14.5	..	..	..	..	..	..	8	24	40	61	18	1	..	..	152	20.89	6.39	
15.5	..	..	..	..	..	..	1	7	43	41	18	3	..	..	113	21.18	5.68	
16.5	..	..	..	..	..	..	..	4	18	38	23	7	..	..	90	21.62	5.12	
17.5	..	..	..	..	..	..	..	..	2	10	10	5	4	1	32	22.56	5.06	

The second set of samples consisted mainly of fish which were completing or had just completed their third season's growth. They are representative of a class of herrings which are taken close to shore every winter along the coasts of Dublin, Wicklow and Wexford, sometimes in very large numbers. These samples were as follows:—

Date	Locality	No. of Specimens	Year rings per cent					
			I	II	III	IV	V	VI
7. 11. 22	Dublin Bay	97	24	64	9	3	..	..
8. 11. 22	Howth	212	1	87	9	1	..	..
10. 1. 23	Arklow	234	..	8	82	8	1	..
14. 10. 25	—	116	6	84	7	1	..	2
10. 12. 25	Courtown	189	9	83	6	1	..	..

In the case of these samples it is unlikely that much selection has taken place, for although gill-nets were used, they were of a mesh suitable for the capture of small fish, and the composition of the samples suggests that a complete year class was adequately represented in each. The fish with two winter rings, or, in the case of the sample of 10. 1. 23, with three winter rings, have been tabulated to show their second season's

growth for comparison with the growth rate given above from examination of older fish.

l_1 cm	Second season's growth = l_2 Numbers at each cm. length											Numbers	Mean l_2	Increment = t_2
	13.5	14.5	15.5	16.5	17.5	18.5	19.5	20.5	21.5	22.5	23.5			
7.5	..	5	9	7	7	4	..	..	..	..	..	32	16.37	8.87
8.5	2	4	7	18	12	10	1	..	..	..	..	54	16.76	8.26
9.5	..	..	4	14	17	19	2	3	..	..	..	59	17.67	8.17
10.5	..	..	4	12	21	28	19	2	..	..	..	86	18.10	7.60
11.5	..	..	..	4	16	47	39	6	1	..	..	113	18.76	7.26
12.5	..	..	..	..	9	27	51	12	3	..	..	102	19.23	6.73
13.5	..	..	..	..	..	10	28	17	4	1	..	60	19.80	6.30
14.5	..	..	..	..	..	2	15	13	12	..	..	42	20.33	5.83
15.5	..	..	..	..	..	..	4	21	21	5	1	52	21.08	5.58
16.5	..	..	..	..	..	..	..	4	15	14	1	34	21.85	5.35
17.5	..	..	..	..	..	..	..	1	8	4	3	16	22.06	4.56

To facilitate the comparison of these two sets of samples they have been plotted together in a diagram (Fig. 1) showing the increment (t_2) for each successive length of l_1 .

Fig. 1. Increment in second year. The abscissae show the lengths at the formation of the first winter ring, the ordinates the increments made by fish of each successive length.

Thick line, samples from E. Coast of Ireland with 3 or more than 3 w. r.
Broken line, samples from E. Coast of Ireland with 3 or fewer w. r.
Dotted line, Plymouth sample.

The growth rate of the Plymouth samples as recorded by Ford has also been plotted on the same diagram but it has not been possible to do this directly from his figures as his measurements have been made in a different manner, the total length of the fish being measured from the snout to the tip of the longest ray of the dorsal fluke of the caudal fin bent down parallel to the body.

It is necessary to convert these measurements to the Norwegian scale by applying a "correction" and this can most easily be done by subtracting $1/50$ from the length of the fish, measurements of a large number of herrings of different sizes by the two methods having shown that the difference between them is approximately 2 per cent of the length of the fish. The following table, in which the observed lengths of the Plymouth fish have been taken, shows the result of this conversion.

l_1 (Ford)	9.5	10.5	11.5	12.5	13.5	16.5	15.5	16.5	cm.
l_1 (converted)	9.31	10.29	11.27	12.25	13.23	14.21	15.19	16.17	-
l_2 (Ford)	17.93	18.87	19.58	20.15	20.82	21.22	22.29	22.67	-
l_2 (converted)	17.57	18.49	19.19	19.75	20.40	20.80	21.84	22.24	-
t_2	8.26	8.20	7.92	7.50	7.17	6.59	6.65	6.07	-

It will be seen from the diagram that there is a very fair agreement between the two Irish sets of samples, the older fish showing a slightly higher average growth rate in their second season, suggesting that there may be an infiltration from some region where nourishment is more plentiful. The Plymouth samples have a distinctly higher growth rate than either of the Irish Sea samples.

The growth increment (t_3) for the third season has in like manner been calculated for Irish Sea fish, using all fish with three or more winter rings from the first set of samples used above in estimating t_2 and from one sample, that of 10.1.23, in the second set of samples.

The resulting figures are tabulated below:—

l_2 cm.	Third season's growth = l_3 Numbers at each cm. length									Numbers	Mean l_3	Increment $= t_3$
	18.5	19.5	20.5	21.5	22.5	23.5	24.5	25.5	26.5			
16.5	..	7	34	41	12	3	..	..	..	97	21.18	4.68
17.5	1	4	19	59	47	4	..	..	..	134	21.69	4.19
18.5	..	..	2	70	111	26	4	..	..	213	22.30	3.80
19.5	..	..	..	18	113	114	19	1	..	265	23.02	3.52
20.5	..	..	..	3	44	100	64	6	..	217	23.62	3.12
21.5	..	..	..	..	7	49	98	36	..	190	24.36	2.86
22.5	..	..	..	..	..	2	22	41	6	71	25.22	2.72
23.5	..	..	..	..	..	..	2	4	8	14	25.93	2.43

The growth increments of Plymouth fish, as shown by FORD's observed figures, converted to the Norwegian scale by the above mentioned method, are as follows:—

l_2 (Ford)	16.5	17.5	18.5	19.5	20.5	21.5	22.5	23.5	24.5	cm.
l_2 (conv.)	16.17	17.15	18.13	19.11	20.09	21.07	22.05	23.03	24.01	-
l_3 (Ford)	21.00	21.87	22.76	23.50	24.02	25.06	26.11	26.79	(27.33)	-
l_3 (conv.)	20.58	21.63	22.32	23.03	23.54	24.56	25.59	26.25	(26.78)	-
t_3	4.41	4.28	4.19	3.92	3.45	3.49	3.54	3.22	(2.77)	-

Fig. 2. Increment in third-year. The abscissae show the lengths at the formation of the second winter ring, the ordinates the increments made by fish of each successive length.

Thick line, samples from E. Coast of Ireland.
Dotted line, Plymouth samples.

If the graphs of the Irish Sea and Plymouth fish are compared (Fig. 2) a noticeable difference is evident. The fish with l_2 of 16.5—19.0 cm. put on approximately equal increments in both localities but the fish which started the year at sizes above 19 cm. show in the Plymouth samples a much higher and more irregular growth than those from the Irish Sea.

It would be premature to speculate on the cause of this difference, which may be due merely to insufficient sampling, until a definite correlation has been determined, as far as is possible, between the annual increment made by a large and a small herring of the same year group under identical conditions, assuming that the original difference is due to differences in the date of hatching and in previous nourishment and not to racial or physiological causes.

Mr. FORD suggests that the graph of these annual increments can be represented by a straight line but this suggestion does not seem to meet the state of affairs found on the East Coast of Ireland, and it is partly in the hope of eliciting data from other localities bearing on this question, which appears to be a fundamental one in herring investigations, that this note is published.