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An Example of Anchovy Egg Patches*

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Abstract

Anchovy egg patches were examined based on spatially fine scale of sampling in Ise Bay along the Pacific coast of central Japan. A egg patch with the highest density of 856 inds./m^3 was found to have an elliptical form with a long radius of 2.25 km and with a short radius of 1.0 km. The eggs were collected abundantly in the water shallower than 5 m depth where a sharp halocline was observed.

1. Introduction

Recently, despite the difficulties of sampling planktonic organisms to gain their space-time series of distribution in the sea, studies have considerably been done with regard to fine (1 m –1 km) and micro-scale (less than 1 m) distributional patterns of the organisms (SEKIGUCHI, 1984), Consequently patches are a normal feature of the distributions of many planktonic organisms and may be generated by interactions of behaviour of the organisms and dynamic physical factors of the environment (HAURY *et al.*, 1978; MACKAS and OWEN, 1982). Biological oceanographers have focused on the problem of a patch, because a patch is a general phenomenon and there is little question of its ecological and evolutionary importance (STEEL, 1976). A patch is as defined in MAUCHLINE(1980, p. 613): a patch is an aggregation within a defined environmental region.

On the other hand, the studies as stated above are still with meagre for pelagic eggs and larvae of fishes (MATSUSHITA *et al.*, 1982; SAKAMOTO and TANAKA, 1986). However, they believe that this aspect of distributions is vital for estimating abundance of the eggs and larvae and making clear the dynamics of fish populations (HUNTER and THOMAS, 1974; MATSUSHITA *et al.*, 1982).

During the course of investigating the spatial distribution of anchovy (*Engraulis japonicus*) eggs and larvae in Ise Bay, central Japan, we had a chance to measure a patch of the anchovy eggs. This observation seems sufficiently unusual to warrant a short paper.

2. Materials and Methods

Ise Bay, covering a surface area of 1600 km^2, is located along the Pacific coast of central Japan and is separated from the Pacific Ocean by a passage, 13 km wide and 73 m deep (Fig. 1).

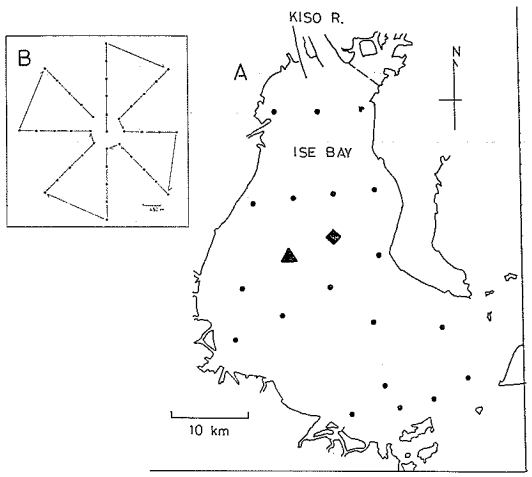

Fig. 1. The studying area and location of sampling stations. A: Ise Bay; B: location of sampling stations for surveying anchovy egg patches; solid lines: tracking course of the vessel; solid circles: sampling stations; solid triangle: the studying area for the egg patch; rhombus: the station where vertical distribution of the eggs was examined.

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The Kiso River runs into the innermost part of the bay. The water in the bay is rich in nutrient and highly turbid due to the freshwater discharge and sewage effluent from the cities.

Shortly after a preliminary survey for the occurrence of anchovy (*Engraulis japonicus*)eggs, a floating buoy with a radar reflector was set at the center of the surveyed area in the central part of the bay (Fig. 1). Localization of sampling positions which were determined with a radar on board the ship is shown in Fig. 1. The buoy, though its movement was not checked, would have been transported probably by a gentle wind and a weak movement of the surface water during the 3-hour investigation, while sampling stations were determined as relative positions against a radar reflector set at the central station.

This investigation took 3 hours from a.m 11.30 to p.m 2.30 on 25 May 1982. Anchovy eggs were collected with vertical hauls of a Marutoku plankton net (45 cm in diameter at mouth, 0.33 mm mesh-openings) from 15 m depth to the surface. The net was towed vertically with a speed of 0.5 m/s and was not equiped with a flowmeter, but a filtering rate of the net is about 0.8 according to previous zooplankton studies in the bay (SEKIGUCHI, 1978). This means that a seawater of 1.9 m^3 was filtered with the net at each station. Vertical profile of anchovy eggs was obtained on 2-10 June 1982 by pumping a seawater of 100 litter at intervals of 1 meter from the surface down to 15 m depth in the central part of the bay (Fig. 1). The seawater was filtered with a sieve of 0.33 mm mesh-openings on board.

Furthermore, spatial distributions of anchovy eggs in the bay were examined with vertical hauls of Marutoku plankton nets from 20 m to the surface at a total of 19 stations on 10-11 May 1982 and on 7-8 June 1982 respectively. All investigations were undertaken on board Seisui Maru, Mie-Isewan Fisheries Experimental Station, during the daytime. The stage of anchovy eggs was identified according to ASAMI (1953).

3. Results and Discussion

Before going on describing features of an anchovy egg patch observed in the present study, it is better to represent spatial distributions of anchovy eggs (Fig. 2) obtained on 10-11 May and on 7-8 June respectively shortly before and after the egg patch was examined in Ise Bay on 25 May. The eggs in the both months apparently indicate localized and/or patchy distributions in the bay: high densities (more than 100 inds./m^3) are found in the central to southern parts of the bay (Fig. 2). The Kiso River has a great influence on the surface waters in the innermost to western parts of the bay: the waters with relatively low water temperature

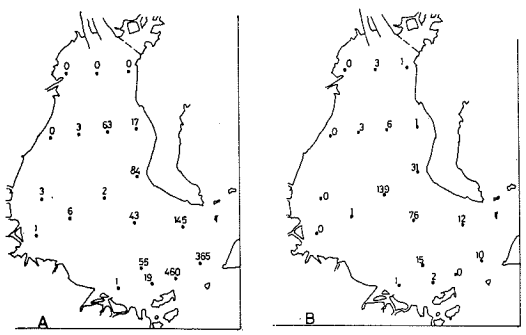

Fig. 2. Spatial distributions of anchovy eggs (inds./haul) in Ise Bay. A: on 10-11 May

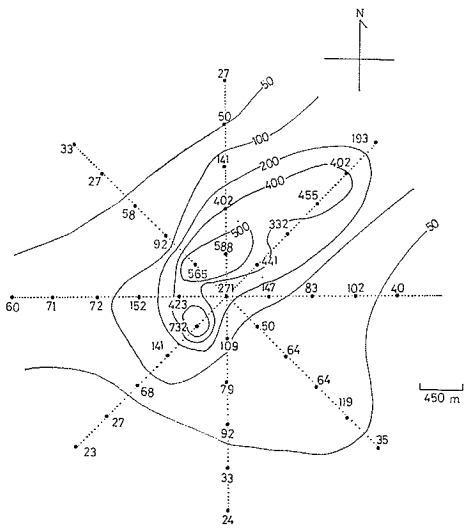

Fig. 3. An anchovy egg patch. (inds./haul, see the text forexplanation)

(15–16°C) and low salinity (less than 30‰). High densities of the eggs have not been found in the less saline waters of the bay. As referred afterward, the eggs have abundantly been collected in May to June everg year. Therefore, we believed that it would not be difficult to observe anchovy egg patches in the bay.

Results of measuring the anchovy egg patch are summarized in Fig. 3. Within the circular area with a radius of 2.25 km densities of the eggs vary from 23 to 732 inds./haul, i.e., from 12.1 to 383.3 inds./m³. Fortunately, we would come by chance on a large and clear-cut patch of the eggs. Provided that a margin of the egg patch is at the density of 400 inds./haul, the egg patch indicates an elliptical form which has a long radius of ca. 2.25 km with a short one of ca. 1.0 km. An elliptical patch of the eggs extends from southwest to northeast, though the highest density (732 inds./haul) is found at the southwestern margin of the egg patch. The densities of the egg patch are higher about ten times as those of the background within the surveyed area. According to MATSUSHITA *et al.* (1982), densities of anchovy egg patches are in general higher one hundred times as those of the background.

The thermocline has not developed yet in the bay on 2–10 June when vertical distributions of the eggs were examined. However, the surface water is much less saline than in the deep water (Fig. 4). Most anchovy eggs appear in the surface water shallower than 5 m depth as illustrated in Fig. 4. Therefore, the densities of the eggs within the surveyed circular area with a radius of 2.25 km (Fig. 3) have to be multified by 3, so that those of the eggs would vary from 69 to 2196 inds./haul, i.e., from 36.3 to 855.9 inds./m³. Such extraordinary high densities of the eggs as obtained in the present study were also detected in a spatially fine-scale series of sampling anchovy eggs in the neritic water by MATSUSHITA *et al.* (1982). So we believe that such extraordinary high densities of the anchovy eggs are not exceptual in Japanese neritic waters, though it depends on methods and design of sampling.

Although we have not done oceanographic surveys in detail around the area where the anchovy egg patch was found, we could not observe a front (slick zone) during this survey, which is distinguishable from the neighbouring waters by sun glitter and aggregation of particulate matters and foams, and with which high densities of anchovy eggs are associated (SAKAMOTO and TANAKA, 1986). Judging from the intermittent records of surface water salinity and water temperature measured with the instruments on board the vessel during the course of sampling the egg patch, we could not detect a sharp and/or drastic fluctuation of physical factors of the environment. Then, it would be safe to

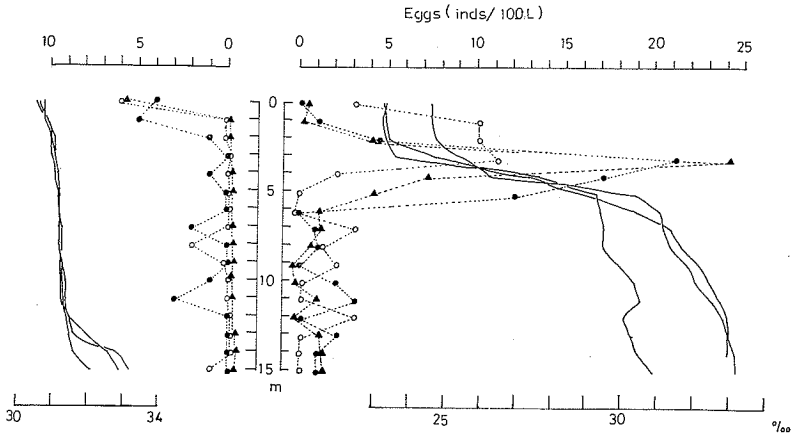

Fig. 4. Vertical distributions of anchovy eggs. solid lines: salinity; dotted lines: anchovy eggs. (see the text for explanations)

say that the eggs, shed free in water by adult anchovy spawners, form a patch which has not been disordered yet on 25 May.

Anchovy eggs pass eight stages from Aa, shortly after the spawners shed their eggs in water during the nighttime, to Cb, shortly before hatching, and take less than three days at 16-18°C (ASAMI. 1953; HATTORI, 1966). Accordingly, anchovy egg patches would generally have a life span of less than three days in the present study, because the present egg patch is caused not by oceanographic conditions but by the spawner's behaviour as referred above. The present egg patch is composed of the Aa stage eggs, though those of the Ac-Cb stages with meagre numbers. Judging from these, it is probable that the present egg patch would have been produced at the night on 24 May, because it was observed from a.m. 11.30 to p.m. 2.30 on 25 May.

The Mie Prefectural Fisheries Experimental Station has investigated spatial distribution and abundance of anchovy eggs in Ise Bay through a year for the last 20 years. The spatial distribution and abundance of the eggs show considerable fluctuation interannually (Table 1), it is probably explained by the distributional abundance of the spawners immigrating from outside and by oceanographic conditions in the bay. The eggs in the bay have generally been collected in a maximal number in May to June through a year. Densities of the eggs, obtained in the bay for the last ten years, are shown in Table 1 where sampling methods and design were same as in the present study: the densities considerably vary at different sampling stations, so that the eggs would have a patchy distribution (Fig. 2). According to Table 1, high densities more than 200 inds./haul (equivalent to 315 inds./m^3 because the eggs largely appear in the surface water shallower than 5 m depth as indicated in Fig. 4) are usual in the bay. This suggests that extraordinary high densities of the eggs, obtained in the present egg patch, would are not rare in the bay.

Apart from the difficulties inherent in sampling gears (variation of filtering rates of the nets, net avoidance caused by planktinic organisms, and etc) (TRANTER and FRAZER, 1979; SMITH and RICHARDSON, 1977), information on the irregular and/or patchy distributions of the organisms would be vital for estimating abundance of them within a certain area. Adult anchovies generally spawn within a defined area and time during their reproductive season, with the result that their eggs and early-stage larvae show much localized distributions in a spatially coarse (1-100 km)—to meso (100-1000 km)—scale (KONISHI, 1983). In such a spatial scale migration and localization of the adult populations have

Table 1. Abundance of anchovy egg in Ise Bay*

Year		May	June
1978	total	13	1
	minimum	0	0
	maximum	42	1
1979	total	149	715
	minimum	0	0
	maximum	37	287
1980	total	86	0
	minimum	0	0
	maximum	18	0
1981	total	1034	1222
	minimum	0	0
	maximum	439	460
1982	total	682	318
	minimum	0	0
	maximum	223	146
1983	total	910	4857
	minimum	0	0
	maximum	270	2391
1984	total	487	1415
	minimum	1	0
	maximum	104	627
1985	total	2299	366
	minimum	3	0
	maximum	1248	128
1986	total	77	1523
	minimum	1	1
	maximum	46	496
1987	total	262	1032
	minimum	1	1
	maximum	34	349

* A Marutoku plankton net was hauled vertically from 20 m to the surface at a total of 19 sampling stations at each month.

superficially been controlled by dynamic physical factors of the environment, while behaviour of the spawners would contribute considerably to form a patch of the eggs and early-stage larvae in a spatial fine scale as indicated in the planktonic organisms by SEKIGUCHI (1984).

Acknowledgements

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カタクチイワシ卵のパッチの一例

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要旨：伊勢湾の中央部水域において，カタクチイワシ卵のパッチが見いだされた。このパッチは最高で 856 inds./m^3 の密度をもち，北東から南西方向に約 2.25 km の長軸，そして約 1.0 km の短軸をもつ，ほぼ楕円形であった。また，カタクチイワシ卵は，塩分躍層が位置する 5 m 以浅の表層に集中的に出現した。

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