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THE ABUNDANCE OF SPRAT EGGS AND LARVAE IN THE LANGESUND AND  
THE OSLOFJORD AREAS, SOUTH EASTERN NORWAY, 1974-1978

by

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Abstract

Sprat eggs and larvae were sampled through monthly cruises in two fjordsystems of South Eastern Norway from 1974 to 1978. The abundance and distribution of the eggs and larvae were studied. Eggs were found throughout the sampling period from February to June in the Langesund area and from April to June in the Oslofjord area, with peak abundance in April-June. The main spawning occurred in the innermost parts of the two fjords.

## Introduction

In the period 1974-1978 nearly monthly cruises were undertaken for baseline studies in the Langesund and Oslofjord areas. These studies were part of a project studying the effects of heated effluent from a planned thermal power plant. Sampling programs were designed to monitor phytoplankton, zooplankton, ichthyoplankton and fish through a period of five years. One of the main objectives has been to locate spawning areas of fish important to the fisheries.

In the Oslofjord and along the Norwegian Skagerrak coast sprat is by far the most important commercial fish. Several studies have shown that sprat is spawning in the Skagerrak-Kattegat area and in the Oslofjord (Sund 1911, Høglund 1938, Dannevig 1956, Lindquist 1961 and 1970). According to Dannevig (1954) the local spawning of sprat in the Oslofjord seems to be important for the sprat stock in the fjord. However, it is proposed that the sprat on the Norwegian coast is mainly recruited from the Skagerrak-Kattegat spawning area.

The purpose of the present report is to present the results through a five years period of the abundance and distribution of sprat eggs and larvae in two fjords on the Norwegian Skagerrak coast.

## Material and methods

The two areas with the sampling stations are shown in Fig. 1 and 2. The cruises were operated on the following dates:

1974	1975	1976	1977	1978
24 Jan-1 Feb	11-20 Feb	5-12 Feb	9-16 Feb	6-17 Feb
22 Feb-14 Mar	5-12 Mar	1-10 May	8-16 May	6-16 May
25 Mar-4 Apr	9-17 Apr	29 Mar-6 Apr	12-19 Apr	10-19 Apr
23 Apr-7 May	5-12 May	4-11 May	2-9 May	18-26 May
4-18 Jun	4-12 Jun	8-16 Jun	15-22 Jun	12-21 Jun
12-15 Aug	24-28 Jun	10-17 Aug	9-15 Aug	21-30 Aug
23-26 Oct	12-17 Aug	4-12 Nov	8-17 Nov	30 Oct-23 Nov

On each cruise zooplankton and ichthyoplankton were sampled with a 20 cm diameter modified Bongo sampler (Posgay et al. 1968) fitted with a 0.180 mm and a 0.500 mm net. The ichthyoplankton was sampled with the 0.500 mm net. The hauls were made as oblique tows in the depth intervals 50-35, 35-20, 20-10 and 10-0 m; 2 minutes at each 5 meter depth. The sampling program in 1974 was reduced compared to the subsequent four years period. There were fewer stations and the sampling depths were 50-25 and 25-0 m. The samples were preserved in 2-4% formaldehyd.

The eggs were distinguished in three stages of development according to Dannevig 1919.

The larvae were measured to the nearest mm below.

### Results

The Langesund area

The number of eggs per  $m^2$  surface during the sampling period are shown in Fig. 3. In general, sprat eggs were present from February to June. However, in the Frierfjord there were only sampling in March 1974 and the sampling was partly prevented by ice conditions in the beginning of 1976 and 1977. In both these years, eggs were detected through the sampling period, from March to April, respectively, until June.

Eggs were found at all stations and the results indicates an earlier occurrence of eggs in the inner area. Greatest egg number were recorded in the Frierfjord, which is the innermost part of the fjordsystem. In this fjord, there was 200-600 eggs per  $m^2$  with two peaks in the abundance, one in April and one in June. Maximum abundance were found in June 1975 and May 1976 with about 1700 eggs per  $m^2$ .

Table 1 shows the distribution of the sprat eggs in per cent of each of the three development stages in the Frierfjord.

All three stages were present from February to June all years with stage I as the dominant one. The number of stage III was comparatively low, especially early in the spawning season.

In the middle area (the Breviksfjord-the Mørjefjord), the results show small differences in egg occurrences and abundance between the stations each year. From March to May less than 50 eggs per m<sup>2</sup> were detected. The figures indicates an increasing number toward a maximum in June. Except for 1975, where a more intensive local spawning seemed to have occurred in the Langangsfjord, the egg abundance in this area were rather small.

In the outer region (the Langesundsbukta) there were fewer and less regular occurrence of sprat eggs compared to the other sampling areas. In general, 1-15 eggs per m<sup>2</sup> were found.

The eggs were sampled at all depths. In the inner fjord generally 55-90% of the eggs were sampled in the intermedial depth and less than 6% in the upper 10 m (Fig. 4). Outside the Frierfjord, eggs were found more or less distributed in the 50-0 m water column, with a trend to a higher concentration in the upper 20 m.

Table 2 shows the distribution of sprat larvae in the Langesund area. Single sprat larvae occurred occasionally in February-May and the catches indicate an earlier occurrence in the Frierfjord than outside this fjord. In June, however, the larvae were distributed in the whole area.

The length distribution in per cent of the larvae is given in Tabel 3. The length of the larvae sampled in June were from 4 to 26 mm, which indicate an extended spawning season. According to the Table 3, the larvae caught in June 1978 were marked smaller than in the preceding years. Few larvae greater than 20 mm were found, probably a result of net avoidance.

## The Oslofjord area

The egg abundance are shown in Fig. 5. Sprat eggs were sampled from April to June, with sporadic occurrence in February and March. These earlier occurrence were mainly detected in the Bonnefjord. The results indicate the greatest number of sprat eggs in the fjord area, as such, in 1975 and the lowest number in 1977.

The greatest egg concentrations throughout the sampling period were recorded in the inner fjord, in the Bonnefjord. Greatest abundance were found in 1976. This year the spawning commenced in March and the number of eggs increased from about 100 eggs per  $m^2$  in March to about 1400 eggs per  $m^2$  in June. In 1974-1975 and 1978 maximum abundance were detected in April-May, with 250 to 1100 eggs per  $m^2$  as peak values. Less than 90 eggs per  $m^2$  were found in 1977, with maximum numbers in June.

The Sandebukta was an other area with high egg concentrations throughout the surveys. In general, more than 100 eggs were recorded per  $m^2$  surface. Peak abundance occurred in May 1975 and May 1978 with about 600 and 750 eggs per  $m^2$ , respectively.

On stations in the middle of the fjord higher concentrations of sprat eggs were found. These greater occurrences, however, seemed to be more irregular. At the other localities, there were generally less than 50 eggs per  $m^2$ . In April-May the egg number were fewer than 10 eggs per  $m^2$ . The eggs were distributed in the whole water column with a tendency to a higher concentration in the upper 20 m at the end of the spawning season (Fig. 6).

The three developing stages were represented in the samples of sprat eggs. Table 4 gives the per cent distribution of the developing stages at selected stations, representing the inner, middle and outer fjord area, in April and June 1976 and 1978. The results indicates an increasing amount of the stages II and III outwards from the inner area. These two

stages made a greater part of the total numbers of eggs in 1976 than in 1978.

Sprat larvae were found in May and June with major occurrence and distribution in June (Table 5). Greatest abundance were recorded in 1974-1976. In these years the larvae were distributed in the whole area. The larval occurrence were more irregular in 1977-1978 and detected in a number of 1-6 larvae per m<sup>2</sup>. No larvae were sampled in the inner area in 1977 and 1978. In the previous years larvae were detected in the inner area, in 1974-1975 mainly at the outer station and in 1976 in a great number (68 larvae per m<sup>2</sup>) in the Bonnefjord. In August 1975 and 1977 single larvae were found.

During the whole period of time the larvae had lengths from 3 to 28 mm, but larvae shorter than 15 mm dominated the samples (Table 6). The greatest larvae (>20 mm) were caught in the middle area, making 2-4.5% of the larval stock. In April the length distribution was 4-9 mm, in June 3-28 mm and in August 9-27 mm.

### Discussion

During the period 1974-1978 there were a yearly spawning with long spawning season. There have been differences between the years both in the patterns of egg distribution and in the total quantities present. Although both the patterns of egg distribution and total abundance varied from year to year, it is obvious that the main spawning localities are situated in the innermost areas of the two fjordsystems. This was also confirmed by echo survey combined with trawling (Dahl, Ellingsen and Tveite 1974 a,b, 1976 a,b, 1977 a,b, 1978 and 1979 a,b). Spawning were undertaken within a fairly wide range of temperature and salinity. From October-November to June there were relatively dense pelagic echotraces restricted to the inner areas, at 30-50 m depths and temperatures between 5.5 and 7.5°C. In June the dense distribution had dispersed. Few or no traces were found in the innermost part of the fjords,

only small scattered shoals further to the mouth of the fjord were recorded. In the inner fjord the sprat may occur closer to the surface due to a higher temperature (12-16°C) and thus avoiding the echotracing.

It is indicated a longer spawning season in the Frierfjord (Langesund area) compared to the Bonnefjord (Oslofjord), from January and March, respectively, until the end of June/July. For both areas the peak spawning occurred in the period of April-June. The long period with stage I are explained by the fact that sprat is a serial spawner (Heidrich 1925)

Outside the Frierfjord and the Bonnefjord the abundance seemed to be more irregular and occasional. A decreasing egg number outwards from the innermost fjord in the Langesund area was also indicated by Dannevig (1930). The greater egg concentrations in the innermost areas can be favoured by the more protected localities.

The egg abundance (600-1700 eggs per m<sup>2</sup>) was rather high. Høglund (1938) recorded maximums of 500-1000 eggs per m<sup>2</sup> surface in the Skagerrak spawning area and along the Swedish West coast. As the sampling methods were different the values of egg concentrations are, however, not directly comparable.

There appear to be no direct relation between the spawning start and its progress and the hydrographical conditions, but seems more to be explained by the age of the sprat. Stock analyses, based on trawlcatches, indicates differences in the age distribution for these two surveyed areas. Throughout the spring three year groups were making the sprat in the Frierfjord, group 0, I and II. About 40-50% of the sprat were in each of the 0 and I groups and 10-20% in the II group. In the Bonnefjord there seemed to be more variations in the sprat but consisted mainly of group 0 and I. The II-group occurred sporadic in the catches and in less than 10%.

The 1976 year class was quite strong in the Bonnefjord. The

same year there was a high abundance of eggs and larvae in the inner Oslofjord. From November 1976 to November 1978 this year class made from 80-100% of the sprat stock. The spawning stock in 1976 in this area consisted of 90-95% of age 1974 (I-group) sprat with a mean length of 9.1 to 9.4 cm. In 1977, which shows very low spawning activity, the sprat consisted mainly of 0-group and had a mean length of 7.1-7.9 cm.

Sampling once a month gives restricted informations when spawning is going on in variable spawning intensity for a long period, up to 5-6 months. To get more sufficient data, it is needed detailed studies particularly in the period of April-July. This is the period which seems to have the highest abundance of eggs and larvae. The same period seems to be most favourable for larval development. The great spawning intensity delt with in this report indicate that a local spawning on the Norwegian Skagerrak coast is of importance for recruitment to the fishable stock.



REFERENCES

- Dahl, E., Ellingsen, E. and Tveite, S. 1974. Fiskeribiologiske undersøkelser i forbindelse med kjølevannsutslipp. Feltundersøkelser i Oslofjordområdet, januar-juni 1974. Fisken og Havet Ser. B, 1974 (19): 1-59
- Dahl et al. 1976a. Fiskeribiologiske undersøkelser i Langesundsområdet, august 1974-oktober 1975. Fisken og Havet Ser. B, 1976 (6): 1-51
- Dahl et al. 1976 b. Fiskeribiologiske undersøkelser i Oslofjorden, august 1974 -oktober 1975. Fisken og Havet Ser. B, 1976 (14): 1-56
- Dahl et al. 1977 a. Fiskeribiologiske undersøkelser i Langesundsområdet, februar-november 1976. Fisken og Havet Ser. B, 1977 (8): 1-37.
- Dahl et al. 1977 b. Fiskeribiologiske undersøkelser i Oslofjorden, februar-november 1976. Fisken og Havet Ser. B, 1977 (9): 1-37.
- Dahl et al. 1978 .. Fiskeribiologiske undersøkelser i Langesundsområdet, februar-november 1977. Fisken og Havet Ser. B, 1978 (6): 1-23.
- Dahl et al. 1979 a. Fiskeribiologiske undersøkelser i Oslofjorden februar-november 1977. Fisken og Havet Ser. B, 1979 (4) : 1-27
- Dahl et al. 1979b. Fiskeribiologiske undersøkelser i Langesundsområdet, februar-november 1978. Fisken og Havet Ser. B, 1979 (6) :
- Dahl et al. 1979 c. Fiskeribiologiske undersøkelser i Oslofjorden, februar-november 1978. Fisken og Havet Ser. B, (in press).
- Dannevig, A., 1919. Fiskeegg og yngel i Lofoten..  
Rep. Norw. Fish. Mar. Invest. 3(3): 1-63
- Dannevig, A. 1930. The propagation of our common fishes during the cold winter 1924. Rep. Norw. Fish. Mar. Invest. 3(10): 1-60
- Dannevig, G. 1954. Brislingens gyting. I. Undersøkelser i Skagerrak- og Ryfylke. Fiskets Gang, 40: 207-208, 214.

Dannevig,G.1956.The occurence of spræt larvae in Norwegian waters.Annls biol.,Copenh.,11:60

..

Høglund,H.1938.Über die horizontale und vertikale Verteilung der Eier und Larven des Sprotts (Clupea sprattus L.) in Skagerak -Kattegatgebiet.Svenska hydrogr.-biol.Komm.Skr.N.S. Biologi 2(3):1-40

Lindquist,A.1961.Swedish investigations of sprats in the boundary areas between Skagerak and Kattegat.Coun.meet.int.Coun.Explor. Sea,1961 (20):1-3

Lindquist,A.1970.Zur Verbreitung der Fischereier und Fischlarven im Skagerak in der Monaten Mai und Juni.Inst.Mar.Res.,Lysekil Ser.Biol.,19:1-81.

Posgay,J.A.,Marak,R.R.and Hennemuth,R.C.1968.Development and tests of new zooplankton samplers.Int.Commn NW Atlant.Fish. Res.Doc.,1968/85:1-5

Sund,O.1911.Undersøkelser over brislingen i norske farvand. Aarsberetn.Norg.Fisk.1910.357-474.(eng.summary).

Table 1. The distribution in % of the three developing stages of sprat eggs in the Frierfjord, 1975-1978

	Stage	Feb	Mar	Apr	May	Jun
1975	I	81.7	83.1	75.8	83.4	68.0 <sup>x)</sup>
	II	16.5	15.3	19.1	11.4	19.1
	III	1.8	1.6	5.1	5.2	12.9
1976	I		77.0	65.3	69.7	56.2
	II		12.6	16.9	23.4	27.7
	III		10.4	17.8	6.9	16.1
1977	I			75.0	89.2	44.5
	II			15.7	7.5	27.2
	III			9.3	3.3	28.3
1978	I	62.1	75.3	28.3	68.8	68.2
	II	23.1	9.3	51.1	14.7	19.6
	III	14.8	15.4	20.7	16.5	12.0

x): Mean values of two sampling periods

Table 2. The number of sprat larvae per m<sup>2</sup> in the Langesund area, 1974-1978

Area	1974		1975			1976			1977		1978			
	Jun	Mar	May	Jun	Mar	May	Jun	May	Jun	Feb	Mar	Apr	May	Jun
Inner	X	1	0	4.5 <sup>x)</sup>	34	8	6	0	3	2	5	4	4	3
Middle	8.3	0	0.7	24	0	+	7	+	5.3	0	0	+	+	1.7
Outer	2	0	0	10.5	0	0	10	0	0	0	0	0	0	5

X : No sampling

x): Mean of two sampling periods

+ : <1 larvae per m<sup>2</sup>

Table 3. Length distribution in % of sprat larvae in the Langesund area in June 1974-1978

Year	Length groups (mm)				N	$\bar{I}$
	<10	10-14	15-20	>20		
1974	14.1	67.2	18.8		64	12.0
1975 <sup>x)</sup>	30.2	52.8	14.8		297	11.4
1976	43.2	44.4	7.4	3.7	81	10.7
1977	18.2	51.5	30.3		33	12.5
1978	95.5	4.5			22	6.2

x): Mean of two sampling periods

Table 4. The distribution in % of the three developing stages of sprat eggs at some stations in the Oslofjord area

Month	Stage	Station						
		1	2	7	9	10	15	18
April 1976	I	54.6	x)	24.1	x)	x)	x)	x)
	II	25.6	33.3	51.7	25.0	14.3	0	7.1
	III	19.8	40.0	24.1	50.0	64.3	50.0	50.0
April 1978	I	86.5	26.7	24.1	25.0	21.4	50.0	42.9
	II	9.8	8.7	13.1	33.3	30.8	0	33.3
	III	3.7	13.0	6.5	16.7			16.7
June 1976	I	57.3	38.8	53.7	16.7	17.1	x)	3.8
	II	18.7	36.9	23.9	22.9	30.1	33.1	34.5
	III	24.0	24.4	17.1	60.4	52.1	66.7	51.7
June 1978	I	81.6	62.5	100.0	48.0	95.9	x)	x)
	II	2.6	25.0		38.1	4.1	66.7	80.0
	III	15.8	12.5		13.9		33.3	20.0

x): The number of eggs < 20 eggs per m<sup>2</sup> surface

Table 5. The number of sprat larvae per m<sup>2</sup> sea surface in the Oslofjord area, 1974-1978

Area	1974	1975		1976		1977		1978	
	Jun	May	Jun	May	Jun	May	Jun	May	Jun
Inner	16	0	x)	0.5	46	0	0	0	0
Middle	18.9	+	12	0	6.1	1	1.4	+	1
Outer	6.1	+	15	+	4.8	1	1.9	+	0.6

x): Mean of two sampling periods  
 + : < 1 larvae per m<sup>2</sup>

Table 6. Length distribution in % of sprat larvae sampled  
sampled in the Oslofjord in June, 1974-1978

		Length groups (mm)				N	$\bar{I}$
		< 10	10-14	15-20	20<		
1974	inner	19.2	71.8	9.0		78	11.3
	middle	14.1	62.2	19.4	4.4	320	12.8
	outer	14.3	70.1	15.6		77	11.9
1975x)	inner	61.1	33.4	5.5		13	10.1
	middle	28.2	43.4	26.5	1.9	211	11.7
	outer	49.9	41.9	8.8	0.2	308	10.2
1976	inner	85.0	15.0			1.3	7.1
	middle	19.4	52.8	25.0	2.8	72	12.3
	outer	49.2	50.8	23.1		65	9.5
1977	inner	0	0	0	0	0	
	middle	38.5	61.5			13	10.1
	outer	26.9	50.0	23.1		26	10.7
1978	inner	0	0	0	0	0	
	middle	88.9	11.1			8	7.3
	outer	100.0				8	6.5

x) Mean of two sampling periods

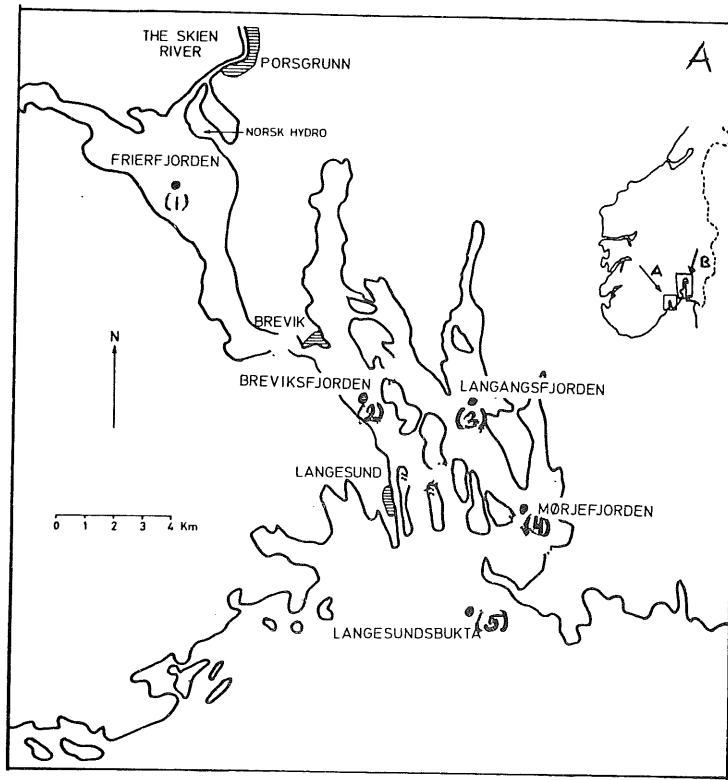


Fig. 1. The Langesund area with the sampling stations. Station numbers are shown in parentheses

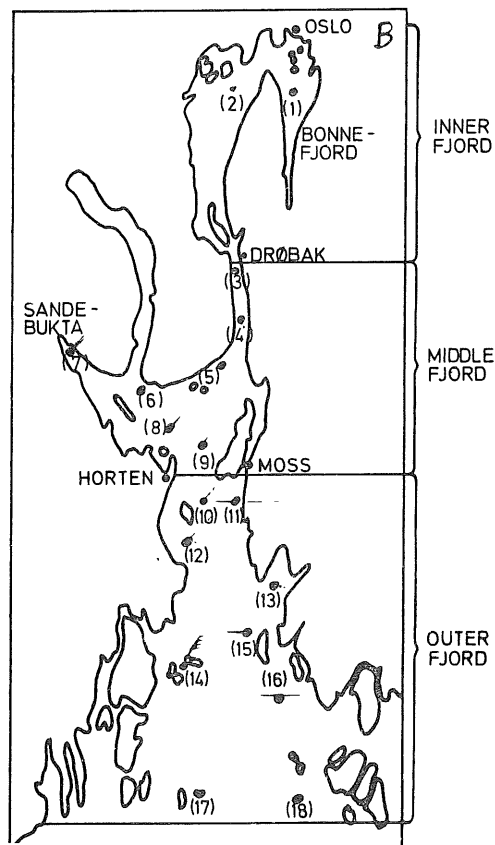


Fig. 2. The Oslofjord area with the sampling stations. Station numbers are shown in parentheses

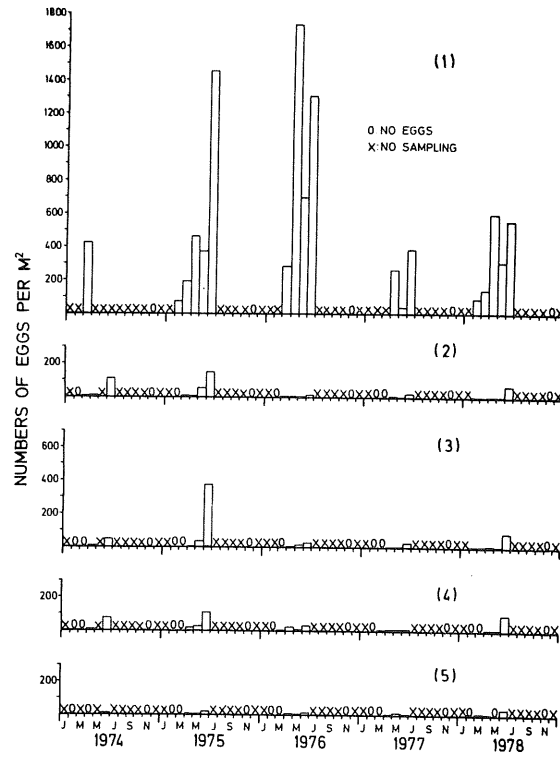


Fig. 3. The abundance of sprat eggs taken in the Lange-sund area, 1974-1978

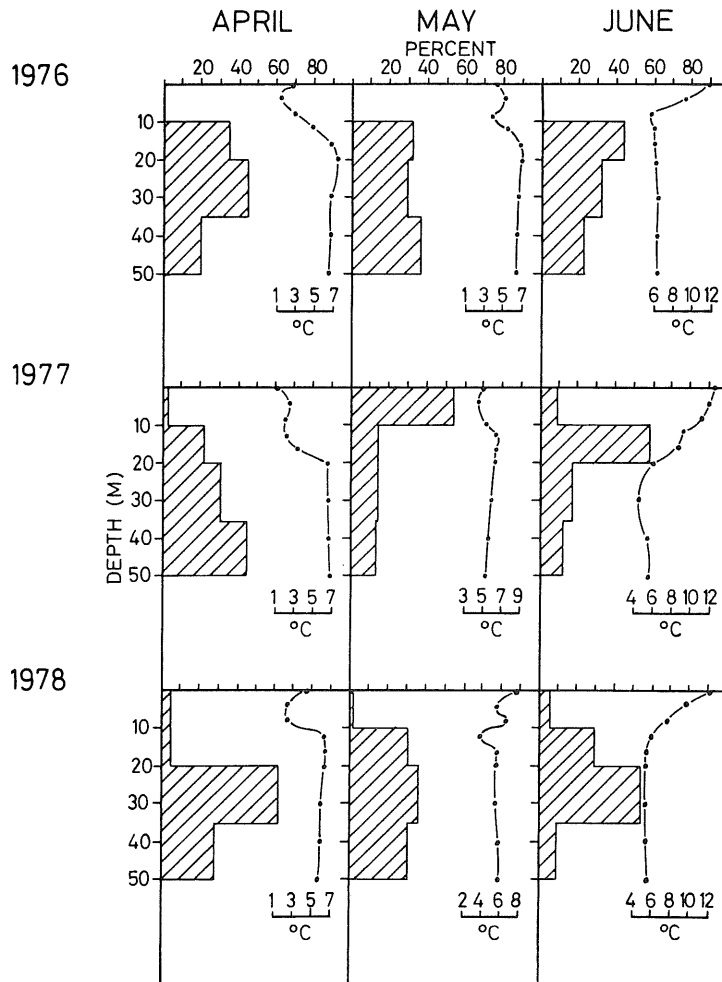


Fig. 4. The vertical distribution of sprat eggs of all stages taken in the Frierfjord in April-June 1976-1978. Alongside each distribution is the vertical profile of the temperature

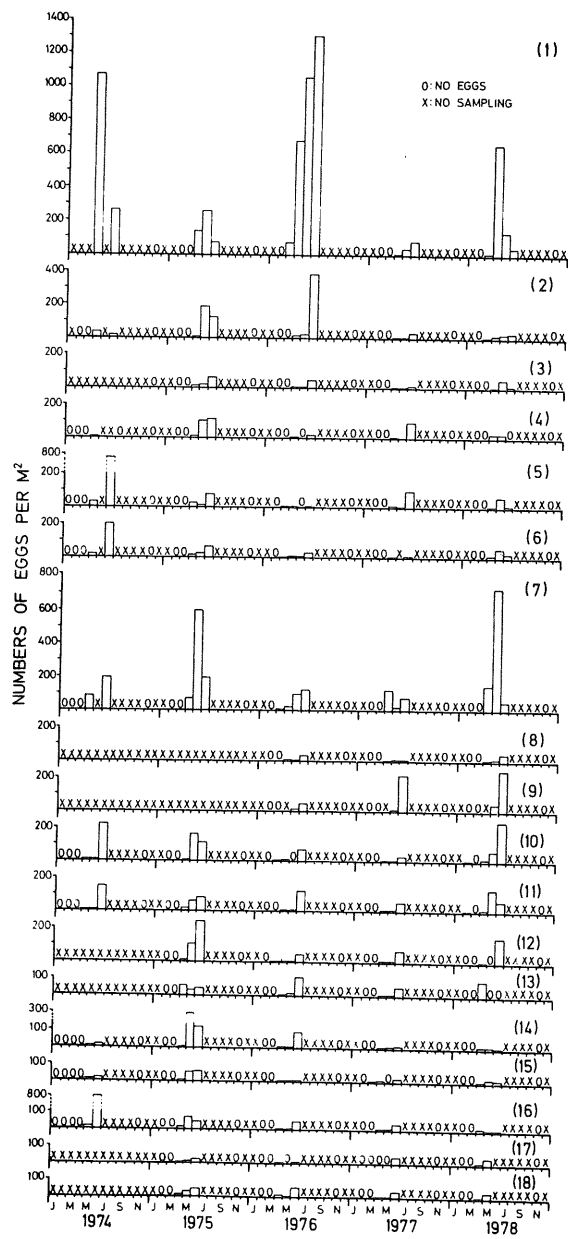


Fig. 5. The abundance of sprat eggs taken in the Oslo-fjord area, 1974-1978



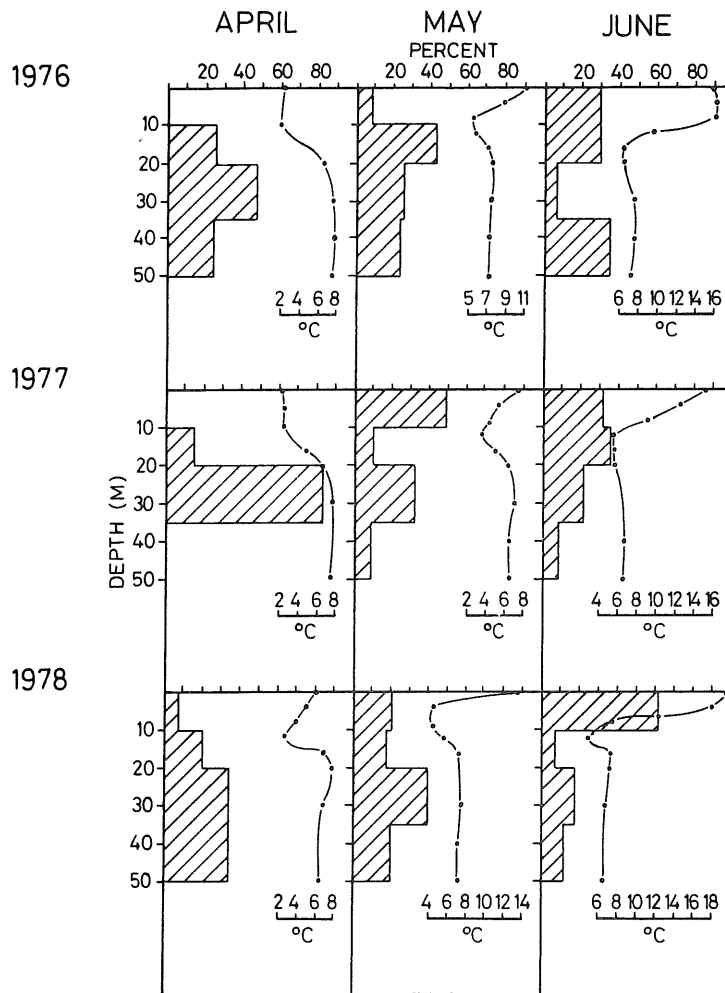


Fig. 6. The vertical distribution of sprat eggs of all stages taken in the Bonnefjord in April-June 1976-1978. Alongside each distribution is the vertical profile of the temperature