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SCYPHOMEDUSAE AS PREDATORS AND FOOD COMPETITORS OF LARVAL FISH

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Abstract

Literature data are compiled on mass occurrence of jellyfish, their hinderance to fisheries and their predation on fish larvae. By studying the scyphomedusa *Aurelia aurita* and spring spawning herring in Kiel Bight, the impact of jellyfish on a larval fish population is described. On the average, 0.09 medusae per m^3 with a biomass of 25 g occur between July and September. The standing stock is below 10 mg from December to April. Growth is characterized by a stagnation period in winter and early spring, by rapid increase in June and by size reduction in autumn after release of gonadal products.

By reducing copepod stocks during summer months, *Aurelia* is a major food competitor for all kinds of fish larvae. The quantity of surviving herring larvae in Kiel Fjord is essentially depending on the actual size of the *Aurelia* stock. Comparing the years 1978, 1979, and 1980 as well as comparing different samples of the same series, few larvae are found if the biomass of medusae is relatively high. Up to 10 (12mm medusa) and 68 (42mm medusa) yolk-sac larvae were found in the stomach of a single *Aurelia*. Daily lost by predation is in the dimension of about 4 larvae per medusa during May. At least 2-5 % of the total yolk-sac stage is eaten per day by medusae.

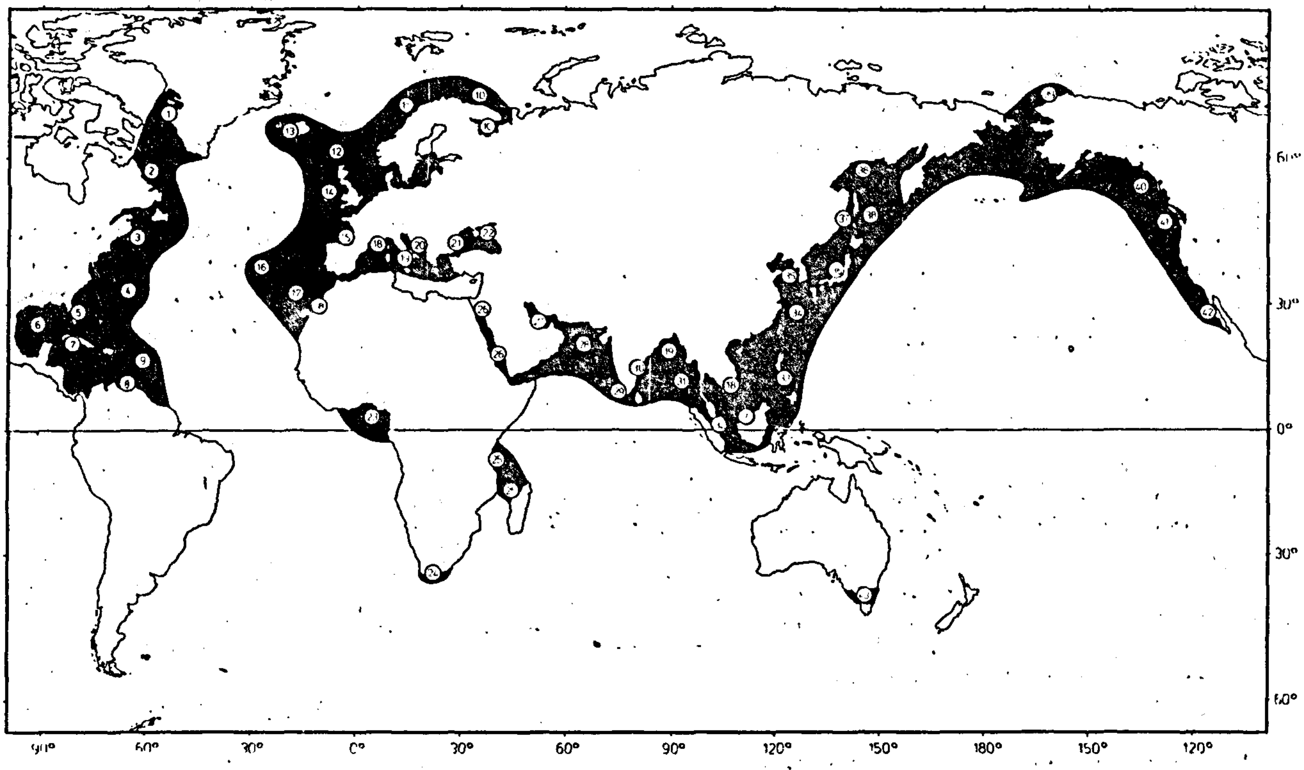
Introduction

Mass occurrence of scyphomedusae has been reported already in some of the earliest marine biological studies (KALM 1753-61 and BASTER 1762, both cited by EIMER 1878, MOHR 1786 and FABER 1829, both cited by KRAMP 1939). Most data are available on the genus Aurelia with the arctic species A. limbata and with A. aurita in more southern regions (KRAMP 1965). According to KRAMP's (1961) literature compilation, this genus is abundant in most coastal areas between 70°N and 40°S (fig. 1). Mass occurrence of Aurelia was reported from waters around Scotland (KRUMBACH 1925), Iceland (KRAMP 1939), Cuba (KRUMBACH 1925), Kamtschatka(VANHÖFFEN 1906), the Barentssea (ZENKEVITCH 1956) and the Baltic (MÖLLER 1979). From Japanese waters, YASUDA (1970) reported up to 596 individuals (5-6 cm in diameter) or 12.8 kg wet weight Aurelia per m^3. In other scyphozoan genera as well, mass occurrence was observed: Chrysaora (SCHWEIGGER 1959), Cyanea (AGASSIZ 1865, KRAMP 1939, KRUMBACH 1925, ZENKEVITCH 1956) and Pelagia (KRUMBACH 1925).

By clogging trawl nets and power plant intake systems and by stinging swimmers, jellyfish have become a nuisance in various coastal areas (tab. 1). Still more significant than these direct implications may be, from the commercial as well as from the ecological point of view, the impact of jellyfish predation on larval fish and their food resources.

Determination of survival rates and causes for death in larval fish populations is one of the main problems in fisheries biology (BLAXTER 1974). The role of abiotic factors like temperature (COLTON 1959, IRVINE 1974, SOUTHWARD and DEMIR 1974), salinity (ALDERDICE and FORRESTER 1968, WESTERNHAGEN 1968), dissolved oxygen (BRAUM 1973), wave activities (PINUS 1974, POMMERANZ 1974) and power plants (WINKLE 1977) have been discussed in this respect.

May (1974) summarized field observations on the significance of qualitative and quantitative food supply for the survival of fish larvae. Although a vast body of literature was reviewed, hardly quantitative information were the result.



1 KRAMP (1913)
2 BIGELOW (1920)
3 RANSON (1945 b)
4 BIGELOW (1938)
5 MAYER (1914)
6 HEDGPETH (1954)
7 RANSON (1945 a)
8 STIASNY (1919)
9 RANSON (1949)
10 YASHNOV (1948)
11 NAUMOV (1961)
12 FRASER (1950)
13 KRAMP (1939)
14 GOTTO (1951)
15 LEDANOIS (1913)
16 STIASNY (1940)
17 MAYER (1910)
18 RANSON (1945 b)
19 NEPPI (1915)
20 KOLOSVARY (1945)
21 NETCHAEFF and NEU (1940)
22 NAUMOV (1951)
23 KRAMP (1955)
24 KRUMBACH (1930)
25 THIEL (1959)
26 MAADEN (1959)
27 MAYER (1910)
28 STIASNY (1937)
29 NAIR 1951
30 GRAVELY (1941)
31 RAO (1931)
32 SEARLE (1957)
33 MAYER (1917)
34 UCHIDA (1955)
35 TU (1931)
36 YASUDA (1979)
37 KISHINOUYE (1910)
38 STIASNY and MAADEN (1943)
39 MACGINITIE (1955)
40 FRASER (1938)
41 STIASNY (1922)
42 CHILD (1951)
43 STIASNY 1924

Figure 1.

Geographical distribution of the genus Aurelia

(for literature see KRAMP 1961)

Due to sparse field studies, the determination of impacts of predation on fish larvae is still more problematic, although its importance has been pointed out for several times (FRASER 1962, 1969, HEMPEL 1974, MURPHY 1961). Jellyfish seem to belong to the most voracious fish larvae predators within the planktonic system. In the gastral cavity of Aurelia, fish larvae were found by EHRENBERG (1837), FRASER (1969), KELLER (1895, cited by KRUMBACH 1930), KERSTAN (1977), LEBOUR (1922, 1923), PERON and LESUEUR (1809, cited by THIEL 1964) and THILL (1937), in Cyanea by FRASER (1969), GAEDE (1809, cited by THIEL 1959), HARGITT

Table 1.

Hinderance of fisheries and cooling systems by jellyfish

A. hinderance of fisheries		
locality	species	source
Skagerrak	Tima bairdii	BERNT (1967)
Bergen (Norway)	Aurelia aurita	Inst.Mar.Res.Blomsterdalen
western Baltic	Aurelia aurita	original
central Baltic	Aurelia aurita	HELA (1951)
Netherlands	Aurelia aurita	MAADEN (1942)
Farør	Aurelia aurita	RUSSELL (1970)
Constanta (Romania)	Aurelia aurita	Mar.Res.Inst.Constanta
Wakasa Bay (Japan)	Aurelia aurita	YASUDA (1979)
Skagerrak	Cyanea capillata	original
Scotland	Cyanea sp.	Dep.Agric.Fish.Scotl.Aberdeen
Peru	Chrysaora sp.	original
Hongkong	scyphomedusae	Agric.Fish.Dep.Hongkong
Falkland Islands	scyphomedusae	Inst. Nac. Invest. Desarrollo Pesquero Mar del Plata
Gulf of Maine	Nanomia cara	ROGERS et al. (1978)
Weser estuary	Pleurobrachia pileus	original
Gulf of Maine	coelenterates	SHERMAN et al. (1979)

B. clogging of cooling water inlets		
locality	species	source
Ringhals (Sweden)	Aurelia aurita	Svenska Vattenfall
Kiel (Germany)	Aurelia aurita	original
Japan	Aurelia aurita	MATSUEDA (1969)
Peru	Chrysaora sp.	SCHWEIGGER (1959)

(1902), and PHILLIPS et al. (1969), in hydromedusae by FRASER (1969), GREVE (1972), GUDGER (1942), JENSEN (1950), KRUMBACH (1925), LEBOUR (1923), and STEVENSON (1962). LARSON (1976) reviewed literature on predation of cubomedusae on fish larvae.

Kiel Bight offers good conditions to study the impact of medusae on a larval fish population. The population dynamics of Aurelia aurita medusae, main species in this part of the Baltic, have been studied during the last years (MÖLLER 1979) and seasonal fluctuations of their major food organisms are well known (HILLEBRANDT 1972, MARTENS 1975, SCHNACK 1975, 1978). Larvae of spring spawning herring hatch during the time of Aurelia's main growth period. The impact of Aurelia on herring and its food resources in Kiel Fjord is subject of this study.

Materials and Methods

Between 27.4.1978 and 11.6.1980, 26 stations in Kiel Fjord (fig. 2) were sampled weekly (March-October) or every 2 weeks (November-February) with a 6 weeks interruption due to ice conditions in early 1979 and a second interruption from mid-

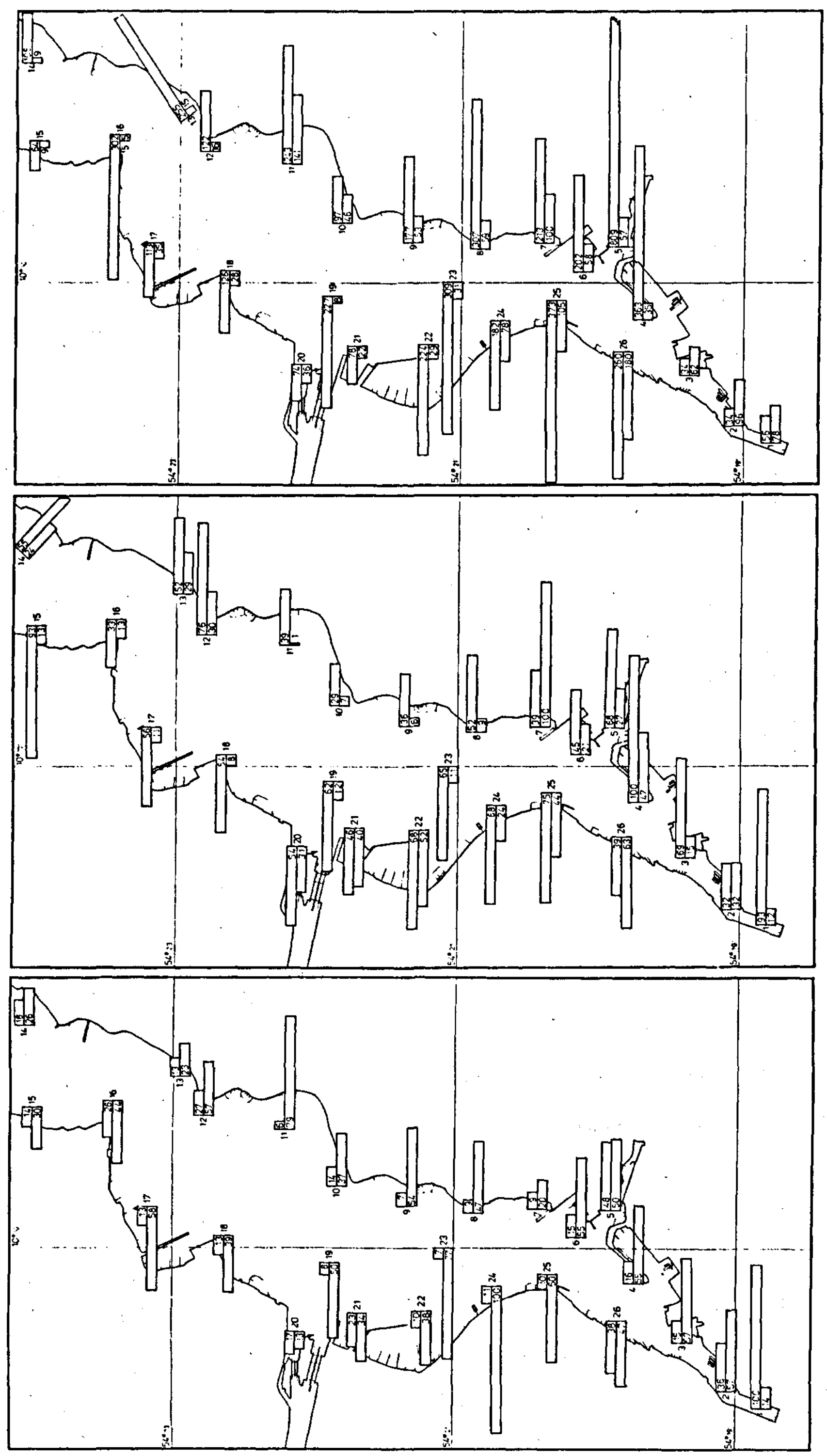


Figure 2. Relative abundance in the plankton of Kiel Fjord

left: *Aurelia* ephyrae (< 1 cm) upper diagrams: average of 1978

middle: *Aurelia* medusae (> 1 cm) lower diagrams: Average of 1979

right: herring larvae (5-7 mm)

November 1979 to the end of April 1980. Oblique hauls were taken with a CalCOFi-net of 1 m mouth opening and 0.5 mm in mesh size from the surface to 1 m above bottom. Water depth was 8 m in general, the ship's speed 3-4 kn, and the average sample volume 171 m^3 water.

Medusae of more than 4 cm in size were measured alive. Their diameter was determined at the interradialia (fig. 3). Medusae up to 10 cm were measured to the mm below, larger ones to the cm below. To determine the total volume per station, jellyfish were transferred to measuring cylinders. Wet weight of 1 l medusae was equated with 1 kg.

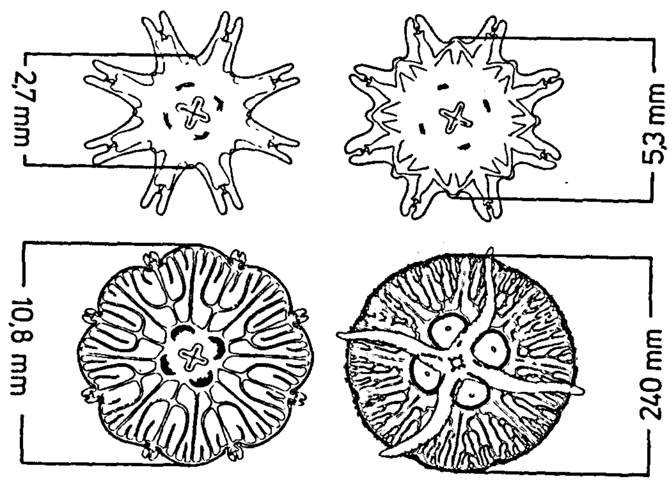


Figure 3. Determination of Aurelia diameter

Small medusae (< 4 cm) and ephyrae (< 1 cm) were measured after preservation in 4 % formaline. By this method, a lost in volume of 62.5 % had to be taken in account. The diameter was reduced for up to 30 %, depending on the jellyfish's size. In animals with a life diameter of 1.3 - 8.0 mm it was 15 % only. In all size groups, a shrinkage of about 14 % was observed during the first 2 days. In medusae of 10 cm bell diameter, size reduction stopped after 6 weeks. Data in tab. 2 are based on measuring 3 x 64 individuals per size group. To obtain the life diameter, to the size of preserved jellyfish 17.5 % were added. All following data mean wet volume and size and are the average of all 26 stations in Kiel Fjord.

days after preservation	life diameter in mm 1,3 - 3,7	3,8 - 8,0	10 - 18	21 - 50	51 - 116
0	100	100	100	100	100
1	86,8	88,4	85,6		
2	86,1	87,6	85,6	86,9	86,2
4	85,7	86,8			
7 - 11	85,3	86,0	84,9	81,2	80,5
14 - 17	85,3	86,2	84,9		
35 - 45	84,6	86,0		80,4	76,2
66 - 84	84,6	86,0	79,1		
160				78,2	71,5
181 - 197	84,6	85,6	79,1	78,5	71,5

Table 2. Shrinkage of Aurelia aurita after fixation in 4 % formaline (1 part formaline 40 % and 9 parts sea water 16 ‰)

Studies on stomach contents were carried out on 19.-24.5. 1979, 15.-16.5. and 26.-27.5.1980 at 11-13°C water temperature near stat. 26 (fig. 2). Medusae were caught individually with a hand net to avoid unnatural pressing of food organisms into the gastral cavitiy of medusae. Each sample consisted of 50-226 medusae, a total of 5.873 was examined (tab. 3).

date	sampling intervals	number of samples	n Aurelia per sample	total Aurelia	length (in mm) distribution of Aurelia 6-10	11-15	16-20	21-25	26-30	31-35	36-50
19.-24.5.1979	irregularly	20	57-226	2742	112	1005	1404	221	0	0	0
15.-16.5.1980	1 hour	23	51-100	1931	0	0	368	696	518	268	81
26.-27.5.1980	1 hour	24	50	1200	0	0	0	0	0	0	0

Table 3. Sampling data on food examinations in Aurelia medusae

Results

population dynamics of Aurelia medusae

First ephyrae of the new population occur late in November in Kiel Fjord plankton. A first maximum of abundance can be observed at the end of December, but until the beginning of April the number stays below 3 per 100 m^3 (tab. 4). Maximal production takes place in April and May, when 6-7 ephyrae <1 cm per 100 m^3

	number per 100 m³ 1978-79			average diameter in mm		monthly increase of diameter in %		standing stock in g wet weight per 100 m³			
	ephyrae	medusae	total	1978	1979	1978	1979	1976-77	1978	1979	average of 1976-77 and 1978-79
Jan	1.8	0	1.8		2.0			0	(0)	0	0
Feb	1.0	0	1.0					0	(0)	0	0
Mar	1.4	0	1.4		2.1			0	(0)	0	0
Apr	6.6	1.1	7.7	7.4	2.6		+ 24	0	1	0	0
May	7.3	8.5	15.8	14.0	6.7	+ 89	+ 158	0	331	1	83
Jun	3.6	7.9	11.5	74.5	48.5	+ 432	+ 624	1270	654	225	855
Jul	0.8	9.7	10.5	137.0	155.7	+ 84	+ 221	3020	2523	2116	2670
Aug	0.3	6.9	7.2	187.8	197.0	+ 37	+ 27	(2600)	2125	2666	2498
Sep	0	12.1	12.1	135.0	170.9	- 18	- 13	2190	1552	3928	2465
Oct	0	6.4	6.4		163.9		- 17	(1110)	55	2660	1234
Nov	0.1	0.2	0.3					40	0	97	44
Dec	2.2	0	2.2	1.8				0	0	0	0
average								850	603	974	821

Table 4. Growth parameters of Aurelia aurita from Kiel Bight (1976-77) (MÖLLER 1979) and Kiel Fjord (1978-79). Figures in brackets were estimated.

are found on monthly average. Their number decreases constantly until August and during the following two months they are caught only occasionally. Already late in April some ephyrae enter the medusa stage > 1 cm.

Due to ongoing strobilation, the total number of Aurelia increases until May up to 16 per 100 m³ in Kiel Fjord. This quantity becomes reduced to an average of 9 per 100 m³ between June and September. Weekly values ranged from 2 to 33 per 100 m³ in 1978-79, they are presented as monthly averages in tab. 4. The old Aurelia population dies in autumn and in November medusae are found only scarcely.

When liberated from the polyp, an ephyra measures about 2 mm. No growth takes place during winter and early spring (fig. 4). In April 1979 the average diameter was 3 mm, in May 7 mm, in June 48 mm, in July 156 mm, and in August 197 mm. The maximum monthly growth rate was 623 % in June. In late summer and autumn, the diameter of medusae shrinks. On the average of September and October 1979, this reduction was 15 % per month.

Based on the length-weight-relationship $G = 0.07 \times L^{2.8}$ (KERSTAN 1977), the average weight of an Aurelia increased from 0.06 g in May 1979 to 22.8 g in June and 308.5 g in July.

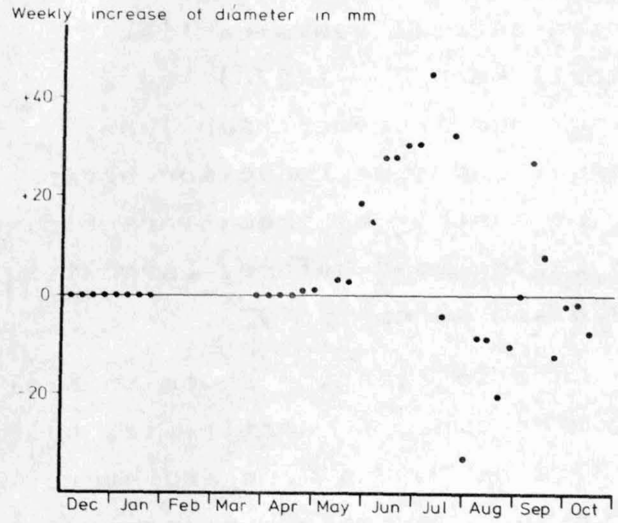


Figure 4. Weekly growth of Aurelia aurita 1978-79 in Kiel Fjord (gliding average over 3 values)

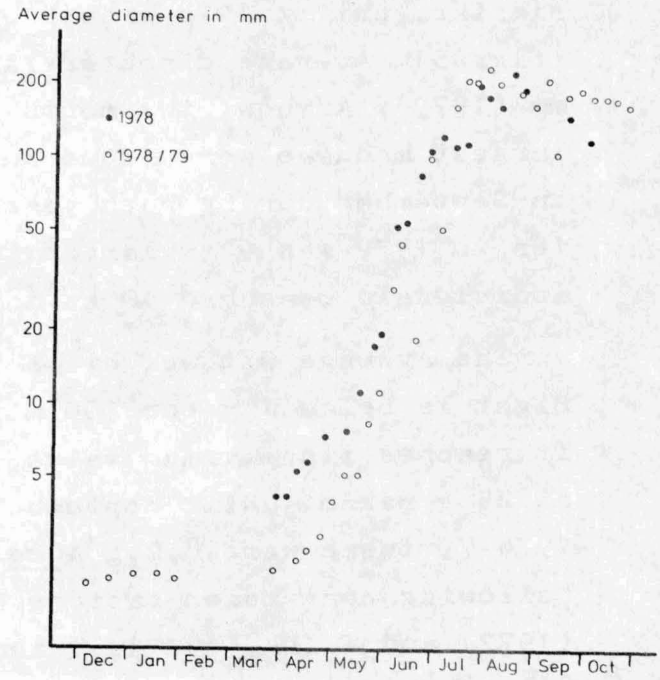


Figure 5. Growth of Aurelia aurita in Kiel Fjord

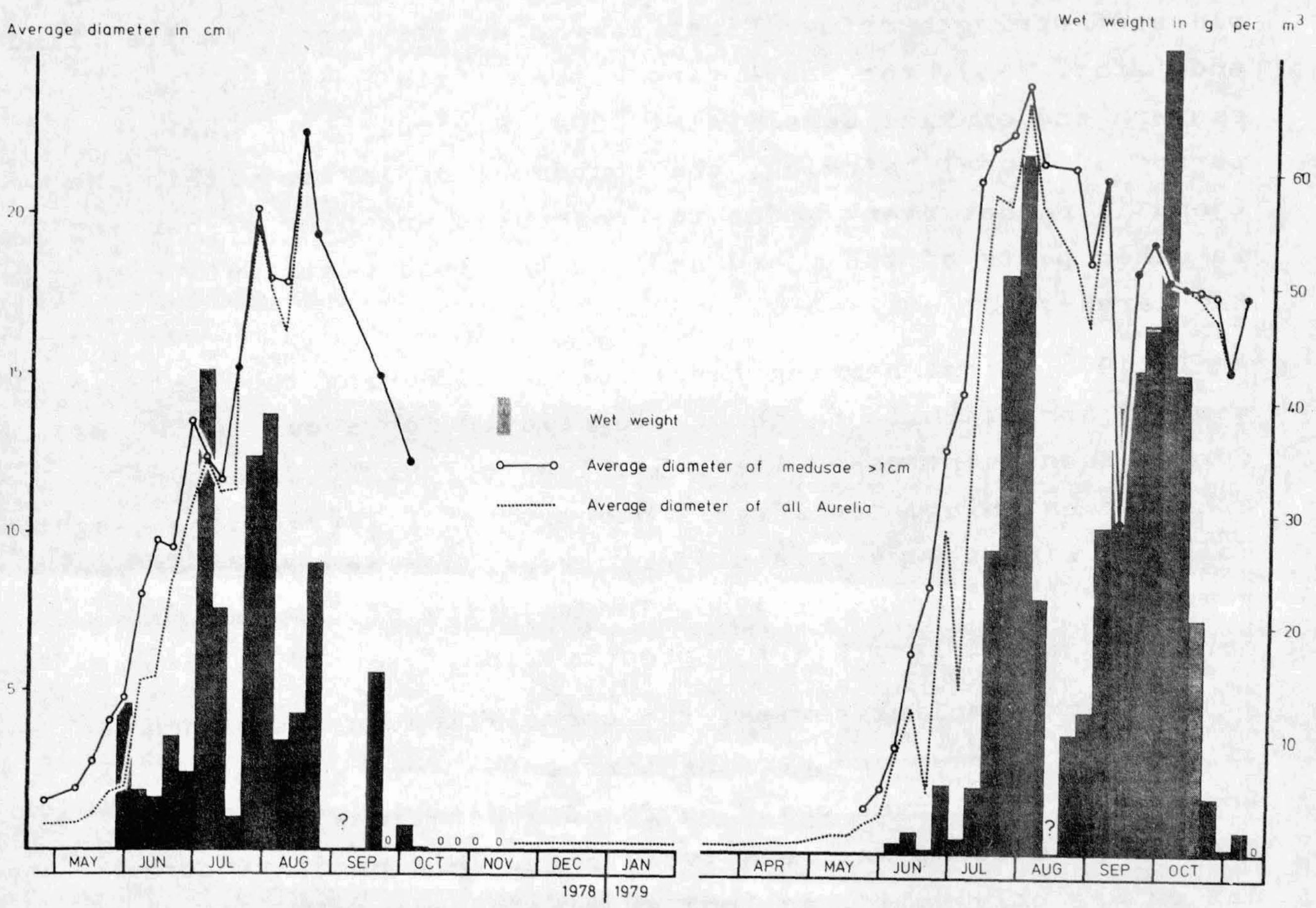


Figure 6. Development of Aurelia diameter and standing stock in 1978 and 1979

Growth characteristics of Aurelia in 1978 and 1979 were similar, but in 1978 growth started several weeks earlier (fig. 5). Average diameters in April were 7.4 (1978) and 2.6 mm (1979). Anyhow, the month of maximum increment was June, largest medusae were found in August and size reduction began in September during both years. The monthly maximum average diameter in 1979 was 9 cm larger than in the year before. Largest individuals measured 40 cm in 1978 and 44 cm in 1979.

The average wet weight of the Aurelia standing stock in Kiel Bight is below 1 g per 100 m^3 from December to April (fig. 6). It reaches its maximum value of 27 g per m^3 in June and stays at 25 g per m^3 until September. On the average of the period 1976-79 there were 8.2 g Aurelia per m^3 and month (tab. 4). Following conversion factors of CUSHING et al. (1959), KERSTAN (1977) and THILL (1937), this equals 150 mg dry weight or 12.6 mg organic carbon (MÖLLER 1979).

occurrence of herring larvae in Kiel Fjord

Within the western Baltic, Kiel Fjord is a famous spawning place of spring herring. First larvae usually occur in its blind end (stat. 1-3), the Schwentine estuary (stat. 5) and the eastern end of Kiel Canal (stat. 20). Regarding the whole period of larval hatching, the abundance of larvae within the fjord is rather evenly, due to subsequent spawning of herring in other parts of the fjord and due to rapid distribution of the larvae.

In 1978, first herring larvae occurred during the last week of April, while hatching was delayed for about two weeks during subsequent years (tab. 5). Two to four weeks after start of hatching, the largest quantities of larvae were caught. Yolk-sac larvae were present for 8 weeks during the first two years and for 6 weeks in 1980. The majority of them measured 5-7 mm in total length after preservation.

For each sampling series, the correlation in the abundance of Aurelia biomass and herring larvae (5-7 mm) was determined. Low numbers of larvae could be found at stations, where the biomass of medusae was relatively high. This negative correlation was only valid, as long as more than ca. 30 g Aurelia per 100 m^3 on the average were present. The only exception was 23.5.1979, when a confidence level >99 % was observed at even a rather low abundance of Aurelia (tab. 5).

Table 5. Correlations between abundance of yolk-sac herring larvae (5-7 mm) and biomass of Aurelia at 26 stations in Kiel Fjord

date	herring larvae per 100 m^3	g wet weight Aurelia per 100 m^3	correlation coefficient	level of confidence
27.4.78	13.6	1.2	- 0.17	-
9.5.78	32.2	1.2	- 0.224	-
17.5.78	39.2	9.8	- 0.17	-
25.5.78	111.1	38.8	- 0.55	99 %
31.5.78	36.5	1,273.0	- 0.51	99 %
8.6.78	9.4	524.0	- 0.73	99 %
14.6.78	11.3	443.7	- 0.73	99 %
22.6.78	1.4	976.7	- 0.44	95 %
average of 1978	31.8	408.5		
9.5.79	2.4	0.1	- 0.14	-
16.5.79	80.5	0.2	- 0.06	-
23.5.79	489.5	0.9	- 0.69	99 %
31.5.79	240.8	2.6	- 0.10	-
6.6.79	19.3	87.2	- 0.10	-
11.6.79	29.7	182.0	- 0.44	95 %
20.6.79	9.3	22.8	- 0.01	-
27.6.79	5.4	609.3	- 0.61	99 %
average of 1979	109.6	113.1		
8.5.80	37.6	24.4	- 0.45	95 %
14.5.80	81.1	27.9	?	
21.5.80	16.6	72.0	- 0.52	99 %
28.5.80	11.1	1,297.4	- 0.57	99 %
4.6.80	7.2	510.7	- 0.59	99 %
11.6.80	4.1	4,163.3	- 0.48	95 %
average of 1980	26.3	1,015.9		

food of Aurelia

Food examinations were mainly concentrated on the occurrence of herring larvae. Total contents of gastral cavities were studied of 961 medusae from 20.-23.5.1979 and of 1,200 medusae from 26.-27.5.1980. Microscopical random checks gave evidence, that the percentage of phytoplankton and protozooplankton on the weight of total stomach contents was far below 5 %. During the first series, 0.02 hydromedusae, 0.19 cladocerans, 0.84 copepods of various developmental stages, 0.44 herring larvae, and very few polychaete larvae, small amphipods, and mites were discovered per Aurelia (11-20 mm). On 26.-27.5.1980, the average dry weight of stomach contents per Aurelia (36-50 mm) was 0.32 mg, consisting of 0.11 mg herring larvae, 0.20 copepods, cladocerans and indeterminable food rests, and 0.01 mg insects. Additionally, few numbers of amphipods, cumaceans, Cottus larvae, and 1 Aurelia ephyra were found.

Herring larvae were a major part of Aurelia's food during all days of investigation. In May 1979, 0.44 larvae per medusa and in May 1980 0.16 and 4.43 larvae per medusa were detected on the average. There was no correlation between size of medusae and percentage of medusae containing larvae. The number of larvae per medusa, anyhow, was increasing with increasing medusa diameter (tab. 6).

date	size group of Aurelia	percentage of Aurelia with herring larvae	number of herring larvae per Aurelia
19.-24.5.1979	6-10 mm	13.3	0.13
	11-15 mm	36.7	0.48
	16-20 mm	35.0	0.48
	21-25 mm	27.1	0.24
	average	34.1	0.44
15.-16.5.1980	16-20 mm	9.2	0.13
	21-25 mm	8.9	0.14
	26-30 mm	8.3	0.18
	31-35 mm	11.2	0.19
	36-40 mm	9.9	0.27
	average	9.2	0.16
26.-27.5.1980	36-50 mm	40.0	4.43

Table 6. Abundance of herring larvae in gastral cavity of Aurelia medusae

Nearly all larvae caught were in the yolk-sac stage and measured 5-7 mm. The smallest Aurelia with a herring larva in its stomach was 6 mm in diameter. Medusae of 12 mm in size contained up to 10 larvae and medusae of 42 mm up to 68 larvae. On 22.5. at 19^{00} and on 27.5. at 1^{00} and 2^{00}, all medusae examined had eaten larvae. On the average of single samples, up to 13.5 larvae were found in 36-50 mm medusae and up to 1.3 in 11-20 mm medusae (tab. 6). Averaging data of all 3 series, there were 1.2 herring larvae per Aurelia.

No clear diurnal periodicity in the uptake of larvae by medusae became evident. Maximum values were found at 5^{00} on

May 23rd -24th, between 15^{oo} and 17^{oo} on May 15th-16thand between 0^{oo} and 4^{oo} on May 26th-27th. Samples without any medusa containing herring larvae were taken between 3^{oo} and 21^{oo}.

Within 5 hours an ingested larva is digested to indeterminability. This value was obtained by averaging digestion times of 20 Aurelia, determined at 10-12°C water temperature. Individual times ranged from 3.5 to 9.5 h.

size of Aurelia (mm)	11 - 20						16 - 40		36 - 50	
start of sampling	May 1979 19.	20.	21.	22.	23.	24.	May 1980 15.	16.	26.	27.
0^{oo}								0.05		9.58
1^{oo}						0.04		0.02		11.64
2^{oo}								0.03		13.52
3^{oo}								0		6.42
4^{oo}		0.87						0.01		11.52
5^{oo}						0.89		0.03		4.44
6^{oo}		1.16						0		1.28
7^{oo}						0.50		0.02		0.78
8^{oo}				0.23				0		0.10
9^{oo}						0.27		0.03		0.08
10^{oo}								0		0.06
11^{oo}		0.36	0.33	0.47		1.13		0.02		0.10
12^{oo}										0.02
13^{oo}				0.26		0.39		0		0
14^{oo}								0		0.08
15^{oo}					0.21		0.53			0.02
16^{oo}							0.46			0
17^{oo}					0.12		0.87			0
18^{oo}							0.42			0
19^{oo}	1.26		0.29	1.09	0.09		0.24			0
20^{oo}							0.35			0
21^{oo}							0.06			0
22^{oo}							0.11		0.24	
23^{oo}					0.23		0.09		1.86	

Table 7. Diurnal fluctuations in the presence of herring larvae in the stomachs of Aurelia medusae

Discussion

Larval fish populations may be affected in two ways by medusae: by predation and by competition for food. Copepods are the favourite food items of larval fish in Kiel Bight, several species seem to feed exclusively on them (WOSNITZA 1975). The food of spring herring larvae caught in June 1969 consisted of 92 % copepods, 7 % rotifers, and 1 % cladocerans (SCHNACK 1972). Also *Aurelia* seems to feed mainly on copepods (KERSTAN 1977).

In various coastal areas of the world, mass occurrence of scyphomedusae as well as of ctenophorans is suspected to limit the size of copepod stocks. KAMSHILOV (1959, cited by FRASER 1962) found evidence, that during years with large numbers of *Bolinopsis infundibulum* in the plankton, the *Calanus* stocks of the Barentssea were much smaller than in years, when the ctenophore occurred le frequ ntly. A similar relation was detected between abundance of ctenophores and copepods in Narragansett Bay. Reduction of copepod stocks by jellyfish predation during summer resulted in increasing stocks of phytoplankton in this area (HULSIZER 1976).

In Kiel Bight, the development of *Aurelia* stocks up to 25-27 g wet weight per 100 m^3 between June and September results in a sharp decrease of the copepod standing stocks from 2.6 g C_{org} m^{-3} in May to 1.2 g in June and 0.8 g in July. Although sufficient phytoplankton food organisms are available, copepod stocks do not recover until autumn, due to permanent predation by jellyfish. As a consequence of lowered predation pressure by copepods, phytoplankton builds up new mass populations >4.2 g C m^{-2} between July and October (MÖLLER 1979). This indicates *Aurelia aurita* to be the dominant factor in regulating plankton dynamics in Kiel Bight during summer months. The theory of reduction of the natural copepod stocks by *Aurelia* is supported by theoretical evaluations of FRASER (1969), showing that the food demand of *Aurelia* during summer is even greater than the copepod stocks in Kiel Bight during this time.

While it is not possible to quantify effects of food competition on the survival of larval herring populations, the direct predation of medusae on herring can be expressed in figures.

Based on laboratory experiments, FRASER (1969) estimated that one Aurelia from Newfoundland during its life might catch about 450, one Cyanea 15,000, and one hydromedusa 50-250 fish larvae. Food examinations on Aurelia from Kiel Fjord support these estimates.

No diurnal periodicity in the uptake of larvae was observed. This indicates, that in young medusae, unlike adult ones (KERSTAN 1977), there is no constant daily resting period during night. Anyhow, during both series in May 1980, medusae contained rather few food organisms for about 6 h per day, once in the early morning (15.-16.5.) and once in the afternoon (26.-27.5.).

On 19.-24.5.1979, the medusae examined had eaten 0.44 herring larvae on the average. Assuming a daily activity of 18 h and a digestion time of 5 h, each medusa had taken 1.6 larvae a day. Due to the relative abundance of 36 herring to 1 Aurelia (>1 cm), a daily lost of 4.4 % of the larval stock or 1.8 million herring in the area of investigation has to be taken in account. Corresponding values for 15.-16.5.1980 were 0.6 larvae per medusa and day and a daily lost of 2.6 % of the total stock. On 26.-27.5.1980, on the average 15.9 larvae had been eaten by one Aurelia. One day later, in the plankton of the inner fjord the relation herring : Aurelia (>1 cm) was 1 : 6.2. Averaging data from all 3 surveys, 4.3 larvae per medusa had been caught per day.

The significant impact of predation on herring larvae stock becomes evident when comparing relative abundances of both groups at all stations of one series. Low numbers of larvae were found at stations, where a high Aurelia biomass was present. Also the average abundance of herring larvae during different years seems to be influenced by the biomass of medusae present during the yolk-sac stage of the larvae. The total quantity of Aurelia produced remains within the same order of magnitude during all years, but the initial point, when medusae start their enormous growth, is variable. In 1980, a large biomass of Aurelia was already present, when the first herring larvae were hatching. An average of 10.2 g medusae and only 0.3 larvae were caught per m^3 this year. Contrary, the year before most herring larvae had hatched before mass development of Aurelia. During the yolk-sac stage of larvae there were only 1.1 g Aurelia and consequently as much as 1.1. larvae per m^3. Data from 1978 show a comparable tendency.

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