VERTICAL DISTRIBUTION OF MACKEREL EGGS IN ISHIKARI BAY, HOKKAIDO *

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For determining the vertical distribution of eggs of mackerel (*Scomber japonicus HOUTTUYN*) at their spawning ground off Hamamasu, west coast of Hokkaido, serial horizontal tows with six nets were made at every successive four hours on 23rd and 24th, June, 1954. The net tows were made usually for an hour by the movement of ship drifting in moderate wind. During tows the angle of warp carrying the nets against the vertical line measured approximately 45 degrees, so that the towing strata of six nets were calculated to correspond to about 0.7 m, 1.1 m, 4.2 m, 7.7 m, 11.2 m and 14.7 m depth respectively, though these depths may have fluctuated to some extent by the condition of drift of the ship. In these tows a flow meter developed by Mr. Z. Nakai was held rigidly at the centre of the mouth ring of the second net at 1.1 m depth to register the distance of tows. The revolution of flow meter has been calibrated to be 153 in mean from four experiments for 20 – 0 metre vertical haul in which the net had been removed from the ring, so that 100 revolution was calculated to be corresponding to the distance of tow as long as 131 metres when there was not any resistance due to anything such as the net.

The nets employed in collecting the eggs were constructed of No. 40 grit gauze having approximately 0.6 mm of opening between meshes. They were conical in shape, 35 cm in diameter at the mouth (about 0.1 m^2 in mouth area) by approximately 165 cm in length. Thus, the 100 revolution of flow meter attached to the present nets indicates that water to the amount of about 12.6 m^3 has been filtered. Vertical hauls from 20 m, 15 m, 10 m and 5 m depth to the surface with the same net as above, yielded only occasional eggs, only one egg if present for a haul, so that the contamination of samples from overlying layers which may have occurred when the nets were lowered and retrieved in the serial horizontal tows was considered to be negligible, needless to adjust for the samples obtained by horizontal tows.

Among the pelagic eggs sampled those of which the diameter was one mm or thereabout and in which an oil globule was contained were tentatively counted as mackerel eggs. Although exact identification of pelagic eggs was impossible on such materials as preserved in formalin, the majority of the eggs counted as mackerel's were thought to be the eggs of this fish because of the presence of a large shoal of spawning adults in the area which presupposed the occurrence of their eggs in the sea.

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There were seen various stages of development among the samples which were treated as mackerel eggs, but separation of stages in counting the number of occurrence was made only into two groups for convenience, viz., the eggs in early stage, i. e. still in blastodisc stage (stage I) and the eggs in later stage including various developmental grades of embryonic stage (stage II) (fig. 1). The eggs in stage II were supposed to have passed at least more than 20 hours after spawning at the temperature of the sea surface in the present area, about 13°C (cf. Kamiya, 1916, 1925).

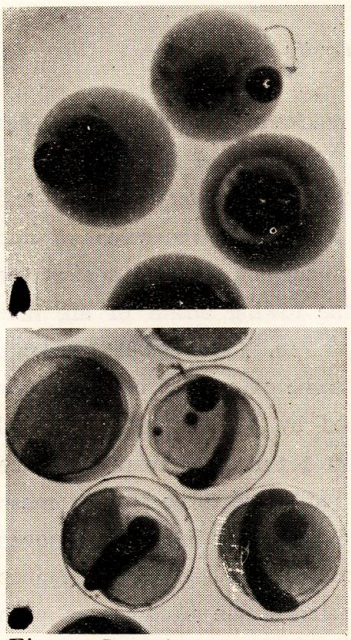

Fig. 1. Grouping of mackerel eggs into two kinds
a. Stage I b. Stage II

Table 1 gives the number of two stages of mackerel eggs together with the displacement volume of total plankton collected at different strata and at different times of a day; the simplified figures illustrating the occurrence of mackerel eggs are given in figure 2. In this table and figure the number of eggs and the volume of total plankton are expressed as the number or volume in 100 m^3 of water by adjusting for readings of flow meter at each tow. Although irregularities of the data cause confusion in finding general tendency of distribution of the eggs, certain mention will be made comparing with the results of previous investigators.

It has widely been believed that mackerels spawn at night as proved in the case of the California sardines and the Japanese sardines. Kamiya (1916, 1925) was of the opinion that mackerels spawn during the time mainly from sunset to midnight. According to the observations of Sette (1943) on the Atlantic mackerels, however, the proportion of number of occurrence of two stages of eggs, one in the stages up 10 hours after spawning and another in the stages up to 20 hours, in nature was not apparently different by the times of a day. In the present collections the eggs in stage I, as well as those in stage II to some extent, are comparatively abundant at about 5:00 p. m., but whether major spawning has taken place a certain number of hours before this time cannot yet be concluded from this single datum. It is more probable that the eggs in concentration may have been drifted to this area by current at that time. The results are not sufficient for determining the spawning time, unless more precise separation of the stages in young eggs is made and more precaution for sampling in keeping the same water during 24 hours is taken.

Sette (1943) found that the mackerel eggs in more advanced developmental stage, were distributed deeper. In the present observation the eggs in later stage were rare

Table 1. Results of serial horizontal tows

Time of sampling	Amount of water filtered by the net	Depth of sampling	Displacement of total plankton in 100 m^3 of water	Number of mackerel eggs in 100 m^3 of water	
				Stage I	Stage II
23, June		0.7 m	<1 cc	2	0
		1.1 m	<1 cc	0	0
1 : 22 p.m.	57 m^3	4.2 m	<1 cc	5	0
-2: 22 p.m.		7.7 m	<1 cc	4	5
		11.2 m	<1 cc	9	9
		14.7 m	<1 cc	18	5
		0.7 m	<1 cc	140	9
		1.1 m	<1 cc	55	0
4 : 34 p.m.	22 m^3	4.2 m	<1 cc	9	0
-5: 34 p.m.		7.7 m	<1 cc	100	55
		11.2 m	1.9 cc	46	36
		14.7 m	<1 cc	23	9
		0.7 m	6.4 cc	10	4
		1.1 m	4.4 cc	4	2
8 : 35 p.m.	52 m^3	4.2 m	9.6 cc	19	15
-9: 35 p.m.		7.7 m	13.5 cc	63	56
		11.2 m	7.9 cc	27	19
		14.7 m	7.6 cc	100	21
24, June		0.7 m	8.9 cc	8	3
		1.1 m	9.0 cc	3	3
1 : 05 a.m.	71 m^3	4.2 m	9.9 cc	7	0
-2: 36 a.m.		7.7 m	11.5 cc	34	1
		11.2 m	13.6 cc	21	1
		14.7 m	12.4 cc	14	0
		0.7 m	<1 cc	2	0
		1.1 m	<1 cc	2	3
4 : 35 a.m.	119 m^3	4.2 m	<1 cc	3	4
-5: 35 a.m.		7.7 m	2.3 cc	16	6
		11.2 m	<1 cc	3	0
		14.7 m	1.9 cc	2	1
		0.7 m	<1 cc	0	0
		1.1 m	<1 cc	0	0
8 : 30 a.m.	56 m^3	4.2 m	1.8 cc	0	7
-9: 30 a.m.		7.7 m	<1 cc	2	11
		11.2 m	<1 cc	12	14
		14.7 m	1.4 cc	11	14

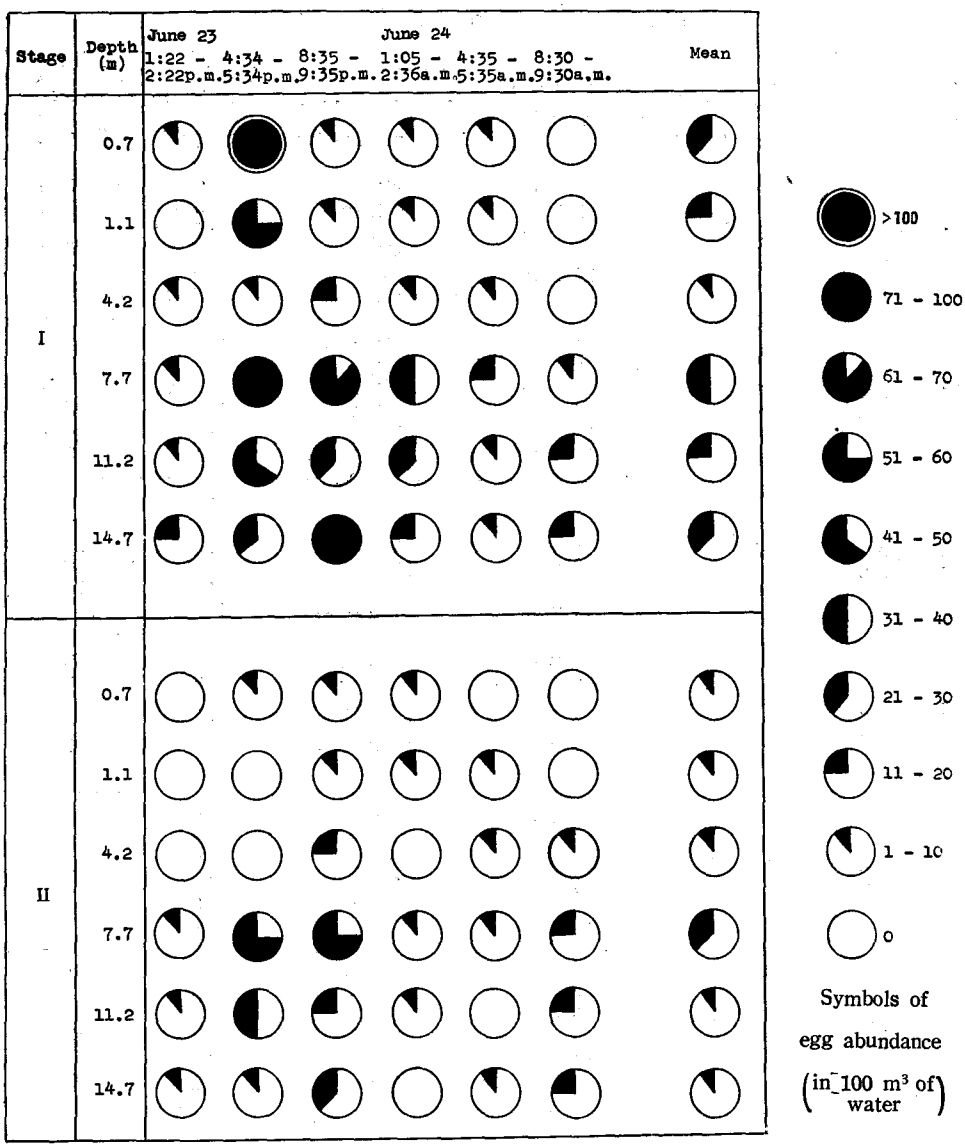

Fig. 2. Occurrence of mackerel eggs in various depths at various times of a day

Table 2. Gradient of temperature

Depth (m)	Temp. (°C)
0	12.95
5	12.80
10	12.50
15	12.20
20	11.10
25	10.20
30	9.90
35	9.60

above 4 m depth as compared with those at about 8 m depth, while the number of eggs in early stage was not reduced in the upper layers. The observation of Sette (1943) proved that the mackerel eggs as a whole were distributed in large number in upper 10 metres, but nearly absent at 20 m layer. In his case the lower limit of distribution of the eggs was disturbed by the existence of discontinuity of density of water at 10—20 m depth. In the present observation temperature was nearly uniform from the surface to about 15 m depth (table 2), and the eggs as a whole were sometimes found in considerable number through the vertical range from the surface to at least about 15 m depth, below which presence or absence of eggs was unascertained owing to the lack of collection.

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