The Ovary as an Indicator of the Spawning Period in Fishes.

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With 1 Figure in the Text.

Accounts of the ovarian development of the eggs of fishes have been given by Kisselevitch (1923), Mayenne (1927), and recently by Hickling (1930) and Raitt (1933). They have concluded that in the ovary of the adult fish there is a general egg-stock of small eggs, yolkless and transparent in fresh material, and with deeply staining cytoplasm in fixed and stained material. From this egg-stock a quota is withdrawn each year to be matured and finally spawned, and to this egg-stock a fresh batch is added each year by the development of oocytes present beneath the surface of the ovigerous lamellæ, the minimum period of development being two seasons.

It has occurred to us that measurements of the diameters of eggs, in ovaries well advanced towards spawning, may give evidence of the duration of spawning in a fish of which the spawning habits are unknown. For where the spawning period is short and definite, the batch of transparent yolkless small eggs, destined to mature and be spawned, will be withdrawn from the general egg-stock in a single group, sharply distinguishable, at least in the later stages of maturation, from the stock of small eggs from which it was derived. But when the spawning period is long and indefinite, the withdrawal of eggs from the egg-stock, to undergo maturation, will be a continuous process, and there will be no sharp separation between the general egg-stock and the maturing eggs. These will pass continuously one into the other. We have tested this hypothesis with four species of fish of known spawning habits.

Material.

We have compared the ovaries of Herring from the southern North Sea and Pilchard; Haddock from North Shields and Hake, and have also examined the ovaries of *Lepadogaster gouani*, the Cornish Sucker, a small

fish of the tidal zone. We would acknowledge our thanks to Dr. E. J. Allen, F.R.S., for sending the Lepadogaster material from Plymouth, and to Mr. T. S. Leach, District Inspector of Fisheries at North Shields, for the haddock material. The ovaries were in all cases fixed in Bouin's Fluid, cut into sections and stained with iron hæmotoxylin and eosin. We would thank Mr. B. G. Clarke, Chief Laboratory Assistant at the Lowestoft Laboratory, for his care and skill in the preparation of the sections.

From 5 to 10 ovaries of each species, in the penultimate stages of ripeness, were examined, and the contained eggs measured. To make sure that the eggs measured had been cut approximately at their maximum diameter, only eggs in which the nucleus was visible were measured. The samples of eggs measured were unselected, except in the haddock, where the small transparent yolkless eggs were so numerous that towards the end of the measurements the smallest of these were omitted.

The results of these measurements are given in Table I as a frequency at each micrometer division, and a scale is added by which micrometer divisions can be converted into millimetres. They are also shown graphically in Figure 1, except that, for ease in producing the graphs, the eggs of the transparent yolkless egg-stock less than 6 micrometer divisions (0·095 mm.) in diameter have been omitted and the frequencies have been grouped in pairs.

Results.

Comparing the measurements of the eggs in the ovary of the hake with those in that of the haddock, it will be seen that in the hake there is no sharp separation between the ripening eggs and the small eggs of the general egg-stock, whereas in the haddock there is a sharp separation, the larger maturing eggs forming a separate group. Between the two Clupeoids, the pilchard and the herring, there is the same difference. In the herring the separation is very sharp, for the mature eggs of the herring are exceptionally large. The difference noted between the hake and the haddock, the pilchard and the herring, is shown even more clearly in individual specimens than in all specimens combined (as they have been combined in Table I and Figure 1).

Discussion.

The hake has a long spawning period. Hickling (1930) has shown that, though the main spawning months of the hake are from April to July, ovaries in the ripe condition are found in every month of the year except December, and he has found female hake actually running with eggs in March, July, August, September and late October in the waters to the

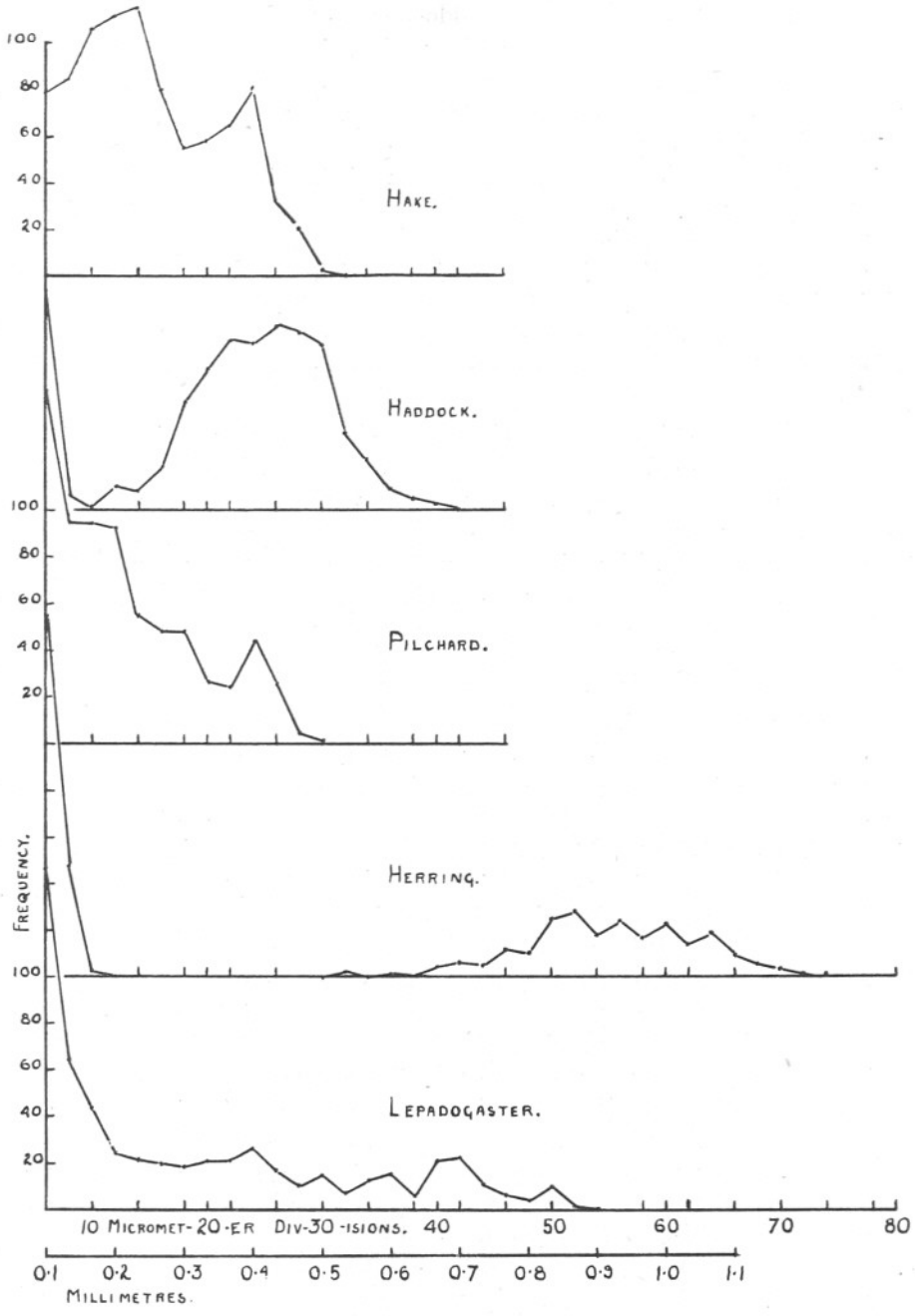

FIG. 1.—Frequency of diameters of the eggs in full ovaries of the five fishes given, grouped in pairs of micrometer divisions. (Date in Table I.)

south and west of Ireland. The haddock of the North Sea, on the other hand, has a more restricted spawning period. Damas (1910) shows that the eggs of the haddock in the North Sea are found from the end of January to the beginning of May, and that February, March and April are the principal spawning months.

The pilchard also has a long spawning period. Clark (1919) gives the spawning period in the neighbourhood of Plymouth as from April to October, with a maximum in July and August, and Russell (1929–30) confirms these findings with more recent material. On the other hand, the herring of the southern North Sea, according to Hodgson (1929) have a short and definite spawning period extending from December to February, and this is confirmed by the captures of herring eggs in the Straits of Dover.

In the case of the four species dealt with, the distribution of the frequencies of the diameters of the eggs in the ovary is in good agreement with the known duration of the spawning period, thus supporting the hypothesis set out in the introduction above. We intend to continue and extend this work with many other species of fish of which the spawning habits are known. If the measurements of the eggs in the ripe ovary correctly reflect the spawning habits, this may become a valuable method of deducing the spawning habits of new or rare species of fish.

Thompson (1915), Heidrich (1925), and Clark (1925) used this method of investigating the spawning habits of the halibut, sprat and grunion respectively. Clark, especially, shows an instructive series of graphs of egg-measurements, in which the fifteen-day spawning period of the grunion (*Leuristhes tenuis*) can be followed.

Kisselevich (1923) remarks with respect to Volga-Caspian herring (*Caspialosa caspia* and its subspecies) that their spawning is broken into three separate periods, spaced one to one and a half weeks apart. In the course of these intervals the next portion of eggs is ripening. The spawning is divided by intervals of time accompanied by change of location. Despite the relatively small size of the body and large eggs the Volga herrings are some of the most fertile fishes.

Ambroz (1931), having made a study of the Pacific herring (*Cl. har. pallasi* C. & V.), writes that the ripening of eggs also depends on the age of the fish : the older the fish the more similar they are with respect to condition of their ovaries. Their ripening is accomplished earlier, and their spawning period is shorter than that of younger herrings.

As far as we know, however, the method has not been used in comparing one species with another. The graph of the measurements of the eggs of *Lepadogaster gouani* drawn in the figure very much resembles that of *Leuristhes tenuis*, and suggests that Lepadogaster also may spawn

at frequent intervals over a prolonged period of time. Precise information as to the duration of spawning in this species seems to be lacking however.

Another point that occurs to us is that attempts to use Hjort's scale of maturity-stages encounter difficulties when applied to a fish with a prolonged spawning period. For as the eggs contained in the ovary are progressively ripened and shed, the ovary itself grows smaller, and, to the naked eye, seems to reverse the stages by which it attained its full maturity. In such cases some other method of recording the stages should be used.

SUMMARY.

Measurements of diameters of the eggs in the ripening ovaries of four species of fish, namely the hake and haddock, pilchard and herring, give frequency-distributions which are consonant with the known duration of the spawning period. It is suggested that this method may provide information as to the spawning habits of new or rare species of fish.

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TABLE I.

FREQUENCY OF DIAMETERS OF EGGS AT EACH MICROMETER DIVISION.

Micro. div.	mm.	Hake.	Haddock.	Pilchard.	Herring.	Lepadogaster.
1		74	510+	68		74
2		174	215+	143	7	210
3		248	300+	241	36	180
4		189	240+	232	61	149
5	0·082	90	190	187	114	127
6		47	70	90	106	92
7		32	24	62	49	53
8		38	6	52	37	40
9		47	1	43	11	24
10	0·166	50		51	2	27
11		56	1	44		16
12		55	3	53		17
13		56	7	40		7
14		57	3	25		9
15		58	6	30		12
16		46	4	26		14
17		34	15	22		6
18		29	23	23		11
19		26	24	25		8
20	0·333	37	30	16		9
21		21	31	11		12
22		29	28	10		5
23		36	45	14		16
24		38	36	19		17
25		43	36	25		9
26		19	44	17		13
27		14	35	8		4
28		5	44	2		7
29		6	32	2		3
30	0·500		45	1		10
31		2	26			5
32			22			5
33			11		2	2
34			15			2
35			7			11
36			6		1	13
37			3			3
38			1			3
39			4			3
40	0·669		3		1	8
41					3	13
42					2	12
43					4	10
44					1	4
45					4	7
46					4	3
47					8	3
48					6	1
49					4	3
50					15	7
51					10	3
52					15	1
53					13	
54					10	
55					8	
56					11	
57					13	
58					11	
59					6	
60					15	
61					8	
62					6	
63					8	
64					6	
65					13	
66					6	
67 and over					14	