Copyright ©

Kieler Meeresforsch., Sonderh. 6, 323 – 330 Kiel 1988

Seasonal change of zooplankton in Kiel Bay: IV. Ichthyoplankton

A. Müller

Institut für Meereskunde an der Universität Kiel,
Kiel, Federal Republic of Germany

Abstract

Fish eggs and larvae were sampled during 1970 and 1971 at approximately monthly intervals in the Kiel Bay using a Bongo-Net. Samples of 0.5 mm mesh net were considered in this study. At every station temperature and salinity were measured. The most abundant fish eggs were of sprat origin, followed by flounder, cod and plaice. Spawning areas of this species are also described. Fish larvae showed high abundance from June to August with gobies predominance. Commercially important species such as herring, cod and plaice were present in low numbers. Species exceeding the 5 % relative proportion level (tow-year average) were herring, sprat, rockling, gobies and gunnel.

Introduction

Investigations on zooplankton have been carried out in the Kiel Bay since the early 1900's. From the whole area, few stations were sampled in winter/spring and summer/autumn periods. Reports on fish eggs and larvae were given by EHRENBAUM und STRODTMANN (1904), STRODTMANN (1906, 1918), APSTEIN (1911), HEINEN (1912), MIELCK und KÜNNE (1935). In a series of investigations, KÄNDLER (1939, 1949, 1950, 1961) estimated the seasonal occurence of fish eggs and larvae as well es other macroplankton. The first attempt to investigate the seasonal change of fish larvae at several stations, representative of the Kiel Bay area was undertaken by MÜLLER (1970). However, his investigation contained only a qualitative overview, since the gear used gave results unsatisfactory for quantitative estimate.

Based on this experience, a more detailed study was carried out by MÜLLER in 1970–1971 sampling the whole water column and the uppermost surface layer using quantitative plankton net tows to quantify seasonal changes in the zooplankton and to assess the relative importance of the surface layer for the early life stages of the fishes. Results from this investigation have been published with respect to the zooplankton displacement volumes and the seasonal changes of ichthyoneuston by MÜLLER (1973, 1978), and the seasonal changes of planktonic adult calanoid copepods by SCHNACK (1978).

The present paper summarizes the results of investigations on ichthyoplankton in relation to its environment.

Material and methods

This study was based on a station grid of about 20 stations representing the whole Kiel Bay area (Fig. 1.). For more details on the sampling strategy see MÜLLER (1973). The stations were sampled at approximately monthly intervals with a modified Bongo-Net, consisting of two nets with 0.28 sqm mouth opening and mesh sizes of 0.3 mm and 0.5 mm respectively. In this paper, 360 samples from the 0.5 mm mesh size Bongo-net were considered. The samples were taken by double oblique hauls at a constant speed of three

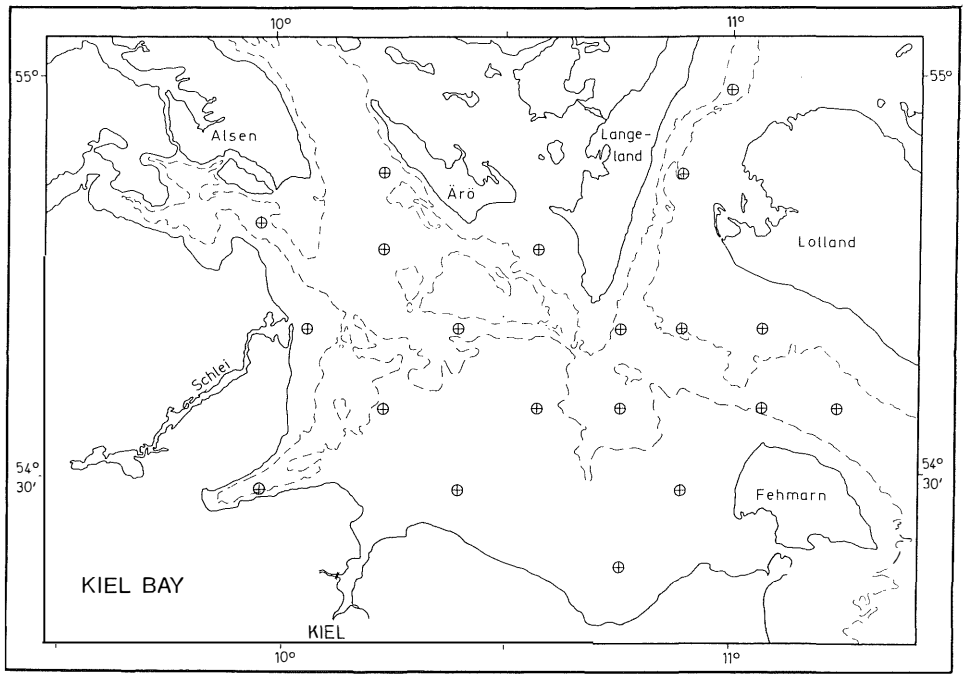

Figure 1
The station grid

knots. The volume of water strained was calculated by means of an attached flow meter, which gave 100–350 m^3 measurements. Tow depth was monitored on bord with a depth recorder according to KRAUSE und SIEDLER (1962). Thee samples were preserved in 4 % buffered formaldehyde/seawater solution and examined for fish eggs and larvae. At every station temperature and salinity were measured using a t/s-sensor, in some cases BT and water bottles were used instead.

Results

Fish eggs

The seasonal variation in species composition, distribution and abundance of fish eggs are listed in Table 1. With few exceptions, most eggs were from fish common to the Kiel Bay. The most abundant eggs were from sprat followed by flounder, cod and plaice. Surprisingly high numbers of sprat eggs were found in October 1970 at the station off Flensburger Bucht (NW-part). Fish eggs were encountered in all months of the year, except in November. The mean egg concentration at the different stations indicated spawning areas for plaice, cod flounder and sprat in the NW-part of the Kiel Bay. South of the Great Belt (NE-part) plaice, cod and sprat were spawning. Rockling eggs were present in low numbers and were more or less dispersed over the whole area. The seasonal occurence of fish eggs showed in 1970 an uncommon feature. Due to the long winter, the spawning was delayed which resulted a shorter spawning time. The spawning activity was more intensive resulting in higher egg numbers of all species, except rockling and dab.

Table 1: Total number of fish eggs and average concentration (n/100 m^3) caught in Kiel Bay 1970/71

Year-Month/ Fish Eggs	No. of Stat.	Paice	Cod	Flounder	Rockling	Sprat	Dab
1970							
January	11	32(2)	7(–)	–	–	–	–
March/April	19	924(28)	1183(36)	349(11)	60(2)	–	–
April/May	20	243(6)	752(19)	2004(50)	304(7)	2012(50)	355(9)
June	20	–	33(1)	2(–)	125(4)	1975(59)	394(12)
July	20	–	7(–)	–	21(1)	554(15)	290(8)
August	19	–	–	–	68(2)	47(2)	–
September	20	–	–	–	48(2)	–	–
October	20	–	–	–	–	70(2)	–
November	15	–	–	–	–	–	–
December	20	10(–)	38(2)	–	–	–	–
1971							
January	20	142(7)	192(9)	6(–)	–	–	–
February	20	196(11)	372(21)	312(18)	4(–)	–	–
March	19	33(2)	163(8)	274(14)	31(1)	96(5)	1(–)
April	14	9(–)	118(10)	305(26)	159(13)	346(29)	298(25)
May	20	–	16(1)	7(–)	76(4)	302(16)	31(2)
July	20	–	–	–	71(4)	295(15)	2(–)
August	8	–	–	–	28(3)	8(–)	–
September	15	–	–	–	24(1)	–	–
October	20	–	–	–	–	–	–
December	20	3(–)	1(–)	–	–	–	–

Additionally single catches of Turbot (4) in June '70, Mackerel (5) in July '70, Horse-Mackerel (2) in March '71 and Wrasse (3) in May '71.

Fish larvae

The seasonal occurence of fish larvae is listed in Table 2. and 3. Fish larvae showed a higher abundance from June to August, with gobies predominance. Commercial important species such as herring, cod and plaice were present in winter in low numbers. Species exceeding the 5 % relative proportion level were herring, sprat, rockling, gobies and gunnel. Herring larvae were almost exclusively from late spawners. From October to March, they were common in the plankton and were most abundant at the stations west of Fehmarn, indicating a spawning ground, which has also been reported earlier by WEBER (1971).

Sprat larvae were commonly found in late spring and summer, especially at two stations in the northern half of the Kiel Bay off the Flensburger Bucht. This correlated well with their egg distribution.

Rockling larvae were mostly from the species *Rhinonemus cimbrius*, mixed with a few *Ciliate mustella* in winter. The larvae could be found during the whole year and in higher numbers in late summer. No indication for a preference in a distinct area was observed.

Gobies larvae were the most common fish larvae with maximum abundance at deeper water stations. In a two-year average more than 60 % of all fish larvae were gobies, mainly *Pomatoscistus minutus*. The number of larvae in 1970, after the harsh winter was low in comparison with 1971.

The gunnel, *Pholis gunnellus* is frequently found during the first months of the year. In 1970 its distribution was restricted to the northern part of the Kiel Bay, but in 1971 they could be found more or less at every station.

Discussion

During the investigation in 1970/71 fish larvae of 32 species were found, but most of them in insignificant numbers. The most abundant species were not important commercially, except herring which almost exceeded the 10 % relative abundance level. Other species of commercial value such as plaice, cod, flounder and sprat reproduced successfully in the Kiel Bay, but the survival rate of eggs and larvae must be considerably low when considering the eggs/larvae ratio. The total catch of cod and plaice in the western Baltic was in 1970–71 in order 19000 and 450 tonnes respectively or in a ratio of 42:1, which represents a rough expression of the stock size of this two species also. The ratio of cod eggs to plaice eggs about 2:1 indicated that only a small proportion of the cod passed the Western Baltic for spawning there in the time of investigation. Since the Kiel Bay belongs to the transition area, between Kattegat and Baltic Sea, a permanent inflow of bottom water occurs from the Baltic Sea, which transports larvae from the Kattegat area. In addition to this bottom current, short term irregular in- and outflow surface currents prevail, as indicated by the rapid changes of surface salinity in the vicinity of Fehmarn Island and the Great Belt (Fig. 2). If there is an inflow period in a season, rich in ichthyoplankton, this could support larvae to the stocks in the Kiel Bay. Several short inflow periods were observed during the investigation time, indicated by "guest" fishes (MÖBIUS und HEINCKE 1884). The periods were of short duration, since "guest" numbers were low. These larvae, cannot survive for long and most of them die, presumably within a few weeks due to by the sudden change in the environment, therefore the local stock of commercial fish was not influenced significantly by the populations of the Danish Belt Sea or Baltic Proper due to the short inflow periods. The high proportion of *Gobius minutus* was interesting, since they accounted for more than 80 % of fish larvae in 1971. It seemed that the long and harsh 1969/70 winter resulted in a stock depletion, whereas the milde 70/71 winter was favourable to a more successful reproduction. In comparison to earlier

Table 2 The seasonal occurrence of fish larvae (n/2000 m^3), Kiel Bay 1970

Year-Month/Species	J	F	M	A	M	J	J	A	S	O	N	D	fish larvae total	%
Clupea harengus	18.2	–		4.2	2.4	0.6	1.2	–	–	14.4	28.8	26.2	107	11.5
Sprattus sprattus	–	–		–	5.4	28.2	12.2	13.2	2.6	2.0	–	–	107	
Syngnathus rostellatus	–	–		–	–	–	–	–	5.2	–	–	–	8	
Nerophis ophidion	–	–		–	–	–	1.2	2.0	0.6	0.6	–	–	7	
Gasterosteus aculeatus	–	–		–	–	–	–	0.6	3.2	0.6	–	1.0	8	
Gadus morhua	–	–		–	2.0	5.4	0.6	–	–	–	–	–	14	
Merlangius merlangus	–	–		–	–	–	1.2	–	–	–	–	–	2	
Onos spec.	–	–		2.4	6.0	3.6	1.2	9.8	25.2	11.6	2.2	1.0	97	10.4
Trachurus trachurus	–	–		–	–	–	0.6	–	–	–	–	–	1	
Ctenolabrus rupestris	–		–	–	–	0.6	–	–	–	–	–	–	1	
Hyperoplus lanceolatus	–	–		–	–	2.4	2.8	16.0	1.2	–	–	–	34	
Ammodytes tobianus	–	–		6.0	–	2.4	16.2	0.6	2.6	2.0	–	–	51	
Ammodytes marinus	–	–		–	–	–	–	–	–	–	2.2	–	2	
Scomber scombrus	–	–		–	–	–	0.6	–	–	–	–	–	1	
Gobius spec.	–	–		–	1.0	2.4	45.6	113,2	27.2	13.0	15.6	–	326	35.0
Lebetus scorpioides	–	–		–	–	–	–	–	–	–	–	–	0	
Aphia minuta	–	–		–	–	–	–	–	3.8	1.4	3.4	–	11	
Callionymus lyra	–	–		–	–	–	–	–	2.0	–	–	–	3	
Chirolophis ascanii	–	–		–	–	–	–	–	–	–	–	3.8	4	
Pholis gunnellus	–	–		30.0	12.0	–	–	–	–	–	–	–	73	7.8
Lumpenus lampretaeformis	–	–		5.4	–	–	–	–	–	–	–	–	9	
Myoxocephalus scorpius	–	–		5.4	–	–	–	–	–	–	–	–	9	
Agonus cataphractus	–	–		2.4	2.4	–	–	–	–	–	–	–	9	
Cyclopterus lumpus	–	–		–	–	0.6	–	1.4	–	–	–	–	3	
Liparis liparis	–	–		0.6	–	–	–	–	–	–	–	–	1	
Scophthamus maximus	–	–		–	–	–	–	0.6	–	–	–	–	1	
Arnoglossus laterna	–	–		–	–	–	–	–	0.6	–	–	–	1	
Limanda limanda	–	–		–	–	6.0	5.0	2.0	–	–	–	–	22	2.4
Pleuronectes platessa	–	–		–	3.0	–	–	–	–	–	–	–	6	
Microstomus kitt	–	–		–	–	–	–	–	–	0.6	–	–	1	
Platichthys flesus	–	–		–	–	5.4	–	–	–	–	–	–	9	
Solea solea	–	–		–	–	–	–	–	1.2	–	–	–	2	
Total number of fish larvae	17			93	69	97	158	230	117	68	47	34	930	

Table 3 The seasonal occurrence of fish larvae (n/2000 m^3), Kiel Bay 1971

Year-Month/Species	J	F	M	A	M	J	J	A	S	O	N	D	fish larvae total	%
Clupea harengus	15.0	11.2	11.2	5.2	1.0	–	–	–	–	112.6	–	37.8	207	9.2
Sprattus sprattus	–	–	–	–	12.6	–	37.2	–	0.8	–	–	–	49	
Syngnathus rostellatus	–	–	–	–	–	–	3.0	–	0.8	3,4	–	–	8	
Nerophis ophidion	–	–	–	–	–	–	3.0	–	0.8	–	–	–	4	
Gasterosteus aculeatus	–	–	–	–	–	–	–	–	–	3.4	–	1.0	5	
Gadus morhua	–	–	–	3.4	8.4	–	–	–	–	–	–	–	10	
Merlangius merlangus	–	–	–	–	–	–	–	–	–	–	–	–	0	
Onos spec.	11.2	8.0	1.0	1.6	4.2	–	10.2	9.4	17.0	8.6	–	1.0	71	
Trachurus trachurus	–	–	–	–	–	–	–	–	–	–	–	–	0	
Ctenolabrus rupestris	–	–	–	–	–	–	1.0	–	–	–	–	–	1	
Hyperoplus lanceolatus	–	–	–	1.6	–	–	15.4	–	2.4	–	–	–	19	
Ammodytes tobianus	–	–	–	–	–	–	4.2	4.8	1.6	2.6	–	3.2	14	
Ammodytes marinus	–	–	–	1.6	–	–	–	–	–	–	–	–	1	
Scomber scombrus	–	–	–	–	–	–	–	–	–	–	–	–	0	
Gobius spec.	4.6	1.2	2.0	–	–	–	1156.0	312.0	222.0	40.0	–	9.4	1585	70.8
Lebetus scorpioides	–	–	–	–	–	–	1.0	–	–	–	–	–	1	
Aphia minuta	1.8	–	1.0	–	–	–	–	–	–	0.8	–	3.2	7	
Callionymus lyra	–	–	–	–	–	–	–	–	–	–	–	–	0	
Chirolophis ascanii	1.0	–	–	–	–	–	–	–	–	–	–	–	1	
Pholis gunnellus	66.4	43.0	40.8	8.6	–	–	–	–	–	–	–	–	154	6.9
Lumpenus lampretaeformis	–	1.2	1.0	–	–	–	–	–	–	–	–	–	2	
Myoxocephalus scorpius	–	–	2.0	1.6	–	–	–	–	–	–	–	–	3	
Agonus cataphractus	1.0	2.2	–	–	–	–	–	–	–	–	–	–	3	
Cyclopterus lumpus	–	–	–	–	–	–	–	2.4	–	–	–	–	1	
Liparis liparis	–	1.2	4.0	3.2	–	–	–	–	–	–	–	–	7	
Scophthamus maximus	–	–	–	–	–	–	–	–	–	–	–	–	0	
Amoglossus laterna	–	–	–	–	–	–	–	–	–	–	–	–	0	
Limanda limanda	–	–	–	–	–	–	86.6	–	–	–	–	–	84	3.7
Pleuronectes platessa	–	1.2	–	–	–	–	–	–	–	–	–	–	1	
Microstomus kitt	–	–	–	–	–	–	1.0	–	–	–	–	–	1	
Platichthys flesus	–	–	–	–	1.0	–	–	–	–	–	–	–	1	
Solea solea	–	–	–	–	–	–	–	–	–	–	–	–	0	
Total number of fish larvae	108	61	62	16	26		1275	139	302	198		53	2240	

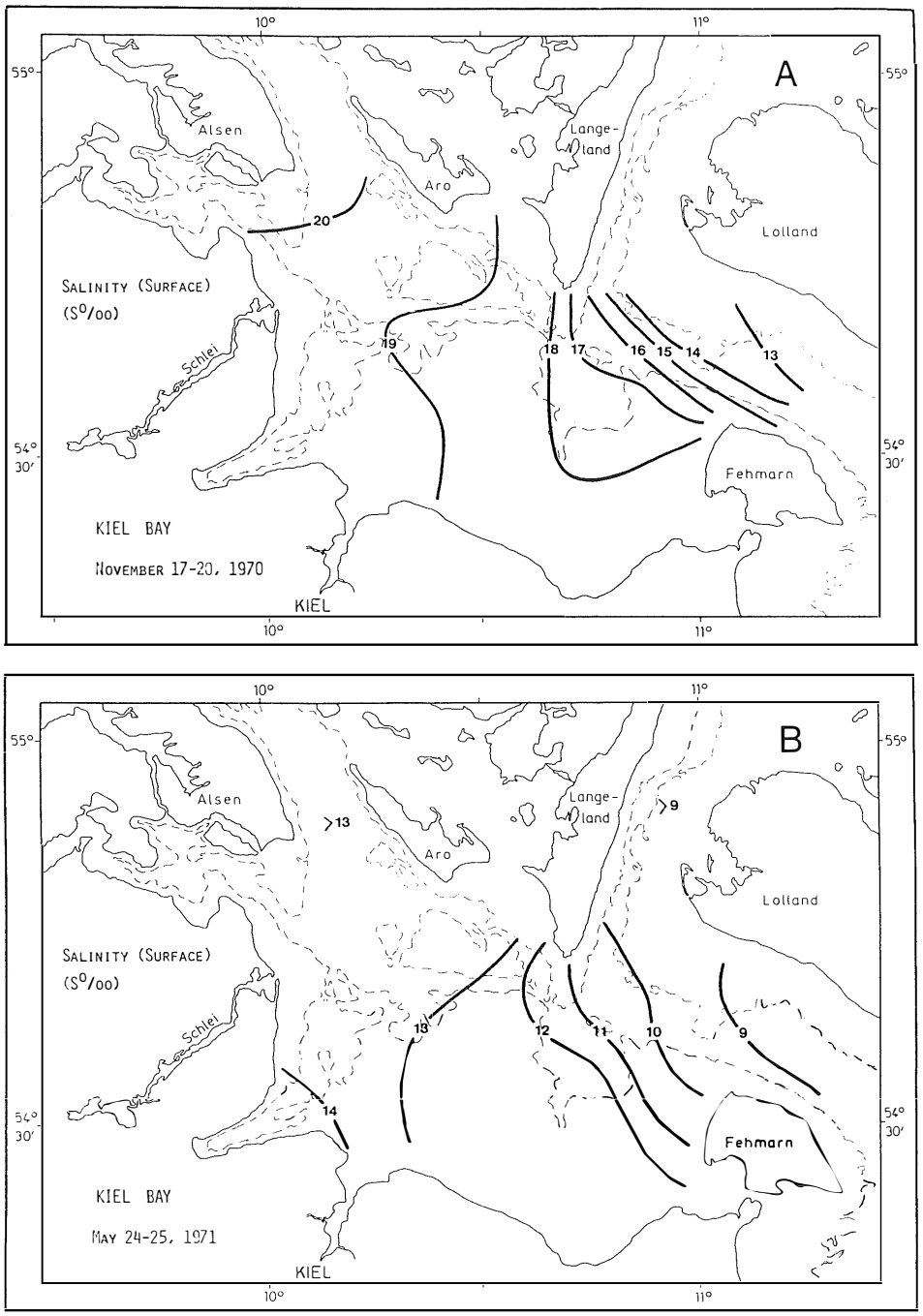

Figure 2
Distribution of surface salinity. Chart A: inflow of Kattegat water. Chart B: outflow of Baltic water

investigations, the number of dab was remarkably low. They exhibited an abundance of only about 3 percent of total fish larvae.

References

APSTEIN, C., 1911. Die Verbreitung der pelagischen Fischeier und Larven in der Beltsee und den angrenzenden Meeresteilen. Wiss. Meeresunters. Abt. Kiel NF. **13**, 225–284.

EHRENBAUM, E. und S. STRODTMANN, 1904. Eier und Jugendformen der Ostseefische. I. Bericht. Wiss. Meeresunters. Abt. Helgoland NF. **6**, 57–126.

HEINEN, A., 1912. Die planktonischen Fischeier und Larven der Ostsee. Wiss. Meeresunters. Abt. Helgoland NF. **14**, 129–189.

KÄNDLER, R., 1939. Einige Ergebnisse der Untersuchungsfahrten mit dem R.F.D. "Poseidon" in der westlichen Ostsee 1938. II. Beziehungen zwischen Großplankton und Einstrom. Ber. dt. wiss. Komm. Meeresforsch. **9**, 550–560.

KÄNDLER, R., 1949. Die Häufigkeit pelagischer Fischeier in der Ostsee als Maßstab für die Zu- und Abnahme der Fischbestände. Kieler Meeresforsch. **6**, 73–89.

KÄNDLER, R., 1950. Jahreszeitliches Vorkommen und unperiodisches Auftreten von Fischbrut, Medusen ind Dekapodenlarven im Fehmarnbelt in den Jahren 1934–1943. Ber. dt. wiss. Komm. Meeresforsch. **12**, 49–85.

KÄNDLER, R., 1961. Über das Vorkommen von Fischbrut, Dekapodenlarven und Medusen in der Kieler Förde. Kieler Meeresforsch. **17**, 48– 64.

KRAUSE, G. und G. SIEDLER, 1962. Zur kontinuierlichen Bestimmung der Tiefenlage von Schleppgeräten im Meere. Kieler Meeresforsch. **18**, 29–33.

MIELCK, W. und C. KÜNNE, 1935. Fischbrut- und Plankton-Untersuchungen auf dem Reichsforschungsdampfer "Poseidon" in der Ostsee, Mai–Juni 1931. Wiss. Meeresunters. Abt. Helgoland NF. **19**, 1–120.

MÖBIUS, K. und F. HEINCKE, 1884. Die Fische der Ostsee. Ber. Wiss. Komm. **4**, 193–296.

MÜLLER, A., 1970. Über das Auftreten von Fischlarven in der Kieler Bucht. Ber. dt. wiss. Komm. Meeresforsch. **21**, 349–368.

MÜLLER, A., 1973. Der Jahresgang des Zooplanktons in der Kieler Bucht: I. Das Verdrängungsvolumen. Kieler Meeresforsch. **29**, 23–33.

MÜLLER, A., 1978. Seasonal change of zooplankton in Kiel Bay: II. Ichthyoplankton in the uppermost layer. Kieler Meeresforsch., Sonderh. **4**, 194–200.

SCHNACK, S., 1978. Seasonal change of zooplankton in Kiel Bay: III. Calanoid copepods. Kieler Meeresforsch., Sonderh. **4**, 201–209.

STRODTMANN, S., 1906. Laichen und Wandern der Ostseefische. II. Bericht. Wiss. Meeresunters. Abt. Helgoland NF. **7**, 133–216.

STRODTMANN, S., 1918. Weitere Untersuchungen über Ostseefische. III. Bericht. Wiss. Meeresunters. Abt. Helgoland NF. **14**, 29–97.

WEBER, W., 1971. Die Laichplätze des Herings (*Clupea harengus* L.) der westlichen Ostsee. Kieler Meeresforsch. **27**, 194–208.