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SHORT NOTE

Factors Affecting Egg Characteristics in the Fish *Sillago sihama*

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ABSTRACT: *Sillago sihama* (Fôrskal) egg diameter varies with stage of development, age of spawner, water temperature, salinity, and timing of spawning season. Among these factors, spawner age, water temperature and salinity seem to be the most important. Three-month-old fish produced smaller eggs than 1-year-old fish. The size of released eggs tended to decrease with increasing water temperature. Above 28.7 °C, more than 50 % of the eggs contained multiple oil globules. Salinity decrease causes the production of larger and more buoyant eggs.

In Japan, *Sillago sihama* exhibits fractional spawning over the spawning season (late May to late September). Under normal conditions, its fertilized eggs are pelagic, spherical and transparent – usually with an oil globule, wholly segmented yolk, and a smooth membrane. The perivitelline space is narrow and not apparent. At late stages of development, pigments are present on yolk sac and oil globule. The egg diameter varies from 0.60 to 0.78 mm (Ookupo, 1932; Ueno and Fujita, 1954; Kiyono, 1974; Kumai and Nakamura, 1977). It has been reported that the age of the female spawner (Madai Culture Project Team, 1974), the timing of spawning season (Blaxter, 1969; Russell, 1976) and various environmental factors (Solemdal, 1967; Holliday, 1969; Alderdice et al., 1979) would affect the egg diameter in a variety of marine fishes. I have examined variations in the size of fertilized *S. sihama* eggs under different abiotic and biotic environmental conditions, as well as the diameter of the oil globule.

Laboratory-reared larvae from the previous season were held in two concrete ponds (2.5 m long × 2 m wide × 1 m high) and used as spawners for the present study. During the experimental period, 30 spawners (1♀:2♂♂) were held in each pond. Random egg samples (30 to 35 eggs, blastomere stage) were collected from different conditions and measured immediately (without preservation) by means of a binocular microscope with a 5-μm graduated eyepiece. Differences in mean egg diameter were established by *t*-test (Sokal and Rohlf, 1969). Water temperature was lowered by passing the inlet water through the cooler. Salinity was adjusted by mixing seawater and tapwater.

By raising the water temperature, natural spawning was induced 1 month prior to the normal spawning season. Fish raised from this spawning were able to spawn naturally at an age of 3 months. They were kept under the same environmental conditions as 1-year-old spawners; however, they produced smaller eggs. In 3 out of the 4 pairs of data, younger spawners showed significantly smaller egg diameters ($P < 0.01$, *t*-test; Table 1).

Table 1 *Sillago sihama*. Egg diameters (μm; mean ± SD) from spawners of different ages at peak of spawning season. The numbers in parentheses: sample size

Age of spawner	Aug. 17 28.0 °C 31.4 ‰ S	Aug. 26 26.9 °C 32.0 ‰ S	Sept. 6 28.2 °C 31.7 ‰ S	Sept. 15 25.5 °C 31.5 ‰ S
1 year	654 ± 11•• (33)	661 ± 11•• (30)	672 ± 13 (33)	688 ± 15•• (31)
3 months	627 ± 14 (30)	640 ± 18 (30)	666 ± 13 (30)	677 ± 13 (30)

•• Significant at 0.01 level

When water temperature alone was changed, spawners raised at 27.5 °C produced significantly smaller eggs than those raised at 25 °C ($P < 0.01$). Mean egg diameters were 667 ± 13 μm and 701 ± 11 μm, respectively. Where the water temperature exceeded 28.7 °C, 50 % or more of the fertilized eggs possessed multiple oil globules (Table 2). The highest water temperature at which eggs with a single oil globule were produced was 28.2 °C. Only 46 % of the larvae hatched from eggs with multiple oil globules retained multiple oil

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Table 2. *Sillago sihama*. Water temperatures and salinities at which fertilized, multiple oil-globule-containing eggs were found. Spontaneous spawning

Temperature (°C)	30.1	29.3	28.8	28.7	28.2	28.0	28.0	27.5	26.9
Salinity (‰)	30.8	30.9	32.4	32.9	31.7	32.1	31.6	32.3	31.9
Eggs with multiple oil globules (%)	58.7	52.0	50.0	50.0	0	39.0	35.0	29.0	10.0

globules; the majority of the larvae subsequently coalesced the globules into a single globule.

Spawners acclimated for 2 weeks to a lower salinity of 16.9 ‰ S produced significantly ($P < 0.01$, t-test) larger eggs (mean diameter 752 ± 20 μm) than spawners in ordinary seawater of 31.5 ‰ S, which produced eggs with a mean diameter of 715 ± 16 μm. If salinity in the spawning pond was lowered gradually from 32.9 to 15.0 ‰ S over a period of 3 d, the eggs produced were significantly larger than those produced at 30.8 ‰ S. Under these two conditions mean egg diameters were 700 ± 14 μm and 632 ± 12 μm, respectively. Hence, larger eggs are produced by spawners acclimated to lower salinities. Prior to the formation of 2 blastomeres, fertilized eggs were transferred from the original seawater (32.3 ‰ S) directly to 25.3, 19.8, or 12.9 ‰ S. Egg diameters were then measured at the blastula stage. The mean egg diameter was 664 ± 11 μm at 32.3 ‰ S, and 665 ± 12, 667 ± 11, or 672 ± 11 μm in the three lower test salinities. Significant

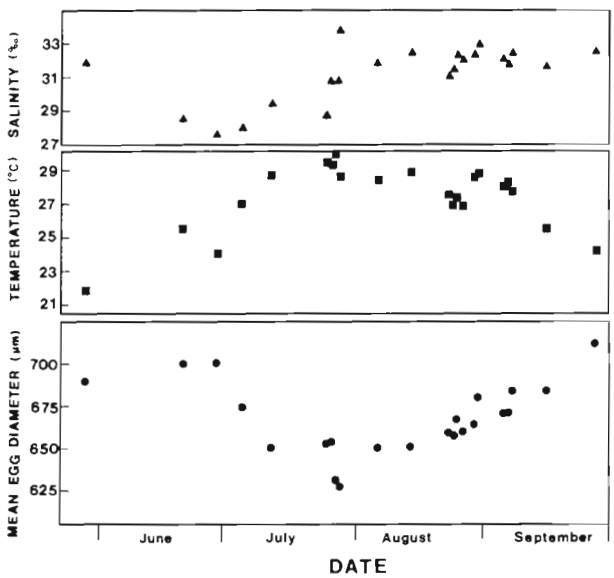

Fig. 1 Fluctuation of mean egg diameter, water temperature and salinity during spawning season (May 29 to September 27). Salinity changed from 27.6 to 33.8 ‰. There was an inverse relation between mean egg diameter and water temperature (21.9°–30.1 °C)

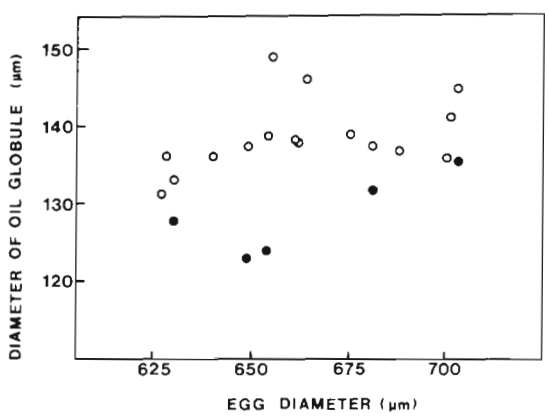

Fig. 2. *Sillago sihama*. Relation between diameters of oil globule and egg. Solid circles: diameter of largest oil globule in cases of multiple globules

changes in mean egg diameter are indicated only for eggs transferred from 32.3 to 12.9 ‰ S ($P < 0.01$, t-test).

The egg diameter varied during the spawning season (Fig. 1). There appears to be an inverse relation between egg diameter and water temperature. Southward and Demir (1974) and Hislop (1975) also found that decreasing egg size during the spawning cycle was inversely correlated with temperature. As the salinity varied between 27.6 and 33.8 ‰ S, no relation between salinity and egg diameter was apparent. There was no direct relation between egg size and oil-globule size, the latter varying from 125 to 150 μm (Fig. 2). The relationship between egg size and survival rate of hatched larvae will be determined in further studies.

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