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THE BUOYANCY OF SPRAT (*Sprattus sprattus*) EGGS AND LARVAE IN THE SKAGERRAK AREA

by

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ABSTRACT

Buoyancy of sprat eggs and larvae was determined with a linear density gradient. There were four experimental groups of eggs, three caught at sea and one from spawning in the laboratory. The neutral buoyancy (σ_t) of the sprat eggs ranged from 23.5-26.2 with the salinity range from 30.2-33.2 o/oo. No difference in vertical distribution of eggs in different developmental stages was shown.

The sprat larvae are expected to be at the same salinity range as the eggs.

INTRODUCTION

The sprat eggs and larvae are pelagic. Beyond this, little is known about their ecology.

The egg distribution is influenced by several factors, as the effects of physical conditions (Pommeranz, 1971; Iversen, 1973) and size and specific gravity of the eggs (Alderdice and Forrester, 1971; Coombs, 1981; Coombs et al., 1981; Haug et al., 1984).

In Norwegian waters sprat spawn from February to July, with peak spawning between April and June (Ellingsen, 1979; Torstensen, 1984). The spawning starts when the temperature is about 6°C and maximum spawning activity in the temperature range 9-12°C (Sund, 1911). The eggs in the fjords and coastal areas are more or less distributed in the upper 50 m of the water column. In the summer season, the greatest concentration seems to be within the upper 20 m. At this time the surface layer is characterized by low salinity and is separated from the water below by a pycnocline. Own unpublished data indicate that the sprat eggs are distributed beneath this pycnocline. Høglund (1923) reported great range in the values of specific weights.

Egg surveys have become one of the standard methods for estimating spawning stock sizes and it is therefore of great importance to know the vertical distribution for quantitative sampling. To obtain more information on the buoyancy of sprat eggs and larvae, laboratory studies were made during the spring 1985.

MATERIALS AND METHODS

Eggs were sampled in the Frierfjord, a known spawning area for sprat on the south-eastern Norwegian coast (Fig. 1). The samples were collected on April 17 (group 1) and on May 7 (group 2 and 3). The samples were taken by a 20 m Ø Bongo, with 500 µm mesh

size in the nets, in oblique hauls from 50 to 0 m. The eggs were kept in jars with fresh seawater (6.5°C and 31.5 o/oo) and transferred to the laboratory at Flødevigen Biological Station within 5 hours after sampling.

One batch of sprat eggs (group 4) was spawned in the laboratory on July 2. These spawning sprats had been kept in the laboratory for 1 1/2 year after being caught in the Flødevigen area (Fig. 1).

Neutral buoyancy (σ_t)of the eggs and larvae was determined with a linear density-gradient (Coombs, 1981), which was calibrated by use of glassfloats with known specific gravity. The eggs were introduced at the surface of the gradient and a cm scale on the side of the gradient made it possible to read the exact value of both the calibration floats and the individual eggs and larvae. When the temperature in the gradient and the cm values of the calibration glassfloats are known, the neutral buoyancy (σ_t) of the eggs and larvae could be determined. The eggs and larvae were kept in the density-gradient for the whole experimental period. The starving larvae were not anaesthetisized.

At the start of the experiment the eggs in group 2 and 3 were in different egg stages. The eggs in group 1 were mainly newly spawned, while the eggs in group 4 were all newly spawned.

Mortality during the incubation period of eggs was estimated by taking the relation between the maximum number of observed larvae to the total number of eggs as an index of mortality.

RESULTS AND DISCUSSION

The temperature in the four experimental groups is shown in Fig. 2, where the x-axis defines the number of days from sampling in the sea or fertilized in the laboratory. The temperature varied from 5.9 to 6.8°C in group 1, from 6.6 to 7.9°C in group 2

and 3 and from 8.0 to 10.0°C in group 4. These ranges are within observed temperature values in the Frierfjord area (Ellingsen, 1979).

The diameter of the eggs in group 1-3 was from 0.88 to 1.04 with a mean diameter of 0.98 ± 0.03 mm and with no significant difference in the three egg batches. In group 4 the egg diameter was in the range 0.72-1.07 mm, with a mean diameter of 0.96 ± 0.07 mm.

The number of eggs and larvae used in the four experimental groups is shown in Fig. 3, 4, 5 and 6. In group 1-3 a high mortality was observed on the eggs, probably due to sampling and transportation. It has, however, earlier been reported rather high mortality (approximately 50%) on artificially fertilized sprat eggs under experimental conditions (Thompson et al., 1981). The variation in the observed number of larvae, as in group 3, is probably caused by difficulties in seeing the larvae in the density-gradient. As the larvae were not anaesthetisized, they could freely move in the gradient.

Buoyancy of sprat eggs

The neutral buoyancy (σ_t) of the sprat eggs in group 1, 2, 3 and 4 is indicated in Fig. 7, 8, 9 and 10. The mean values were 24.9 to 26.4 (group 1), 24.1 to 24.7 (group 2) and 23.6 to 25.4 (group 3). In the density-gradient it was not possible to distinguish dead eggs from live eggs. With the possibility of dead eggs being "hanging" in the gradient, the observed density values might be too high. However, the buoyancy values of the eggs in group 4, which had a low mortality, are of the same order as for the other groups.

No attempts were made to measure the sinking speed of dead eggs.

According to Moksness and Selvik (1984) there is a maximum buoyancy at the gastrulation in haddock eggs. The sprat eggs in group 2 and 3 were of all developmental stages, making it

impossible to correlate the buoyancy to developmental stages. Group 1 and 4, however, consisted of newly spawned eggs. In these two groups there are no indications of fluctuation in the incubation period.

In Table 1 is given the neutral buoyancy of the sprat eggs in the four groups with corresponding salinity values. The table gives the mean values with standard deviation at the two first observations of each group. That is the observations where the number of eggs in each group was high. The mean calculated salinity in the groups was within 31.5 and 31.9 o/oo with a standard deviation of maximum 1.3 o/oo.

Buoyancy of sprat larvae

In Fig. 7, 8, 9 and 10 are also given the observed mean buoyancy (σ_t) values with SD of sprat larvae. The values are higher than observed for the eggs and were from 23.7 to 29.8. Due to the larval movement, these values are not the neutral buoyancy values. However, the observed buoyancy values give information on which densities the larvae are expected to be distributed.

The curves indicate increasing values during the experimental period, a phenomenon common for starving larvae.

CONCLUSION

Suggesting that the vertical distribution of sprat eggs is determined by their buoyancy and that this is closely correlated to the seawater salinity, the results indicate that the eggs are distributed in waters with a salinity range of 30-33 o/oo. Any difference in vertical distribution of eggs in different developmental stages has not been shown. The sprat larvae are expected to be at the same salinity range as the eggs, with, however, a higher maximum salinity value.

So far, this study seems to support the assumption that sprat eggs and larvae in May-June are distributed beneath the pycnocline.

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Table 1. The observed neutral buoyancy (σ_t) of sprat eggs and corresponding salinity (S o/oo).

Group	Day	Buoyancy			Salinity S o/oo			Temp. °C	N
		SD min	x	SD max	SD min	x	SD max		
1	0	24.1	24.9	25.7	30.6	31.6	32.6	6.2	18
	1	24.0	25.1	26.2	30.5	31.9	33.2	6.2	17
2	1	23.9	24.7	25.5	30.5	31.6	32.6	7.3	23
	2	23.8	24.7	25.6	30.3	31.5	32.6	6.7	20
3	1	23.7	24.8	25.9	30.3	31.7	33.1	7.4	83
	2	23.7	24.8	25.9	30.2	31.7	33.0	6.9	58
4	0	23.5	24.7	25.9	30.2	31.7	33.2	8.1	99
	1	24.3	24.7	25.1	31.2	31.7	32.2	8.1	87
	2	24.3	24.7	25.1	31.2	31.7	32.2	8.1	89

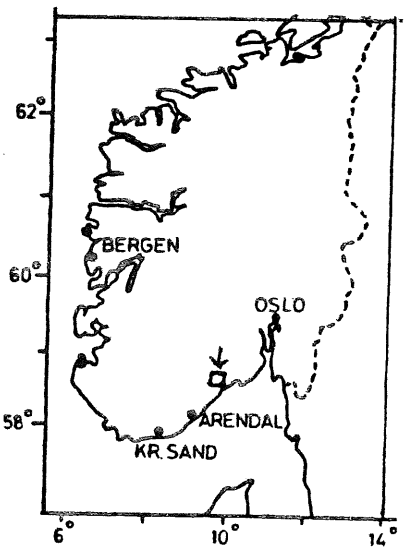

Fig. 1. The location of Arendal and the Frierfjord (▫).

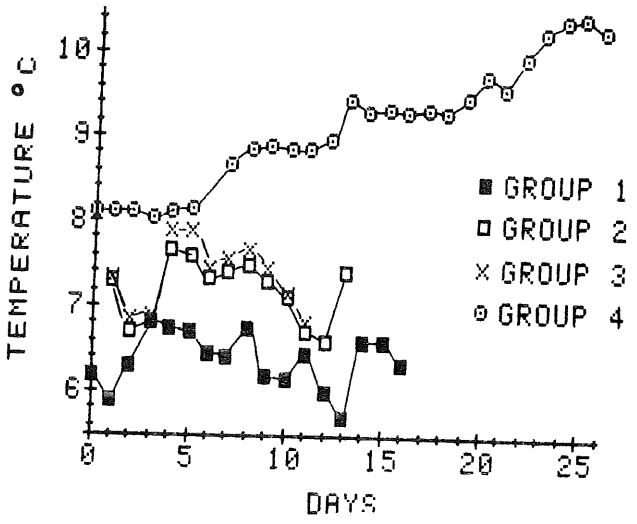

Fig. 2. The temperature in the gradient during the four experimental periods.

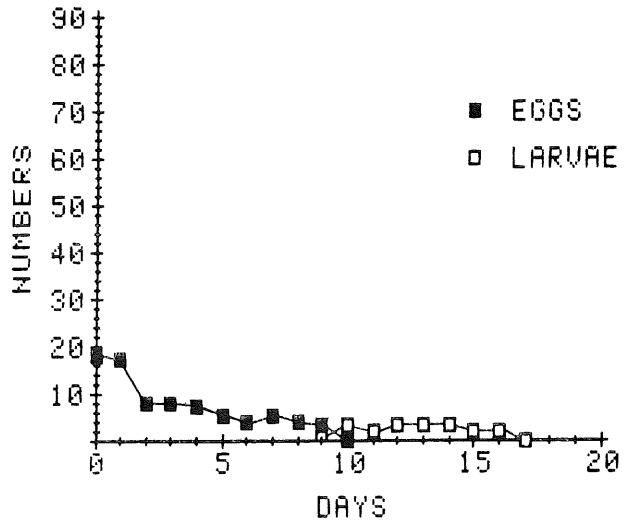

Fig. 3. The numbers of sprat eggs and larvae in group 1.

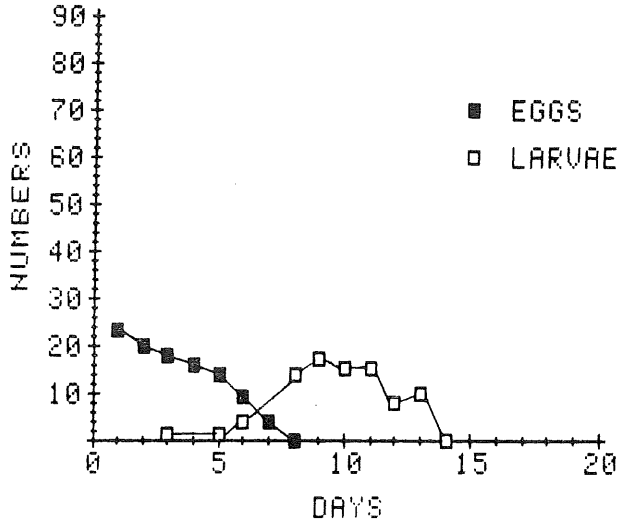

Fig. 4. The numbers of sprat eggs and larvae in group 2.

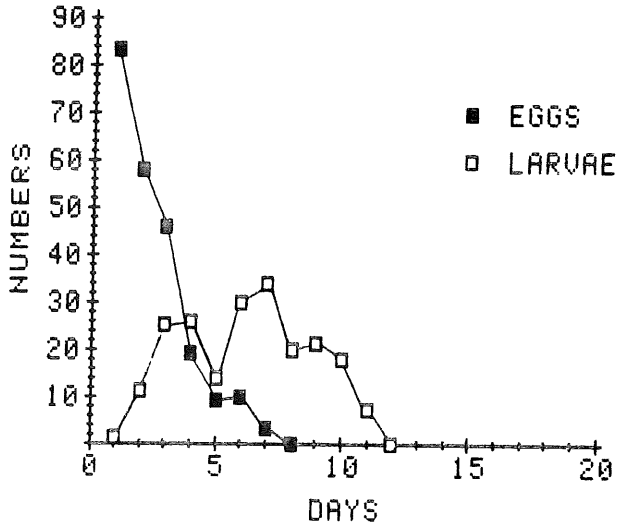

Fig. 5. The numbers of sprat eggs and larvae in group 3.

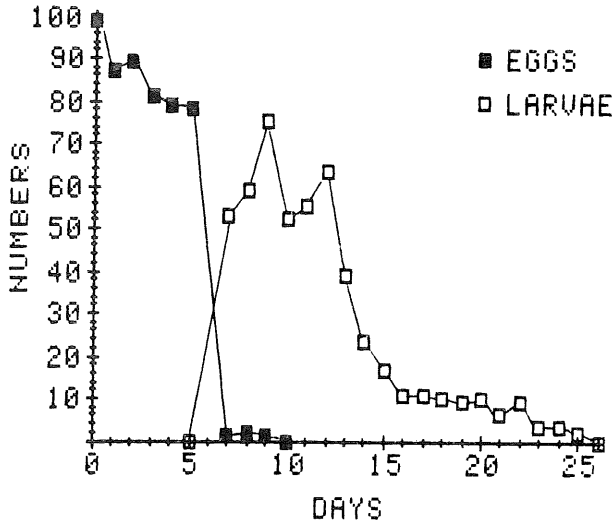

Fig. 6. The numbers of sprat eggs and larvae in group 4.

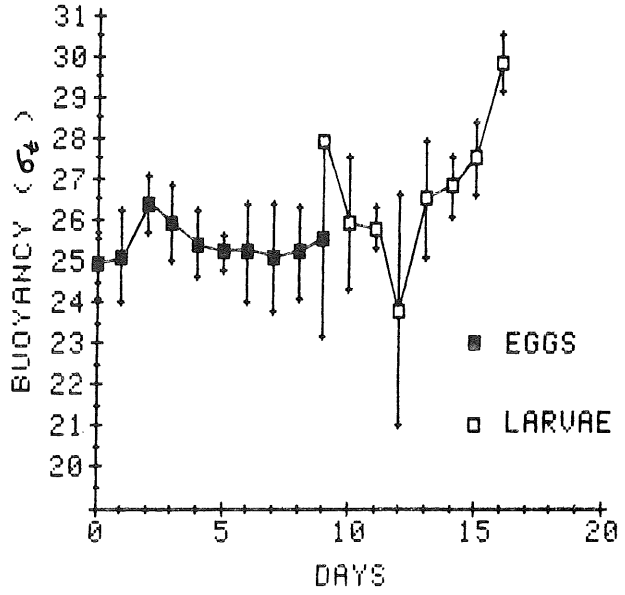

Fig. 7. The buoyancy (σ_t) of sprat eggs and larvae in group 1.

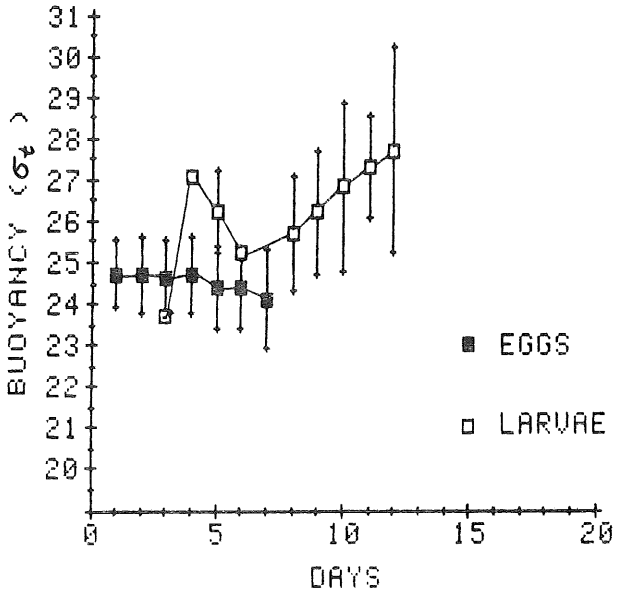

Fig. 8. The buoyancy (σ_t) of sprat eggs and larvae in group 2.

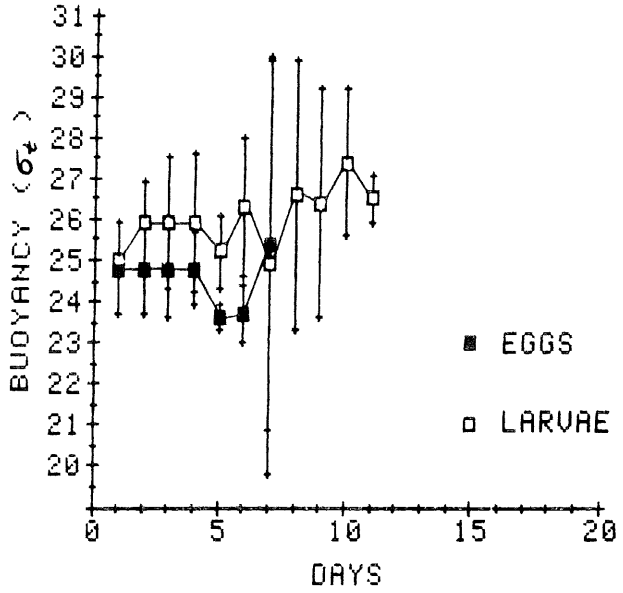

Fig. 9. The buoyancy (σ_t) of sprat eggs and larvae in group 3.

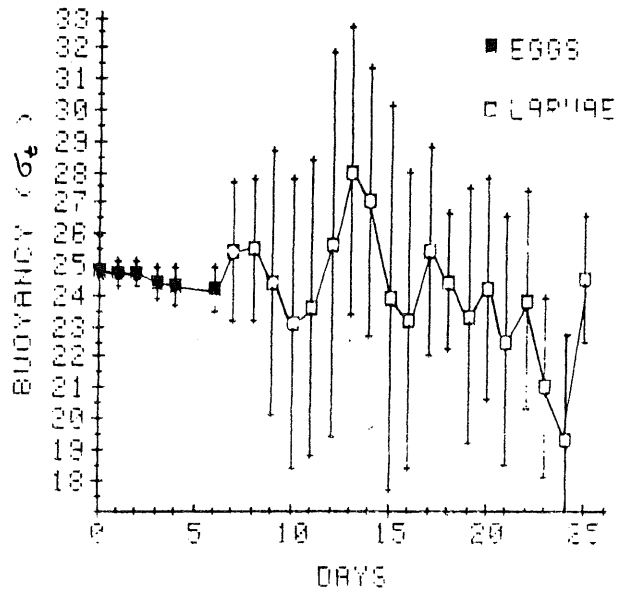

Fig. 10. The buoyancy (σ_t) of sprat eggs and larvae in group 4.